UNESCO sponsored Conference

6th DUBROVNIK CONFERENCE ON SUSTAINABLE DEVELOPMENT OF ENERGY, WATER AND ENVIRONMENT SYSTEMS

BOOK OF ABSTRACTS

September 25th – 29th 2011, Dubrovnik, Croatia

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Conference Venue: Dubrovnik

"Those who seek paradise on Earth
should come to Dubrovnik and see Dubrovnik."

(George Bernard Shaw)

Dubrovnik is situated in the southernmost part of the Republic of Croatia. Founded in the 7th century, Dubrovnik is rich with cultural and historical monuments and is included in the UNESCO World Heritage list. The city is surrounded with the walls built between the 11th and 17th century. Its cultural and scientific institutions include Museum at Rector's Palace, Cathedral Treasury, Pinacotheca, Franciscan monastery and cloister, with one of three oldest pharmacies in Europe (14th c.), the Cathedral (initial funds given by King Richard the Lionheart), one of the European oldest Synagogues, Marin Drzic Theatre, Dubrovnik Symphony Orchestra, Interuniversity Center. Nature lovers can find here true Mediterranean landscape, and "enjoy the cleanest sea in the Mediterranean" (Jean Jacques Cousteau). Dubrovnik International Airport is situated 22 km from the city center.

Scope and Objectives

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
The Report of the U.N. Brundtland Commission, Our Common Future, 1987

The Dubrovnik Conference on Sustainable Development of Energy, Water and Environment Systems, to be held in 2011 for its 6th consecutive time, is dedicated to the improvement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development by de-coupling growth from natural resources and replacing them with knowledge based economy, taking into account its economic, environmental and social pillars, as well as methods for assessing and measuring sustainability of development, regarding energy, transport, water, environment and food production systems and their many combinations. Sustainability being also a perfect field for interdisciplinary and multi-cultural evaluation of complex system, the Dubrovnik Conference has during the first decade of the 21st century become a significant venue for researchers in those areas to meet, and originate, discuss, share, and disseminate new ideas.

"...We, the representatives of sustainability science:- 1. Urge all nations, at whatever stage of development, to recognise the urgency for action to achieve sustainable development, including through low carbon and other programs involving the use of the basic scientific practices of whole of life sustainability of operation...
…
4. Demand that the world's policy makers recognise and heed the fact that sustainability science is now a vital component of the means by which knowledge, measures and practices can be identified and applied to establish a sustainable future for the world and its rapidly increasing population and further states that a failure to adequately act upon this demand will result in a fatal failure to achieve a timely change thereby increasing the cost of necessary measures and possibly of irreversible change and will lead to the discrediting, in international public opinion, of the seriousness, capacity and application of the policy makers themselves..."
From the 2009 Dubrovnik Sustainable Development Conference Declaration and Communiqué

The scope of the Conference will continue to successfully cover the following areas (with examples in parentheses, but not confined to these examples only):

- Sustainability comparisons and measurements methodologies (metrics and indices, multi-criteria analysis, external costs, exergy analysis, footprint methods, emergy)
- Sustainable development as a driver for innovation and employment
- Green New Deal (energy and environment for jobs and regional development, macroeconomic analysis, financial and regulatory mechanisms, trends and predictions, models and tools, rebound effects)
- Decoupling growth from resources (potentials, models, costs and benefits, macroeconomic analysis, financial and regulatory mechanisms, trends and predictions, models and tools, rebound effects, de-growth)

- Decarbonisation (wedges, policies, potentials, models, costs and benefits, macroeconomic analysis, financial and regulatory mechanisms, trends and predictions, models and tools, rebound effects)
- Energy policy (security of supply, climate change mitigation, renewable energy support schemes, energy efficiency, employment generating, agriculture and forestry, financial mechanisms, tax, cap and trade, feed-in, green certificates)
- Transport policy (urban sprawl management, traffic management, congestion and road pricing, dynamic road pricing, modal management, alternative fuels, social aspects, rail vs. air)
- Water policy and the energy-water interaction (water management, wastewater management, water reuse, water pricing)
- Environmental policy (waste management, wastewater management, climate change, air pollution policy, water pollution policy, land management, biomass management, social aspects, emission tax, cap and trade, cap and trade vs. pollution tax)
- Agricultural policy (energy use in agriculture and food processing, food vs. biofuels, sustainability of biofuels production, sustainability of food subsidies, subsidies vs. free trade, new green revolution, R&D in agriculture, sustainability of GMO(Genetically Modified Organisms) vs. Terroir)
- Employment and energy, transport, water and environment systems (technology development, equipment production, installation, maintenance, macroeconomic analysis, financial and regulatory mechanisms, national, regional and municipal policy)
- Technology transfer and development (emerging markets, developing countries, least developed countries, clean development mechanism, new opportunities)
- Social acceptance (reform, NIMBY, nuclear, wind, biofuels, hydrogen, hidden and special interests)
- Sustainable resilience of engineering systems (Resilience of Energy Systems, Resilience of Water Systems, Resilience of Environmental Systems, Resilience of Social Systems)
- Sustainable tourism (energy systems, transport systems, water systems, environment systems, green hotels, certification, labelling proliferation)
- Urbanism (urban planning, zoning, transport, modal shift, zero energy buildings and energy system planning, district heating, district cooling, Civitas, Concerto)
- Regional planning and cooperation (energy and environment for jobs and development, financial and regulatory mechanisms, obligations and standards, energy and resource flow optimisation, 100% renewable regions, regional cooperation and networking, sustainable development across international borders)
- Sustainable islands (energy and environment for jobs and development, financial and regulatory mechanisms, obligations and standards, energy and resource flow optimisation, 100% renewable islands, islands networking)
- Research, innovation and development (demand side funding, supply side funding, researchers mobility, intrasectorial mobility, industry-academia partnership, knowledge based society)
- Education in Sustainable Development (Governance, Environmental Awareness, Higher Education in SD, Engineering Education in SD)
- Cooperation for Development (International Development Mechanisms, Clean Development Mechanisms, emerging markets, least developed countries, etc.)

- Energy system analysis (Energy system analysis models, tools and methodologies, Energy system analysis surveys and results)
- Water system analysis (models, tools and methodologies, surveys and results)
- Transport system analysis (models, tools and methodologies, survey and results)
- Life cycle assessment, Environmental impact assessment, Eco-design and Eco-labelling, Product cycle assessment
- Energy planning (power system planning, smart energy networks, natural gas system planning, high penetration of renewables, island energy systems, development of energy planning tools, internalizing environmental externalities, electrification of transport)
- Transport management (modelling, optimisation, tracking, GPS/mobile systems, dynamic road pricing system implementation, electrification of transport)
- Renewable energy resources (forest and agricultural biomass, biofuels, second generation biofuels, biogas, hydro, wind, solar, geothermal, wave and ocean, technical and economic potentials, barriers, cost and benefits)
- Primary energy resources (oil, gas, coal, uranium, thorium, oil peaking)
- Water resources (surface, ground, desalination, etc.)
- Food and agriculture (energy and water use, environmental impact, financial mechanisms, subsidies, free trade, impact of biofuels, new green revolution, R&D, GMO, biogas, using renewables in agriculture, solar and wind energy in agriculture)
- Renewable electricity generation systems (biomass, grid and fluidized bed, biofuels, biogas, hydro, wind, photovoltaic, concentrated solar thermal power, geothermal, wave, tide, ocean thermal)
- Thermal power plants (clean coal, fluidized bed, combined cycles, advanced cycles)
- District heating and/or cooling infrastructures in future energy systems (Integration of renewable energy heat supply, Cogeneration, waste incineration and CHP, heat pumps, integration of CHP with district heating and electricity markets).
- Nano and micro technologies and science for sustainable development of energy, water, and environment systems
- Carbon capture and storage/sequestration (oxy-fuel combustion, pre-combustion capture, post-combustion capture, CO2 transport, enhanced oil/gas recovery, enhanced coal bed methane recovery, chemical fixation, aquifer storage, bedrock storage, ocean storage, leakage)
- Nuclear energy (new power plant designs, waste, proliferation, fusion, transmutation, sustainability, policies, social acceptance)
- Advanced sustainable energy conversion systems (fuel cells, thermoelectric, thermionic, organic, ORC, waste heat recycling)
- Pyrolisis, torrefaction
- Renewable heat systems (biomass, biofuels, biogas, solar, geothermal)
- Biofuels and biorefineries (biodiesel, bioethanol, second generation biofuels, anaerobic digestion, BTL, biorefineries, vehicles, infrastructure, combustion modeling, sustainability assessment, pyrolisis, torrefaction)
- Hydrogen production and use technologies (stationary, mobile, small applications, electrolysis, reforming, nuclear hydrogen, infrastructure)

- Hybrid and electric vehicles (first generation, plug in, charging, batteries, infrastructure)
- Other alternative fuels (BTL, DME, CNG, resources, production, vehicles, infrastructure)
- Water treatment (methods, health issues, standards, grey water)
- Water Desalination (distillation, reverse and forward osmosis, electrodialysis, energy recovery, discharge management)
- Wastewater treatment (municipal, industrial, agricultural)
- Waste treatment (composting, incineration, landfill, anaerobic digestion, gasification, mechanical biological treatment, mechanical heat treatment, plasma arc waste disposal, pyrolysis, recycling)
- Waste to energy (incineration, landfill gas capture, biogas, RDF, cement industry, tyres, combustion modelling)
- Recycling waste (glass, paper, metals, containers, tyres, textiles, batteries, biodegradable waste, electronic waste, separation, financial schemes)
- Pollution modelling (CFD models, air pollution spreading, water pollution spreading, combustion modelling)
- Heat and mass transfer modelling (CFD models, energy efficiency)
- Cogeneration (heat and power, water and power, biofuels and power, transport and energy, food and energy, waste to energy)
- Trigeneration, polygeneration
- Storage (heat storage, hydrogen storage, hydropower as storage, pump storage, compressed air storage, batteries, water storage, biofuels storage, storage optimisation modelling, financial support mechanisms, maximising renewables, optimising load, power market arbitrage)
- Smart energy networks (smart meters, dynamic electricity pricing, ICT, network-user interface)
- Energy efficiency in industry and mining (cement and lime, construction material, glass, pulp and paper, food industry, metallurgy, chemical industry, process optimisation, kilns, boilers, heat exchangers, pinch analysis, exergy and exergoeconomic analysis, energy audits, waste minimisation)
- Energy efficiency in agriculture and aquaculture
- Energy efficient appliances (smart appliances, labelling and standards, user interfaces, user behaviour)
- Buildings (zero energy buildings, passive buildings, smart buildings, smart metering, ICT, load and demand side management, green buildings, building standards, heating, ventilation, air-conditioning, cooling, insulation, renewables, heat pumps, storage, sustainable architecture, buildings certification)
- Energy markets (liberalisation, deregulation, spot markets, pools, storage, renewables, merging and acquisitions, modelling)
- Emission markets (Emission trading system, carbon taxing, carbon markets, GHG, SOx, CER, ERU, AAU, EUA, certification standards, VER, air transport participation)
- Political aspects of sustainable development (long term planning, the role of political leaders and of voters, international conflict vs. sustainable development)

Preface

The objective of the 6th Dubrovnik Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES) is to provide a forum for world-wide specialists and those interested in learning about the sustainability of development, to present research progress o and to discuss the state of the art, the future directions and priorities in the various areas of sustainable development. This includes the improvement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development, taking into account its economic, environmental and social pillars, as well as methods for assessing and measuring sustainability of development, regarding energy, transport, water and environment systems and their many combinations.

It is noteworthy that the 6th Dubrovnik SDEWES Conference received over 1000 abstracts that were peer-reviewed and nearly 450 papers were accepted and are included in the corresponding electronic proceedings. The organizers wish to express their gratitude to all these authors for having taken interest in the conference and for their valuable contributions. We sincere thank the Members of the International Scientific Committeee and the Members of the Scentific Advisory Board who devoted much time for reviewing the abstracts and papers, as well as to other reviewers, who contributed to the success of this conference and to the quality of these proceedings. We are also grateful to our colleagues, the members of the Local Organising Committee and to all those who contributed in many ways to the organization of the conference. Special thanks are extended to the invited lecturers.

We would like to welcome all the participants of the 6th Dubrovnik SDEWES Conference coming from nearly 60 countries. We trust that this conference will reach the goal of bringing together scientists and engineers and inspire them to generate r more knowledge fortackling mankind's future problems. Last but not least, we would be happy if your stay in Dubrovnik, a is included UNESCO World Heritage tow, would be enjoyable, fruitful, happy and sunny.

Prof. Noam Lior
Chairman of the International Scientific Committee

Prof. Ivo Šlaus
Chairman of the Scientific Advisory Board

Prof. Neven Duić
Chairman of the Local Organising Committee

Prof. Zvonimir Guzović
Conference Secretary

Programme

Sunday, September 25	
11^{00} - 19^{00}	Registration at University of Dubrovnik (HALL A)
19^{00} - 21^{00}	Welcome reception (Revelin Fortress)
Monday, September 26	
7^{00} - 9^{00}	Registration at University of Dubrovnik (HALL A)
9^{00} - 11^{00}	Opening session (Valamar Lacroma Hotel)
11^{00} - 11^{30}	Coffe break (Valamar Lacroma Hotel)
11^{30} - 12^{15}	**Keynote lecture** Prof. Noam Lior: Sustainable Energy Development: The Present (2011) Situation and Possible Paths to the Future (Valamar Lacroma Hotel)
12^{15} - 12^{30}	Poster session overview (Valamar Lacroma Hotel)
12^{30} - 13^{00}	Transfer from Valamar Lacroma Hotel to University of Dubrovnik
13^{00} - 14^{00}	Lunch (HALL B + HALL C)
14^{00} - 16^{00}	Parallel sessions Renewable electricity generation systems I (ROOM A) Special session: Geopolitics of Climate Change (ROOM B) *Chair: Prof. Bosnjakovic* Special session: Modeling of Energy Systems related to Climate Change for Sustainable Development (ROOM C) *Chair: Dr. Bekteshi* Energy planning I (ROOM D) Special session: Energy and Water Efficiency for Sustainable Future (ROOM E) *Chair: Prof. Klemes* *Co-chair: Dr. Varbanov* Special session: Research and Governance for Sustainability - New Approaches (on the occasion of 80th birthday of Ivo Šlaus) (ROOM F) *Chair: Prof. Zidanšek* *Co-chair: Prof. Blinc* Water treatment I (ROOM G)
16^{00} - 17^{00}	Poster session I (HALL B + HALL C) Coffe break (HALL B + HALL C)
17^{00} - 19^{00}	Parallel sessions

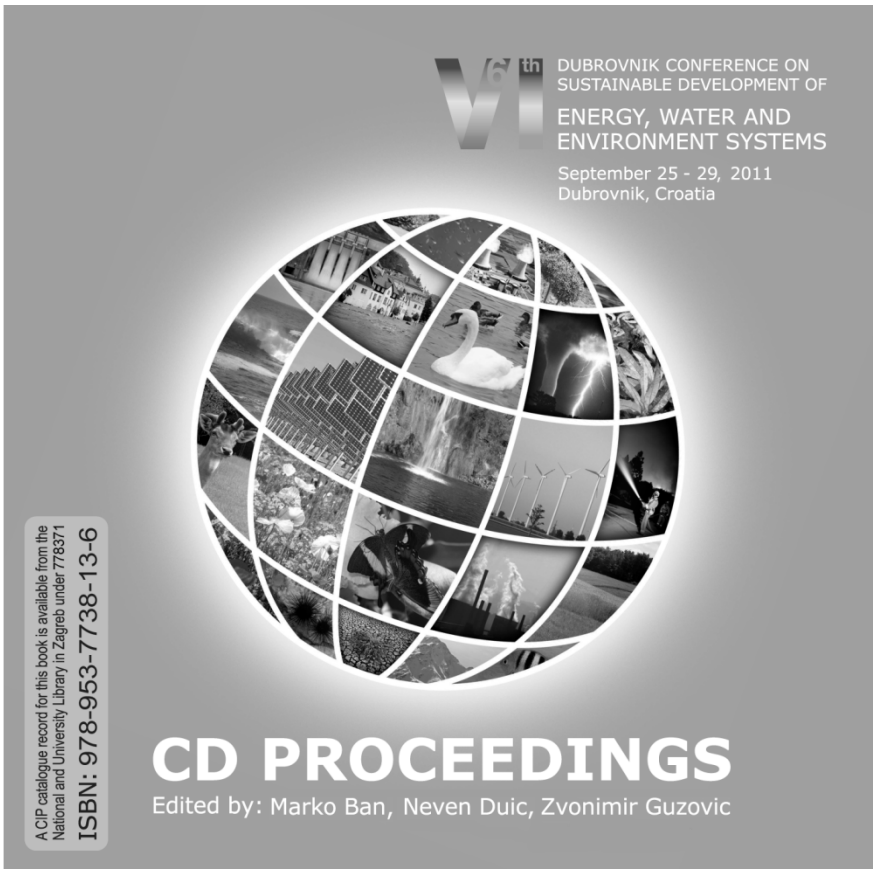
	Special session: Geopolitics of Climate Change (ROOM A) *Chair: Prof. Bosnjakovic* Renewable electricity generation systems II (ROOM B) Environment and Energy policy and management (ROOM C) Waste Management and Recycling (ROOM D) Special session: Energy and Water Efficiency for Sustainable Future (ROOM E) *Chair: Prof. Klemes* *Co-chair: Dr. Varbanov* Special session: Research and Governance for Sustainability - New Approaches (on the occasion of 80th birthday of Ivo Šlaus) (ROOM F) *Chair: Prof. Zidanšek* *Co-chair: Prof. Blinc* Water policy and the energy-water interaction (ROOM G)
19^{00} - 22^{00}	International Scientific Committee meeting (per invitation)
19^{00} - 19^{30}	Coffe break (HALL B + HALL C)
19^{30} - 21^{00}	Panel: Water sustainability (ROOM A)
	Tuesday, September 27
8^{00} - 9^{00}	Registration at University of Dubrovnik (HALL A)
9^{00} - 9^{45}	**Keynote lecture** Prof. Henrik Lund: The Economic Crisis and Sustainable Development (ROOM A)
9^{45} - 10^{30}	**Keynote lecture** Richard Taylor: Hydropower and Sustainable Development (ROOM A)
10^{30} - 10^{45}	Poster session overview (ROOM A)
10^{45} - 11^{30}	Coffe break (HALL B + HALL C) Poster session II (HALL B + HALL C)
11^{30} - 13^{30}	Parallel sessions Sustainable development (ROOM A) Biofuels I (ROOM B) Special session: The interaction between heating technologies and renewable energy systems (ROOM C) *Chair: Prof. Mathiesen* Special session: Electrification as a tool for sustainable development (ROOM D) *Chair: Prof. Silveira* Decarbonisation/Emission markets (ROOM E)

	Special session: The improvement of the environmental conditions of towns by means of energy efficiency policies: method of analysis and case studies (ROOM F) *Chair: Prof. Rizzo* Thermal power plants & WBalkICT project (ROOM G)
13^{30} - 14^{30}	Lunch (HALL B + HALL C) Energy Journal Elsevier - Editorial board meeting (per invitation) (ROOM F)
14^{30} - 19^{30}	WBalkICT PCM (By invitiation only)
14^{30} - 16^{30}	Parallel sessions Water system analysis (ROOM A) Biofuels II (ROOM B) Special session: The interaction between heating technologies and renewable energy systems (ROOM C) *Chair: Prof. Mathiesen* Special session: Electrification as a tool for sustainable development (ROOM D) *Chair: Prof. Silveira* Special session: Utilization of industrial byproducts towards sustainability (ROOM E) *Chair: Prof. Tsimas* Special session: The improvement of the environmental conditions of towns by means of energy efficiency policies: method of analysis and case studies (ROOM F) *Chair: Prof. Rizzo* Energy systems I (ROOM G)
16^{30} - 17^{00}	Poster session II (HALL B + HALL C) Coffe break (HALL B + HALL C)
17^{00} - 19^{00}	Parallel sessions Special session: Utilization of industrial byproducts towards sustainability (ROOM A) *Chair: Prof. Tsimas* Regional planning, Cooperation and Research (ROOM B) Special session: The interaction between heating technologies and renewable energy systems (ROOM C) *Chair: Prof. Mathiesen* Pollution modelling (ROOM D) Thermodynamics in Sustainability (ROOM E) Special session: Educating Engineers for Deep Sustainable Development (ROOM F) *Chair: Dr. Mulder*

	Water resources I (ROOM G)
19^{00} - 19^{30}	Poster session II (HALL B + HALL C) Coffe break (HALL B + HALL C)
19^{30} - 21^{00}	Panel: Sustainable development and jobs (ROOM A)
	Wednesday, September 28
8^{00} - 9^{00}	Registration at University of Dubrovnik (HALL A)
9^{00} - 9^{45}	**Keynote lecture** Prof. Naim Afgan: Energy System Resilience (ROOM A)
9^{45} - 10^{00}	Coffe break (HALL B + HALL C)
10^{00} - 12^{00}	Parallel sessions Special session: Measuring the Sustainable Development in the Energy Sector. Energy models between weak and strong sustainability (ROOM A) *Chair: Dr. Schlör* Cogeneration/Trigeneration and District Heating (ROOM B) Special session: Future Sustainable Electricity Supply Grids mesh with Supplies for Heat, Cold and Transport (ROOM C) *Chair: Prof. Stadler* Energy efficiency (ROOM D) Sustainability analysis and measurements methodologies (ROOM E) Special session: Biofuels sustainability (ROOM F) *Chair: Prof. Kafarov* Energy planning II (ROOM G)
12^{00} - 13^{00}	Lunch (HALL B + HALL C) Assembly of the Croatian Section of the Combustion Institute (per invitation) (ROOM F)
13^{00} - 15^{00}	Parallel sessions Special session: Measuring the Sustainable Development in the Energy Sector. Energy models between weak and strong sustainability (ROOM A) *Chair: Dr. Schlör* Agriculture, Food (ROOM B) Special session: Understanding environment- society interactions for sustainable development (ROOM C) *Chair: Ms. Offermans* Buildings I (ROOM D) Hydrogen production and use technologies (ROOM E) Special session: Biofuels sustainability (ROOM F) *Chair: Prof. Kafarov*

	Energy economics (ROOM G)
15^{25} - 20^{00}	Boat excursion (Gruz - Sea port of Dubrovnik, boarding until 16:00 as ships must leave harbour)
20^{30} - 24^{00}	Gala dinner (Hotel Palace)
	Thursday, September 29
8^{00} - 9^{00}	Registration at University of Dubrovnik (HALL A)
9^{00} - 9^{45}	**Keynote lecture** Prof. Neven Duic: Energy policy in Southeast Europe, between the coal and the European Union (ROOM A)
9^{45} - 10^{30}	**Keynote lecture** Prof. Ingo Stadler: The three pillars for a 100% electricity supply with renewable energies (ROOM A)
10^{30} - 10^{45}	Poster session overview (ROOM A)
10^{45} - 11^{30}	Poster session III (HALL B + HALL C) Coffe break (HALL B + HALL C)
11^{00} - 13^{30}	HAWE meeting (per invitation only) (ROOM G)
11^{30} - 13^{30}	Parallel sessions Special session: Energy and Buildings Efficiency for Sustainable Future: from smart buildings to sustainable behaviors (ROOM A) *Chair: Prof. Jacomino* Buildings II (ROOM C) Energy policy (ROOM D) Renewable energy resources I (ROOM F)
13^{30} - 14^{30}	Lunch (HALL B + HALL C) Assembly of International Centre for Sustainable Development of Energy, Water and Environment Systems (per invitation) (ROOM A)
14^{30} - 16^{30}	Parallel sessions Special session: Energy and Buildings Efficiency for Sustainable Future: from smart buildings to sustainable behaviors (ROOM A) *Chair: Prof. Jacomino* Renewable energy resources II (ROOM B) Advanced sustainable energy conversion systems (ROOM C) Waste to energy (ROOM D) Water resources II (ROOM E) Energy systems II (ROOM F)
14^{30} - 19^{00}	HAWE meeting (per invitation only) (ROOM G)

16^{30} - 17^{00}	Poster session III (HALL B + HALL C) Coffe break (HALL B + HALL C)
17^{00} - 19^{00}	Parallel sessions Special session: Sustainability in Energy and Water supply in Developing Countries: a Humanitarian Crisis (ROOM A) *Chair: Prof. Micangeli* Carbon capture and storage/sequestration (ROOM B) Biofuels - Algae (ROOM C) Waste treatment (ROOM D) Sustainable transport and vehicles (ROOM E) Life cycle assessment (ROOM F)
19^{00} - 19^{30}	Coffe break (HALL B + HALL C)
19^{30} - 21^{00}	Award ceremony and closing session (ROOM A)
Friday, September 30	
9^{00} - 18^{00}	Visit to HPP Trebinje
9^{00} - 14^{00}	Visit to HPP Dubrovnik



To this Book of Abstracts a CD Proceedings is enclosed, containing all submitted manuscripts in full

Contents

BOOK OF ABSTRACTS

Invited lectures

SDWS2011.0068 Sustainable Energy Development: the Present (2011) Situation and Possible Paths to the Future

N. Lior[*1]

[1]University of Pennsylvania, Mechanical Engineering and Applied Mechanics, United States;

Abstract

This invited keynote paper is the most recent among similar reviews published by the author, update to year 2011. In a format similar to that in past reviews, recent estimates and forecasts of the conventional fossil fuel resources and their reserve/production ratio, nuclear power, and renewable energy potential, and energy uses are surveyed. A brief discussion of the status, sustainability (economic, environmental and social impact), and prospects of fossil, nuclear and renewable energy use, and of power generation is presented. Beyond the general review, the paper focuses this year on some of the many important areas that deserve more attention: (1) the recently emerging game-changing developments of postponement of "peak oil", nuclear power future following the disaster in Japan, and effects of the recent global economy downturn of global sustainability, (2) the potential and impacts of electric cars (3) the often neglected energy status and promising potential of Africa. Some ways to resolve the problem of the availability, cost, and sustainability of energy resources alongside the rapidly rising demand are discussed. The author's view of the promising energy R&D areas, their potential, foreseen improvements and their time scale, and last year's trends in government funding are presented.

SDWS2011.0063 The Economic Crisis and Sustainable Development

H. Lund[*1]

[1]Aalborg University, Department of Development and Planning, Denmark;

Abstract

This presentation describes and promotes strategies for how to use the present economic crisis and investments in sustainable energy as a driver for job creation and industrial development and, thereby, economic growth.

The presentation takes a historical point of departure in the economic crisis of the 70s and 80s, in which countries like Denmark experienced massive unemployment in combination with severe balance of payments deficits. However, an active Danish energy policy with a focus on sustainable energy and employment did succeed in stabilising the primary energy supply while maintaining economic growth and developing growth in exports related to sustainable energy. The Danish policy was based on active strategies of job creation, technological innovation, and concerns for the balance of payment.

Especially in the 80s, such strategies played an important role in the implementation of investments in green technologies such as CHP plants, wind turbines, and renovation of buildings. Both at the governmental as well as at the municipal level, methodologies of including job creation benefits in socio-economic feasibility studies were developed and applied when political decisions were made. Expenses related to fossil fuels import were partly replaced by salary costs in Denmark. Moreover, the Danish export of green energy technologies has increased year by year and is now a major factor in the Danish economy. From being a burden to the Danish economy, the energy sector today makes a positive contribution to the GDP.

From such historical point of departure, this presentation promotes the thesis that the same type of strategies may be applied again today in Denmark as well as in similar countries. The presentation puts forward the results of a recent study entitled "Heating Plan Denmark 2010", showing how, over the next 20 years, fossil fuels can be replaced with biomass, solar, wind and geothermal energy. Over the course of the next 20 years, Denmark will be able to heat its homes, institutions and commercial buildings without any CO_2 impacts on the climate. The conversion to renewable energy sources is projected to cost around DKK 70 billion over 10 years, but more importantly, it will result in the creation of 7-8000 additional jobs in Denmark, and it is therefore expected to give positive returns on the governmental expenditures. Tools and methodologies to conduct such analyses are presented.

SDWS2011.1010 Hydropower and Sustainable Development

R. Taylor[*1]

[1]International Hydropower Association, United Kingdom;

Abstract

The presentation will review the current role of hydropower in the global energy mix, with current trends on a regional basis, followed by an analysis of factors determining further development. Specific attention will be given to sustainability assessment in the hydropower sector.

An overview of hydropower in the world's energy mix will be presented in relation to primary energy, electricity and renewable energy generation. This will include a review of the levels of service from hydropower according to its generic typologies.

A regional analysis of hydropower development, remaining potential, and capacity under construction will be presented, with some explanations for the differentiation of current activities and levels of deployment. This will include discussion on synergies with other renewables; and perspectives on financial structuring and market incentives.

The question of sustainability, its definition within particular contexts, and its assessment have been challenges for many human activities; hydropower is certainly no exception. For more than a decade, work has been conducted to define good practice and establish an assessment methodology that is globally applicable to hydropower. A

summary of the progress of this multi-stakeholder initiative to define and measure sustainability will conclude the presentation.

SDWS2011.0508 Energy System Resilience

N. H. Afgan[*1]

[1]Instituto Superior Tecnico, Portugal;

Abstract

Resilience is the ability to avoid, minimize, withstand, and recover from the effects of adversity, whether natural or man-made, under all circumstances of use. Resilience applied to the critical infrastructure is trustworthiness under stress and spans high availability, continuous operation, and disaster recovery.

Energy resilience is the ability of the energy system to provide and maintain an acceptable level of service in the face of various challenges to normal operation. Loss of resilience can cause loss of valuable energy system services, and may even lead to rapid transitions or shifts into qualitatively different situations and configurations, described for e.g. people, ecosystems, knowledge systems, or whole cultures. In general terms, the vulnerability of a system is assessed according to the concept of resilience, developed in the mathematics of non-linear differential equations.

The resilience of energy systems is defined as the capacity of an energy system to withstand perturbations from e.g. climatic, economic, technological and social causes and to rebuild and renew itself afterwards. In this respect, quantification of the resilience capacity change can be used as the merit to withstand different events leading to potential catastrophic consequences.

In this analysis, a coal fired power plant of 300 MW in condense regimes is taken into consideration. Due to limited availability of data, this exercise has been limited to economic, environmental, technological and social criteria. As defined, the Sustainability Index is the measure of the Resilience Index. In this respect, the change of indicators is scaled in the same scale, so that the time increment for all indicators is the same.

The Resilience Index of the power plant under consideration is defined under specific constrains, namely the change of specific indicators with other indicators being constant. This approach gives us thepossibility to validate the effect indicators change on the safety of an energy system under specific constrain.

SDWS2011.0088 Energy Policy in Southeast Europe, Between the Coal and the European Union

N. Duic[*1]

[1]University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Croatia;

Abstract

Traditionally energy policy of Southeast European countries was based on the combination of local fuels, mainly local coal and hydro power, while the balance was filled by fuel oil. The nuclear energy has made strong growth in countries with weak coal lobby. The natural gas, some local but mainly imported from Russia is making inroads, and European integration of the region is pushing new renewable energies, in particular wind and biomass. Meanwhile, often integrally integrated energy companies are blocking energy liberalisation and integration of regional energy markets which is currently planned for 2014. Traditional use of biomass for heating is strong accross the region, while the solar heating is only strong in countries which did not have much of natural gas and hydro. On the other hand the European Union, under the pressure of security of energy supply and climate change, has started to implement a new energy-climate package of measures, reaching for obligatory targets of 20% renewable energy in gross consumption, 10% renewable fuels in transport, 20% decrease of greenhouse gases emissions, 20% increase of energy efficiency by 2020. It is only a stepping stone on the way to decarbonize the energy systems in the long run. Starting from 2018 newly build and refurbished buildings will have to be energy neutral, meaning they would have to become very efficient in order to produce its own energy from renewable resources. The plan is to fully decarbonize power generation by 2050 by investing significantly into renewable resources, energy storage, while keeping the nuclear energy as much as public acceptance allows and obliging fossil fuel power plants to store CO2 underground. Power systems with high penetration of renewables require much better and smart power grids, but also integration of different energy systems like power, heat and transport, and the energy storage becoming one of the pillars of the new energy systems. The growth of reversible hydro has already started in countries that reached 15% of wind energy on yearly basis, while heat storage and electrical cars are considered significant technologies for evacuating excess of intermittent energy in the near future. EU has also started to regulate CO2 emissions per km driven for new vehicles, which will eventually force electrification of the transport. The Southeast Europe governments are preparing for the new energy policy, but being pulled by their local coal and imported natural gas interests, its implementation will go slowly, unless the EU rules become biting.

SDWS2011.0917 The Three Pillars for a 100% Electricity Supply with Renewable Energies

I. Stadler[*1]

[1]Cologne University of Applied Sciences, Germany;

Abstract

100 % electricity supply by renewable energies is content of several scientific studies. Nowadays, they exist for many countries or even transnational regions like e.g. the EU-MENA-region combining the electricity markets by large so-called overlay-grids. Today, it is not any more questioned whether it is possible to have a 100 % renewable supply or not. The controversial issue is more the best way on how to arrive there – the best future system configuration.

This paper doesn't want to answer this question about the best way. It wants to highlight the extremes between positions and to illustrate how heat, cold and transport are affected by different approaches to a 100 % electricity supply by renewables and to present current scientific discussions. Among these:

Centralized or decentralized? Renewable resources have the big advantage that they are widely distributed and that electricity could be produced by small and decentralized converters. On the other hand some locations in the world have better renewable resources than other locations and it is proposed to interconnect even continents via grids. What is best? Or is there a compromise in-between?

Balancing renewables via energy storage, via large interconnected areas or via renewable overproduction? Most renewables are of intermittent nature. Anyhow, basically three ways could lead to stable electricity systems. Renewable electricity could be stored in times of overproduction in order to be used during times of underproduction. Renewable converters could be interconnected in order to better balance weather dependent generation. Or, when renewable generation is continuing with decreasing costs simply renewable overproduction could be the solution. What is the best way?

With the requirement for seasonal storage in large quantities maybe only hydrogen production and storage or renewable methane production and storage are feasible ways to go. Especially the least one opens the opportunity to mesh electricity system with supplies for heat and cold – and this without changing the current infrastructures. How do storage solutions interact with heat and cold supply?

Special session: Geopolitics of Climate Change

In a globalised world, climate change, population trends, food security, energy supply, use of water, of land and of ecosystems are interconnected. As the world experiences a shift of global power to emerging economies, in particular China, the geopolitical implications of climate change are of prime interest. They find their expression in the positions of the major players, and the related issues and processes. The failure of the Copenhagen climate summit 2009 revealed clearly the divergent positions of major players – the US, EU, Russia, China, other emerging economies, oil producing countries, and least developed countries - with regard to limiting anthropogenic emissions of greenhouse gases (GHG). A thorough root-cause analysis of this divergence is still missing, as it would need to address, next to economics and power politics, other aspects including historical. As it seems now most unlikely that global warming can be limited to 2 °C above pre-industrial levels, adaptation to elevated temperatures and to their regional consequences, becomes an urgent matter.

Geopolitics examines the political, economic and strategic significance of geographic space. With respect to climate change, a relevant factor is that planetary warming does not, and will not have a uniform effect over the entire globe. But the regional variation of the physical factors is only a part of the story. Geographic distribution of a Global Climate Vulnerability Index, when applied to water, has been calculated on the basis of several impact factors, including geospatial, resource quantification, accessibility and property rights, capacity of people and institutions, utilization, and ecological integrity and maintenance (see "Guidance on Water and Adaptation to Climate Change", UNECE, Geneva 2010). Similar analyses could address other resources, such as land-use, food, and shipping. There are numerous regional examples of geopolitical linkage between energy, climate and water issues. Climate change in the Arctic is occurring at an unprecedented rate, thus leading to the viability of large-scale shipping, and of hydrocarbon exploration and exploitation. Extended continental shelf claims have been submitted by riparian countries. Thawing of permafrost may release significant amounts of the greenhouse gas methane. In the river basins of Central and South East Asia fed from the Himalaya watershed, 75-80% of river runoff is derived from glaciers and permafrost. Retreating glaciers and changing precipitation patterns increase water supply volatility ("droughts and floods") that affects the lives of millions, and the geopolitics.

A geopolitical topic of increasing importance is the interaction between competition for land-use and climate change. Ongoing deforestation due to timber exploitation and conversion to agriculture, is responsible for up to 20% of global GHG emissions. Massive demand for biofuel feedstock leads to shifts in crop production and corresponding price increases for foodstuffs: maize, sugarcane, cassava. Land-use requirements due to massive introduction of renewables –wind and solar – may become a limiting factor in regions with high population density. Harvesting solar/wind electricity in desert areas of North Africa/Middle East and transmitting it to Europe, may become an

antithesis to exporting virtual water in form of foodstuffs from water-rich to water-deficient areas.

The contributors to the session are invited to address and analyse the geopolitical aspects of climate change in terms of key players and major processes, with special emphasis on institutional aspects. Climate change implications extend far outside the environment sphere, linking several processes of globalisation. This situation may require the strengthening of existing instruments like the UN Convention on the Law of the Sea, and the creation of new ones, such as arrangements concerning the financing of adaptation measures and transfer of low-carbon technologies. Contributions to this session will cover geopolitical aspects linking climate with energy, land-use, water and food, ranging from regional case studies to thematic approaches addressing e.g. water, environment and carbon footprints, vulnerability analysis, technology responses, conflict prevention and resolution, institution building and international law.

It is planned to publish the contributed papers in the book series "Pangaea II: Global/Local Studies", SUNY (State University of New York) Press, and/or in the "Globality Studies Journal".

Session organizer:
***Prof. Branko Bosnjakovic**, UN Economic Commission for Europe (retired), Geneve, Switzerland*

Branko Bosnjakovic is titular Professor of Environmental Management at the Faculty of Engineering, University of Rijeka, Croatia. He has a scientific, management and policy advisory background and experience on various aspects of environmentally sustainable transition and development. His specific interest included radiation protection, industrial risk management, transboundary water protection and management, renewable energy systems and geopolitics. He has been actively involved for more than 30 years in various aspects of international and transboundary environmental management, both as academic researcher, official in governmental and intergovernmental organisations, manager and international consultant. His former appointments include: Regional Adviser on Environment, UN Economic Commission for Europe, Geneva, Switzerland (1994-2001), providing policy and legal advice to authorities in more than 20 countries in transition (Central and Eastern Europe and the former Soviet Union) on environmental matters and sustainable development; Adviser, WHO European Centre on Environment and Health, Bilthoven, the Netherlands (1993-1994); Manager (Development, Outreach, Planning), Regional Environmental Centre for Central and Eastern Europe (REC), Budapest, Hungary (1991-1993); Senior Policy Adviser and Programme Manager, Ministry of Environmental Protection, Housing and Physical Planning, The Netherlands (1975-1991); various research positions in Germany, the Netherlands and Switzerland (1965-1975). He has been consultant to several international organisations, including the European Commission, OSCE, UNDP, UNEP, UNESCO, and WHO.

Dr. Bosnjakovic is a native of Zagreb (Croatia) and a resident of Switzerland, with a dual Dutch and Croatian citizenship. He holds academic degrees from the universities in Goettingen (Germany) and Utrecht (the Netherlands). He was a member of the International Non-Ionising Radiation Committee of the International Radiation Protection Association (IRPA) from 1979 to 1992. He has been a member of the International Board of the Avalon Foundation (for sustainable agriculture in countries in transition) since 1992 until 2009, and of the Commission on Education and Communication of the World Conservation Union (IUCN) since 1995. Since 1998 he has been a Honorary Associate of the Centre for Petroleum and Mineral Law and Policy, University of Dundee (Scotland, UK).

SDWS2011.0145 Potential of Concentrating Solar Power Plants for the Combined Production of Water and Electricity in Mena Countries

M. Moser[*1], F. Trieb[2], T. Fichter[2]

[1]DLR, Institute of Technical Thermodynamics, Germany; [2]DLR, Germany;

Abstract

The widening gap between use and availability of water poses a serious threat to a sustainable socioeconomic development of the Middle East and North Africa (MENA). Indeed, freshwater sources in the region are currently persistently over-used, partly due to low efficiency of water distribution and water use and partly because of continuous growth of population and economy in the region. This calls for an even larger augmentation of water supply using non-conventional methods like seawater desalination. However, these plants are affected by high specific energy consumption, while the uncertainty about fossil fuel prices in the future represents a severe problem. Several past and on-going studies show the feasibility of renewable energies and in particular Concentrating Solar Power Plants (CSP) for seawater desalination. These studies are typically structured in a number of tasks:

- Review of the state of the art of technology options (CSP and desalination) and selection of the most appropriate configurations for applications
- Development of long term scenarios for water and electricity demand, with particular focus on critical issues like water deficit and possible short and mid term strategies and countermeasures to reduce this problem
- Check of proposed concepts and configurations with the help of hourly simulations based on performance models. Different options for solar field layout, storage, desalination and cooling are analysed and compared. Concerning the economic point of view - depending on the financing boundary conditions - adequate economic conditions like feed-in tariffs or grants are required in order to attract investors.

- The project results provide baseline information for decision makers for the establishment of a favourable framework for the deployment of concentrated solar power and desalination plants. In conclusion, the intent of this paper is to underline the importance to start as soon as possible a paradigm change in water and electricity supply, in order to meet the requirements for low cost water and electricity in the MENA region and to avoid conflicts related to water scarcity.

SDWS2011.0188 The Role of the Private Sector in Climate Change - a Paper by the Global Sustainable Electricity Partnership (Formerly E8) - Presented by Mr. Ralf Blomberg

R. Blomberg[*1]

[1]Global Sustainable Electricity Partnership (formerly e8), Canada;

Abstract

The private sector has a vital role in climate change mitigation. The majority of the mitigation solutions can be ensured in both their implementation and delivery by the private sector. Not only does the private sector provide the necessary technologies and knowledge, but it can also be one of the main financial channels needed in the fight against climate change.

The Global Sustainable Electricity Partnership (formerly e8) – which comprises the top leading electricity companies from the global electricity sector– promotes sustainable energy development through electricity sector projects and human capacity building activities in developing nations. www.globalelectricity.org

The Global Sustainable Electricity Partnership maintains that, in order to be successful, international climate negotiations should aim at reaching an agreement meeting five general requirements:

- Global reach;
- Reasonable and achievable commitments;
- Focus on economically efficient while environmentally effective solutions to climate change;
- Involvement of the private sector by allowing private investors to create value by reducing emissions;
- Financing mechanisms to assist developing countries in the implementation of appropriate policies focused both on mitigation and adaptation.
- Given climate change is a universal problem, the negotiation process must be inclusive of all, including governments and civil society, bringing increased transparency and legitimacy to the process.

Financing technology transfer and deployment is a crucial issue to achieve a global agreement capable to limit the global average temperature. The financial architecture has been laid out in COP15/MOP5 and in COP16/MOP6 based on multiple instruments, intended to leverage both public and private financing. Given the globality of the issue, any further financing mechanisms need to be universally compatible in all countries.

Looking forward to COP17, there are two main financing pillars which need strengthening:

- Pursuing Public-Private Partnerships to deploy low-carbon technology and to support infrastructure expansion in energy access and efficiency in developing and emerging countries.
- Expanding offsets mechanisms by enhancing the engagement of the private sector.
- The Global Sustainable Electricity Partnership is ready and willing to be engaged in public-private partnerships to facilitate the deployment of financing for low- and zero-emitting technologies, as well as contribute to the open discussion on ways to optimize collaborative initiatives between public and private sector to address climate change, energy access and development.

SDWS2011.0228 Geopolitics of Climate Change: an Introduction

B. Bosnjakovic[*1]

[1]UN Economic Commission for Europe (retired), Switzerland;

Abstract

The unfulfilled expectations preceding the Copenhagen summit in 2009 are giving way to a new, more illusion-less discourse about the future approach on how to control, and cope with climate change. The paper reviews the geopolitical elements of this emerging discourse, taking into account past and present methodologies in geopolitical research. The present two-tier approach addresses process-related and actor-related issues. The **first approach** is based on an analysis of various **processes and problem areas** (physical, economic, demographic…) emerging in the geographic space as a consequence of, or linked to climate change. These include: melting Arctic ice and new shipping routes; glaciers´ melting and dwindling mountain waters; competition for land space required by forestry, food production, renewable energies, biodiversity; floods threatening river delta´s and atoll islands; climate refugees. The **second approach** analyses the positioning of **actors** (states, interest groups), trying to develop strategies on how to exercise control of these processes. These include: highly industrialized powers (US, EU, Japan…); Russia; emerging economies (China, India, Brazil…); other developing countries, including oil/gas producing ones, and least-developed countries; and transnational companies.

With failing mitigation policies and instruments, the urgency of adaptation to climate change is increasing. More effort is needed to assess the regional consequences of predicted climate change, including the perceptions and motivations of presumed losers or winners. New security implications related to climate change are emerging in the Arctic, South-East Asia, Africa and the Pacific. Energy supply security, also in relation to climate change, remains a dominant factor in geopolitical considerations. The challenge of climate change is a race with time, whereby the main challenges are a timely availability of appropriate technologies, and the quality of governance.

The geopolitics of climate change is inextricably linked to other issues of the present wave of globalization: population growth, urbanization, changing patterns of consumption and mobility, availability of safe food and water, access to electricity. Significant shift of global power, with diverging positions of main players in the climate change game, raises inevitable discussion of ethical responsibility. Coping with climate change evolves as a testing ground for competing political and economic models in achieving sustainability.

SDWS2011.0424 Mapping Public Regulation Measures for Photovoltaic Technologies

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[1]Aalborg University, Department of Development and Planning, Denmark; [2]Aalborg University, Dept. of Development and Planning, Denmark;

Abstract

There is a relatively large potential for the use of photovoltaic (PV) technologies in the Nordic countries, including Denmark. Optimally designed PV support policies are a main prerequisite for the utilisation of this potential. The paper provides an overview of the main (financial) public regulation measures to support PV development. The crucial importance of a (national) market formation phase for renewable energy technologies is emphasized as a phase during the technological innovation process. A review of the international literature reveals that public PV support schemes involving feed-in tariffs (FITs) have been most effective in triggering such national PV market formation. Danish PV development is described briefly and the current Danish PV support scheme is presented and discussed in relation to some of the challenges of PV development. Denmark is one of the few European countries that have implemented a net metering scheme, according to which PV based electricity compensates for a household's electricity consumption. It is suggested that while Danish PV development seems ready to exit the demonstration phase and to enter the diffusion phase, the current net metering scheme may actually not be appropriate to facilitate such a transition. For example, it remains to be seen if the PV capacity limit per household can act as a barrier for the utilisation of the PV potential required in a future 100% renwable energy system. Also, in some cases this capacity limit may decrease the financial attractiveness of electricity

savings in households, which also is an important prerequisite for the implementation of future energy systems.

SDWS2011.0630 Long-Term Prospects of Biofuels in Eu-27

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[1]Vienna University of Technology, Energy Economics Group, Austria; [2]Joanneum Research, Austria;

Abstract

Currently used 1st generation biofuels (e.g. biodiesel from rape seed, bioethanol from wheat and corn) are associated with ecological problems, high costs, low net energy yields, limited potentials, and competition to food production. As an important alternative biofuels second generation – BTL, FT-Diesel, Ethanol from lignocellulose, Synthetic natural gas – are considered as a very promising option for clean energy carriers for the future. Major advantages suspected are low life-cycle carbon emissions – and if produced on large scale also economic competiveness. Moreover, due to the fact that they are produced from lignocellulose also huge potential for feedstocks required are suspected. These primary lignocellulose resources encompass: fuel wood, straw, corn stover, forest wood residues, wood industry residues, waste wood and short rotation copies

The core objective of this paper is to analyse the economic, ecological and energetic perspectives of these 2nd generation biofuels. In addition, we analyse the potentials for EU-27 countries.

The method of approach is based on international learning rates for the above-mentioned technologies, scenarios for development of conversion efficiencies, corresponding life-cycle $CO_{2\text{-equ}}$-balances and scenarios of oil price and CO_2-cost development. Regarding exploration of potentials we start with using historical data (FAO, EUROSTAT) for feedstock yields, production and areas of agricultural and forestry feedstocks as well as meadows/pastures and fallow land. Further on, we vary yields in future scenarios depending on production costs and market prices. Potentials are achieved in practice if the production costs are lower than the market prices of conventional diesel and gasoline prices, including taxes.

The most important result of this analysis is that for the EU-27 2nd generation biofuels might become economically competitive between 2020 and 2030. Yet, this will only be achieved if the following aspects are achieved: (i) achievement of significant learning effects leading to considerable lower plant costs; (ii) significant improvement of conversion efficiency from feedstock to fuel leading to lower feedstock prices and better ecological performance; (iii) increases in conventional diesel and gasoline prices, e.g. due to CO_2-based taxes.

A major conclusion of this analysis is that the over-all potential also depends on the final service costs of mobility in comparison to competitive use of fuel wood, wood industry residues and short rotation copies for other uses like heating and electricity generation. This leads to the major final conclusion that only if the corresponding

conversion efficiency of vehicles for transport is significantly improved biofuels may ever provide a remarkable contribution to transport services.

SDWS2011.0693 Fossil Fuels: Climate Change and Security of Supply

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[1]Chalmers University of Technology, Energy and Environment, Sweden;

Abstract

This paper is based on seven years of assessment of the global fossil fuel markets, i.e. of the coal, gas and oil markets. The work is part of the project "Pathways to sustainable European energy systems" which aims at investigating pathways for the European energy system up to the year 2050 while meeting climate mitigation targets. Although Europe is in focus, the continued prospects of fossil fuel resources depend on the global development of the fossil fuel markets (as well as on the development of CO_2 Capture and Storage technologies). Thus, as part of the research several separate databases were established on global coal, gas and oil fields, fuel infrastructure such as coal ports and LNG facilities and facilities on user level like the European power plant database which contains all power plants with a capacity of at least 10 MW in EU, Norway and Switzerland, as well as a database containing coal plants under development in key countries (China, India, Indonesia, USA, Pakistan, Russia, South Africa, Vietnam).

The main conclusions from the work presented in this paper are that from a climate change perspective there is an abundance of fossil fuels, coal in particular. For instance, the CO_2-emission potential of proven reserves of fossil fuels alone are up to twice as high as the global carbon budget in the 21st century required to limit the temperature increase to 2.9°C (mean estimate) as estimated by IPCC (2007). Nevertheless, apart from possibly natural gas, it will be increasingly difficult to meet baseline demand projections particularly for oil and cost of producing fossil fuels are likely to rise. As a consequence there is an increasing focus on security of supply. Globally, there are few concrete signs that we are actually moving away from a dependency on fossil fuels and it appears extremely challenging to meet climate change targets limiting the global temperature increase to 2°C. This is partly due to the unwillingness of the developed world to agree on a strong enough political framework controlling emission reductions and partly due to low per capita demand in expanding undeveloped countries coupled with large populations and large domestic coal resources. For instance, China added nearly 300 GW of coal based power (IEA CCC 2009) on a net basis between 2004 and 2008 which, in base-load, may emit 1.7 Gt CO_2, corresponding to the entire GHG emission reduction target in the EU up to 2020 if EU decides to reduce emissions by 30%.

SDWS2011.0706 The Importance of CO2 Capture and Storage–A Geopolitical Discussion

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Abstract

The last decade has seen a significant increase in the research and development of CO_2 capture and storage (CCS) technologies, and CCS is now considered to be one of the key options for climate change mitigation. This paper discusses the implications for the further development of CCS, particularly with respect to climate change policy in an international geopolitics context.

The rationale for developing CCS should be the over-abundance of fossil fuel reserves (and resources) in a climate change context. However, CCS will only be implemented if society is willing to attach a sufficiently high price to CO_2 emissions. Although arguments have been put forward both in favour and against CCS, the authors of the present paper argue that the most important outcome from the successful commercialisation of CCS will be that fossil fuel-dependent economies will find it easier to comply with stringent greenhouse gas (GHG) reduction targets. Therefore, the success of CCS may moderate geopolitical risks related to regional differences in the willingness to comply with large emission cuts. In contrast, failure to implement CCS will require that the global community agrees almost immediately to start phasing out the use of fossil fuels and will result in a situation associated with increased geopolitical risks associated to differences in regional conditions on strong climate change mitigation options. Thus, in the near term, it is crucial to initiate CCS demonstration projects, such as those supported by the EU. If this is not done, there is a risk that the introduction of CCS will be significantly delayed. Among the stakeholders in CCS technologies (R&D actors in industry and academia), the year 2020 is typically considered to be the year in which CCS will be commercially available. Considering the lead times for CCS development and in the slow pace of implementation of climate policy (post-Copenhagen), the target year of 2020 seems rather optimistic.

SDWS2011.0869 Towards Sustainable Industrial Areas: Building a Mediterranean Model

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Abstract

A European Union research project (Mediterranean Eco-Industrial Development, (MEID)) which involves different actors from six Mediterranean regions, funded in the framework of the MED Program, is currently in progress. Its general objective is to

provide innovative management figures and a decision support tool (model) to plan, build and govern more competitive Sustainable Industrial Areas (SIA) in the Mediterranean region. Well planned and equipped Industrial Areas (IAs) stimulate in fact the relocation of industries and help to relieve congestion and pollution in metropolitan areas. Moreover, the successful development of a region depends on the region's capacity to support and sustain the competitiveness of its local firms by creating a rich milieu of synergies.

The model introduces or encourages the continuous improvement of environmental performances of the Mediterranean industrial areas in the following fields: integrating production and dismissal of solid wastes, energy saving and use of renewable energies, reducing water consumption, better viability and avoid the deposit of dangerous material. Thanks to this "green approach", SMEs will be the final beneficiaries, fostered to eco-innovation, competitiveness and transnational cooperation.

In order to correspond to a coherent solution a SWOT analysis of several target IAs is performed. Following its results, it is possible to define the most relevant aspects aiming at sustainability of IAs in the Mediterranean area.

In this paper the general context and the first results of the MEID project are presented.

SDWS2011.0886 Optimization of Photovoltaic Energy Production Through an Efficient Switching Matrix for Reconfiguration

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Abstract

The benefits brought by photovoltaic power generation are a lot. Some of these are the limited environmental impact and the decreasing installation costs supported by governmental incentives in many countries. Furthermore, photovoltaic modules are usually the lowest cost method to supply electrical energy to remote, off-grid, low-power applications. The literature on the subject mostly deals with the problem of catching the maximum output power from these systems. Most papers attain the objective of maximizing output power by means of suitable conditioning systems that adapt the load to the generation system. Other authors have proposed the PV array or modules reconfiguration technique to improve the PV generation system's performance. In this paper, the authors propose a new and efficient system for the maximization of the output power generated by the PV system by means of a suitable reconfiguration of the modules. through a new reconfiguration system, called DES, to increase the PV generator of energy production under partial shading of modules. In comparison to the power values extracted by the PV generator in the static configuration as well as with other proposed reconfiguration systems, the reconfiguration with DES has allowed a satisfactory power

gain both in case of non-homogeneous irradiance due to the climatic changes (like the transit of clouds) and in case of the fixed obstacles. The latter is a promising result because it guarantees the small-scale system potential integration in urban environments where the partial shading problem is charged with the shadows projected on the PV generator by the surrounding buildings. The large number of possible configurations allowed by DES is managed with great reliability by the optimization algorithms that identify the sub-optimal configuration in a quite limited calculation time allowing the real-time adaptation to environmental conditions. The number of switches required for the DES is still high but, at least the random search algorithm maximizes the life span of the switches implementing the configuration for which the minimum number of switching operations is required. Further work will be addressed towards the implementation of the DES and relevant control algorithms for larger PV generation systems.

SDWS2011.0678 Explaining Differences in Greenhouse Gas Emissions in Developed Countries: Causes and Policy Implications

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Abstract

This article assesses the reasons for observed differences in greenhouse gas (GHG) emissions among developed, industrial countries. Influential factors compiled from a literature review are regressed with per capita GHG emissions from the Organization for Economic Co-operation and Development (OECD) for 2002. The compiled factors are climate, population pressure (measured as both growth and density), economic output, technological development, industrial structure, energy prices, environmental governance, pollution abatement and control expenditures, and environmental pricing. Selecting with Akaike's Information Criterion corrected for sample size, the most appropriate subset of factors for OECD per capita GHG emissions are energy prices, economic output, and environmental governance. Combined, these three factors explain about 81% of the variation observed in OECD per capita GHG emissions. Individually, energy prices is the most important factor of the three, explaining about 55% of the variation in per capita GHG emissions, while economic output explains about 19%, and environmental governance about 7%. Thus, the energy prices factor is about three times as important as economic output and about eight times as important as environmental governance to influencing OECD per capita GHG emissions. Consequently, developed countries should examine energy prices within their jurisdictions to assess potential opportunities for using market-based instruments to reduce per capita GHG emissions.

SDWS2011.0907 Economical and Geopolitical Aspects of Gas Supply from Russia to Korea

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Abstract

Over the last two decades, economic growth in Northeast Asia (NEA) – and particularly in China and the Republic of Korea (ROK) – has rapidly increased regional energy needs. Although the region, taken as a whole, possesses financial, technical, labour, and natural resources sufficient to address much of the region's needs now and into the future, no one country has all of those attributes. As a result, there was over the past two decades significant interest in regional proposals that would allow sharing of resources, including infrastructure to develop and transport energy resources.

The Russian Eastern Siberia (ES) and Far East (FE) regions are rich in natural resources such as natural gas, oil and coal. However, the high development cost of Greenfield gas deposits and also the huge distances of some thousands of kilometers to potential gas markets in Europe and Asia, earlier made the development of these resources economically inefficient. In the last decade however, with the rapid increase in oil prices (and correspondingly in the gas prices), and the substantial strengthening of climate policy actions, gas production from the difficultly accessible deposits in Russian ES and FE regions is becoming rather actual and in high demanded for sustainable development of ole Northeast Asia.

The objective of this study is to calculate the total cost for gas supply from Russia to Korea. That cost includes: the gas production cost in the prospective gas fields in Russian ES and FE regions, gas pipeline transportation cost across Russia to the Pacific coast and further gas transportation by gas pipeline through the Korean Peninsula (PNG transportation) or transportation of gas by tankers in liquefied form as a liquefied natural gas (LNG) to Korean consumers.

For our research we employed computational methods of fluid dynamics - to determine the optimal parameters (diameter and working pressure) of the trunk gas pipelines; bottom-up cost estimation to make pre-engineering estimates of gas field development, pipeline transportation and LNG chain costs as well as a Cost-Benefit and Breakeven analysis for the gas production and transportation investment projects.

Our calculations show that the estimated cost of Russian gas at the Korean border in constant 2011 USD during the period of the possible contract duration from 2017 to 2041 could be as follows: for PNG 12.91 \$/MBtu (468 \$/1000m^3), and for LNG 13.22 \$/MBtu (479 \$/1000m^3),which is rather competitive under the projected oil price between 18.37 and 25.79 \$/MBtu. This fact together with the presence of the rich gas deposits in the Eastern regions of Russia lead to the conclusion that Russian gas can become an attractive alternative source of gas supply for Korea in the next two or three decades and could thus help the sustainable development of South Korea and probably of the Korean peninsula as a whole.

Special session: Modeling of Energy Systems related to Climate Change for Sustainable Development

World's energy system is unsustainable for current global trends in energy supply and consumption. Climate change also represents a fundamental challenge for global sustainable development. Our knowledge of energy systems and climate change mitigation, combined with a computing technology, allows modeling of these systems. This session welcomes papers dedicated to three main thematic areas:

- Modelling of energy systems related to climate change: Modeling of energy systems, including conventional and renewable energy sources; modeling near- and medium-term energy supplies, demands, and prices; modeling of energy demand side, e.g. electricity, heating and transport; integration of variable renewables like wind power, biomass, hydrogen into the energy system; integration of demand side in energy system models – saving, improvement of energy efficiency and flexible demand; energy system optimization models, etc.
- Climate change modeling: Modeling climate system to simulate global climate and regional climate; modeling long-term climate change for given various greenhouse gas emission reduction rates; modeling seasonal and longer term climate variations; modeling rapid climate changes, etc
- Integrated modeling: Integrated modeling of energy systems, air pollution, environmental and economic impacts and climate change; the impacts of energy production and use on climate and the impacts of a changing climate on our future energy; projections for emissions of greenhouse gases and impacts on development in the energy sector, etc

Session organizer:
***Dr. Sadik Bekteshi**, University of Pristina, Pristina, Kosovo*

Sadik Bekteshi works at Department of Physics of Faculty of Natural Sciences, University of Prishtina, lecturing in Computational Physics on Master Degrees. My specific scientific research interest is the system dynamic modelling, particularly of the climate and energy, as well as the systematic measurements related to the environmental protection and renewable and sustainable energy production problems in Kosovo. I am active in a number of national and international research projects. Combining the background as a nuclear physicist and experience in system dynamic modelling, recently I am a very active member of the international program of the scientific-technological cooperation between the Academy of Sciences and Arts of Kosovo and the Academy of Sciences and Arts of Albania, with the focus on the radioecological research and measurements in several regions of Kosovo.

SDWS2011.0076 Effects of Electric Vehicles on Power System Investments and Operation

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Abstract

Efficient utilisation of wind power in energy systems poses challenges due to the variable and only partly predictable nature of wind. When charged/discharged intelligently, electric vehicles can support the integration of wind power reducing fossil fuel consumption and system costs. A large penetration of electric vehicles will not only affect power system operation but also investments. As power system investments are realised continuously, these effects are best investigated by analysing several years over a period. In this study, it is analysed how a gradual large-scale implementation of plug-in hybrid electric vehicles and battery electric vehicles in Denmark, Sweden, Norway, Finland, and Germany will influence power system investments and operation in the years 2015, 2020, 2025, and 2030. Inspired by EPRI and IEA scenarios, increasing shares of electric vehicles are assumed, leading to a total 52 % of the vehicle fleet in 2030. The deterministic investment model Balmorel is used and hourly model simulations are made with five year intervals where optimal investments identified in previous years are included in the optimisations of subsequent years. Plug-in patterns based on a national investigation of transport habits are implemented and intelligent charging and vehicle-to-grid power flows are identified as part of the energy system optimisation. The results reveal the effects on power system investments, electricity generation, CO2 emissions and costs. In addition, the effects of electric vehicles are compared to the effects of investing in heat measures, i.e. heat pumps, electric boilers and heat storages, forming alternative ways of increasing system flexibility and facilitating wind power integration.

SDWS2011.0345 Modeling the Wind Grid Code Requirements for Wind Farms Connection in Kosovo Transmission Network

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Abstract

These paper present aspects of Kosovo Grid Code relating to wind turbine generators. All Generators connecting to the Kosovo Transmission System are required to

comply with the Grid Code. The Grid Code was originally developed with conventional synchronous generators. Since Wind Turbine Generators don't have the same characteristics as synchronous generators, it was considered appropriate to develop a new set of Grid Code provisions specifically for Wind Farm Power Stations in relation with specific characteristic of Kosovo Power System. With the high excepted penetration of wind power a simultaneous loss of Wind Farms generation will put in the risk the security and reliability of Power System. Therefore, the main requirements for Wind farm power stations concern the fault ride through capability, frequency operation range, and reactive power capability of wind turbines. In the case of network faults wind turbines have to supply a definite reactive power depending on the instantaneous voltage level of connection point and they must return quickly to normal operation.

SDWS2011.0354 Modeling Air Quality Near Some Stationary Sources in Kosovo

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Abstract

The objective of this paper is air-quality modeling in Kosovo including modeling of Steady-State Point Source, Plume Rise, Steady-State Line Source, and Steady-State Area Source. We describe an air quality model for different distances from the source based on the distribution of pollutants through atmospheric diffusion. We modeled the quality of air in the vicinity and far from the stationary sources of pollution in Kosovo depending on the meteorological conditions, temperature, wind velocity, dispersive characteristics of the atmosphere: thermal power plants units A and B, and new thermo power plants unit Kosovo e re, Ferronickel, Cement Factory, etc. These models are usually distinguished by type of source, pollutant, distance of transport, and averaging time. We present one, two and three-dimensional maps for the transport of the air pollutants from the identified source of pollution, depending on meteorological conditions in the vicinity and far from the source of pollution; design of the model for building new emitters, for example, chimneys for new thermo power plants, so that emitted gases do not pose a risk for the region where they are built.

SDWS2011.0405 Kosovo's Energy System and Scenarios for Sustainable Development

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Abstract

We presenta brief study of possible baseline energy developments and available options to mitigate emissions. We also discuss problems associated with them. For this purpose we developed an integrated energy demand–supply and emission model (ESDE model) for time period 2010-2025 and analyzed a set of energy and emission scenarios for Kosovo considering also "The energy strategy of Republic of Kosovo 2009 – 2018". In various scenarios the potentials and possibilities of the growth of the renewable energy sector (energy from wind, biomass, solar energy, etc.) and its integration into the energy system of Kosovo as a whole are investigated. The analysis of scenarios shows that there exists a large potential to mitigate and reduce emissions compared to the business-as-usual (BAU) scenario by 25% which is above the EU Emissions Targets to achieve 20% reduction by 2020. We find that orientation on environmentally friendly energy sources would pose near-term costs that are relatively modest compared to their contribution to sustainable energy development of Kosovo.

SDWS2011.0423 Modeling and Analysis of Post-2012 Scenarios for Medium and Longer Term Pollution Emissions Reductions

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Abstract

By modeling of medium and longer term emissions reductions scenarios, we analyse some factors that could establish a foundation for undertaking actions to mitigate climate change beyond 2012, taking into account both their environmental and economic consequences. The aim of this work is to find out which of the discussed factors are the most affected by pollution emission reduction, in order that mid-term and long-term pollution emission reduction could be implemented without significantly harming the world economic growth. All the scenarios analyzed assume that pollution emission reduction is achieved at a global level. While percentage of pollutions reduction is a

significant factor; nevertheless, in long-term, the target year of achieving the pollutions reduction is more important. The results obtained in this paper show that increasing the rate of pollution emission reduction can be associated with nonlinear responses of economic and ecological factors.

SDWS2011.0813 Environmental Management and the Sustainable Development.

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Abstract

In my paper I would like to consider, if there is a connection between the environmental management and the sustainable development. I would like to prove that the implementation of the environmental management can be considered as an element which could improve the sustainable growth.

Coming closer to the environmental management question, considered on the bases of the EMAS regulation, it also should be stressed, that the environmental management is founded on the grounds of the idea of prevention, reduction and if possible, elimination of the environmental pollution at source which should take place at the enterprise level – so at the source of pollution. The aim of such approach to the problem is to reveal the measure of reasonable use of the natural goods as well as to present the apply of the environmental friendly, "clean" technologies. Therefore the main stipulation of the environmental management is to protect the environment which remains still under very strong influence from the industrial planks side, however by the new method founded inter alia on the constant improvement of the enterprise as well as on the new instruments which entail the reduce of the negative environmental impact. Consequently EMAS (Eco Management and Audit Scheme), is the European Union system destinated for those organizations which aim is to stay in accordance with the environmental law and in the same time they aspire to self-improvement, diminishing simultaneously its negative environmental effect. The EMAS purpose is also to encourage the industrial planks – but not only them – to take the responsibility of the environmental dangers generated by their action. Furthermore, because of the environmental management implementation, organizations have the opportunity by its voluntary self-restraint, to decrease the environmental negative impact mentioned above. Implementation of the EMAS system is also the measure by which enterprise has a chance to raise its competitiveness as the organization performing on the base of environmental management system might become a guarantee of a higher social confidence. In the time of paying wider attention to the problems of environmental protection and taking higher care of natural goods, companies concerned for its environmental friendly image have obviously stronger market position. It also should be stressed, that efficiently working environmental management system contributes to reduce the costs of enterprises' actions as well as to its improvement.

It can be stated that the EMAS system is the norm created for realisation of the sustainable development idea on the level of organisation which has implemented the system.

Special session: Energy and Water Efficiency for Sustainable Future

Industrial production still requires a considerable and continuous supply of energy delivered from natural resources—principally in the form of fossil fuels such as coal, oil, and natural gas. The increase in our planet human population and its growing nutritional demands have resulted in annual increases in energy consumption. Furthermore, many nations have accelerated their development in the last 10 years, and countries with large populations (such as China and India) have seen even more significant increases in energy demands. This growing energy consumption has also resulted in unsteady climatic and environmental conditions in many areas because of increased emissions of CO_2, NO_x, SO_x, dust, black carbon, and combustion process waste.

It has become increasingly important to ensure that the production and processing industries take advantage of recent developments in energy efficiency and in the use of nontraditional energy sources. The additional environmental cost is related to the amount of emitted carbon dioxide (CO_2) and may take the form of a centrally imposed tax. A workable solution to this problem would be to reduce emissions and effluents by optimizing energy consumption, increasing the efficiency of materials processing, and increasing also the efficiency of energy conversion and consumption.

Although major industry requires large supplies of energy to meet production targets, it is not the only sector of the world economy that is increasing its energy demands. The particular characteristics of these other sectors make optimizing for energy efficiency and cost reduction more difficult than in traditional processing industries, such as oil refining, where continuous mass production concentrated in a few locations offers an obvious potential for large energy savings. In contrast, for example, agricultural production and food processing are distributed over large areas, and these activities are not continuous but rather structured in seasonal campaigns. Energy demands in this sector are related to specific and limited time periods, so the design of efficient energy systems to meet this demand is more problematic than in traditional, steady-state industries.

In recent years there has been increased interest in the development of renewable, noncarbon-based energy sources in order to combat the increasing threat of CO_2 emissions and subsequent climatic change. These sources are characterized by spatial distribution and variations as well as temporal variations with diverse dynamics. More recently, the fluctuations and often large increases in the prices of oil and gas have further increased interest in employing alternative, non-carbon-based energy sources. These cost and environmental concerns have led to increases in the industrial sector efficiency of energy use, although the use of renewable energy sources in major industry has been sporadic at best. In contrast, domestic energy supply has moved more positively toward the integration of renewable energy sources; this movement includes solar heating, heat pumps, and wind turbines. However, there have been only limited and ad hoc attempts to design a combined energy system that includes both industrial and residential buildings, and few systematic design techniques have been marshaled toward the end of producing a symbiotic system.

Another important resource is water – both as raw material and effluent. Water is widely used in various industries as raw material. It is also frequently used in the heating and cooling utility systems (e.g., steam production, cooling water) and as a mass separating agent for various mass transfer operations (e.g., washing, extraction). Strict requirements for product quality and associated safety issues in manufacturing contribute to large amounts of high-quality water being consumed by the industry. In addition, large amounts of aqueous streams are released from the industrial processes, often proportional to the fresh water intake. Stringent environmental regulations coupled with a growing human population that seeks improved quality of life have led to increased demand for quality water. These developments have increased the need for improved water management and wastewater minimization. Adopting techniques to minimize water usage can effectively reduce both the demand for freshwater and the amount of effluents generated by the industry. In addition to this environmental benefit, efficient water management reduces the costs for acquiring freshwater and treating effluents.

This session provides a platform for development of modern technologies for energy and water efficiency and for exchanging ideas in the field. They include, beside the others, the Process Integration and optimisation methodologies and their application to improving the energy and water efficiency of mainly industrial but also nonindustrial users. An additional aim is to evaluate how these methodologies can be adapted to include the integration of waste and renewable energy sources for energy conversion and water supply/purification. The session is outlining the field of energy and water efficiency, including its scope, actors, and main features. The deals with energy and water saving techniques. An increasingly prominent issue is assessing and minimizing emissions and the the environmental footprints: carbon and water footprints. The carbon footprint (CFP) is defined by the U.K. Parliamentary Office for Science and Technology as the total amount of CO_2 and the other greenhouse gases emitted over the full life cycle of a process or product. IN a similar way the water footprint embodies the various water quantities used for the manufacturing and delivery of a product. For energy supply, there have been numerous studies that emphasize the "carbon neutrality" of renewable sources of energy. However, even renewable energy sources make some contribution to the overall carbon footprint, and assessment studies frequently do not account for this. The carbon footprint should also be incorporated into any product life-cycle assessment (LCA).

Session organizers:
***Prof. Jiri Klemes**, University of Pannonia, Veszprem, Hungary*
***Dr. Petar Varbanov**, University of Pannonia, Veszprém, Hungary*

Jirí Klemeš - Pólya Professor and EC Marie Curie Chair Holder (EXC) at University of Pannonia, Veszprém, Hungary. Previously the Dpt of Process Integration and at UMIST and The University of Manchester, UK. Research in neural network applications at University of Edinburgh, Scotland. Comprehensive industrial experience, process integration, sustainable technologies and renewable energy. Successful applications. Managing 66 major European and UK Know-How projects and consulted

on energy saving and pollution reduction. Editor-in-Chief of Chemical Engineering Transactions, Subject Editor of Journal of Cleaner Production, Dpt Regional Editor of Applied Thermal Engineering, Associate Editor for Heat Transfer Engineering and ENERGY; Cleaner Technologies and Environmental Policies; Resources, Conservation and Recycling. In 1998 founded and is the President of International Conference Process Integration, Mathematical Modelling and Optimisation for Energy Saving and Pollution reduction - PRES

Dr Petar Varbanov is a Senior Lecturer and Senior Researcher at the Research Institute of Chemical Technology and Process Engineering, Faculty of Information Technology University of Pannonia, Veszprém, Hungary. He graduated from the University of Chemical Technology and Metallurgy in Sofia, Bulgaria, with an MSc in Chemical Engineering. His professional interests include process modelling and optimisation of chemical processes and energy systems. He worked several years in the field of energy efficiency, specializing in heat integration, at the IChE - Bulgarian Academy of Sciences. He got his PhD in Optimisation and Synthesis of Process Utility Systems from University of Manchester Institute of Science and Technology, Manchester, UK. For performing research on minimising and mitigating Climate Change he was awarded a scholarship from the UK Tyndall Centre. Later he was awarded a Marie Curie EIF Fellowship and successfully performed research on Optimising the Start-up of Distillation Columns at the Technische Universität Berlin. This was followed by a Marie Curie ERG Fellowship for assisting his integration into the University of Pannonia – Hungary. Presently he is a member of the team of the Marie Curie Chair (EXC) "INEMAGLOW".

SDWS2011.0006 The Question of the Use of Non-Traditional Energy Sources in Light of the New Energy Strategy for Europe 2011-2020

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Abstract

The essay analyses the issues for consideration listed in the stock taking document "New Energy Strategy for Europe 2011-2020" and explores the impact of their implementation on the use of non-traditional energy sources. The main objective of the paper is to introduce and provide a summary of the theoretical and methodological achievements required for an analysis of the implications of such an EU level strategy. It also provides a summary of the results of the analysis of the impacts of the Strategy on a specific field; namely, on the use of non-traditional energy sources. Contradictions

inherent in the Strategy are discussed as well, and a proposal is put forward to aid the resolution of these contradictions.

The essay also points out that the further development of the theoretical and methodological achievements may result in the creation of a simulation model the application of which could effectively aid the process of strategic planning and the testing of strategies prior to approval. Finally, the paper discusses how an EU level and/or a global network of Energy Security Centres introduced by the corresponding author in her earlier publications could promote the development and implementation of an energy policy ensuring the appropriate utilization of non-traditional energy sources.

SDWS2011.0010 Identification of the Influence of Fouling on the Heat Recovery in a Heat Exchanger Network

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Abstract

The paper presents a novel method of diagnosing the influence of deposits on the heat recovery in an industrial heat exchanger network. The method is based on mathematical models enabling the interpretation of industrial measurements of operating parameters (temperature, mass flow, chemical composition of process streams) of heat exchangers. The crucial assumption is that measurements of the mass flow and inlet and outlet temperature are available for each process stream, this making it possible to evaluate fouling-induced reduction in the recovered heat flow. Using a numerical procedure based on the mathematical models, the thermal resistance of deposits can be determined. The proposed approach allows to monitor long-term changes in the condition the heat exchanger network and to collect data that are necessary for scheduling of cleaning interventions on the individual exchangers. By applying the novel method to a data base acquired from two years of operation of a real Crude Distillation Unit, the mathematical models were validated. This made it possible to work out the diagnosis of deposits influence on the heat recovery in a real heat exchanger network. The developed method can be used as a tool to assist plant operator in the decision-making aimed at the stabilisation of heat recovery in the heat exchanger network, and consequently – reduction of energy consumption in the plant.

SDWS2011.0031 Sustaining High Energy Efficiency in Existing Processes with Advanced Process Integration Technology

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Abstract

To reduce emissions in the process industry, much emphasis has been put on making step changes in emission reduction, by developing new process technology and making renewable energy more affordable. However, the energy saving potential of existing systems cannot be simply ignored. In recent years, there have been significant advances in process integration technology with better modeling techniques and more advanced solution methods. These methods have been applied to the new design and retrofit studies in the process industry. Here attempts are made to apply these technologies to improve the environmental performance of existing facilities with operational changes. An industrial project was carried out to demonstrate the importance and effectiveness of exploiting the operational flexibility for energy conservation. By applying advanced optimization technique to integrate the operation of distillation and heat recovery in a crude oil distillation unit, the energy consumption was reduced by 8% without capital expenditure. It shows that with correctly identified technology and the proper execution procedure, significant energy savings and emission reduction can be achieved very quickly without major capital expenditure. This allows the industry to improve its economic and environment performance at the same time.

SDWS2011.0039 Kinetic Analysis and Safety Implications in Biodiesel Transesterification Production Process

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Abstract

Economic recession in the last few years has caused demand for refined petroleum products to slump, so that the refined margins have dropped from an average net margin of $ 2.79/bbl in 2008 to $ 1.11/bbl in 2009. In order to remain competitive, several refineries consider to extend the production to alternative biofuels, by applying an integration economy principle. Biodiesel is an alternative non-petroleum based fuel, consisting of alkyl esters obtained either by esterification of free fatty acids with low molecular weight alcohols, or by transesterification of triglycerides. The latter is the most common way and refers to a chemical reaction involving vegetable oil and alcohol, catalyzed by a strong base, to yield fatty acids alkyl esters and glycerol. The realization of a biodiesel unit within a downstream petrochemical plant can pose several safety issues

and inherent safety application opportunities, given the particular context in which the production will take place and the hazardous materials potentially involved in the process. In this paper, we consider these issues, starting from a detailed classification of chemical and physical hazards of raw materials and catalysts, considering different biodiesel process options. A detailed statistical survey on accidents related materials involved in the process was carried out, analyzing the various causes of accidents and the severity of the consequences. In the experimental phase, we studied at laboratory scale, different catalysts and the relevant reaction parameters, suitable to be adopted in a continuous process for biodiesel production from vegetable feedstocks. A simple, even if not simpler, kinetic modelling approach of the transesterification process is developed, allowing to evaluate relevant kinetic parameters, providing as well intensification opportunities for the plant design, certainly impacting in a positive way on the process and personal safety.

SDWS2011.0041 Lca-Based Mathematical Programming Approach to Sustainable System Synthesis

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Abstract

This contribution presents some basic ideas, challenges, and advantages when performing the mathematical programming approach to sustainable system synthesis. Two life-cycle assessment (LCA)-based multi-objective approaches are studied: i) the first one based on a relative sustainability index and ii) the second one based on a concept of eco-costs.

For the former approach, a special normalized LCA index is defined and included in the multi-criteria optimization for determining several environmental impacts from "cradle" to "grave". A two-level mixed-integer nonlinear programming (MINLP) system synthesis is performed where an economically-effective synthesis is carried out at the first level in order to obtain a solution which is then considered as a base case or reference solution for the multi-objective MINLP synthesis, performed at the second level. For the sake of the multi-objective optimization, the system superstructure is expanded with sustainable alternatives and the model augmented for the LCA environmental criteria. An epsilon constraint multi-optimization method is applied and a set of Pareto optimal solutions are thus generated that are economically more efficient and yet environmentally less harmful than the base case solution. In order to illustrate the approach, the synthesis of multi-technology process network for the production of bio-ethanol from different raw materials will be discussed.

For the latter approach, a sustainable synthesis of bioprocesses for the production of biogas from organic and animal wastes will be presented and a novel concept of maximization of economical profit vs. eco-profit will be introduced in order to identify those process solutions that are the most economically profitable and yet offer the most

positive impacts of unburdens on the environment, expressed as a monetary value – annual eco-profit.

SDWS2011.0147 Structured Multimedia Education in Energy and Water Use Optimisation

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Abstract

The emergence of educational programs combining the fields of energy and water integration into complete sustainability curricula is relatively recent. It is not yet widely appreciated by practitioners of science and technology. The situation can be remedied by developing Internet-based multimedia programmes delivering the curricula within international networks, reducing or even eliminating the high costs associated with travelling of the students or lecturers.

The authors are capitalising on their both long term and recent experience gained from several leading European universities and initiatives in the UK, Hungary and Slovenia under the auspices of EURECHA. This European Committee for the Use of Computers in Chemical Engineering Education was formed in 1983 to enable software for teaching and methods of computer aided teaching to be exchanged between universities in Europe and has been also seeking collaboration with the US.

The methodology demonstrated in this presentation suggests ways how to efficiently develop multimedia teaching materials and deliver them including the internet based options – improving the teaching impact whilst not unnecessarily wasting the time and resources. A special attention is paid to newly emerging sustainability curricula. The effectiveness of the teaching processes can be improved by implementing an alternative to conventional presentations. The role of multimedia in teaching programs in sustainability is considerable as it offers various information delivery formats simultaneously. Using the various delivery formats brings the added advantage of exploiting the differing perception styles of the students. Some people learn better from well structured texts or presentations while others learn better from an interactive, game-like experience.

The combination of text, audio, still images, animation, video and interactivity, as well as hyperlinks has an advantage of using both of the two main channels (visual and verbal) for presentation in an efficient way. It is capable of reducing the overall cognitive effort for given amount of presented information. The advantageous features can be applied in sustainability courses, which have to be multidisciplinary in various fields from highly technology related to societal and psychological in the same course. They are many

questions to be answered and much potential for improvement both on student and presenter sides.

SDWS2011.0148 The Dynamic Total Site Heat Cascade for Integration and Management of Renewables with Variable Supply and Demand

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Abstract

Reducing CO_2 emissions could be achieved by maximising heat recovery and increasing the share of renewables in the primary energy mix. Adopting renewable energy resources and maximising their utilisation acts simultaneously on reducing CO2 emissions and energy dependencies.

Process Integration has includes Total Site Heat Integration, which combines the heating and cooling requirements of individual processes allowing better integration. Integration of renewable sources of energy imposes new challenges. The major integration challenge is the varying availability of renewable resources, most notable from which are solar irradiation and wind.

The current paper presents an extension of the Total Site methodology for the incorporation of renewable energy sources (solar, wind, biomass, and some types of waste) into Total Sites, accounting for the often substantial variability on the supply and demand sides and for the use of non-isothermal utilities. It builds upon several previous works extending the Total Site concept from purely industrial Process Integration to also including residential, service, business and agricultural energy users.

It further applies the extension of the heat cascade principle by explicitly defining a heat cascade for the inter-process heat exchange. The intervals in the cascade are defined by the utility types allowed on the Site. To accommodate renewable energy sources and varying demands, heat storage is considered and modelled as heat transfer flows between time periods.. The cascade minimises the heat waste and carbon footprint of the considered sites. This is illustrated with a comprehensive case study.

The results show that applying Total Site Heat Integrated storage can significantly reduce the targets for fossil-fuel as well as solar-based utilities. The Dynamic Total Site Heat Cascade shows the pathways through the system to maximise the energy savings through demand-side management of the process energy demands.

SDWS2011.0895 Advanced Optimisation and Control of Energy Systems

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Abstract

Energy is one of the most critical international issues at the moment and most likely to be so for the years to come. As part of the energy debate, it is becoming gradually accepted that current energy systems, networks encompassing everything from primary energy sources to final energy services, are becoming unsustainable. Driven primarily by concerns over urban air quality, global warming caused by greenhouse gas emissions and dependence on depleting fossil fuel reserves, a transition to alternative energy systems is receiving serious attention. Such a tradition will certainly involve meeting the growing energy demand of the future with greater efficiency as well as using more renewable energy sources (such as wind, solar, biomass, etc.). However, although there exist many technical options and technology pathways to enable this transition, they are usually treated separately by their very own technical communities and political groups without coordination with others, and the overall effect and potential is therefore greatly constrained as compared to a systematic approach where all alternatives are taken into consideration in an integrated way. Energy systems engineering provides a methodological modeling and optimization framework to address the complex energy and environmental problems existed in design, optimisation and control of energy systems in an integrated manner. This methodological framework is generic, and it can help to produce optimal design and operational plans for energy systems ranging from nanoscale, microscale, mesoscale, to mega-scale levels over operating horizons from milliseconds to months and years.

This paper provides a review of recent work by the authors regarding the development of new techniques, methodologies and tools for the design, optimisation and control of energy systems. Emphasis is placed on advanced energy systems which illustrate severe difficulties in the control and optimisation. Thus, the integrated optimisation and control of CHP systems, Fuel Cells and Kiln operation for the production of tiles and bricks are considered in detailed. The applicability of advanced dynamic optimisation techniques, Model-Based control strategies and new design approaches is clearly illustrated in several real-life industrial case studies. Results indicate that significant benefits in terms of energy efficiency, energy reduction, and cost attractive design options can be achieved.

SDWS2011.0908 Integration of Industrial Waste Oil, Biomass and Municipal Wastes into Malaysian Urban Area Energy Supply Chain

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Abstract

Recently several studies of the waste utilization possibilities in Malaysia have been carried out. However, there is a lack of studies dealing with the integration of different types of waste as well as the proper supply chain analysis and synthesis for waste-to-energy (WTE) system. The research to still be done is crucial for solving energy and environmental problems. At the same time this topic lies within the objectives of Malaysian energy policies and the 10th Malaysia Plan: "Clean and Green Energy". This paper presents an integrated WTE approach to (i) improve the energy balance between the urban and rural areas; (ii) exploit and maximise the utilisation of waste as local energy sources; (iii) syntheses an efficient supply chain for WTE; and (iv) develop an evaluation system for the WTE system. To achieve these objectives, the following steps are proposed: (i) collecting the biomass from the surrounding rural/ plantation areas and sending them to the major energy-deficit areas (e.g Klang Velley and Johor Bahru); (ii) investigating new combinations of available waste to form the higher energy densities material e.g. the biomass briquette and pellets with industrial waste oil absorption and co-firing of combined MSW and waste oil; and (iii) developing an evaluation tools for WTE supply chain, process , life cycle, safety and health analysis. The most updated results will be presented and the future works that can be extended from this work will be given in the conclusion part.

SDWS2011.0651 Water-Energy Capital: Sustainability Implications Through the Implementation of Water Allocation in Tiam-Fr Energy Model.

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Abstract

Water and energy represent joint productions that support human welfare. We need water to produce energy and we use energy to clean and transport water. To deal with the

anthropogenic pressure and climate changes, long-term solutions to water scarcity and energy demand needs to be developed. Studying the interconnections between water and energy sectors allows us to analyze and developing such strategies. The main aim of the study was first to estimate the exploitation, regeneration and management of water resources over long term horizons, and thereafter to anticipate or forecast development of the energy system under constrained water consumption to guarantee sufficient supply, regeneration and conservation. For this purpose we discuss the concept of Water-Energy Capital (WEC). It is adapted from the Natural Capital concept, with a view to creating economic incentives for water-energy nexus. The WEC is defined as a water sustainable consumption indicator through time, and enables us to estimate the energy footprint of water uses. Water allocation issues were implemented in the TIAM-FR (TIMES Integrated Assessment Model) energy system model, which is an bottom-up model offers a technology-rich representation of the energy systems in 15 regions of the world. It considers the long-term development of the energy system. All water uses were integrated in terms of a Water Reference Energy System detailing water consumption levels by different technologies. The proposed TIAM-FR model was used to optimize water allocation considering of opportunities for water reuse or non-conventional water use and to estimate the WEC. The water-scarce Middle East context was choosen as a case study. As the prospective model considers emissions of greenhouse gases, it may also be used to project the development of the energy systems and water allocation under the constraints of climate goals. Furthermore, constrains on water availability and energetic costs are also taken into account. Implementing water allocation in the TIAM-FR energy model has some sustainability implications. We determine an ecological economics framework in order to define the assumptions of our new concept of Water-Energy Capital (WEC). We develop long-term water-energy foresight exercises to assess an optimal "water-energy" mix through economical, social, and environmental points of view.

SDWS2011.0272 Ecological Footprint as a Tool for Integrated Coastal Zone Management

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Abstract

The Ecological Footprint (EF) is a widely accepted tool for translating all human activities so as to assess their environmental impact. It has been often used as an indicator for environmental sustainability over the last years providing information on the impacts of human activities on environmentally valuable ecosystems. The application of ecological footprint in a given area also involves various sectors such as tourism or transportation and contributes to the better understanding of the development of these sectors through a sustainable procedure.

On the other hand, Integrated Coastal Zone Management (ICZM) sets the basic principles and methodologies for the sustainable development and management of coastal areas. ICZM is a dynamic, continuous and iterative process designed to promote sustainable management of coastal zones. The "Integrated" refers both to the integration of objectives and to the integration of the multiple instruments needed to meet these objectives. ICZM includes the integration of all relevant policy areas, sectors and levels of administration as well as the terrestrial and marine components of the geographical area under consideration.

Especially coastal areas call for an integration between ecological, social and economic considerations into strategic decisions. This creates the need for a new look at decision making processes in ICZM. Although coastal areas may have great differences between them, all must point at the same direction, the effective achievement of sustainable development. Therefore, tools used by planners or decision makers have to provide the same quality of information for different sustainability dimensions of coastal zone impacts. EF could be proved a usefull tool to enable this and it could also be used in different stages of the decision-making processes: from the analysis of the examined issues, to developing the vision and proposed actions, and to measuring the environmental impacts during the implementation process.

The continuous human activities development without an effort of a minimization of their EF could jeopardize the future sustainability of urban and non-urban areas. The purpose of this paper is to examine the methods through which EF could act as an indicator in the context of ICZM and for human impacts on certain coastal areas and be implemented in decision-making processes and the interest focuses on the diversity of the European coast and its environmentally fragile ecosystems.

SDWS2011.0487 Operating Conditions of a Cfb Biomass Gasifier to Produce Low-Tar Syngas

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Abstract

Fluidized bed biomass gasifiers produce a "dirty" gas, containing mainly ash/char particles and tars among other impurities. These components must be eliminated before the syngas use in gas engines or gas turbines. Catalytic hot gas cleaning is an interesting and promising method for tar elimination, but these catalysts deactivate rapidly due to coking as a result of tar cracking.

It is therefore of paramount importance that the gasifier already generates a "clean" syngas, with a tar concentration of 2 g/Nm³ frequently cited as target (against values of 8 to 15 g/Nm³, commonly encountered).

The main possibilities to achieve the low-tar targets have been investigated, and involve (i) the use of biomass feed with a moisture content below approx. 12 wt%; (ii) the

use of a catalytic bed material, such as Ni/olivine or sand with added calcined dolomite; (iii) a controlled air equivalence ratio (ER, being the amount of air supplied as fraction of the stoichiometric air for biomass combustion, thus fixing the gasifier operating temperature); (iv) a short residence time of the syngas in the reactor, thus limiting the contact time with char, itself acting as catalyst for coking reactions; and (v) nevertheless achieving a good contact of the syngas with the catalytic bed-material, where a plug flow is preferred.

Whereas the effects of biomass moisture, bed material and ER have been previously reported and can help in reducing the tar content of the syngas, the main parameter to meet the 2 g/Nm³ target relies on the controlled operation of the CFB itself.

There are two important parameters that govern the solids and gas hydrodynamics in the CFB and hence its design, i.e. the solid circulation flux expressed in kg/m².s, and the air flow rate through the riser.

The paper will review the fundamental kinetics of the gasification reactions and predict required operating conditions. Tracer experiments and measurement of the residence time distribution of both solids and gas in the riser of the CFB have enabled to delineate the operating regimes where the required plug flow of solids and gas can be achieved. Results are transformed into equations and recommendations for the design of the CFB gasifier.

Special session: Research and Governance for Sustainability - New Approaches (on the occasion of 80th birthday of Ivo Šlaus)

Intertwinning research and governance is necessary for achieving sustainable development. The session will be devoted to the analysis, measurement and assessment of activities increasing human, social and natural capital assuring sustainable development. In this session we primarily aim to address the opportunities for a synergy between research and governance for sustainable solutions to contemporary problems. This session invites innovative ideas in energy, climate, demography, economy and governance, which would assure economic development, social cohesion and environmental sustainability in the emerging global sustainable knowledge-based society. This session, organized in cooperation with The Club of Rome - European Support Centre and National Associations and the World Academy of Art and Science – South East European Division will study the aspects of opportunities in research and governance for sustainable solutions.

The session is planned as follows:

- Theoretical approaches to sustainability with a focus on intertwinning scientific research and governance;
- Innovative ideas in energy, climate, demography, economy and governance, both on Earth and in space;
- Opportunities for long term change toward sustainable knowledge society in research and governance.

Session organizers:

***Prof. Aleksander Zidanšek**, Jozef Stefan International Postgraduate School, Ljubljana, Slovenia*

***Prof. Robert Blinc**, Institute Jozef Stefan, Ljubljana, Slovenia*

Aleksander Zidanšek is Associate Professor of Physics and a researcher at Jozef Stefan Institute, Director of International Center for Sustainable Development and Secretary General of the Jozef Stefan International Postgraduate School. Dr. Zidanšek holds Ph.D. in Physics and Master Degrees in Physics and Business Administration, with specialization in sustainable development management. Prof. Zidanšek is active in both solid state experimental physics and in research of renewable energy sources, in particular for applications in multifunctional devices. He has been involved in a number of national and international research and education projects in solid state physics and in sustainable development, most recently in networks Tenvors and Train to LA21. He received a Fulbright Grant for research at Montana State University with Prof. V. H. Schmidt in 1995/1996. He became associate member of tt30 in 2001 and associate member of the Club of Rome in 2005 (www.clubofrome.org).

Robert Blinc is Professor of Physics and researcher at Jožef Stefan Institute and Dean of the Jožef Stefan International Postgraduate School. Dr. Blinc holds Ph.D. in Physics and is active in solid state experimental physics and in sustainable development. He has published more than 660 scientific papers and has more than 13000 citations. He has been a visiting professor to University of Washington in Seattle, Universidade Federal de Minas Gerais in Belo Horizonte, ETH Zürich, University of Vienna, and Adjunct Professor at University of Utah in Salt Lake City. He is also member of the World Academy of Art and Science, Academia Europaea and many other academies. He was President of the Societe AMPERE 1986-1994, European Steering Committee on Ferroelectricity 1986-1999, and Committee for Sustainable Development, Slovenian Academy of Sciences and Arts since 1999. He is also Past Vice-President of Slovenian Academy of Sciences and Arts, Past President of JSI Scientific Council, and President of Slovenian Association for the Club of Rome since 2000.

SDWS2011.0108 Happiness in Nations and Governance

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Abstract

Happiness in nations has been systematically followed by Veenhoven for almost two decades. It has been demonstrated that it is positively correlated with different sustainability indicators. Recently President of France and government of Britain decided to explore possibilities to collect national data on happiness in a similar way as GDP per capita is measured. Namely, happiness in nations is determined as average happiness of population of a given country. In this way it is directly related to individual happiness. This is an important advantage against composite indices such as the Human Development Index or Happy Planet Index which contain more information, but their relation to happiness of individuals in not so easy to understand. The disadvantage of happiness in nations compared to GDP per capita is that it is only measured on a small sample of the population, and therefore has a relatively large statistical error.

In this contribution we analyse possibilities to implement happiness in nations as an additional or alternative indicator of well being, which could compete with the GDP per capita. We also analyse possible influences of happiness research and its results on good governance. We build on results of Jan Ott who found that technical quality of governance correlates positively with happiness in nations both in rich and in poor nations more strongly than democracy, and is therefore a universal condition for happiness. We analyse this relation in more details in order to get additional insight on cause and effect relations between good governance and happiness in nations, and to develop strategies for simultaneous improvement of happiness and governance.

SDWS2011.0085 Reconciling Long-Term Sustainable Development and R&d Planning with the Short-Term Preferences That Drive Governments, Businesses, Institutions, and Individuals

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Abstract

By definition, sustainable development of large scale must be planned and executed to maintain the well-being of future generations, meaning that it has to extend to the far future and be global in extent. Long—term strategic planning is, however, fraught with difficulties for governments, companies, institutions, and individuals, which presently often make it impossible. Such difficulties stem from plain economic reasons where the resources are deemed to be inadequate even for the immediate critical needs, from great uncertainties in future conditions and needs, and from political reasons. The latter tend to focus elected politicians' attention to their term in office and re-election, typically 2-8 years, and to pressures from special interest groups that do not aim for national and world sustainable development.

Moving from the temporal boundaries of sustainable development responsibility to the geographic ones, it needs to be recognized that the future generation we try to keep happy may live anywhere in the world and not just in the country of their ancestors' (our!) birth/residence and that it is impossible in the long term to maintain sustainability of a country without ensuring the sustainability of most of the other countries on earth. While "globalization" is largely acceptable world-wide for its economic benefits, there are still strong objections from all sides of the political spectrum, some subjective based on chauvinistic grounds, and some objective based on concerns about equitable treatment and benefits among the nations.

This paper focuses on government long-term planning for sustainable development, especially in energy, describing the current status of such planning, and attempting to make recommendations about preferred ways that democratic governments could overcome the difficulties and work more effectively for a sustainable future. These recommendations range from scientific methodology for attempting to evaluate cots, benefits and risks, through proper public education, to enlightened legislation that securely allocates some funds for long-term R&D, all with proper periodic monitoring and updating.

SDWS2011.0958 Real Values and Their Role in Promoting the New Economics of Growth and Employment

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Abstract

Economics has rapidly become divorced from real values. This results in sub-optimum decisions and the wasteful use of scarce resources: financial, natural , human and social. We need a major paradigm shift in the way we value the goods and services that will provide the most benefit to the future of humankind. In doing so we must re-assess the most important characteristics of a sustainable and safe world and reflect upon the current scale and challenges posed by the level and nature of global unemployment; the extent to which we undervalue the world's natural resource and environmental base; the nature of current and future markets and their role in sustainable value creation; and the extent to which we need a major effort to restore and develop the social and cultural capital we have lost. This will require bridges to be built between normative and positive economic thinking. While measurement and increased understanding of the nature of the problems we face is important we must also focus on what we can actually do to restore our planet back into equilibrium. A renewed focus is required on actions that are needed including policies, instruments and institutions. New global governance arrangements are an inevitable consequence.

SDWS2011.0152 Science and Economics: the Case of Uncertainty and Desequilibrium

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Abstract

Economics as a social discipline was founded at the end of the eighteen century on the basis of the book "The Wealth of Nations" by Adam Smith. As such it was determined by the birth of the Industrial Revolution, in a period in which the large majority of what today could be called social scientists, insisted to proclaim that the determinant basis of wealth was agriculture. Adam Smith, as a moral philosopher, was essentially interested to fight poverty with any possible new means: he identified them in the scattered examples of (industrial) manufacturing.

In writing his book he proposed how to account value: based on price due to an exchange beetween supply and demand. Such an exchange could then be considered as an objective social reality, on which to build a social theory (later called economics) with scientific pretentions.

In fact, in a world still dominated by Cartesian-Newtonian principles, the reference to a price equilibrium justified the search for a system providing a higher and higher degree of certainty. It was deterministic, linked to a frozen definition in time and space. Uncertainty was considered as due to insufficient knowledge, to be overcome with time, and finally eliminated.

Even most contemporary economics is still linked, often implicitly, on this principle. Furthermore, modern economic thinking, from about 80 years, priviledges the demand side (contrary to the classical preference for the supply side) of the trade equation: after all if you know one side, in a tendentially perfect equilibrium system, you automatically know the other side. A good tautology!

But science in fact has shifted, for at least a century towards undeterministic views: it does not pretend to provide defitive (godlike) knowledge. Progress in thinking depends on the identification of insufficient points/or issues in present knowledge. Paradoxically, the more we know, the more we identify an increasing number of questions: understanding our ignorance is the first tool in the advancement of knowledge. Even Pascal once said: Our knowledge is like a ball in a universe of ignorance - when the ball grows it faces more and more ignorance.....

In our contemporay real economy, supply is based on research (which might take even decades), production based on many services, distribution and maintenance, utilisation, waste management, which are all services and take place in time. Hence two uncertainties: the duration of the utilisation, and the costs from research to the disposal of waste. And when time and the future are involved, you rapidly find out that any hope to get objective certainty (as in the classical economics' equilibrium) is not part of reality.

Uncertainties and probabilities are the main road for managing now the wealth of nations.

SDWS2011.0773 The Sustainable Development in Greece and the Financial Crisis

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Abstract

Some details and information about Greece will be given related to the sustainable development, the factors, the indicators and connected systems that may influence Greece and South East Europe in general:

Climate and Air:

- Emission of Carbon Dioxide CO2 and Sulphor Oxide SO2
- Emission of Nitrogen Oxides NO2
- Concentration of pollution in big cities and pollution control and Environmental protection as a % of GDP

• Ambient concentration of pollutants in Urban Areas

Energy:
• Energy consumption per capita
• Materials consumption per capita
• Infrastructure in non pollutant energy (water, wind, sea)

Demography:
• Population Growth Rate
• Mortality Rate (infant etc)
• Life expectance at birth

Economy:
• GDP before and after the crisis
• Inflation for the last 5 years
• External depth / GDP according to official information
• Actual crisis and measures to restrain the unemployment.

Waste Management:
• Percent of population served by a Waste collection system
• Generation of Municipal solid wastes per capita
• Generation of solid waste per capita
• Clean combustion in Greece and pollution control.

Water:
• Water exploitation index i.e. Annual withdrawals of ground and surface
• water /exploitable water resources
• Surface water quality
• Ratio of renewable water supplies to withdrawals.
• Water quality indicator
• Water consumption per capita per year

The above data are reanalysed in the perspective of the present financial crisis in order to address the question how to solve this crisis and to prevent a future crisis.

SDWS2011.0968 Organization of Global Governance for Sustainable Development

G. Jacobs[*1]

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Abstract

The greatest threats confronting human beings today are the result of problems that affect humanity as a whole and can only be addressed in concert by the entire human race. International financial instability, unemployment, terrorism, proliferation of nuclear weapons and climate change are indications that humanity is entering a new phase in social evolution that compels us to evolve more effective instruments for governance at the global level. No nation or group of nations acting on its own can protect itself from these threats. Trillions of dollars circling the globe daily in search of higher speculative returns leave a trail of unstable financial markets in their wake. A few nuclear weapons in the hands of terrorists can hold the entire world at ransom. Employment markets are increasingly porous and subject to impacts from around the world. Carbon emissions respect no national boundaries. Effective action to address these issues is unlikely to come from governments whose source of power and very identity are based on national sovereignty and separateness.

In this contribution an analysis of correlations between governance, economic, social and environmental indicators is presented. Innovative governance strategies with proposals for effective actions enhancing human and social capital as well as protecting natural capital are addressed.

SDWS2011.0883 The Role of Technology in Sustainable Development

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Abstract

The contribution will assess the possible role of technology in achieving a sustainable development. It demonstrates that a sstainable development will not be achieved automatically via a "technology fix" but needs further requirements.

- Technology consumes some resources itself and if it was applied in an inappropriate environment, it might even have adverse (rebound) effects.

- But also a Change of Mind Strategy will fail as long as malicious behaviour is rather rewarded than punished, the phenomenon of eco-schizophrenia will prevent progress towards sustainability.

- A Frameworks Strategy alone will not be successful because over-ambitious measures for sustainability are risky for politicians. There is a “democratic brake”.

Technology will be necessary but not sufficient for sustainability. A strategy for a sustainable development needs to include both a Change of Mind and a Frameworks Strategy (and of course the technology itself). All the strategies have specific disadvantages, a combined approach is therefore necessary. In such an approach, the components could not only have effects for specifically achieving sustainable development, each component might also decrease the influence of the obstacles which the other component faces.

SDWS2011.0549 Environmental Assessment Rules for Simple Trigeneration Systems Under Variable Operation Conditions

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Abstract

Buildings represent one of the dominant energy-consuming sectors in industrialized societies. For example, in the European Union (EU) buildings account for more than 40% of final energy consumption and this figure is increasing. Cogeneration and trigeneration has been contributing significantly and cost-effectively in the last decades to economic competitiveness, environmental friendliness and security of energy supply for the industrial sector. Furthermore, the necessity to consider the environment as an additional design factor is ever increasing due to the rise in environmental conscience and requirements to reduce the environmental impact of modern society.

Previous papers presented a thermoeconomic characterization of a simple trigeneration system considering different operation modes and variable conditions. The demands of buildings varied seasonally as well as throughout the day. The system was interconnected to the electric utility grid, both to receive electricity and to deliver surplus electricity. A fraction of the cogenerated heat could be wasted. The optimal operation mode with the lowest variable cost was obtained through a linear programming model.

When dealing with multi output systems it is often critical to know how much of the costs should be attributed to each product. In this paper the attention is focused on the environmental burden, evaluated by applying the Life Cycle Assessment technique, provoked by the trigeneration system. The aim is to determine appropriate environmental assessment rules to properly apportion the environmental loads to the final energy services and internal flows for whichever set of operation conditions. Environmental assessment criteria proposed in the literature were applied and analyzed. An allocation method was proposed considering the different operation modes and the market structure, in order to promote rational and environmentally friendly production and consumption of

energy services. All consumers of cogeneration energy services were benefited with the same discount rate applied to environmental loads of separate production.

SDWS2011.0172 Enabling Environment for Better Utilization of Solar and Wind Energy in Macedonian Agricultural Sector

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Abstract

The most effective actions towards sustainable development may originate from the intersection among two or more economy sectors. Along this line, pursuing the sectoral synergy "Agriculture-Energy" identified in the National Strategy for Sustainable Development, the paper investigates prospects and provides guidance for better utilization of solar and wind energy in Macedonian agricultural sector.

With no doubt, the creation of "enabling environment" for better utilization of the solar and wind energy technologies in agriculture is complex process which involves a variety of stakeholders, each, with a specific role and assignment, but acting in partnership with the others. The presented research, supported by findings and recommendations derived at a thematic workshop with the key stakeholders, mainly includes stakeholder analyses and problem and objective analyses. In consequence, some recommendations in a form of short- and long-term priority actions with roles and responsibilities assigned to various stakeholders are proposed.

SDWS2011.0258 The Impact of More Efficient New Passenger Cars on Energy Consumption in Eu-15 Countries

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Abstract

The current problems arising from motorized individual transport lead to an urgent need for implementing efficient policy measures. Currently, in the EU standards e.g. for CO2 emissions per km are discussed as a policy tool of priority. To get a reliable appraisal of the effects of standards it is important to identify the overall impact of the corresponding parameter fuel intensity on energy consumption.

The core objective of this paper is to analyze this impact of fuel intensity changes on energy demand of new passenger cars in EU-15 countries. Of special relevance in this context is how the rebound effect due to the change in car fuel efficiency and car size (average engine power) affects the energy conservation effect.

The method of approach is based on an econometric analysis of the EU-15 countries. We focus on analysing the demand for energy (e.g. litre of gasoline and diesel), as well as the demand for service for the stock of cars. With respect to service we consider long-term service demand (kW of cars) as well as short-term service demand (vkm - vehicle km driven). The usage of new cars is derived from the use of the average of the entire fleet of gasoline and diesel cars by using service price elasticity and different service prices.

A specific aspect of our investigations is to find out how changes in fuel intensity and car size interact. This is especially important to get an appraisal of the rebound effect due to a lower fuel intensity or lower fuel cost. Lower fuel intensity reduces the cost of car travel, and may lead to further growth in vehicle kilometre driven and car size, while higher fuel prices may offset this effect to some extent.

The preliminary results of our analysis based on an econometric analysis of data for the EU-15 vehicle stock (Ajanovic ed., 2009) and for new cars in EU-15 (from EC monitoring report, COM(2010) 655) are: Rebound due to increase in vehicle kilometre driven in EU-15 is about 40% and rebound due to increase in car size is about 15%.

SDWS2011.0086 Knowledge Structuring for Water Sustainable Development of Aviation

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Abstract

Water doesn't form a big discussion in aviation environment discussions yet (Nakamura, 2009). However, we can't operate a flight without water and also we need decades to bring a change into such a complex socio-technical system. In this research, we would like to contribute toward avoiding "too late" for aviation development on water sustainability by structuring knowledge about water actual use, experience and problems, which are within each operating company such as airlines and airports or manufactures and not shared among stakeholders.

Our research is on following very simple but essential basic research questions; A) What purposes water is used for during an operation. B) How much of water is used for a flight operation, C) How water is treated after use, and D) What kind of problems water in aviation operation may cause. Although there can be many definitions for a flight

operation, we focused on water required for an annual operation of a typical mid-size short-haul aircraft without water use by passengers at airport and on the way to airport. Some of information for A)~D), especially how much of water an airline carries for a scheduled flight, are not opened by airlines. We conducted our researches on airline environment reports and interviews with airlines and manufactures. We also analyzed more than three thousands of academic papers and also more than five thousands of patents using a computer-based bibliometric method to understand what kind of problems are now recognized and what kind of technology related to water are developed by researchers and engineers in the aviation domain. A computer-based approach is compatible with the scale of information and can be used to complement the expert-based approach (Börner et al., 2003, Boyack et al., 2005).

As a result, we estimated about 40 tons of water is used for maintenance purpose on the ground and 430 tons of water is consumed for customer service purpose in the sky per aircraft per year in a selected condition. We found many knowledge, problems and technologies related to water in the aviation system, classified aviation water issues in 3 big categories; effective use of water during the operation, water pollution of wastewater and climate change by water produced by aviation and discussed the perspectives.

Finally, we take the amount of water used in the sky significant and then we proposed a new air water cycle system which can reduce the water use and also climate change impact.

SDWS2011.0716 Cycles in History and Sustainable Development

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Abstract

Strauss and Howe studied five centuries of Anglo-American history and they claim that four different types of generations follow periodically about every 20 years. The period of crises is the last generation – fourth turning, which repeats about every 80 years, usually when people born after the last crisis get control of the institutions. In the time of crisis society often completely redefines its structure, nature and purpose. In view of this historical model we analyse the effects of current complex crises of governance, economy, finance, energy and environment systems with a particular emphasis on long term sustainability of possible scenarios for resolution of these crises. We use a self organised model of civilisation and a spin glass model of coalition building. Within these models we observe different indicators of the quality of life and their effect on the long term sustainability of the global economic, social and environmental systems.

Special session: The interaction between heating technologies and renewable energy systems

Buildings account for a substantial part of the energy supply. The development of sustainable buildings plays an important role in the transformation of national energy systems into future sustainable energy supplies aiming at reductions in fossil fuels and CO_2 emissions. In such a perspective the design and interaction between buildings and the energy systems surrounding it becomes important in the analyses of which heating systems are able to facilitate these technological changes.

The required technological changes are different in the renovation of existing buildings than in new buildings, however in both cases the concept of zero emission buildings and improvements in energy efficiency cannot be seen isolated from the renewable energy sources and the energy system surrounding them. In some cases individual solutions are most suitable but in other cases district heating is a more fuel and cost efficient solution.

This session focuses on the interaction between the heating technologies in buildings and renewable energy systems. The issues addressed range from technical system analyses to environmental and economic feasibility and public regulation in the interaction between heating technologies and renewable energy systems.

Session organizer:
***Prof. Brian Vad Mathiesen**, Aalborg University, Aalborg, Denmark*

Brian Vad Mathiesen is Associate Professor and PhD at Aalborg University. He specializes in technical and economic analysis of large-scale integration of renewable energy. His research covers analyses of short-term well-known transition technologies to analyses of 100 % renewable energy systems as well as technical energy system analyses, feasibility studies as well as public regulation and technological change. Since 2005 he has been involved in research in renewable energy systems as well as technologies for large-scale integration of wind. Dr. Mathiesen holds a M.Sc. and a Ph.D. focusing on fuel cells in future energy systems (2008). In the IDA Climate Plan 2050 (2009) he was responsible for the technical and socio-economic analyses for making a detailed road map towards 100% renewable energy. In 2008 and 2010 he was involved in the making of Heat Plan Denmark, where the future heating options were analysed in the light of the current status and the future goal of 100% renewable energy as well as the technical and economic impacts and an action plan for with new public regulation. He was work package leader of a group analysing 100% renewable energy in transport and mapping the residual biomass resources in the CEESA project and the main responsible for analyzing scenarios to reveal the potential and challenges in and towards 100% renewable energy systems in Denmark. The CEESA project involves five Danish universities among others and ran from 2006 until 2010. In a research project for the Danish TSO focus on the integration of renewable energy, socio-economy and CO2 emissions from hydrogen fuel cell vehicles, as well as different charging strategies for

hybrid hydrogen fuel cell vehicles and battery electric vehicles in 2009. He has also worked with researchers on large-scale integration of wind power and 100% renewable energy systems for Croatia and for Ireland. He has been involved in developing LCA methodologies and PCR focusing on the interrelation between energy system analyses and LCA.

SDWS2011.0254 Mismatch Regarding Heat Supply for Net Zero Energy Buildings

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Abstract

The long-term goal for Denmark is to develop an energy system solely based on renewable energy sources (RES) in 2050. To reach this goal energy savings in buildings are essential. Therefore, a focus on energy efficient measures in buildings and net zero energy buildings (NZEBs) have increased. NZEBs are characterized by having a greatly reduced energy demand that on an annual basis can be balanced out by an equivalent generation of energy from RES.

Most buildings in Denmark are connected electricity grids and around half to district heating (DH) systems. Connecting buildings to larger energy systems enables them to send or receive energy from these systems. This is beneficial for NZEBs because even though they have an annual net exchange of zero, there is a temporal mismatch in regard to the energy consumption of buildings and the production from the renewable energy units added to them. In other words, situations occur where the renewable energy units produces more energy than the building consumes. If the building was not connected to a grid, the energy produced would have to be either stored or unused. By connecting the building to a grid it is possible to sell the energy to the grid instead of wasting the energy. The objective in this paper is find how large an area of NZEBs is to be built within DH areas and how the heat mismatch of NZEBs influence different types of Danish DH systems.

In the analyses nine different scenarios are analyzed. The examination is from a technical perspective, looking into how the overall heat production within DH areas is affected by the NZEBs excess heat production from solar thermal collectors. The resource consumption, primarily biomass, is used as an overall indicator of the effect on the DH system.

The main findings are that the heat mismatch in general is positive in DH systems, decreasing the production from CHPs and boilers and thereby fuel consumption. This however, is not the case in systems where the heat demand in summer months is covered

by solar thermal already. By adding seasonal heat storages to the DH systems, the situation can be prevented.

SDWS2011.0322 Developing a Regional Energy Plan for Two Counties in Ireland

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Abstract

Developing a sustainable energy supply will most likely require a transition from large-scale centralised plants to decentralised distributed generation. Consequently, local planning authorities will play a more important role in energy planning in the coming years, as more decentralised energy facilities begin to develop. In this paper, a regional energy plan is begun for two counties located on the west coast of Ireland to identify how they can reduce their overall CO2 emission by 20% by the year 2020. The two counties in question are called Limerick and Clare, which have a combined population of approximately 296,000 people over an area of approximately 6,200 km2. Two primary objectives were set to create the energy plan. Firstly, an energy balance is developed here for the region based on the year 2020 using the existing consumption of energy and national energy projections. The results indicate that fossil fuels supplied over 90% of the energy in the two counties in 2009 which cost the local economy over M€300. In addition, even with the implementation of national energy efficiency and renewable energy policies, the region will still supply over 80% of its demands using fossil fuels. The energy balance here will form the basis for the second key objective, which is the creation of a new regional energy strategy using the energy-systems-analysis tool, EnergyPLAN.

SDWS2011.0582 Heat Pumps and User Practices – Energy Reductions Or Increased Comfort?

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Abstract

From a technical point of view transitions towards sustainable energy systems include increased use of heat pumps because of their higher efficiency factor as compared to direct electric heating, and because of the potential of substituting direct oil and gas burning with electricity based on renewables. From a socio-technical point of view it can,

however, be expected that the full technical potential for energy efficiency will not be meet because of changes in user practices. The objective of the present research project was to investigate the actual reductions in electricity consumption in households that had installed an air-to-air heat pump, and to point to possible answers as why the full potential of reductions in electricity was not meet. Investigations included a questionnaire survey among 2800 households having installed a heat pump, resulting in 480 usable questionnaires, whereof it was possible to include electricity consumption as delivered from utilities some years before and after installation of the heat pump for 185 households. Furthermore twelve of these households were selected for detailed technical inspection of the installation of the heat pump and for qualitative interviewing with the owners. Descriptive statistics were used on survey data and regression analysis on the combination of survey data and households' electricity data.

Major results include that permanently occupied dwellings on average realized a 14% reduction in electricity consumption after installation of the heat pump. From a technical approach a reduction of up to 50% could have been expected. The main explanations for not realizing this potential is shown to be a combination of changes in heating and comfort practices, including extension of the heated area, keeping a higher temperature, extending heating season, using the heat pump for air-conditioning and that the heat pump substitute firewood rather than direct electric heating. In summerhouses results include that on average there is not seen any reduction in electricity consumption following from installing a heat pump. This is mainly because the heat pump is used to heat the summerhouse in wintertime, when the house is not regularly occupied. Before installation of the heat pump the summerhouses typically would not have been heated or only kept non-freezing.

SDWS2011.0609 Contribution of Domestic Heating Systems to Smart Grid Control

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Abstract

How to prioritize domestic heating systems in a smart grid, is the question to be answered in this paper. The use of thermal power could be modified from its own prescribed value, in order to compensate power imbalances in the grid. Heating systems could be forced to consume energy, i.e. storing it in heat buffers when there is a power surplus in the grid; and prevented from using power, in case of power shortage. We have investigated how much the residents' thermal comfort would be affected by drifting from the normal function of heating systems. Our case study is an under-floor heating system supplied with a geothermal heat pump. Both planned and unpredicted power interruptions are considered and handled by a hierarchical model predictive control scheme which exploits PI controllers at the bottom of the hierarchy. It is shown that the large heat

capacity of the concrete floor alleviates undesired temperature fluctuations to the extent that power imbalance intervals of approximately half an hour can be well tolerated without serious impact on residents' thermal comfort.

SDWS2011.0621 Primary Energy Factors, Primary Energy Use and CO2 Emissions – the New Indicators for Evaluating the Overall Energy Performance of Buildings

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Abstract

In the last couple of decades of the 20th century one could notice a growing concern about environmental issues and the use of energy and the efficiency of the energy systems throughout the world. From the start of the 21st century the industrialised society really realized the importance of increasing the share of renewable energy sources in the energy system. The "Directive 2002/91/EC on the energy performance of buildings"(EPBD) (Recast 2010/31/EU) has introduced Primary Energy Use (PEU), calculated by Primary Energy Factors (PEF) and CO_2 emissions as the main energy performance indicators from now on. These performance indicators pinpoint the main challenges for the future and they are expected to be among the most important guiding indicators for the change of the competitiveness of the different energy systems in the time to come.

This paper introduces the whole idea of the PEF-concept and demonstrates how system efficiency can be calculated for local heating systems and for the whole energy chain by PEF values. The results will give an indication on which heating systems one should choose and how the variation of central parameters affects the system efficiency. Furthermore the paper shows how the new performance indicators favour the use of renewable energy sources in heating systems.

SDWS2011.0624 Mapping Heat Demand and Supply in Renewable Energy Systems

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Abstract

District heating may facilitate the use of low-carbon and renewable energy sources: It may ease the change of primary supply, and hence be a pillar of future renewable energy systems. In order to assess the potential of district heating with the prospective of

competing technologies, such as energy efficient buildings and individual heat supply, a geographical representation of heat demand, energy efficiency and energy supply is needed. The present paper describes a Heat Atlas as a data retrieval and decision support system, which is built around a spatial database using geographical information systems (GIS). The present atlas comprises 2.5 million heated buildings in Denmark, for which individual calculations of energy saving potentials and costs, connectivity to existing district heat in terms of potentials and costs, as well as information on the current heat supply and demand is extracted. The geographical delineation of data extracts, whether administrative or in terms of energy supply infrastructure, can be chosen freely. For the entire building mass a conclusive link is established between the built environment and its heat supply. Potentials for energy savings and their costs, which are not linearly dependent, can be calculated for several geographically related subjects. Matters like the expansion of district heating; the interconnection of distributed district heating systems; or the question whether to invest in ultra-efficient buildings with individual supply, or in collective heating using renewable energy for heating the current building stock, can now be based on improved data. The paper evaluates experiences from a series of projects and case studies carried out in Denmark

SDWS2011.0708 Intelligent Demand Response Electric Water Heating to Integrate Wind Power in Ireland

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Abstract

Ireland has a target of generating 40% electricity from renewable energy sources by 2020. This is expected to come mainly from variable wind power. However, wind power forecasting is limited. Next to wind power forecasting, energy storage, geographical dispersion and interconnection, demand response (DR) can reduce the effects of wind power variability.

Internationally EWH using storage tanks can account for 7% to 30% of residential electricity consumption. In Ireland EWH can account for up to 23% of domestic electricity usage annually. EWH is estimated to be installed in 48.6% of homes. Electricity demand trends indicate that EWH is an ideal candidate for wind power integration because of the energy storage capability of hot water tanks. EWH has been applied previously, but with Ireland's renewable energy targets, the benefits of using DR to control EWH merits investigation. This paper presents the results of such a study.

SDWS2011.0725 The Role of Cool Thermal Energy Storage in Integration of Renewable Energy Sources and Peak Load Reduction

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Abstract

The building sector is one of the largest energy consumers. Even if cooling needs did not contribute with a large share in overall energy demand in the temperate climates, recent trends show tendency of large growth. This growth is related to two main drivers: the cheap and affordable air-conditioning units that overran the market and more frequent appearance of hot and extremely hot weather conditions. In combination with inadequate insulation and sealing in the most of old buildings, both drivers contributed to new cooling installations that are significantly increasing electricity demand and peak load even on the national level. Consequently, use of fossil fuel in power plants and electricity import has been increased. Development of sustainable buildings and use of renewable energy sources seems as promising solution. But the problem with integration of renewable energy sources in current energy system is related to their intermittent nature and not controllable occurrence.

Cool Thermal Energy Storage may play important role in management of peak load and solving the intermittency problem of renewable energy sources, especially when cooling storage is integrated in district cooling system. Mathematical model of system with integrated renewable energy sources and cool thermal energy storage has been developed. Hourly system analysis has been conducted for one building, group of buildings connected to district cooling system and region represented by mixture of different demands for cool thermal energy. Paper also includes results for overall energy efficiency, cost effectiveness and environmental impact of analysed systems.

SDWS2011.0736 Seasonal Solar Thermal Energy Storage Through Ground Heat Exchangers – Review of Systems and Applications

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Abstract

Energy demands in commercial, industrial and residential sectors vary on daily, weekly and seasonal basis. These demands can be matched with the help of Thermal Energy Storage (TES) systems that operate synergistically and are carefully matched to each specific application.

Increasing energy demands, shortages of fossil fuels and environmental concerns are providing impetus to the development of renewable energy sources, such as solar energy. Solar energy is an important alternative energy source for heating applications. One main factor that limits the application of solar energy is that it is a cyclic, time-dependent energy source.

Solar energy is usually available when the energy demand is low, namely during summer. This mismatch can be balanced by seasonal storage of energy. Seasonal solar energy TES systems are designed to collect solar energy during the summer and retain the stored heat for use during the winter months.

The use of seasonal thermal energy storage can substantially reduce the cost of providing solar energy systems that can supply 100% of buildings energy needs. Seasonal solar thermal energy storage requires large inexpensive storage volumes and the most promising technologies were found underground, using borehole heat exchangers (BHE). Although such systems have been constructed and demonstrated, it is challenging to make them cost effective. Economically justified projects can be designed using annual storage on a community-wide scale, which could reduce cost and improve reliability of solar heating.

In this work, a review of monitoring campaigns and/or simulation studies for various seasonal solar energy storage systems through ground heat exchangers is presented. It reveals several important system parameters. A proper sizing of the solar collector and the borehole field storage capacity are required. Small storage volumes result in high heat losses from the storage system. Another issue is the return temperature to the solar collector. Thermal stores operated at lower temperatures will result in reduced heat loss from the store and lower return temperatures to the solar collector, hence increased collector efficiencies. However, in case of heat pump integrated into the system, too low storage temperatures will decrease the performance of the heat pump and increase the use of electricity.

Integrated approach evaluating the performance of all system components should be used during the design process and determination of system control strategies.

SDWS2011.0751 An Optimization Methodology for the Design of Renewable Energy Systems for Residential Net Zero Energy Buildings with On-Site Heat Production

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Abstract

The concept of net zero energy buildings (NZEB) has received increased attention throughout the last years. A well adapted and optimized design of the energy supply system is crucial for the performance of such buildings. In the designing process several constraints and requirements proprietary to NZEB need to be considered. This paper aims

at developing an engineering methodology for the optimal design of renewable energy supply systems for residential NZEB involving on-site production of heat and electricity in combination with electricity exchanged with the public grid.

The optimization approach involves four basic steps:

1) Identification of the building energy demands

2) Identification of suitable on-site energy production technologies

3) Development of a mathematical model representing the energy system including relevant constraints and requirements, e.g. costs, efficiencies and reliabilities of possible technologies as well as noise levels, space requirements, etc.

4) Application of a solution strategy for the multi-objective optimization problem.

The outcomes of this approach result in a number of optimal design solutions. The methodology is applied in a case study on a residential single family house and allows for including economical, design and performance demands into the dimensioning process of the energy system. The presented approach will also serve as a basis for further development of a holistic optimization method for NZEB design implementing e.g. the trade-off between energy saving measures and energy generation.

SDWS2011.0754 Heating Technologies for Limiting Biomass Consumption in 100% Renewable Energy Systems

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Abstract

The utilization of biomass poses large challenges in the transition to 100% renewable energy systems. Biomass is a crucial element of such systems and needs to be available for multiple purposes. Buildings account for a substantial part of the energy supply also in 100% renewable energy systems. The implementation of energy savings and efficient technologies plays an important role in the transformation into an energy system that is not entirely based on a strategy replacing all fossil fuels with biomass.

In this paper heating technologies are analysed in the context of limiting the biomass consumption in renewable energy systems. The analyses show that 1) district heating systems are especially important in limiting the dependence on biomass resources and to create cost effective systems, 2) district heating systems are especially important in renewable energy systems with large amounts of fluctuating renewable energy sources as it enables fuel efficient and lower cost energy systems and 3) district heating enables the use of combined heat and power production (CPH) and other renewable resources than biomass such as large-scale solar thermal, large-heat pumps, geothermal heat, industrial surplus heat etc. Where the energy density in the building stock is not high enough for districts heating geothermal heat pumps can be recommended for individual heating systems however the costs and biomass consumption is still higher than the district heating solution.

SDWS2011.0809 District Heating Versus Individual Heating in a 100% Renewable Energy System by 2050

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Abstract

In a future 100% renewable based energy system is district heating (DH) then a good solution, when looking at system balance, energy efficiency and socio-economic system costs? Often analysis of 100% renewable energy systems are made for countries or areas either without or with existing DH infra-structure as a premise, as most of the energy system models do not have the possibility endogenously to invest in DH networks.

In this paper we want to compare total energy system efficiency, investments and costs for running a future renewable energy system in a case where DH infra-structure is present with a case with no DH infra-structure (district heating versus individual heating). Denmark is used as "test area" and the Balmorel model is used to configure a socio-economic optimal energy system in 2050 given the above mentioned cases.

Balmorel is a linear optimisation model of heat and power sectors in Denmark and power and DH sectors in Norway, Finland, Sweden and Germany. The model has a higher level of details for Denmark and includes here a possibility to invest in heat saving measures in buildings as an alternative to heat generation. Additionally, local air pollution related to human health externalities are internalised in Balmorel in order to design a renewable heat and power system with the least negative impact on human health.

The presence of DH in an energy system can have a great impact on the balancing of the power system via heat pumps and heat storages. This possibility is missing if all heating are based on individual installations. Individual boilers based on biomass also have more negative health impacts compared to using the biomass in large central combined heat and power plants. So, can the expensive investment in DH infra-structure be outbalances by lower efficiency and higher health costs in the individual system? This is the hypothesis we want to test in this paper.

SDWS2011.0819 Gas Grid Scales and the Value of and Incentives for Biogas Production

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Abstract

In Sweden, biogas is to a large extent used as fuel in the transport sector while in the rest of Europe it is more commonly used to generate heat and power in CHPs. There are considerable climate benefits from both sorts of use compared to baseline options and the most beneficial, from a climate point of view, future use of the biogas depends on developments in the stationary energy sector as well as in the transport sector. In Sweden, unlike most of Continental Europe, there is no general gas infrastructure. That implies that the possibilities for mixing of produced biogas with the grid-distributed natural gas are limited. Now, there is a political-industrial controversy on the benefits of a gas grid extension through southern Sweden from the natural gas grid along the west coast of Sweden. There are three major grid options: a national gas grid, mainly local grids, or an intermediate option of so-called regional grids, and also a truck-based distribution option. The two latter grid infrastructures will only be for biogas and not for natural gas. The controversy concerns aspects related both to energy supply and environmental issues. Thus, an assessment was carried on focusing on the impact of different gas grid scales on future cost-efficient biogas utilization. Further, the study also addresses the level of subsidy required for biogas utilization and how gas grid scales and subsidy levels affect the cost-efficient biogas use; as transport fuel, for combined heat and power generation or for heat only production. The study concerns the Västra Götaland region of Sweden and employs an optimization model, the so-called MARKAL_VG. The system cost is the objective function. The model covers all major municipalities and district heating systems of the region. Electricity can freely be transmitted throughout the region and cross the region boarders while the use of produced heat is restricted to the represented district heating systems. The results show that gas grid scales are important for the outcome and also have an effect on the where the biogas is most cost-efficiently used. At subsidy levels around 20 -30 Euro/MWh the major share of the technical potential can be utilized.

SDWS2011.0840 Efficient District Heating in the Future Energy System

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Abstract

In the EU and in Denmark, the aim is to reduce dependence on fossil fuels and to use energy more efficiently. District heating and combined heat and power may play an important role for the efforts to achieve this aim. However, heat savings may weaken the financial basis for district heating in some areas. At the same time, large amounts of wind power in the electricity system may reduce the operating hours of CHP plants. New technology and altered framework conditions may make individual solutions such as electric heating, heat pumps and micro-CHP more attractive than previously. Therefore, the competitive conditions between district heating and other types of heating may change in the future, both seen from a socioeconomic and a financial point of view. The question is therefore, to which extent district heating will become part of the answer to future requirements regarding energy efficiency and use of renewable energy. Denmark is an interesting case to analyze as the country currently supplies district heating to 60% of the households and produces 20% of the electricity with wind power. The aim of the analysis is to assess how district heating can develop its role in the future energy system by reducing the energy losses and through dynamic use of both well-known and new energy technologies such as heat pumps, geothermal power, district cooling and heat storage. Furthermore, the aim is to explain how the interaction between the electricity market and district heating can be made more efficient. The analyses are carried out using the electricity market model Balmorel, which facilitates cost optimization of operation and investments in energy production plants as well as electricity transmission. To be able to perform the analysis an extension of the model is developed, where it is also possible to optimize between investments in individual heating plants or in expansion of the district heating networks, depending on investment costs, energy density of the potential areas and their distance to existing district heating networks.

SDWS2011.0880 Medium Term Development Prospects of Cogeneration District Heating Systems in Transition Country – a Croatian Case

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Abstract

A dominant share of Croatian cogeneration capacity and future cogeneration potential belongs to district heating systems currently operating in almost all bigger mainland and coastal towns. Since public cogeneration and public heating plants, at present, cover approximately only 10 % of heating requirements of households and services sectors it is reasonable to assume that in future energy supply district heating could take a bigger relative and absolute share even in conditions of reduced heat demand imposed by implementation of Energy performance of buildings directive.

However, development of future district heating projects will inevitably depend on capability to bridge financing barriers usually manifesting in large investment and long pay-back time. The public involvement will be necessary either at state or/and at municipal level since private companies are focused on short-term profitability.

In this paper, taking a midsize town as an example, a cost analysis of implementation of various measures directed to strengthening of market position of district heating system will be performed. The results will be compared with competing concepts of individual buildings heating, such as condensing gas boilers, heat pumps and decentralised systems based renewable energy resources. Levels of financial support will be recommended required for sustainability of district heating projects in specific conditions of Croatian energy market.

SDWS2011.0326 Solar, Pellet Combisystem for Apartment Buildings

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Abstract

As the fossil fuels are constantly depleting and their prices are rising, the need for new energy systems emerges. Especially this is noticeable in the field of domestic heating field for apartment buildings, where the heating bill is increasing each month. There is an urgent need to switch to renewable energy resources because of their lower price and environmental impact. Combined wood pellet and solar power system is seen as one of the best solutions to solve the issue as the pellet prices stable and not so high and solar power is free.

Main objective of this research is to develop and optimize compact combined solar, pellet combisystem for apartment building, for the highest possible solar fraction.

System of one 100kW pellet boiler and 42 m^2 solar collectors was developed for 36 apartment building. System is enclosed in one standard size shipping container to allow easy installation of the combisystem.

Simulation model of the solar, pellet combisystem was developed using TRSYS. For the model continuous monitoring of the buildings thermodynamic parameters, solar collector and pellet boiler energy outputs and site-specific weather conditions was carried out.

Using the simulation model, combined pellet, solar system performance analysis was done. Considering all the monitored data, series of simulations (e.g. to find out the optional size of the pellet tank and hot water accumulation tank) were carried out to reach the highest efficiency of the solar, pellet combisystem.

To validate the simulated data, optimized system was installed in the existing apartment building and continuous monitoring was carried out.

Major results indicated that in the new developed and optimized system 5% from the total yearly energy demand are covered by solar energy and 95% by wood pellets. During summer, solar fraction for the hot water can be close to 100%.

Main conclusions of this research are:

- Due the simulations optimum parameters of the combisystem were found and implemented
- Developed and optimized system can guarantee domestic hot water supply at required temperature all year round.
- Space heating demand is guaranteed by the system at the required level during all heating season.
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SDWS2011.0177 A Detailed Thermal Model of a Parabolic Trough Collector Receiver

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Abstract

Parabolic trough collectors are made by bending a sheet of reflective material into a parabolic shape. A metal black pipe, covered with a glass tube to reduce heat losses, is placed along the focal line of the receiver. When the parabola is pointed towards the sun, the parallel rays incident on the reflector are reflected and focused onto the receiver tube. The concentrated radiation reaching the receiver tube heats the fluid that circulates through it, thus transforming the solar radiation into useful heat. It is sufficient to use a single axis tracking of the sun and thus long collector modules are produced. The collector can be orientated in an east-west direction, tracking the sun from north to south,

or orientated in a north-south direction and tracking the sun from east to west. The advantages of the former tracking mode is that very little collector adjustment is required during the day and the full aperture always faces the sun at noon but the collector performance during the early and late hours of the day is greatly reduced due to large incidence angles (cosine loss). North-south orientated troughs have their highest cosine loss at noon and the lowest in the mornings and evenings when the sun is due east or due west.

Although for low-temperature applications bare tube receivers can be used the usual case is to have a glazed receiver, so only this case is considered. The thermal analysis of the receiver takes into consideration all modes of heat transfer; convection into the receiver pipe, in the annulus between the receiver, and the glass cover; conduction through the metal receiver pipe and glass cover pipe walls; and radiation from the metal receiver pipe and glass cover surfaces to the glass cover and the sky respectively.

The model is written in the Engineering Equation Solver (EES) the basic function of which is to solve algebraic equations. The advantages of using EES are that the program includes routines to estimate the properties of various substances by specifying any two properties, such as temperature and pressure. Furthermore, EES supports user-generated property lookup tables and parametric tables. The lookup tables provide an easy means for adding user-defined thermal-physical properties, or any other data needed in the equations in the code. The parametric tables are similar to spreadsheets and are convenient for conducting parametric studies, such as heat losses as a function of heat transfer fluid inlet temperature. Finally, EES can be called from TRNSYS which allows the development of a system model which can use its capabilities such as radiation processor and ready made models for other components.

The model is validated with known performance of existing collectors and can subsequently be used to perform a parametric analysis of the collector we are going to install at our university.

SDWS2011.0573 Modelling of the Heat Pump Operation in Typical Croatian Climatic Conditions

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Abstract

Enhancing energy efficiency of the heating systems in buildings is one of the major tasks for researchers and professionals in the sector of building comfort systems, because buildings use about 40% of the world's energy. Therein, the use of heat pumps, as the renewable energy source, has a large potential, but it also has some disadvantages that often limit the possibility for the more frequent application.

In this paper, the overview of available models for sizing and operation of various types of heat pumps was given. Then, the energy analysis for two single-family house

models, each equipped with three different types of the heat pump systems (air-water, ground-water, water-water) was performed. Each energy analysis was carried out for the heating mode using model with hourly method in two typical Croatian climatic conditions – moderate continental (Zagreb) and Mediterranean (Split), supplied in the format of test reference year. The annual heating energy use of the heat pump system was compared to the heating system with condensing boiler. The results were presented in the proper charts. The analysis of investment and operating costs for all system types was performed to show the cost-effectiveness in different climatic and operating conditions.

The results showed that the heat pumps present energy efficient but still quite expensive system solution with the shortest calculated payback of 19 years (larger house model in Zagreb, system type water-water, current electricity and natural gas prices). The results indicate that the cost-effectiveness would increase with the capacity. Therefore, if the use of renewable energy sources is in the best interest of the society, small heat pump systems have to be subsidized to stimulate wider utilization.

In further research the system utilization in the non-residential large buildings will be analyzed.

Special session: Electrification as a tool for sustainable development

Electricity is an important pre-condition for sustainable development in a modern society, albeit not a sufficient one. Properly applied to the benefit of development, the access to electricity can make clear contributions to employment generation and the formation of markets for new commodities produced in developing countries while also contributing to address a number of environmental problems including climate change. The result is a win-win situation with reduced greenhouse gas emissions and improved energy security, at the same time that employment and development is generated. Thus efforts should focus on how access to electricity can play a role and become a vector to promote sustainable development in developing countries.

A major challenge for the developing world is to provide universal access to electricity to its population observing requirements of reliability, affordability and sustainability. One should not consider only the provision of electricity per se (technology focus), but rather treat technology as one element among others in the development process, thus taking a system solution approach. This special session will review the financial, institutional and environmental aspects and their linkages to the context of electricity provision and sustainable development. The session will also discuss the role of renewables in developing countries.

We aim to invite papers for this session that focus on models for sustainable development that apply the provision of electricity as a catalys for mechanisms to promote sustainable development. The papers can assess policy strategies, institutional aspects in the electrification process, economic issues and environmental impacts of electrification programs in various developing countries. We aim to select the best papers for inclusion in a publication that we are preparing at our division, possibly in the form of a book.

Session organizer:
***Prof. Semida Silveira**, KTH - Royal Institute of Technology, Stockholm, Sweden*

Semida Silveira is Professor on energy and climate studies at KTH. Her program focuses on systems studies linking energy and climate knowledge with sustainable development, planning and policy work. She has a PhD in regional planning from KTH, with focus on development and sustainability. Her work is characterized by a systems approach to problem analysis and resolution, and profound understanding of the role of infrastructure systems, policies and entrepreneurship for sustainable development. Previously, Prof Silveira worked as sustainability expert at the Swedish Energy Agency, and as energy and climate program manager at the Stockholm Environment Institute. Her most recent activities include bioenergy and climate change policy work, promotion of Swedish knowledge and technologies in development assistance, and international business cooperation with corporate responsibility. Prof Silveira won the Jaboti Literature Prize 2001 in Brazil in the category physical sciences, technology and informatics for her book Electricity for Sustainable Development, published in

Portuguese. She is also the author of various articles and books including an anthology of the Swedish energy development, Building sustainable energy systems – Swedish experiences, and her last book Bioenergy – realizing the potential. She has done research at MIT, IIASA and University of Tübingen, and advises in various committees and companies. She has developed and managed projects in collaboration with academics, development banks, policy makers and the private sector in both industrialized and developing countries.

SDWS2011.0130 Rural Electrification and Sustainable Development in Developing Countries

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Abstract

Over 1.5 billion people, a quarter of the world's population, lack access to electricity at home and the vast majority of these people live in rural areas of Sub-Saharan Africa and South Asia. Access to electricity is vital for achieving human and economic development and rural electrification presents a significant challenge in many developing countries. The purpose of this paper is to examine the ways in which decentralized renewable energy technologies can meet the challenges of poverty alleviation, rural electrification and sustainable development. The opportunities, limitations and key barriers regarding the use of renewable energy for rural electrification are discussed, along with strategies to overcome existing obstacles.

A sustainable development approach is taken and data based on fieldwork from three developing countries is presented. Semi-structured interviews with key informants from the respective governmental and non-governmental institutions form the basis of the discussion, along with data from community stakeholders and recipients of renewable energy based rural electrification projects. The case study countries are Nepal, Peru and Kenya. These countries have been selected to represent each of the continents where the main international development work takes place. The extent to which findings are transferable across cultural boundaries and different institutional frameworks is also evaluated.

The paper will encompass fieldwork data from Nepal (conducted in May 2009), Peru (conducted between October and December 2009) and Kenya (conducted in August and September 2010). Decentralized renewable energy technologies can play a significant role in increasing electricity access in rural areas, as well as contributing towards poverty alleviation and sustainable development. However, results have highlighted the importance of the institutional frameworks, delivery models and local technical capacity if an intervention is to be sustainable.

The paper showcases work from a doctoral thesis on rural electrification that is funded by the UK Energy Research Centre. It is interdisciplinary by nature (the author has been awarded an Interdisciplinary Studentship) and it attempts to transcend the boundaries between the engineering and social sciences.

SDWS2011.0408 Delivering Off-Grid Electricity Systems in the Brazilian Amazon

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Abstract

The Brazilian government aims at providing complete electricity coverage for all citizens as a means to achieve development and reduce poverty. More than 13 miilion people have benefited from the most recent rural electrification program Luz Para Todos (LPT – Light for all), mainly through a grid extension approach. Two of them live in the Amazon region. Both, connection and consumption subsidies have been considered for the purpose of achieving universalization goals and there is evidence of promising results. Yet, the need for a new, off-grid approach is widely recognized and, linked to it, the need for a new subsidy delivery mechanism arises.

In this paper we analyze the existing subsidies schemes in connection to LPT an their potentialities regarding a new off-grid approach in the Amazon region. How could the subsidy scheme in place support the development of LPT in isolated areas? Will the transition to an off-grid model imply major adjustments in terms of this existing scheme? How could these adjustments be implemented? Do these local solutions have the replication potential to promote electricity access in the developing world? Our analysis is based on information provided by an extensive literature review and complemented with semi-structured primary field interviews

The study shows that a new subsidy scheme is required, based on the uniqueness of the isolated areas in the Amazon. Connection subsidies are particularly promising in the Amazon due to the low (or non-existing) coverage there, but not enough to actually induce households to connect to the system. In this direction, our conclusions draw attention to potential actions to be taken by LPT within the Amazon context..

SDWS2011.0341 The Zanzibar Blackout - a Case Study on Consequences from the Electricity Power Crisis

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Abstract

Availability of electricity in developing countries is by no doubt a tool for development. However, electricity by it self do not lead to a sustainable development, nor can the development be sustainable if necessary back-up facilities are not in place.

This is argued and demonstrated in this paper, using the last 10 years of development in Zanzibar as a case. In Zanzibar, the demand for electricity has grown fast and the amount of billed electricity increased with more than 50 % from year 2003 to year 2008. The highest increase can be seen in the medium sized industries sector, where the tourism sector consisted of a large proportion.

With increased dependency of electricity, the fundament for a more vulnerable society is also created. This is illustrated by the economic and social depression that hit Zanzibar during the breakdowns of the power system that occurred for one month in 2008 and for almost three months in 2009-2010. As there where no public back-up generation facility in Zanzibar, this resulted in a total electrical blackout and the citizens had to rely on private electricity generation. In the paper some examples of the consequences are given.

SDWS2011.0612 Rural Electrification Through Decentralized Concentrating Solar Power: Technological and Socio-Economic Aspects.

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Abstract

Currently more than 1.6 billion people worldwide lack access to electricity. Many communities will continue to lack access to centralized grid infrastructure due to remoteness or to the poor rates of return on investment in grid extension. Small scale, decentralized concentrating solar power can constitute a cost effective energy solution for remote places with a high solar irradiation.

Researchers at MIT and University of Liège have collaborated with the non-governmental organization STG International for the purpose of developing and implementing a small scale solar thermal technology utilizing medium temperature parabolic collectors and an Organic Rankine Cycle (ORC). The ORC technology is particularly suitable for small scale parabolic trough systems, since it can generate

electricity at a lower temperature than the conventional steam Rankine cycle. A first unit was installed by STG in 2007.

The goal is to provide rural areas of developing countries with a system that can be manufactured and assembled locally (unlike PV collectors) and can replace or supplement Diesel generators in off grid areas, by generating clean power at a lower levelized cost. Operating at a lower cycle temperatures (<200 °C) and Carnot efficiency is an example of a design tradeoff for maintaining low cost at small scales.

In the first part of the paper, technological aspects of the proposed system are discussed : Because no thermal power blocks are currently manufactured in the kilowatt range a small-scale ORC has to be designed for this application. A model of each component is then developed to evaluate the overall efficiency of the global system. With conservative hypotheses, and real expander efficiency curves, it is shown that an overall electrical efficiency between 7 and 8 % can be reached, the water production not being taken into account.

In the second part of the paper, socio-economic aspects of the project are discussed. These aspects are of key importance when implementing such a project in a developing country. The history of development projects, in particular for rural electrification, has shown very high failure rates when factors such as the local institutions, the socio-economic environment or the hierarchical links between the different local actors were not taken into account.

Therefore, an analysis of a large amount of rural electrification projects has been performed. These examples include both successes and failures, whose underlying factors were identified and classified into 10 distinct principles, namely:

- Cost and technological concurrence
- Participation of the target communities
- Demonstration and adoption
- Appropriate technology issues
- Technology transfer and maintenance
- Decentralization
- Identification of the needs
- Environmental impact
- Market
- Financing and subsidization
- Finally, these principles are used as guidelines for the implementation of the project described above.

SDWS2011.0987 Universal Access to Electricity in Sri Lanka: Opportunities and Challenges

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Abstract

The role of electrification in the process of rural economic development has been well recognized by almost all the governments in the developing countries and developmental agencies. But the pathways for reaching the universal access to electricity are often not well defined. About 85% of the population of Sri Lanka have access to electricity as of 2010, and government has put an ambitious target of providing universal access to electricity by the year 2012. However, electrifying the remaining economically poorer and geographically remote section is a challenging task and need special attention. Minimising the poverty gap is important to achieve universal access. Within the existing policy, our study shows that 20% of population will still be under the energy poverty (using less than 40 KWh/month) even after having universal access. The shift in policy paradigm from using oil based resources to renewable based resources are necessary. New political agenda developing in this direction is a positive indication. This study also captures the perception of the stakeholders on the policy, institutional and financing issues for electrification and looks at the opportunities and challenges in meeting the target of universal access.

SDWS2011.0765 Electricity Production from Residual Biomass in Brazil: the Potential Contribution for the Regional Development and Reduction of GHG Emissions

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Abstract

This paper aims at analysing the potential contribution of electricity production from residual biomass in two industrial branches: the sugarcane sector, concentrated in state of São Paulo, with a tendency of expansion in the Central-West, and the rice industry that is concentrated in the Brazilian south. The analysis will be developed taking into account two specific aspects: the spin-off benefits from the point of view of regional development and the potential for mitigating greenhouse gases (GHG) emissions.

The issue of regional development will be addressed in this paper considering the distint realities of the two industries. All sugarcane mills in Brazil are electrically self-

sufficient (6,500 MW installed) and the potential of surplus electricity production is real. As long as the expansion of the sugarcane industry could be planned and directed to new producing regions, surplus electricity production could be instrumental on fostering economic growth. In addition, considering the aim of diversifying the production of biomass industries (making the biorefinery concept a reality), the availability of surplus electricity and also of raw material (biomass) would be crucial.

In the case of rice industries, the potential is small in national terms and it is even difficult producing enough electricity for industry self-sufficency (only 20 MW installed). However, in general, rice mills are located in small cities and local electricity production would bring positive effects such as reduction of residues disposal, job creation and cost reduction. Despite small the potential of electricity generation would be significant in regions where rice production is concentrated.

From the perspective of mitigating GHG emissions, the potential is constrained due to the base-line of electricity production in Brazil. However, the estimated abatment cost of CO_2 emissions of sugarcane cogeneration is very low and Brazil is gradually more commited on reduction of GHG emissions.

The analysis to be conducted in this paper will be based on updated results of three previous studies done by the authors: (i) an assessment of the technical potential of electricity production from sugarcane and rice residues; (ii) the evaluation of the marginal abatment costs of CO_2 emissions due to electricity production from biomass; (iii) the assessment of barriers for CDM projects regarding electricity production from biomass.

Based on these updated information, in the final part of this paper the authors intend to propose specific policies and regulatory actions aiming at fostering electricity production in these two industrial branches.

SDWS2011.0965 Energy and Water Linkage in Mexico

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Abstract

Water and energy are linked resources, which are essential for human welfare. Energy, allows us to obtain water in the desired quality and quantity for either consumption or productive activities, while water is necessary for energy production and use.

The following study analyzes the relationship between water and energy in Mexico. To this end, and based on data from several accounts, we address the water demand necessary for production, transformation, and energy use, along with the topic of the necessary energy for water supply and treatment for its diverse uses. In both cases quantitative estimations are presented, making the most of the information available.

In Mexico, policy and administration of water and energy are situated in diverse institutions, and, excepting hydro-electricity, linked management is scarce. Information regarding the use and pollution of water of the energy utilities is minimal.

The extraction and processing of fuels, along with electricity generation, account for most of the water consumption and pollution in the energy system. According to official data, the calculated water use percentage for the energy sector reaches 6%, and the consumption of electrical energy for different water uses adds up to 7%. Even though these figures might seem low, it appears clear that the energy sector cannot operate under water stress scenarios, and without energy, the potable water supply and water treatment cannot function.

Furthermore, the demand for these resources is growing, and the supply is facing difficulties. Linked management is required more than ever. Because of this, it is of the outmost importance to develop an information system that allows us to understand with greater detail the relationship between this two resources, and in consequence promote policies that minimize risks and encourage a more efficient and sustainable use of both water and energy.

SDWS2011.0239 The Clew Model – Developing an Integrated Tool for Modeling the Interrelated Effects Between Climate, Land Use, Energy, and Water (Clew)

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Abstract

Given growing global demands, the world's water, land and energy resources are under continuous pressure. The use of each of these resources affects demand for the others; and the use of all have consequences for the environment and climate. Water, energy and food are essential for development but are inexorably linked. Using a case study, this paper introduces the prototype of a new tool which analyses the Climate-, Land-, Energy- and Water- (CLEW) resources and their interactions and implications associated with socio-economic development. The CLEW model presented illustrates tradeoffs associated with interventions aimed at meeting development goals (specifically energy, food, and water supply) and their resultant impact on the climate, water and environment. The model quantifies resource use by calculations based on user-defined scenarios and data. Importantly, this instance of the model is not limited to internal (national) effects but also calculates external changes (in other countries) induced through energy imports or exports and land use change. The paper includes a case study, which investigates sugarcane growing in Mauritius, and the subsequent production of either bio-ethanol for local use in cars or sugar for export. It shows very strong implications for GHG emissions when induced land-use changes and various technology systems are

considered, as well as significant changes in water use, electricity generation dynamics and external effects, such as fuel and fertilizer imports. The CLEW model is based on an open source Energy Modeling platform which ensures a transparent use of data and results. It is designed to be easily accessible and usefully interpretable by policy analysts, planners and decision makers. The platform is extended to include non-energy resources for this paper. The motivation for this study follows an extensive review of existing integrated assessment, resource models and modeling literature. Past modeling exercises have often focused only on a single resource (such as water, land or energy) or have been applied on an aggregated scale for use at regional or global levels and, typically, over long time periods. Those approaches are only of limited use for short or medium term national policy analysis. The CLEW model aims to overcome this gap in the modeling sphere.

SDWS2011.0787 Power Generation from Sugarcane Biomass – a Complementary Option to Hydroelectricity in Nepal and Brazil

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Abstract

This paper discusses the complementarity between hydroelectricity and surplus electricity from sugarcane biomass based cogeneration plants in sugarcane mills. The paper investigates opportunities and barriers in the context of governments' initiatives, institutions and prevailing regulatory frameworks in Brazil and Nepal. The paper finds that bioelectricity from cogeneration can be a good complementary option for hydroelectric power, helping foster diversification on the generation side and enhance security of electricity supply based on local resources. Bioelectricity potential from sugarcane biomass is estimated to be in the range of 209 – 313 GWh for Nepal and 62 – 93 TWh for Brazil. In Nepal, the grid connected bioelectricity can provide power for operating industries, and support local development through rural electrification. In Brazil, the biomass potential can be further enhanced through a better utilization of the biomass in the sugar-ethanol industry to balance hydropower availability. This comparative study offers a reflection on the need for better planning and policies to address the barriers which are hindering the development of bioelectricity even in places where the potential is large.

SDWS2011.0275 Modelling Elements of Smart Grids for Least Developed Countries

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Abstract

In 2009, 70% of the population of sub-Saharan Africa did not have access to electricity. The lack of electricity infrastructure required to connect these 70% offers however significant opportunities. This is because there is limited "legacy infrastructure" to be accommodated as the electricity system expands, especially in least developed countries (LDCs). This may in turn allow for a radical departure from traditional electrification approaches enabling potential leapfrogging to the latest grid concepts, systems and technologies. Similarly, possibilities exist to leapfrog policy by introducing novel regulation, balancing the provision of assets with performance based energy-service delivery.

Certain Smart Grid concepts constitute such a departure from historic deployment pathways. While they receive significant attention in industrialised countries since several years, their detailed monetary implications are not yet fully understood. In LDCs, the current Smart Grid discourse is rather at a nascent stage and targets mostly the conceptual level, lacking a solid technical and practical foundation based on an elaborated business case.

With this paper we aim to address these issues by modelling specific technical elements of Smart Grids in LDC contexts, focusing on rural environments. It considers demand side management options which build on the advances in power systems, integrating various distributed storage options as an integral component of the modelling. The paper further explores novel market approaches. We show how such elements may help improve access to, and quality of, electricity in rural electrification schemes with reduced overall costs through an optimised allocation of resources.

The paper reviews literature on the current discourse of the concept of Smart Grids. It then presents how specific Smart Grid functionalities were modelled based on a systems optimisations approach using the Open Source Energy Modelling System (OSeMOSYS). Finally, it interprets the results, describes the limitations of the approach, presents the major findings and suggests a way forward.

SDWS2011.0717 Smart Grid Could Improve Energy Business and Environmental Sustainability in Developing Countries

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Abstract

The Smart Grid technology presents itself as an opportunity to create new energy business which might help to expand the economic growth in countries such as Brazil. The desired investments should be based on existing technologies and / or new solutions, new metrics or indicators to evaluate business opportunities, and, obviously new legislation and market regulation.

The Governmental strategies must be extremely clear, with regulatory and legislative initiatives to foster new business and protect the public interest. Consumers (as clients) must be heard, as they become active players in the energy market. As they develop a dynamic relationship with the operating power industry new conditions and requirements need to be created in order to lead the strategic transformation inside and outside regional businesses. Deals on new energy sources, new technologies, new possibilities of differentials service and prices should be carefully studied. Strong incentives as well as the evolution of regulation rules play a fundamental role to maintain and to expand the power supply and demand-side management, with implications for a better relationship between client-consumers, dealers and incomes/revenues on invested capital. It is also important to relate and to rethink the affordability of the tariffs and energy delivery costs to low consumption clients. Regulation as well as nonpayment issues are extremely important issues, which also results in broadening the perception of value of energy by clients.

Evolving energy business does not appear in this analysis merely as a possibility but as fact to be accomplished. Appropriate efforts should be taken to perform adequate planning, design and costs. All stake holders must be involved, organizing, building and upgrading the power grid in its aspects of quality, availability, infrastructure and interconnectivity, sustainability and awareness target of supply-demand and incomes. The failure of incomplete public policies and accompanying regulation may generate inconsistency with the country's future energy requirements, considering the obsolescence of current networks, trends and the necessary adherence to the pact of global sustainability, especially in developing countries.

To sum up, some scenarios are presented in order to demonstrate the regional impact of stagnation and improper regulations in Brazil.

SDWS2011.0986 How Rural-Urban Migration Affects CO2 Emissions? Evidence from Jakarta, Indonesia

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Abstract

Indonesia as the most populous country in Southeast Asia has demonstrated accelerated urbanization. Current size of urban population equals to 44.3 percent of total country's population and is projected to rise up to 65.9 percent by 2050 (UN 2008). Access to energy and consumption patterns are obviously influenced by the rural-urban migration due to the differences in availability of energy sources in rural and urban areas as well as differences in lifestyles, income levels and consumption patterns. Along with increasing energy consumption, urbanization can be considered as one of the factors of increase in CO2 emission levels in the context of rapidly developing countries like Indonesia. Detailed analysis of household energy consumption before and after the move to an urban area is essential for deeper understanding of what effects the process of migration has on cities, energy consumption patterns, and, thus, on levels of CO2 emissions. Analysis of actual migrant's behavior data on which had been acquired from the city-wide household survey conducted in December, 2009, makes it possible to examine the effect of changing the energy consumption patterns caused by migration. After applying analytical tools to the raw data, changes in CO2 emissions are defined and this practical information can later serve as a basis for policymakers in their efforts to develop effective mechanisms to mitigate CO2 emissions. Having two main objectives: (1) to identify the energy consumption and energy access among the resettled and non-resettled citizens in DKI Jakarta with the emphasis on slum characteristics in regards to energy consumptions; and (2) to assess the changes in access to energy among citizens resettled to DKI Jakarta before and after the resettlement, the study yields following results. In general, living standards of resettled respondents have been improved when judged by the presence and usage of household appliances. "Lighting" and "mobile phones" category demonstrated slightly smaller numbers for non-migrant group of respondent when compared with their resettled counterparts. Analysis of energy consumption changes revealed that migrants' consumption expressed in monetary terms (IDR per month) increased significantly. This is true for all types of analyzed fuels (electricity, gasoline, LPG, kerosene). Electricity and gasoline demonstrated most significant rise. Non-migrant respondents spend less money per month for electricity, LPG and gasoline but more for kerosene than those respondents who moved to DKI Jakarta. Total monthly CO2 emissions by household had been increased for resettled respondents due to the increase in consumption of some types of fuel, namely gasoline and LPG, though the consumption of kerosene demonstrated noticeable decrease. Total emissions of non-resettled households appeared to be significantly higher than those for resettled respondents after their move to DKI Jakarta.

Special session: The improvement of the environmental conditions of towns by means of energy efficiency policies: method of analysis and case studies

Towns, that are the main contexts where people live and work, have experienced a significant worsening of the local microclimatic conditions, mainly due to the rising of the amount of fossil energy sources for accomplishing the growing level of the life style required by inhabitants and of the services related to these needs. As that, towns must be considered as crucial areas for implementing effective policies, able to readdress countries toward a sustainable path, both from the energy and environmental points of view. In this sight, buildings management, urban transportation and commercial activities are the key elements for suitable energy policy interventions.

Anyway, although environmental and energy performance of urban contexts are gaining a rising importance among architects and policy makers, there is a wide gap between the available methods for assessing such performances and the needed level of analysis, chiefly due to the improvement of the level of technologies that are continuously embodied in the design of urban systems.

For example, new building components like green roofing, which are capable of mitigating the heat island effects in towns, are not properly taken into account in the methods currently available to technicians. Moreover, the environmental consequences of changes in the transportation modalities in urban areas (e.g., shifting from private to public means) can be evaluated with difficulties.

Then, what is needed is the availability of simple but reliable methods that, in an integrated way, can evaluate the effects on the environmental performances of urban contexts of different energy scenarios adopted by public administrations. With this aim, the suitability of such integrated methods of analysis (e.g., life cycle analysis, dashboard of sustainability, ecological footprint, etc.) will be focused on this section, by pointing out the current status of this field (also by means of the presentation of relevant case-studies), along with the new incoming methods.

Session organizer:
***Prof. Gianfranco Rizzo**, Universita degli Studi di Palermo, Palermo, Italy*

Gianfranco Rizzo - Gianfranco Rizzo is full professor of Environmental Technical Physics at the University of Palermo since 1994. He is also the Energy Manager of the University of Palermo since 2009 and chairman of the Ph.D. School on Environmental Technical Physics of the University of Palermo, in partnership with four other Italian Universities, since 2003. He was chairman of the Degree Course in "Environment and Land Engineering" of the Engineering Faculty at University of Palermo until 2004. He was involved in research activities at the "Applied Science Division" of the Lawrence Berkeley Laboratory of the University of California and he was teacher of "HVAC design" at the Engineering Faculty of the University of Luanda

(Angola). He participated to researches of International Energy Agency (IEA) within the program "Passive and Hybrid Solar Low-Energy Buildings". He is responsible of several international researches (Validation of CECED Scenario Eco-design of Water Heaters European Committee of Domestic Equipment Manufacturers, CECED, 2009); member of the European panel for the singling out of the criteria for the EU Eco-label award scheme for buildings; member of the scientific board of the Fishing Observatory of the Mazara del Vallo fishing district. He is author of about 300 publications, mainly presented at international conferences (also as invited lectures) or published by international journals; co-author of three books on the issues of energy efficiency of buildings; editor of the Journal of Ecology and The Natural Environment; member of the editorial board of Int. Journal of Sustainable Development and Planning.

SDWS2011.0449 A Possible Approach to Take into Account the Presence of Green Roofs in the Energy Certification of Buildings

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Abstract

Green coverings are widely popular and well established building components in European countries. They are becoming interesting technological options, rapidly increasing, also in the urban context, mainly for reducing energy consumption for climatization in the building sector. As a matter of fact, the building sector, that is particularly responsible for energy consumption in the developed countries, is object of several new standards and rules concerning its energy efficiency and the environmental features. Among these, the European Union has recently issued a new Directive (Directive 2002/91/EC) expressly devoted to the energy performances of buildings, where Member States are called to adopt new effective measures for reducing energy consumption in this crucial sector. This kind of roof is obtained by adding high-quality layers of impermeable waterproofing membrane, an anti-root barrier, a drainage layer, a lightweight substrate and, finally, plants on top of a traditional roof. The best benefit provided by green roofs is that they not only can improve the esthetical level of a city (taking the nature back inside the city) but, as it has been several times pointed out in literature, they can provide either to private building and to the public ones many positive effects which might be clustered in: environmental benefits (e.g. mitigation of “urban heat island effect”); economic benefits (e.g. reduced energy costs especially for cooling); social benefits (e.g. supply of green areas for social interaction and relax). Despite the existence of positive green roof policies which directly and indirectly encourage new green roof installations, also promoting a fast expansion of the green roof market, it has to be noted that such new building components are not properly taken into account in the methods currently

available to technicians for assessing environmental and energy performance of urban contexts. This paper will provide a possible approach to take into account in the current energy certification scheme for buildings the presence of a green roof, in order to cover the gap between the available methods and the new level of analysis, mainly required by the improvement of the level of technologies embodied in the design of urban systems. The proposed approach for achieving the energy balance of this component arises from assuming a parallelism between the energy balance of a green roof and that one of a whole city.

SDWS2011.0561 Micro Wind Turbines for Urban Energy Generation

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Abstract

Some important aspects of energy saving in urban areas concern the improvement of the energy efficiency of buildings and infrastructures through the use of renewable sources.

Among renewable sources the generation of energy through micro wind turbines may represent an available and cheap techniques to reach the goal.

This paper want to propose an operative methodology to evaluate the energy generation by use of micro wind turbines placed in the built environment.

The evaluation of the wind energy generation requires both the knowledge of wind speed data and the wind frequency distribution in the site analysed.

Unfortunately, in the urban area people does not have sufficient information to estimate the effective energy production of wind turbine. These information could be obtained by means of Flow Dynamic Computer Code able to calculate the 3D wind flow field.

To the aim to create a public data base, the results of the flow dynamic study could be implemented into a GIS platform that for each site of installation, gives the necessary information for the evaluation of energy wind production.

The availability of these data could contribute to improve the diffusion of small wind turbines in urban area and, consequently, reduce both the Greenhouse gases emissions related to the building energy consumption and in the same time obtain reductions of electricity energy costs for the users.

SDWS2011.0562 Possible Hazards to Human Health Caused by Changing in Urban Climate

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Abstract

The waste greenhouse gases coming from the use of energy for HVAC plants, transport network and other anthropic activities in urban areas cause a deep impact on the local atmospheric conditions, as like as the urban heat island (UHI), heat waves and so on. The alteration of climate condition (temperature, humidity, etc.) makes the urban environment out of the homeostatic plateaux of human species.

The main bioclimatic indexes may be used in urban climate studies to describe the level of thermal sensation that people feels because of climatic conditions. These indexes provide a meaningful and realistic indicator to readily discover possible physiological and psychological damages that people could suffer for the effects of altered bioclimatic conditions

To the aim to preventing harmful health effects of heat-waves, the Authors have developed a model to forecast the meteorological data for the day after by means Artificial Neural Network (ANN) technique.

In this way the researchers use the forecasted meteorological data for the calculation of the correlated bioclimatic indexes.

The values of the bioclimatic indexes calculated using the forecasted meteorological data by ANN were compared with the bioclimatic indexes values calculated using the data (temperature, relative humidity and wind velocity) recorded, in the same interval of time, from the meteorological stations. The results are very encouraging and people found that the proposed forecasting model predicts the bioclimatic indexes, for the next day, with high degree of accuracy.

The proposed methodology could constitute an useful tools usable as heat health alert system to activate social and health care networks, as like as provisions of practical advice to the population of the urban areas, and on the health risks related to forecasted heat waves.

SDWS2011.0570 Evaluation of the Thermodynamic Performance of the Traditional Passive Systems

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Abstract

The need to reduce energy urban consumption, especially in the buildings, one of the major energy dissipater resulting in emission of CO2, is pushing research in the field of building design to the appreciation of passive air-conditioning systems that can be integrated with conventional systems and determine, therefore, the so-called hybrid systems

This approach is not new, but it is historically rooted in the architectural culture of the Mediterranean area and the in Middle East.

The development of passive systems was caused by the large amount of population (about one third) who lives in the world in conditions of hot - dry or warm – moist climate; also most of the internal areas of the continent is characterized by summer weather conditions with temperatures higher than level of comfort.

These systems exploit: natural ventilation, evaporative cooling, control of solar radiation, thermal mass of the building and the heat exchange with the ground. Today passive systems tend to become the key element of sustainable design in all weather conditions.

In recent years activity research has been focused on this type of problem, through an approach that involves the application of design strategies and the development of computational tools and control systems. The synergy between current scientific knowledge and advanced manufacturing and information technology can in fact make possible to conceive hybrid systems, applying the principles that underlie passive integrated systems with modern conditioning systems.

Through the use of computer programs CFD (Computational Fluid Dynamic) has been test different conditions iterating the process until it get to the shape giving the greatest contribution for the environmental comfort.

The paper will show the result of research developed to the Dipartimento di Architettura, that essentially develops models and case studies on which to compare and adapt project proposals that make current the principles of traditional systems, originally conceived and developed in an empirical way.

Moreover we want to give useful information to designers for a sustainable approach pursued so far other that applies to energy-saving measures after planning the design solution.

SDWS2011.0588 The Importance of Reliable Climatic Data in the Urban Energy Policy

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Abstract

In the last decades, the thermal comfort standards of people have been greatly improved. This has induced an increasing need of energy for the climatization of indoor spaces, both in summer and winter seasons. To address this problem that, in turn, results in an increasing pressure exerted on the natural environment by the building sector, the European Union has issued the well known Directive 2002/91/EC on the Energy Performance of Buildings (EPBD) devoted to a more rational energy use in this important sector for the life and working activities of people.

But in order to minimize the energy needs of buildings, reliable tools should be available to architects and technicians, that is simulation methods of the energy and thermal behaviour of buildings from one hand and input data for such tools from the other.

Among these input data, the more uncertain ones are undoubtedly the climatic data. Anyway, according to the different localities, more or less detailed data are available: monthly average values, Monthly Average Day (MAD), Test Reference Year (TRY).

As that, it is of paramount importance to investigate the effect of differently detailed available climatic data with commonly used simulation tools, in order to understand whether it is important to invest on more and more complicated tools or, instead, on more reliable climatic data.

In this work, referring to the climatic station of Palermo, we will compare the obtained results evaluating the energy consumption of a simple building and the energy produced by a PV system by means of different sets of data.

The proposed methodology is intended to be useful for municipality administrations to single out a suitable urban energy policy.

SDWS2011.0599 Greenhouse Gas Emission Reduction in an Italian Medium Size Town According to the European Directives

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Abstract

The control of excessive use of fossil fuels, major cause of climate change on a global scale, is the basis of international agreements, such as the Kyoto Protocol, which committed member countries to effectively reduce emissions of greenhouse gases. To combat climate change, the European Commission has recently adopted a package of legislative proposals, fixing the objectives to be achieved by 2020, that is: 20% reduction in consumption of primary sources through increased energy efficiency; 20% increase in the share of renewable sources in final consumption; 20% reduction in emissions of greenhouse gases respect to the commitments of the Kyoto Protocol. Indeed, to achieve the prefixed targets, mitigation measures should also involve local communities, in addition to central governments; in particular, cities can play a key role in the transition towards sustainable development. The quantification, even at the local level, of emissions and removals of CO2, major cause of the increase of the greenhouse effect, requires the realizing of Greenhouse gas balance; it consists of an organized series of data on the amount of greenhouse gases that are introduced and removed into the atmosphere by natural sources and/or human activities. This balance is aimed to both quantify the emission rates and address the responsibility of a specific territory, with a view to possible improvements; the final target is the identification of local emission sources and their estimation with the lowest possible uncertainty. In this paper we present the results of the balance of emissions and removals of greenhouse gases, carried out in the Italian city of Reggio Calabria at the aim of identifying the most emissive sectors to be improved with suitable mitigation measures. The analysis has been carried out following the well known Intergovernmental Panel on Climate Change (IPCC) Guidelines methodology. Furthermore iIt has pointed out the critical states and the strengths of the municipal system, in relation to which several hypothesis concerning reduction measures have been developed.

SDWS2011.0647 Evaluating the Environmental Performance of Green Roofs by a Life Cycle Approach: an Application of the LCA Method on a Case Study in Italy

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Abstract

In the recent years green covering systems are becoming an increasingly visible component of urban environments as not only do they improve the esthetical appeal of a city context, but also provide several benefits, mostly environmental and economic ones. Among the environmental benefits, it is likely to mention for example the reduction in the heat island effect, the improvement in the air quality by removing some air pollutants as SOx, NOx and particulates and the reduction in the energy consumption of building with consequent reduction of CO2 emissions due to the climatizzation. In the last years, several researches have been addressed to green roofs but it must be noted that most of them are mainly focused on one specific environmental benefit provided by use phase of green roofs. In other words, the life cycle approach seems to be neglected in the above mentioned researches. As a matter of fact, only two studies adopting such approach for evaluating the environmental performance of green roofs, are currently available in journal papers. In fact, it has not to be neglected that like any other product, even green coverings carry the environmental weight of other phases in their life cycle. Therefore, although such building components provide a positive contribution to several environmental effects during their use phase, as above reported, it seems relevant answer to the following questions as well: what is the environmental impact due to their production, maintenance and disposal? In this paper, we address those questions with a case study in Sicily (Italy). In detail, it presents the results of a first implementation of the Life Cycle Assessment (LCA) of an extensive green covering system. The software tool used to develop this analysis is SimaPro. An obtained result is that the growing medium provides the highest contribution to the global warming (70%) followed by the water storage layer (30%), by considering raw material extraction and production phase of the green roof. Even if the LCA has already been applied to assess the environmental performance of green roofs, this study represents a further contribution because it has been implemented by collecting primary data from an experimental installation in a Mediterranean area.

SDWS2011.0836 Infrastructure, Tariff and Legal Action: How to Achieve a Climate-Friendly Transport System

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Abstract

The field of transport absorbs about 70% of oil consumption in EU countries. No other sector depends on oil as the traffic. The fuels that burn in the field of transport are composed of 96% of oil. Anticipating the exhaustion of sources and the consequent rise in fuel prices, it is must urgently find alternative solutions and significantly improve the energy efficiency of transport modes.

In other words, you have to transfer a major portion of traffic to rail, public and non-motorized transport modes, which are significantly more sustainable in terms of climate. But the energy efficiency of road and air traffic must also be improved.

The Green Group of the European Parliament set out broad objectives and fields of action for a sustainable energy policy on energy and environmental plans into the Declaration of Vienna "A sustainable energy policy in Europe" (2006). They also have focused his attention on the central substantive progress to be made in the transport sector. In this study, concrete actions are proposed to obtain a European strategy for reducing oil consumption, with effects on climate, on road and air transport, according to a sustainable mobility.

CO_2 reductions should be made necessarily through a transfer of traffic from the car, lorries and aircraft to train, ship, and two-wheelers in the city. In fact the former are large producers of greenhouse gases, while the latter are more environmentally friendly means of transport in climate. Reaching an annual increase of 1% of the modal split in favour of more sustainable means of transport on the environment must be set as a goal ecologic. All the EU measures on traffic should also be oriented in this sense.

Legal, infrastructure and tariff measures have to be proposed, in addition to technical measures (reduction of traffic, growth in the energy efficiency of vehicles, reduction of ravelled distances, improved logistics, etc.).

Legal measures refer to possible law limits in terms on fuel consumption and CO_2 emissions due to traffic set by the EU.

Infrastructure measures can be distinguished on the basis of the concerned territory. On the one hand there is the city, where it seems appropriate to move with intermodal chain, more secure and environmentally friendly. On the other hand there are fundamentally the suburbs, where investment in new transport infrastructure may be contradictory in terms of climate protection.

Tariff measures express the already established concept of "who produces pollution, he pays". the external costs generated by different modes of transport have to be progressively turned over to users.

SDWS2011.0905 A New Indicator for the Assessment of Road Traffic Air Pollution: a Case Study

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Abstract

In recent years, the maintenance of a high standard of living and services in urban areas resulted in a progressive deterioration of the air quality, primarily due to the high emission rates connected with the use of fossil fuels. Therefore, air quality in urban areas is strongly affected by the presence of several pollutants, most of which originated by road traffic. The urban area of the Italian city of Messina, located on the Sicilian cost, nearby the Italian peninsula, in addition to the traffic loads related to the local human activities, is also subjects to crossing traffic flows due to vehicles coming from the continent and directed toward other Sicilian centres. With the aim of lightening the traffic pollution load, affecting particularly the centre of the city, the public administration of Messina has adopted a measure, consisting in the displacement of the ferrying activity occurring between the two shores of the Messina Straits, from the harbour of Messina to that of Tremestieri, a small suburban district in the south of the city. In order to assess the effectiveness of the measure adopted, the present work reports the results of an analysis aimed at evaluating the variation in emission rates of major pollutants discharged by the traffic activity. The adopted methodology starts defining an useful specific emission function that allows easy determination of the total amount of pollutant emissions in a year. The parameter, called Yearly Average Vehicle (YAV), represents the mean yearly emission factor of a whole modality of transportation; it is computed for each pollutant and is referred to a specific year. In the work YAVs have been calculated for passenger cars and duty vehicles using emission data from European Environment Agency Copert 4 methodology and vehicle fleet consistency data from Italian Transportation Plan. Calculation were carried out for two different years, corresponding to the pre-and post operam conditions. The adoption of the YAVs has allowed easy different scenario assessments, taking into account different items that could affect results, such as improvements of emissive characteristics of vehicles, changes of the transportation demand and crossing path length variation.

SDWS2011.1011 Preliminary Experimental Analysis of a CHP Hydromethane System

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Abstract

The paper reports the experimental preliminary results carried out on the internal combustion engine set in CHP mode, fueled by hydrogen and methane mixture. This engine is integrated into the hybrid system developed at the "La Sapienza" Universitary Sporting Center in Rome which is one of the energy district included into the already launched project named Smart Grid at "La Sapienza ". The CHP is powered by a hydrogen-methane mixture and the hydrogen is produced in situ by means of a 5 kWp PV plant. The acceptance test conducted with hydrogen percentages ranging from 0% - 10% has been carried out at lower output than the nominal, 45 kWe out of 60 kWe. Without engine parameters optimization, such as air excess and spark advance, was noted slight increases in efficiency with increasing hydrogen addition rate; Thus, it is recorded that the methane consumption decreases disproportionately to the hydrogen amount in the mixture because of the engine control system operating. The engine reflects the change in the fuel and tends to offset the working capacity loss through the throttle valve micro-openings which operates an increasing of volume flow.

Referring to standard operating condition, CO and NOx emissions are reduced by 6.3% and 27% respectively by the use of a mixture of 10% hydrogen and having run the engine with 18 degrees spark advance and air index λ of 1.4.

With the completion of flue gas analysis system installation, ever envisaged in the project, will be possible to repeat the performance tests, run the optimization and provide data on the energy efficiency and CO_2 emission levels, in order to evaluate the environmental cost supported by comparing burdens resulting from environmental voluntary certification scheme.

SDWS2011.0772 Evaluation of Sustainability Indicators for Residential Buildings

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Abstract

Sustainability indicators are the essential characteristics for the energy evaluation of the residental buildings. It is of the significant importance for the assessment of the quality of life to devote special attention to the method for the selection appropriate indicators for the quality assessment of the residental buildings.

Cities are important consumers of energy and the largest share of total energy consumption is in a household sector. In this paper the method of selecting and defining of sub-sub indicators of sustainable development is shown. It was needed for the process of determining the level of sustainable development expressed through the index of sustainability of residential buildings.

In this respect special attention has to be devoted to the definition and procedure for the sub-sub indicators regarding to economic, social and environmental aspect. It is of the particular interest in the sustainability assessment to verify the procedure for the determination of the individual sub-indicators. In accordance to final energy consumption (for space heating, hot water production, cooking and the household electrical appliances) the selection, defining and determining the economic, social and environmental indicators are developed. It is done for several options of residential buildings (single family houses and multi apartment buildings).

Also, this paper shows the aggregation of energy indicators at all levels prior to a level that demonstrates sustainable development.

SDWS2011.0745 The Role of Passenger Modal Shift Nodes in the Interaction Between Land Use and Transport System

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Abstract

In the last years we have observed a sub-urbanization process or “sprawl” process (low density inhabitant models), caused by new economic and production conditions, by a free diffusion of new habitant models in territory, by new organization models of social relationships and by one-side power of road mode and in particular the private use. Commuters need to reach quickly own destinations and the traffic and parking problems

in central areas increase mainly the importance of multi-modal displacements in an integrated transport system between public and private mode.

Planner role should re-balance modal choice in favour to public transport and motivate passenger intermodality integrating the private car with transit.

The optimal location and design of modal shift nodes for potential users involved in multimodal transfers in a urban and metropolitan context, is one of the most important issues in transport system design and planning.

The aim of the proposed research is to analyze the attractiveness towards passenger modal shift nodes in relation to their potential territorial role and the optional services they can offer, which are relevant in vast urban areas.

In particular, the metropolitan area of Palermo, and its outskirts which is taking the connotations of a large expanded city, will be a good case study to verify the effectiveness of the proposed strategy. In particular, some quantitative indicators about the accessibility and the territorial role of the nodes will be used in order to estimate the role of the passenger modal shift nodes for developing a sustainable transport system.

Special session: Utilization of industrial byproducts towards sustainability

The aim of the proposed Special Session is to highlight the decisive role that utilization of industrial byproducts in new application fields plays to sustainability and exchange experience concerning how innovative research findings may be transferred to industrial scale.

Even though such cases and examples usually address to Coal Combustion Products utilized in the construction sector, the session welcomes scientists and experts from other relative fields.

CCP's are a very good example of byproduct's exploitation since more than 100 million tons are produced every year in Europe. Their application rate differs in relation to the different countries and products but approaches a mean value of 50%. The benefits that arouse from their use encourage the efforts in laboratory and industrial scale for the extension of their uses.

A holistic approach of the subject would also include:

- Development of new managerial methods and strategies for increase of the byproducts' utilization rate.
- Proposals for new business opportunities.
- Ways to target corresponding legislation towards the sustainable development of the countries.
- The session is open to scientists showing new and innovative methods and thoughts for recycling or reusing industrial byproducts in several application fields and also experts from the exploiting industries and companies with their approach to the specific issue.

Session organizer:
***Prof. Stamatis Tsimas**, National Technical University of Athens, Athens, Greece*

Professor Stamatis Tsimas is former director of Chemical Sciences Sector in the School of Chemical Engineers of National Technical University of Athens and former also director of the Laboratory of Inorganic and Analytical Chemistry in the same School. His major interests concern: i) the chemistry and technology of aluminosilicates, specializing in cement chemistry and technology, ii) the size reduction techniques and iii) the upgrade techniques of industrial minerals and byproducts with emphasis in Flying Ash. He is member of CEN WG11/TC51, member of International Committee for Concrete Technology in Developing Countries and National Representative in ECOBA`s European WG for the High Calcium Fly Ashes. Prof. Tsimas has published more than 100 scientific papers in International Scientific Magazines (acting also as reviewer in 12 magazines) and International Congresses obtained totally more than 250 citations. In parallel is the author of more than 60 technical reports.

SDWS2011.0158 Coal Combustion Products in Europe - Sustainable Raw Materials for the Construction Industry

H. Feuerborn[*1]

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Abstract

Coal Combustion Products (CCPs) are produced with the production of electricity in power plants fired with hard coal or lignite and partly also together with co-combustion materials. CCP is a synonym for the combustion residues boiler slag, bottom ash and especially fly ash from different types of boilers as well as desulphurisation products like spray dry absorption product and FGD gypsum. Each year about 100 million tonnes of CCPs are produced in the European member states. The production of CCPs has been increased by the years due to increasing energy demand and legal requirements on flue gas cleaning.

The utilisation of CCPs is well established in some European countries, based on long term experience and technical as well as environmental benefits. The CCPs are mainly utilized in the building material industry, in civil engineering, in road construction, for construction work in underground coal mining as well as for recultivation and restoration purposes in open cast mining. They are used as a replacement for natural resources. By their utilization they help to reduce energy demand and greenhouse gas emissions to atmosphere for mining and production of products which are replaced and to save natural resources. By this, the use of CCPs contributes to the sustainability of construction materials. Furthermore, the majority of the CCPs is produced to meet certain requirements of standards or other specifications with respect to utilisation in certain areas. In the standards and regulations definitions and requirements for siliceous and calcareous ashes are given. This is a pre-condition for successful use of CCPs as raw materials.

This paper gives an overview on the present situation of production and utilization of CCPs and the role of CCPs as sustainable raw materials. Impacts on CCP management by European regulations, political decisions of national authorities and by market needs in the construction industry in Europe will be discussed.

SDWS2011.0279 Full Probabilistic Service Life Prediction and Life Cycle Assessment of Concrete with Industrial By-Products in a Submerged Marine Environment: a Parameter Study

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Abstract

Given the considerable amount of cement related CO_2 emissions, it is necessary to develop durable concrete with a lower cement content. Partial replacement of cement by industrial by-products such as fly ash or blast-furnace slag (BFS) is considered as a promising way to reduce concrete's environmental impact. However, to date high cement replacements are not generally accepted because the impact on e.g. the chloride resistance of reinforced concrete is still insufficiently known. The rather strict limitations imposed by standards on the maximum fly ash and slag content, is an evident proof of this. Since durability and service life prediction are necessary inputs for calculation of the environmental benefit of these concrete types using Life Cycle Assessment (LCA), further research is needed.

In this research, we evaluated the chloride resistance of 2 concrete mixes with fly ash and 2 concrete mixes with slag using the non-steady state migration test as defined in NT Build 492. The cement replacement levels of the 2 concrete mixes with fly ash amounted to 15% and 50%. For the slag concrete, cement substitutions of 50% and 70% were applied. For the fly ash concrete, experiments were performed after 1, 3 and 6 months of curing at high relative humidity. The curing ages for the BFS concretes were 1, 2 and 4 months, respectively.

Results show that compared to the prescribed reference concrete for a permanently submerged marine environment (exposure class XS2), the fly ash mixtures are less resistant to chloride attack, yet often still in correspondence with the requirements of the Belgian standard NBN B15-100. Prolonged curing on the other hand, results in a substantially higher chloride resistance in comparison with the same reference. The migration coefficients of the BFS mixes are already lower than for the reference concrete after 1 month of curing.

However, as it is not clear whether the reference concrete has the minimum service life of 100 years for important marine structures, a mere comparison between concrete mixtures is insufficient. Luckily, the adopted chloride migration test provides us with the necessary input parameters for a full probabilistic service life prediction according to the Fib 34 Model Code. Monte Carlo analysis shows that acceptable probabilities of failure ($\leq$ 0.10) or reliability indices ($\geq$ 1.3) can be obtained for both the reference and the concretes with industrial by-products after 100 years. However, some input parameters of the model have an important impact on the maximum service life: the assumed critical chloride content (0.4-2.5%), the concrete cover (40-80 mm) and the aging factor (0.25-0.80). As a consequence, the LCA output for each concrete composition is also influenced by this

dependency. The effect on the environmental score was quantified using the LCA software SimaPro.

SDWS2011.0635 Sustainable Development in the Cement Industry Through Promoting Clinker Factor Reduction; the Effect of New Generation Scms

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Abstract

Despite considered a common approach to minimize the total CO_2 emissions (and cost) in the cement industry, the use of supplementary cementing materials (SCMs) is receiving continuous interest since such a large part of such additions are often sourced from waste and most of them have been established as quality solutions for the final product. However, producers of the most well-known SCMs are beginning to realize the value of their "wastes" and charge them at a point that their use seems not cost effective anymore. There is a need to explore new waste streams with pozzolanic (and/or latent hydraulic) character that could be (a) of continuous supply for cement milling, (b) of good strength profile and (c) free from any association with detrimental effects for the process (e.g. feeding problems, clogging) and quality (e.g. rich in heavy metals, too water demanding, etc.) of cement making. In the current study, four potential SCMs were evaluated, namely HCFA (high-calcium fly ash), classified HCFA, spent catalyst FCC and rice husk ash (RHA). A comparison is attempted herein based on their inherent physicochemical properties (i.e. active components, mineralogy, etc.) and effect on cementitious systems where part of the typical binder was equally replaced with the examined materials. HCFA is a cheap replacement that can impart adequate early strength but sporadically high free lime and sulphur contents inhibit its wider use. Classifying HCFA and using its ground coarse part leads to an excellent pozzolan of improved strength profile and diminished free lime and sulphur; however an extra cost is imparted due to sieving and further grinding. FCC is a strong pozzolan when finely ground however its availability is limited, while RHA exhibits good pozzolanicity and water demand but certain factors (like high unburned carbon) should be monitored carefully. The above can lead to a targeted utilization of those streams (where available) and a "tailored-made cement" approach should be employed to enable their wider absorption towards reducing the clinker factor that is currently within the primal aims of the cement industry.

SDWS2011.0144 Use of Steel Slag as Coarse Aggregate for the Production of Pervious Concrete

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Abstract

Pervious concrete is a new product developed mostly in the U.S.A, in the frame of protecting the environment and ensuring sustainable development. Its particularity lies on its high porosity, which allows rain water to pass through its mass. The environmental benefits arising from the use of such products are summarized to: the management of rainwater, the prevention of flooding and the enrichment of underground waters.

To achieve the high porosity of this concrete, coarse aggregates are mainly used with a little or no participation of fine aggregates.

The present paper comprises an approach to the addition of steel slag (the industrial byproduct coming from metallurgical process of steel production) as substitute for coarse aggregates in pervious concrete. As far as this particular form of exploitation is concerned, steel slag has more porosity than the conventional limestone aggregates, which, for the production of the conventional type of concrete, constitutes a disadvantage, while for the production of pervious concrete it increases the main desired quality (water permeability). Also from previous research papers, the use of steel slag as aggregate for the production of non reinforced concrete increases the compressive strength.

The purpose of this paper is to prove that recycling industrial wastes are indeed an opportunity for the industries and that will be proved through the evaluation of the use of steel slag and of C&D Wastes as aggregates in pervious concrete and the summary of the environmental and technological benefits of this use.

More specifically, three types of aggregates have been used: steel slag, construction and demolition wastes and conventional limestone aggregates. The produced pervious concretes are compared for their properties, such as water permeability, compressive and tensile strength and abrasion behavior. According to the results of this paper, it is observed that the incorporation of industry byproducts or of C&D Wastes leads to better abrasion behavior, and to the increase, in some cases, of the compressive and tensile strength and of the water permeability.

This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund.

SDWS2011.0720 Environmental Assessment of Concrete Incorporating High Volume of Industrial By-Products

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Abstract

The use of industrial by-products in concrete is of great importance for the sustainability of the construction industry as it needs to introduce considerable resource and energy conservation. Concrete may incorporate large quantities of fly ash and slag, which emanate from thermal power plants and steel industries, respectively. Provided that the effectiveness of these by-products is positive on the performance of concrete and mortars, this alternative seems to be not only cost-effective but also environmentally friendly. A life cycle inventory analysis in terms of embodied energy, virgin materials consumption and CO2 emissions is carried out on six different concrete mixtures with 30 MPa 28-day compressive strength and adequate workability (S2 slump category) containing different amounts of slag and fly ash. The environmental characteristics for each of the concrete mixtures are examined and it seems that the utilization of fly ash and steel slag in concrete has a positive effect on the environmental footprint of the produced concrete.

SDWS2011.0804 Earth-Block Building. an Energy Efficient Alternative for Rural Housing

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Abstract

Traditional earth block construction has been abandoned mainly because of the low bearing capacity of earth blocks, as well as low resistance to moisture and seismic vibrations. However, the benefits gained from the use of earth in construction, such as complete recycling, low energy consumption for the production and during service life, high health and comfort performance especially in hot med climates, make building designers to reconsider this type of houses and there are many fans of living in them in Europe.

In this paper, a model house made with earth-blocks is studied and compared to a conventional concrete-based house in a rural area of medium seismicity by applying energy efficiency regulations, cost-benefit analysis and life cycle assessment. Architectural details have been decided so as the facades to be less exposed to train than the conventional concrete-based houses. Compressed earth blocks with the addition of

cementitious materials such as slags and calcareous fly ash are considered as the main building materials. These earth blocks may be produced locally by small-scale manufacturers in order to have low transportation cost. Local soils may be used after testing their suitability. Techniques of improving compressive strength of soils such as compression or addition of sand, cementitious by-products and fibres may be used so as for the strength of earth block masonry to be increased and consequently the static stability of the houses.

SDWS2011.0748 Coal Combustion Products in Road Construction

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Abstract

The paper starts from a brief overview of the current status of utilization of ashes from power generation in road construction in select European countries: Poland, Germany, the United Kingdom, Portugal, the Netherlands, Greece and France.

CCPs may be used in road construction: as substitute for mineral soils, as hydraulic binders for soil treatment and stabilization, and as constituents of mixtures for making subbases and road pavement courses. Of these three broad areas of utilization, the paper discusses more in depth the use of fly ashes as hydraulic binders, addressing their technical properties, European technical standards for such applications, technology of stabilization of soil with a hydraulic binder, characteristics of soils suitable for this type of technology, as well as select design and execution considerations. Specific requirements concerning railroad bases are also discussed briefly in relation to similar requirements for road bases.

Several rail-and road projects are presented where CCPs were used in various functions, providing an overview of the most recent developments in Poland in this area in 2010.

Environmental issues of the use of CCPs are briefly discussed, with focus on REACH regulation and its consequences, as well as a point is made on abusive insistence on technical approvals by some administration, where declarations/certificates of conformity with existing European standards would be sufficient.

SDWS2011.0242 Reuse of By-Products from Ready-Mixed Concrete Plants for the Production of Cement Mortars

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Abstract

This study was motivated by the necessity to recycle sludge water resulting from washing out concrete mixing trucks, a problem of both environmental and economical importance for the ready-mixed concrete industry. Sludge water from ready-mixed concrete plants and dry sludge, deriving from it, are hazardous for disposal, due to their high (over 11.5) pH value.

The object of the study was to reuse both sludge water and dry sludge in the production of fresh concrete and to determine if the characteristics of the water or the sludge affect on the properties of the produced concrete. To be able to study even small differences in the properties of the products, cement mortars were produced instead of concrete specimens.

In order to examine various characteristics of the sludge water, a large amount of water samples was collected directly from the washout of the truck drums and all samples were treated differently. The purpose of this procedure was the production of samples with a variety on pH value, Cl^- content and total solids content. All water samples were used for the production of cement mortars. Additionally, samples of sludge were obtained from the bottom of a water collecting tank, in a ready-mixed concrete plant and were pretreated (drying and grinding) for further use. Similarly, sludge samples were used in various percentages and water/cement ratios as cement fillers in producing cement mortars. All cement mortars were tested for their workability and mechanical strength and demonstrated very promising results.

Selectively, this study shows that sludge water when used with all its content in total solids as cement mixing water can exceed even by more than 10% the mechanical strength of a cement mortar produced with tab water. Moreover, dry sludge, due its fine characteristics was proven to be a perfect candidate as cement filler. The explanations of the results obtained are discussed extensively in the paper. In summary, this study demonstrates that sludge water and dry sludge can be used entirely in concrete production, not only without degrading the quality of produced concrete, but improving its properties.

SDWS2011.0376 Precise and Quick Determination of Silica in Industrial and Agricultural By-Products for the Production of New Additive Value Materials

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Abstract

The concept of sustainability dictates that by-products are to be used as raw materials or fillers for the production of new materials of additive value. Rice Husk Ash (RHA) and Hellenic Lignite Fly Ash (HCFA) both industrial by-products derived from local rice production plants and energy production power plants respectively. RHA and HCFA which primarily consist of crystalline and amorphous SiO_2 can be used in the production of zeolites, cement and waterglass. Previous researches have shown that it is important to determine the structure of silica for further contribution in the production process, thus, the precise determination of silica is a crucial issue. The main goal of this paper is to contact a comparison between the methods widely used for the determination of silica: analytical methods (EN 196-2) and instrumental analysis (X-Ray Diffraction, XRD and Infrared with Fourier Transformation, FTIR)

Samples of RHA of various types of rice and of various processing conditions (burning temperature, boiler pressure, burning time) were chosen. Due to the low temperature process of the RHA production a further thermal pre-treatment (500 to 1000^{o}C for 30' to 3h) was necessary in order to increase the relative amount of silica and study any further increase in crystallinity. The T^{o}C deformation of silica was detected by Thermogravimetric analysis. Subsequently, the quantification of both forms of silica with the chemical method, XRD via Rietveld method and FTIR was done.

Fly ashes were collected from the electrostatic precipitators of the lignite-fired power stations of Greece both classified as high calcareous ashes (Class C). The characterization of samples was done by X-Ray Fluorescence (XRF) and Scanning Electron Microscopy (SEM). HCFA also had to be quantitative determined in respect of both silica forms by the three methods mentioned earlier.

The preliminary findings indicate that the chemical method produces lower values of crystalline silica, which can be attributed to the fact that it is calculated by subtracting the amorphous form from the total silica, but nevertheless is a very time-consuming process. FTIR although faster, is unappealing in relation to composite industrial samples due to the interaction of the different components of the sample, since it requires the creation of standard curves from known-concentration samples, in order to obtain the results. In the XRD method the amount of amorphous silica has to be taken into consideration during the normalization with Rietveld method.

SDWS2011.0243 By-Products: Oil Sorbents as a Potential Energy Source

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Abstract

The current tendency to characterise several waste materials as by-products motivates the development of new application fields for them. The present study aims at developing a new environmental application field for an inorganic waste material, lignite fly ash. The goal of the study is to address two severe environmental issues: the utilisation of an industrial by-product, whose production rises annually only in Greece up to 11Mt and greater amount (85%) is landfilled, and the treatment of oil pollution, with the further profit of energy production. In particular, the application of lignite fly ash in oil spill cleanup, in combination with an agricultural by-product, sawdust, and the further application of the resultant mixture in energy production have been investigated. Properties of both materials, such as the fine particle size, porosity and hydrophobic character of lignite fly ash and the high porosity and low specific gravity of sawdust make them attractive for such an application. The research consisted in mixing of lignite fly ash with sawdust in aqueous solution, drying of the resultant mixture, addition of the mixture to an oil spill in both dry and marine environment and evaluation of its behaviour, estimation of its oil sorption capacity and estimation of the higher calorific value of the resultant oil-lignite fly ash-sawdust mixture. Lignite fly ash-sawdust mixtures, containing 15-25% w/w sawdust, can sorb 1.5-2.9g of oil per gram in dry environment and perform better than each material alone, when added to oil spill in marine environment, since they form a cohesive semi-solid phase allowing total oil removal. The higher calorific value of the resultant oil-lignite fly ash-sawdust mixtures rises up to 29000-31000kJ/kg, which is comparable with the highest one of coals. In conclusion, lignite fly ash mixed with sawdust can find a new application field in oil spill cleanup and, furthermore, in cement industry, contributing possibly to both energy and raw materials saving.

SDWS2011.0581 The Effect of Particle Size on the Adsorption Mechanism of Zn2+ and Cd2+ from Liquid Wastes by Marble and Calcite Tailings

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Abstract

One of the methods of minimizing contaminants (heavy and toxic metal ions) from different aqueous solutions with a broad range of concentrations has been the infiltration

bed in order to remove these undesirable elements. In this research work marble stone (calcite tailings) which is a residual material from cutting and polishing of marble as well as limestone, in several particle size, are studied as substrates and estimate their effectiveness for Zn^{2+} and Cd^{2+} adsorption during the treatment of waste water and specifically of electroplating wastes. Determination of isotherm adsorption curves (Langmuir, Freundlich) and leaching tests support the thoroughness of the research.

Samples were collected from different areas of Greece and excavated from different depths. The samples were sieved and separated into four granulometric fractions each one evaluated in terms of its chemical, mineralogical, surface area and cation exchange capacity (CEC). Aqueous solution of 5, 100, and 500mg/L Zn^{2+} and Cd^{2+}separately and in combination were treated.

Concerning the concentration of the contaminants for Zn^{2+} the behaviour of the materials depends on the pH of the solution and the solubility product of the ions. The chemical speciation of Zn^{2+} is expected to be dominated by Zn^{2+} and in that case the amount of mesoporous and microporous of the mineral as well as the ionic radius of metal ion plays a significant role. In marble the fraction of 1mm+315μm reveals the better solution. Limestone seems to behave similar for the two middle fractions and the selection of the optimum conditions depends on the leaching process.

Concerning the concentration of Cd^{2+} the usual form of otavite is expected or co-precipitation with calcite. By occurring first by a very fast sorption reaction followed by a slower period of solid solution formation or surface recrystallisation in which Cd becomes permanently entrained in the crystal lattice. This fact is more obvious in largest concentrations where the time of 1h seems to be effective for equilibrium conditions. Results of leaching tests carried out and Scanning Electron microscope micrographs of the specimens confirmed the mechanism explanation for the retention of the metal ions.

SDWS2011.0262 Effect of Waste Activated Sludge Age on the Energy Production Through Gasification

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Abstract

The aim of this study was the energy utilization of the biological sludge that is produced in aerobic wastewater treatment plants through gasification. The most characteristic design parameter of the WWTPs is the sludge age, Θc. The fixed and operational costs are usually estimated based on the sludge age of a plant. In order to correlate Θc with the produced energy per unit of dry sludge, a laboratory aerobic treatment plant was operated. This plant produced biological sludge of any desired age. 10 g of this biological sludge entered a laboratory gasification unit that operated under steady conditions: final gasification temperature 800 ^{o}C, temperature increase rate 10^{o}C/min, gas nitrogen flow rate 5 L/h and moisture feeding rate 16 mL/h. The gas products of the

gasification process were determined quantitatively and qualitatively with gas chromatography and the caloric content of the produced gas was then calculated. In this work, the results of the elemental analysis of the biological sludge as well as of the produced energy in form of fuel per mass of volatile suspended solids in relation to Θc are presented. From the results it was concluded that the greater the Θc, the higher the carbon percentage that is transferred in the gas phase during gasification. So, for Θc =5 days, the percentage of the gasified carbon was 34%, while for Θc=70d, this percentage was raised up to 48%. Furthermore, the "older" the biological sludge, the higher the hydrogen production during gasification, and the lower the production of the rest of the gases (CO_2, CH_4, και CO).

Special session: Educating Engineers for Deep Sustainable Development

Many universities developed a specific course for SD. However, these courses are often rather marginal in the engineering curriculum. For real sustainable 'Sustainable Education", a next step is required. How could Sustainable Development become a guiding principle for an ongoing process of educational and research reform and university outreach?

The challenge is to change Sustainable Development from a new and often peculiar element in an engineering curriculum to a guiding principle for university strategy. That is a challenge for changing university culture but also for bridging the gap between the disciplinary depth of science and societal engagement. Societal engagement requires not just contributing knowledge that researchers think is useful for society, but also to listen to stakeholders and interact with them.

The session welcomes papers that analyse local processes of integrating SD in Engineering and Natural Science curricula and Engineering Universities, and reflect on the way forward to integrate sustainable development in engineering institutions.

Session organizer:
***Dr. Karel Mulder**, TU-Delft, Delft, Netherlands*

Karel F. Mulder (1956) is head of the group Technology Dynamics and Sustainable Development of the department of Technology Policy & Management at Delft University of Technology. He received an engineering degree from Twente University, and a doctorate in Business Administration from Groningen University in 1992. He was in charge of a project to include Sustainable Development in all engineering curricula at Delft University of Technology from 1997-2005 and initiated the European Engineering Education in Sustainable Development network. He wrote Sustainable Development for Engineers, A handbook and Resource Guide, Sheffield: Greenleaf, isbn-10: 1-874719-19-5. His Research interests focus on technological innovation and SD.

SDWS2011.0463 Corporate Education for Green Manufacturing from the Discourse of Sustainable Development

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Abstract

Purpose - The purpose of this paper is to present the basic elements of the research which is directed towards the development of models for learning and training of employees for green manufacturing in modern business organizations.

Design / methodology / approach - The objective was achieved through the operationalization of the following major tasks: the theoretical research on the specific characteristics of the development of modern business organizations from the discourse of environmental protection and realisation of sustainable development strategy; reviewing the possibilities of implementing the system of environmental management (ISO 14001) in the system of organizational management; directing the management of an organization, the development of tools for reducing adverse environmental impact and establishing green production. Beside the theoretical approach to the research problem, an empirical study of educational needs of employees for environmental protection in certain Serbian companies was conducted. The observation and description of best practices of corporate learning for environmental protection in some modern and internationally-known business organizations were made as well. Findings – Our findings confirm the need for the transformation of existing organizations into learning organizations as a prerequisite for realisation of green manufacturing industries. Comparative analysis of examples of good practice has helped to identify the benefits achieved in companies by the improvement of corporate learning for sustainable development and environmental protection. Research and practical implications - Implementation of research tasks are to realize immediate implications for development and implementation for training and teaching staff for the protection of the environment in modern business organizations in accordance with modern environmental standards and principles of sustainable development. The practical implications relating to the creation of organizational, programmatic and methodological structure, training of employees for the protection of the environment that will enable the appropriate transfer and dissemination of knowledge in this field. At the same time, research opens up new tasks that are directed to the constant questioning of corporate policy and thinking skills that we need for tomorrow's world and a sustainable future. Originality / value - This paper presents the information about new alternatives for teaching and learning of employees in corporate systems. It offers the reader new approaches to development of green manufacturing and modelling the corporate behaviour in accordance with the strategy of environmental protection and sustainable development principles. Key words: corporate education, learning, green production, sustainable development, environmental management system (EMS).

SDWS2011.0542 Developing a Sustainability Thrust in Mcmaster University's Engineering Programmes

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Abstract

McMaster's Faculty of Engineering's strategic plan (Engineering a Sustainable Society) calls for the undergraduate educational programmes to have a focus on social, environmental and economic sustainability. A task force on sustainability in engineering education has been given the responsibility for developing and implementing this focus. The objective of this paper is to describe some key aspects of the process for ensuring that engineering curricula have a strong focus on sustainability.

The task force has determined that engineering graduates will need to have five sustainability-specific competencies (triple bottom line, metrics and tools, stakeholders, ethics and responsibility, and complexity). The target levels of learning required for each of the competencies has been established using Bloom's taxonomy; all graduates will be required initially to have achieved learning at the second (understanding) level with the expectation that a significant proportion of graduates will have learning well beyond that level, i.e. at the fifth (evaluating) level.

Courses in the engineering programmes are being evaluated to determine the current actual learning levels being achieved in these five competencies. The paper describes the achieved learning levels and associated learning outcomes for three types of courses: i) a design course taken by all students in the first year of their engineering programme, ii) discipline-specific courses with a significant sustainability orientation, and iii) a multidisciplinary senior capstone design course. The achievements in these courses form the basis for a discussion of the potential implications for engineering curricula to be able to reach the target learning levels.

The paper also discusses the development of a "sustainability culture" among engineering students and faculty members.

The conclusions of the paper are presented in terms of the major curricular and cultural challenges needed to achieve a strong focus on sustainability.

SDWS2011.0812 Sustainable Development as a Meta-Context for Engineering Education

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Abstract

At the end of the first decade of the twenty-first century, there is unprecedented awareness of the need for a transformation in development, to meet the needs of the present while also preserving the ability of future generations to meet their own needs. However, within engineering, educators still tend to regard such development as an 'aspect' of engineering rather than an overarching meta-context, with ad hoc and highly variable references to topics. Furthermore, within a milieu of interpretations there can appear to be conflicting needs for achieving sustainable development, which can be confusing for students and educators alike. Different articulations of sustainable development can create dilemmas around conflicting needs for designers and researchers, at the level of specific designs and (sub-) disciplinary analysis. Hence sustainability issues need to be addressed at a meta-level using a whole of system approach, so that decisions regarding these dilemmas can be made. With this appreciation, and in light of curriculum renewal challenges that also exist in engineering education, this paper considers how educators might take the next step to move from sustainable development being an interesting 'aspect' of the curriculum, to sustainable development as a meta-context for curriculum renewal. It is concluded that capacity building for such strategic considerations is critical in engineering education.

SDWS2011.0703 Educating Engineers for Sustainable Development – a Workshop Approach

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Abstract

The United Nations Decade of Education for Sustainable Development (2005-2014) has, together with the increasing attention to climate change in the public and scientific debate, fostered increasingly focus on integrating sustainability in educational activities on all levels. Within the field of science and technology, the political pressure is ever more distinct to provide sustainable scientific and technological transformations to decouple the increase in problematic environmental and social impacts from economic growth, and secure a balance between the three pillars of sustainability. Therefore private

companies and engineering education institutions are facing new challenges to integrate sustainability into their mindset and practices.

This paper reports on two workshop experiments at the Danish company Grundfos Management A/S with the purpose of educating product developers to integrate sustainability in their product development thinking and practise. These experiments are discussed in relation to eco-design theory, and on this foundation a workshop concept is developed including four types of workshops: 1) Consequence assessment workshops; 2) Strategic workshops; 3) Creativity workshops; 4) Tool appropriation workshops.

From that point the pedagogical implications of the four types of workshops is discussed, considering both work based learning and learning in a formal educational set up. The workshops have two common characteristics; they are designed to enhance knowledge, skills and also competences to integrate sustainability into product development thinking and practise; and they are designed in modules in order to enhance flexibility in the educational design. This paper thereby contributes by a workshop concept developed by relating the results of an empirical investigation of sustainability training at the workplace to theory of eco-design and active learning in engineering education.

The conclusion is that the workshop concept as a whole is shaped to work based on learning. The transfer of the concept into formal educational will require an educational model based on active learning principle; whereas some of the modules can be recommended even on a course level in more traditional educational systems. However, the practical implementation of the workshop concept in formal engineering education, is yet to be explored.

SDWS2011.0225 The Sociological Dimensions of Education For Sustainable Development

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Abstract

The process of sustainable development is inherently a process of breeding values, rising awareness and learning with which we, if we choose to, can develop human capabilities, institutional and other capacities to live in a more sustainable manner. In this paper, we shall display in short outlines some processes in the global planetary system (global warmng, the extinction of species, the imbalance between between growth and the environment) which give an education on sustainable development the status of an urgent need. We insist on the differentiation between upbringing and education. Without an adequate ″axiological introduction″ there can be no adequate education for sustainable development. In our work we elaborate on our suggestion of the general content of the curriculum (ten primary topics) for the education of sustainable development. They are: 1. Life as a basic value, biophilia, affirmation of life and the living world as opposed to

destruction; 2. A will to act against ambivalence and apathy; 3.The interdependence of nature/environment, society, economy – ecological, socio- cultural and economic sustainability and the political aspect – self- definition formed from within; 4. The needs and rights of the generations to come; 5. The ″holding capacity″ of ecosystems and development, etc. The social modes of the process of upbringing and education for sustainable development are institutional and non – institutional, and the main social actors - real and virtual participants, (educated) actors and the distribution of work between them. The message of our work is that the development of lifelong learning for sustainable development requires new educational programmes, including programes in higher education, new institutions and new participants who will provide newvalues and knowledges. It won´t be possible to create answers to the challenges put in front ofus by current forms of unsustainable development without them.

SDWS2011.0457 Higher Education in Sustainable Development at the University of Valencia: Initial Diagnostic.

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Abstract

1. MOTIVATION FOR THE PAPER

All the university students should be educated in their fields of specialization according to criteria and sustainable values to reach the sustainability. To do this, the universities will have to acquire a central comprehension of the view of the sustainability so that students can consider this perspective in their future professional controls.

2. OBJETIVES

1. Reinforce the sustainability competences of those professionals with a university education

2. Promote teaching and research incentives to transform the relationships between society and the environment, and promote the prevention strategies and solutions to the problems causing insustainability.

3. Improve the interaction between the social demand of experts in sustainability in any domain and the training of university graduates.

3. WHAT WAS DONE

This research project answered this question by surveying teachers' attitudes at the Teaching School in the University of Valencia, where are formed in Early Childhood Education Teacher Degree and Primary Education Teacher Degree. The questionnaire contained 31 variables which were either dependent or related to the theme studied; there were 18 explicative or independent variables. The 31 variables relating to the themes were

classified into 4 categories: 1. Identification; 2. Perception; 3. Interpretation; 4. Performance.

4. HOW IT WAS DONE AND VALIDATED

In order to presents this paper for the broadcasting international, we selected the more general issues (Q 1, 4, 6, 8, 9 and 11).

The study population was the totally of the Faculty teaching at the Teachers School "Ausias March" at the University of Valencia, during 2007-2008, which were a total of 116 teachers. A total of 52 teachers answered the survey. The error level was 10.3% within 95.5% confidence level.

5. MAJOR RESULTS

More than a half of teachers surveyed believe that the introduction of content and approaches to sustainability in their teaching field may be an appropriate measure, and also says it is already doing.

It is significant that almost two thirds of teachers affirm that since the subject or subjects they plan and teach perform actions related to sustainable development that affect the personal lives of students and promote their participation in acts of solidarity.

6. CONCLUSIONS

• There is an erroneous conception of sustainability

• Being a concept / new field, the teachers seem to wait and see how it develops its implementation rather than having a more proactive role, considering that this role should come from academic institutions.

• For all the above we conclude the adequacy of research on introduction of sustainability in the curriculum being made both at the University of Valencia and in other universities and that they should continue

Special session: Measuring the Sustainable Development in the Energy Sector. Energy models between weak and strong sustainability

The IEA stated in the World Energy Outlook 2008, that "the world's energy system is at a crossroads. Current global trends in energy supply and consumption are patently unsustainable - environmentally, economically, socially. But that can - and must - be altered." A sustainable development is now regarded as a solution for present and future societal problems and Dennis Meadows defines "sustainable development is not the place where you are going. It is how you make the journey." Two sustainability concepts are currently being discussed to shape this journey: the weak sustainability and the strong sustainability concept.

Sustainability indicator systems such as Ecological footprint, Genuine Savings approach, Genuine Progress Indicator, and Energy Indicators for Sustainable Development of the IEA provide the measuring framework for this journey. The question of the measurability of sustainability is the key for the implementation of a sustainable development of the energy sector, because if current systems of sustainability indicators do not clearly signal that the economy is on an unsustainable path, policy errors will be made based on this data.

Energy models could provide the data for the particular sustainability indicators of the sustainability indicator systems. The model results thus deliver data and information for political measures for shaping sustainable development in the energy sector by avoiding policy errors and hence deliver orientation for the Meadows journey.

We are looking for all different kinds of energy models to measure sustainable development in the energy sector from the perspective of both the weak and the strong sustainability concept. We encourage both sector-specific bottom-up models and overall top-down models, such as Energy-economy-environment models, Engineering bottom-up models of energy systems, Socio-economic micro simulation models, Economic models of sustainable development (Overlapping generations models, Stochastic models, Neoclassical models, Evolutionary models, Ecological economic models, Models based on Input-Output analysis, Models of game theory), Multi agent models, Multi Criteria analysis models, Ecological footprint models. The models should thereby enable the analysis of the causal chain between energy policy and its economic, ecological and social effects and make a contribution to the issues addressed by the IEA.

Session organizer:
***Dr. Holger Schlör**, Forschungszentrum Jülich (Research Centre Jülich), Jülich, Germany*

Holger Schlör - Holger Schlör studied economics at the University of Heidelberg and went on to complete his PhD in Economics at the Free University in Berlin. His interest in economics and the idea of sustainable development has remained with him throughout his career. He has conducted research at several institutions and is currently working at Forschungszentrum Jülich in the Institute of Energy Research --

Systems Analysis and Technology Evaluation (IEF-STE). His research here focuses on the fields of sustainable development, economics and energy systems analysis.

SDWS2011.0155 Measuring Sustainable Development in the Energy Sector in Absolute and Relative Terms

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Abstract

The availability of sustainability indicators is a precondition for the conversion of the model of sustainable development into policy. Sustainability indicators define characteristics that are important for sustainable development. A single sustainability indicator defines a key issue, which characterizes a certain aspect of sustainability in the observed system. Sustainability indicator systems capture the complexity and order of the systems, and they offer new knowledge about the system that can be communicated to the general public. That is why in 2002 the German Government developed a sustainability indicator set for its Sustainability Strategy, including indicators for a sustainability energy system within this comprehensive strategy. The Government thereby defined a sustainable order for Germany on the basis of the theme-based sustainability approach.

The sustainability indicators thus have to measure the difference between the real and the normatively defined sustainability order: Do the individual preferences of society (households, enterprises) correspond to the sustainability order of the Government, is the implicit preference order of society congruent with the explicit order of the government as expressed in the national sustainability strategy?

The question of the measurability of sustainability is the key to the implementation of a sustainable development of the energy sector because as, Hamilton and Atkinson clearly expressed it: “If current systems of economic indicators do not clearly signal that the economy is on an unsustainable path, the policy errors will be made and perpetuated (Hamilton and Atkinson, 2006).” The Index of Sustainable Development (ISD) and the Relative Sustainability Index (RSI), developed by the authors, calculate the degree to which sustainability is achieved in absolute and relative terms. Whereas the absolute ISD measures sustainability from a science perspective, the relative RSI measures sustainability from the perspective of political decision makers.

Both indices show whether Germany is on a sustainable energy path according to the goals set by the German Government in its strategy, but from a different perspective. The indices enable us to compare the normatively (politically) defined sustainability order of the German Government (goals) with the actual “behaviour” of German society and with the interpretation of science and policy. Both indices enable us to answer the question of whether the German energy sector is “better off” in absolutely and relatively sustainable

categories. In a monitoring process, calculations of the sustainable indicators help us to understand where political action is needed.

SDWS2011.0396 Sustainability of the Energy Sector in the Mediterranean Region

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Abstract

According to the Brundtland Report (1987) a sustainable path "meets the needs of current generations without compromising needs of future generations". The Millennium Development Goals, approved by 189 countries in September 2000, and the Johannesburg Plan of Implementation, adopted in 2002 by the World Summit on Sustainable Development emphasized the need to change unsustainable production and consumption patterns, to protect and manage natural resources sustainably for economic and social development. The Johannesburg summit also called for regional and national strategies, in recognition that sustainable development cannot be achieved in isolation and that international prescriptions have to be adapted to local circumstances and to the conditions of the eco-region.

The 21 Mediterranean countries and the European Community decided, at the 12th Conference of the Contracting Parties to the Barcelona Convention (Monaco, November 2001) to prepare a "Mediterranean Strategy for Sustainable Development" (MSSD) to reconcile development and environment goals in Mediterranean countries through a wide partnership of nations and a common action plan. They requested the Mediterranean Commission on Sustainable Development (MCSD) of the Mediterranean Action Plan (MAP) to develop a draft of the Strategy.

The document explicitly mentions 4 priorities and 7 seven essential issues to deal with sustainable development in Mediterranean countries. Energy and climate change represents one of the seven essential issues mentioned by the MSSD. In the light of 4 objectives concerning economic development, the reduction of the social disparities, the sustainable management of natural resources and the improvement of governance, the MSSD sets specific quantitative and qualitative targets that Mediterranean countries should consider to follow a sustainable development in the energy and climate change sector.

In this paper we use the popular multi sectors and multi country integrated assessment model International Futures (IFs) to explore to what extent Mediterranean countries will be able to match the targets set in the MSSD over the future years. By implementing a scenario analysis based on assumptions concerning future policy scenarios and changes in the social and economic context we identify those factors promoting a sustainable path in the energy sector and discuss the relevance of the MSSD within the upcoming international challenges.

SDWS2011.0510 Modelling and Analysis of a Sustainable Global Development with an Integrated Assessment Model

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Abstract

The necessary change of behaviour as consequence of climate agreements and short resource supply herald the way for innovations such as the development of renewables in the energy. To reach ambitious and sustainable aims like the reduction of the risks of global warming it is necessary to consider possible ways of sustainable economic and ecological ways. Therefore sustainable system indicators also need to assess future development. One possibility to handle uncertainties and risks is via integrated assessment models (IAM). The frame of our model includes a global, worldwide level and the aggregate model considers a period and perspective till the year 2030. Single sub-modules have also been validated beyond 2030. In order to represent similar spatial and economic framework, the world is separated in regions, so-called agents. In this paper, we ask as to whether and how sustainable indicators can be integrated into IAM. Particluarly the global perspective and the requirements for future sustainable criteria may reinforce the use of measurable data like the gross domestic product as indicators.

SDWS2011.0622 An Ethical Framework on How to Assess Sustainability. Making Use of Sen's Capability Approach

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Abstract

There seems an unanimous consensus that sustainability rests on three pillars – an economic, an ecological and a social one. While there are widely accepted criteria as to how to measure progress or decline within the economical and ecological domain, it is – despite recent progress in the literature on sustainability - uncertain as to how to evaluate or even determine (at least some of) the social aspects of sustainability. Particular within for energy supply and demand, where the socially relevant side effects also touch on future generations, this constitutes a sever problem.

In this paper we explore as to how far practical philosophy may be of use in answering the question as to how to measure (social) sustainability in the energy sector. In particular, we explore the applicability of the so-called capabilities approach – a concept frequently used for evaluating human lives, dating back to A. Sen and developed further by M. Nussbaum and others. It is shown how the principles of the capabilities approach can be transferred to the assessment of sustainability.

It is argued that within an anthropocentric approach, economic wellbeing, an ecologically intact environment, and social aspects are but one aspect of the same final goal of evaluation. We depict some of the advantages of the capability approach as a normative framework for sustainability assessment compared to other ethical approaches. Moreover, we show how certain aspects of sustainability evaluation are reproduced by the capability approach while other new criteria and new foci emerge. It is depicted as to how to use a modified capability approach as an ethical framework for energy models.

SDWS2011.1003 An Ontology-Based Semantic Representation of Energy Policy Goals in the Optimisation of Electricity Generation Mixes

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Abstract

Energy models are optimisation tools which aid in the formulation of energy policies. Built on mathematics, the strength of these models lie in their ability to process numerical data which in turn allows for, among others, the generation of an electricity generation mix that incorporates both cost optimisation and emissions reduction.

Nevertheless, a comprehensive formulation of an electricity generation mix should include aspects associated with sustainability, an evaluation of which requires the consideration of a significant amount of non-numerical information. Unfortunately, the use of energy models for optimisation based on the evaluation of information other than numerical data is a complicated task.

For energy models to consider sustainability aspects, two prerequisites must be fulfilled. First, the information associated with sustainability in the context of energy policies must be identified and defined. Second, a new approach to optimisation-based energy model design, which considers both quantitative data and qualitative information, must be developed.

We have proposed a software framework which uses a semantic representation based on ontologies. Our semantic representation of the energy policy knowledge base contains not only quantitative data related to economics and the environment but also qualitative information related to social issues and politics. Goals associated with sustainability have been identified and defined using description logic. Our semantic representation is then integrated into a prototype energy model which formulates an optimised electricity generation mix.

This paper focuses on the codification of the energy policy knowledge base. It discusses the information which forms the knowledge base, the relationship of energy policies to sustainability and the ontological taxonomy necessary for the knowledge

representation. An example case study, which explores the influence of our extended set of policy goals on electricity generation mixes, concludes.

SDWS2011.1004 Environmental and Economic Sustainability Assessment of an Innovative Building Complex in Italy, Designed Through Energy Efficiency Coordination®

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Abstract

Both on legislative and research level, the attention is focused on the adoption of systems that aim for energy saving and use of renewable energies. The construction sector is one of the leading environmental issue, due to the exploitation of non renewable resources, land use, energy consumption relating to all stages of the life cycle and waste demolition, but also represents the area with the greatest potential for intervention. The coordination for the integrated design aimed to energy efficiency (energy efficiency coordination®) is therefore an efficient tool for sustainable constructions: structural-plant solutions that enable the achievement of an integrated approach to the problems related to needs of comfort and healthy housing, sustainability of the building process, control of energy consumptions and use of renewable resources.

In this paper the case of multifunctional building complex "Solaria" is described: a redevelopment project of a disused industrial area, approximately 20,000 m^2, located in the center of Ponte San Giovanni, a town in the immediate periphery of Perugia (Italy), conceived and designed in accordance with the logic above mentioned. An accurate study has been carried out on energy efficiency solutions and innovative experimental components, which synergistically integrated in a single project have enabled to reach important results, as demonstrated by the assessment of avoided CO_2 emissions. Moreover energy and environmental achievements have been certified by using various methodologies, including LEED Green Building Rating System; for its application a whole building energy simulation has been performed by the use of EnergyPlus soltware. Finally, an economic assessment in terms of cost-benefits have been carried out in order to compare the proposed approach with traditional ones.

The realization of energy efficiency solutions designed for Solaria makes the complex an advanced model, but also repeatable, of integrated planning, as well as a practical application of European Directives on the energy performance of buildings (2002/91/EC) and on energy end-use efficiency and energy services (2006/32/EC).

Special session: Future Sustainable Electricity Supply Grids mesh with Supplies for Heat, Cold and Transport

100 % electricity supply by renewable energies is content of several scientific studies. Nowadays, they exist for many countries or even transnational regions like e.g. the EU-MENA-region combining the electricity markets by large so-called overlay-grids. Today, it is not any more questioned whether it is possible to have a 100 % renewable supply or not. The controversial issue is more the best way on how to arrive there – the best future system configuration.

This special session does not want to answer this question about the best way. But the session wants to highlight the extremes between positions and to illustrate how heat, cold and transport are affected by different approaches to a 100 % electricity supply by renewables and to present current scientific discussions. Among these:

Centralized or decentralized? Renewable resources have the big advantage that they are widely distributed and that electricity could be produced by small and decentralized converters. On the other hand some locations in the world have better renewable resources than other locations and it is proposed to interconnect even continents via grids. What is best? Or is there a compromise in between?

Balancing renewables via energy storage, via large interconnected areas or via renewable overproduction? Most renewables are of intermittent nature. Anyhow, basically three ways could lead to stable electricity systems. Renewable electricity could be stored in times of overproduction in order to be used during times of underproduction. Renewable converters could be interconnected in order to better balance weather dependent generation. Or, when renewable generation is continuing with decreasing costs simply renewable overproduction could be the solution. What is the best way?

What are ways to sustainable transport? Electric vehicles? Fuel cell cars? The session will not answer this. But the balancing of future electricity systems requires storage. Depending on the storage requirements from the perspective of electric grid operation different opportunities can be derived for future transport: short-term storages in a day-night cycle might encourage electric vehicles with battery storage in so-called plug-in-hybrid operation mode. Long-term storage on a more seasonal cycle encourages hydrogen production or renewable methane production out of electricity and encourages more fuel-cell cars or (renewable) natural-gas cars. How does the electricity system provoke changes in transport?

With the requirement for seasonal storage in large quantities maybe only hydrogen production and storage or renewable methane production and storage are feasible ways to go. Especially the least one opens the opportunity to mesh electricity system with supplies for heat and cold – and this without changing the current infrastructures. How do storage solutions interact with heat and cold supply?

Session organizer:
***Prof. Ingo Stadler**, Cologne University of Applied Sciences, Cologne, Germany*

Dr. Stadler is managing director of the Institute for Electrical Power Engineering of Cologne University of Applied Sciences. Within in the institute he covers the areas of renewable energies and energy economics. Dr. Stadler is working since many years with the topic of electricity supply systems with high fractions of renewable energies. Among others he investigates demand response activities and non-electric energy storage devices in order to decouple electricity generation and consumption. In the European project "Dissemination Strategy on Electricity Balancing for Large Scale Integration of Renewable Energy (DESIRE)" it was investigated how fluctuating renewable energies can be balanced with CHP and thermal energy stores. Dr. Stadler co-ordinated the work package "Short-term solutions and long-term perspectives" - the technological side of the project. Within the second grid study of the German energy agency (dena II) it will be investigated on how high fractions of renewable energies can be integrated into the electricity supplies by energy storage and demand side activities. Within that project Dr. Stadler takes care about transition to a flexible demand side and integration of thermal stores in order to improve flexible electricity generation. Additionally, Dr. Stadler has been German's expert for "Stand-alone and Island Applications" in the Photovoltaics Power System Program of the International Energy Agency (IEA) for a period of ten years. Here he dealt with electricity supply of communities that are not connected to the public grid.

SDWS2011.0557 Long Distance Transmission Systems for the Future Electricity Supply - Analysis of Possibilities and Restrictions

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Abstract

To transmit electric bulk power in an economic and efficient way over long distances up to several 1000 km it is necessary to use Ultra-High-Voltages (UHV), i. e. AC-voltages of 1000 kV and DC-voltages of ±800 kV or higher. Especially the UHVDC-transmission is one of the key solutions to transmit bulk power over very large distances. Two bipolar systems with transmission voltage of ±800 kV, transmission power up to 7200 MW and length of up to 2000 km are in operation in China since 2010 and additional systems especially in China and India are planned. So it seems that the UHVDC technology is state of the art and can be used easily. But there are some restrictions which make it difficult to use UHVDC transmission in all cases. To analyze this in detail, in this publication the actual state of the art for long distance transmission systems (DC and AC) is summarized and the possible future development of the different technologies are analyzed. In a second part of the publication different aspects are discussed, which will limit the use of the UHVDC technology in future:

For HVDC-transmission with voltage higher than ±350 kV and transmission power higher than 1200 MV the classical HVDC technology with power thyristors as the main components for converting AC to DC must be used. This technology has some disadvantages, e. g. the need of voltage sources at both terminals and the need of reactive power, which make it difficult and expensive to build up a UHVDC transmission grid. Another limiting factor arises if overhead lines are not possible or not desired. The actual cable technology limits the transmission voltage to ±500 kV, which implies considerably higher transmission losses than in the case of ±800 kV. It is not expected that both aspects can be solved within in the next 10 or 15 years, so that the UHVDC transmission of electric bulk power over long distances seems to be limited in the next time to point-to-point connections using overhead lines.

SDWS2011.0558 Large Scale Energy Storage in Geological Formations

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Abstract

80 % of today's primary energy consumption is supplied by fossil fuels: coal, oil and natural gas. The high volumetric energy density of these fuels enables large volumes of energy to be stored or stockpiled to compensate for imbalances between the steady production of fossil fuels and the fluctuating consumption of secondary energy carriers such as electric power, fuel and heat. Climate change and the growing shortage of fossil fuels mean a change in future to a growing share of renewable energies - with an important role being played by wind and solar power. Both of these energy forms have one thing in common: large short term and long term seasonal fluctuations, no demand-oriented production, no means of storing the primary energy (wind, sun), and only limited means of directly storing the generated electrical power. Options for the required storage of the resulting power output at a grid scale in future are compressed air and hydrogen storage plants, particularly with man made salt caverns, usually used for natural gas storage.

This presentation introduces the current state of the energy supply chain including energy storage and its development in future to provide the base for the requirement of changes in the energy storage system. Large scale energy storage options are presented and compared by each other focussing on the underground as a storage option with a high volume capacity. Main issues are technical and economical characteristics, standard practice and future development, availability of suitable geological formations and an outlook for the future demand of large scale energy storage.

SDWS2011.0583 Integrated Planning of Electricity, Gas and Heat Supply to Municipality

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Abstract

This paper presents the results of a case study to investigate different alternatives for the energy supply to the municipality of Flora on the western coast of Norway. The following alternatives for energy supply are modeled and analyzed: i) District heating system with three different heat stations, ii) Natural gas distribution system and iii) Low temperature distribution system.

The case study is performed with the optimization model 'eTransport' which is developed for planning of local energy systems where several alternative energy carriers and technologies are considered simultaneously. The model minimizes total energy system cost of meeting demands of electricity, heating and cooling within a geographical area over a given planning horizon. The model uses a detailed network representation of infrastructure to consider investments in distributed components, cables and pipelines. The object function includes investments, operating and environmental costs over a planning horizon of several decades.

eTransport is separated into an operation planning module (energy system model) and an expansion planning module (investment module) where both economic and environmental aspects are handled. In the operation planning module there are sub-models for each energy carrier and for conversion components. The operation planning horizon is relatively short (1-3 days) with a typical time step of one hour. This module finds the cost-minimizing hourly operation for a given infrastructure. Annual operating costs for different energy system designs are calculated by solving the operation module repeatedly for different seasons (e.g. peak load, low load, intermediate etc), different investment periods (e.g. 5 year intervals) and alternative system designs. Annual operating and environmental costs for different periods and energy system designs are then used by the expansion planning module to find the investment plan that minimizes the present value of all costs over the planning horizon. Mathematically, the model uses a combination of linear programming (LP) and mixed integer programming (MIP) for the operation planning module, and dynamic programming (DP) for the expansion planning module. An alternative module with stochastic dynamic programming is also implemented.

Flora is the most complex case study performed with eTransport up to now, including electricity, heat, gas and cooling networks.

SDWS2011.0504 Consequences for District Heating and Natural Gas Grids When Aiming Towards 100% Electricity Supply with Renewables

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Abstract

The paper deals with a prediction for the future perspective of gas grids and district heating grids in Germany in 2050. Based on the latest request from the Federal Government for a progressive improvement of the heat insulation of the residential building stock the impact of a comprehensive passive house standard is analysed. In this context the role of decentralised combined heat and power (CHP) as well as heat pumps increases. Their specific application can perform a substantial contribution in combination with an aimed electricity supply with 100% renewable energy.

In 2050 there should be a power supply with 80% of renewable energy in the European Union and in Germany. The actual study deals with a power supply based on 100 % of renewable energy. At the same time the removal of the present residential building stock up to passive house standard is also aimed. In this case the heat output and the gas consumption will decrease significantly. The profitable operation of these supply infrastructures is questionable for the future. A power supply with 100% of renewable energy has considerable fluctuations between electrical production and electrical demand. To find useful compensation strategies is an additional task.

The investigation shows, that our actual heat supply can be increasingly moved by the conventional heat production to a supply with CHP and/or electric heat pumps. A partly separation of heat production and power production using an enlarged thermal storage system permits a current operation mode. Such a virtual plant can be used for the substitution of missing wind energy and solar energy. Thereby the demand of heat and electricity of the buildings can be covered and guaranteed. In connection with absorption cooling systems an additional degree of freedom can be created.

Using simulation programs like MatLab and Digsilent and investigations under real field test conditions the following scenarios are examined and valued:

- Gas and/or district heating grids are not profitable anymore. The heat supply is guaranteed by CHP or heat pumps.
- Gas and district heating grids are tied together by decentralised CHP. In conurbations the district heating grids are extended.
- Big district heating grids are split in several small district heating grids and are supplied with CHP in connection with thermal storage systems. New small district heating grids come into existence.

- District heating grids are also used for cooling production. In this case a combination of the scenarios 2 and 3 is examined.
- To obtain 100% of renewable electricity supply the CHP can be pursued only with "renewable methane". Which requirements does this scenario put to the gas grid?
- CHP arrangements are pursued in the group as a virtual plant. Which balance possibilities thereby arise?

SDWS2011.0926 Contribution of E-Mobility to a Sustainable Energy System

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Abstract

The ambitious goals for the integration of renewable energy sources require vital transformations of the energy storage, transportation and consumption sector. Focussing on the storage sector, several studies depict that a sustainable energy system will not rely on a specific technology. It is rather to expect that a diversified technology portfolio is necessary – combining centralized and decentralized storage systems - to cope with specific operating conditions and limited potentials of single technologies. Thus the potential role of electric vehicles in a future system configuration was evaluated. Since electric vehicles are compatible to electric energy systems, their market penetration affects the grid load and power plant schedules. The possible influence is assessed by simulating the charging loads of a vehicle pool. Hence further investigations had to be accomplished on the following fields: user mobility (according to empirical data of german mobility on household basis) grid connection (scenarios for future charging points in private and public areas) market integration (physical electricity transactions on the spotmarket, offering balancing power) Based on the results, several reference scenarios have been developed to create a basis for further simulation. A vehicle pool is randomly assembled by driving profiles which fulfill certain preconditions (e.g. average yearly mileage: ~12.000km, maximum daily mileage: 150km). In a next step, the grid connection points are defined (e.g. at home: 3.6kW charging/ 0kW discharging, at work: 11kW charging/ 11kW discharging). The marketing options both are a basis for economic evaluation and a potential trigger for a cost optimized charging strategy. The paper and the oral presentation aim at informing about potentials and restrictions of e-mobility in general. Furthermore the introduction of the simulation scenarios and the corresponding results give a more specific insight into the grid integration potentials. The authors would like to thank the German Federal Ministry of Education and Research (BMBF) for funding this study as part of the project "Fraunhofer Systems Research for Electromobility" under project number 13N10599. e.g. Dena: Analyse der Notwendigkeit

des Ausbaus von Pumpspeicherwerken und anderen Stromspeichern zur Integration der erneuerbaren Energien. Berlin 2010

SDWS2011.0608 The Integration of Transportation with Energy System in China

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Abstract

Energy security and climate change are forcing China to change its inappropriate energy structure. Today transport is the second largest contributor of energy consumption in China but with the fastest growth rate. No single method can achieve a fossil fuel independent transport and it is necessary to propose a comprehensive strategy which can achieve mutual benefits to both transport and energy system. This paper aims to evaluate different transport development strategies in terms of their effects on fossil fuel demand reduction and to explore to what extent can renewable energy contribute the transport sector. With this objective, a Chinese transport model has been created and three investigations were carried out in sequence. Firstly, the model has been used to calculate energy demand of transport sector in the reference years. The comparisons between calculation result and real fuel demand show the approach of model is reliable and the model can be used for further investigations. Secondly, two scenarios which are continued improvement (CI) scenario and accelerated improvement (AI) scenario have been designed and evaluated. The results indicate that evident fuel demand reduction can be achieved by formulated transport development planning but more alternative technologies and joint actions are need in order to change the fuel structure. Finally, a 100% non-fossil fuel transport was built up and analysed. The challengers of transfer to a 100% non-fossil fuel transport in China are not severe at least in the perspectives of domestic biofuels potential and transmission capacity.

Special session: Biofuels sustainability

Biofuels gain market as an energy source that can increase security of supply, significantly reduce greenhouse gas emissions as compared to fossil fuels and provide a new profits flow for farmers. However, many of the biofuels that are currently being supplied have been criticized for their unfavorable impacts on the environment, food security, and land use.

Sustainability of a biofuel needs to be guaranteed in a transparent way; this includes aspects such as the social and economic development of local, rural communities, land use, agricultural practices, competition with food, air quality, water resources, agricultural practices, labor conditions, energy efficiency and GHG emissions, life cycle analysis (LCA), etc.

The challenge is to support sustainable biofuel production, including the development of biorefineries, new second and third generation biofuels technologies as well as bio-hydrogen production systems in the most cost-effective way, with a commitment to improve production efficiency and social and environmental performance in all stages of the biofuel production system, together with responsible economic policies to secure that a biofuel commercialization is also sustainable. The session welcomes papers dedicated to different aspects of biofuels sustainability.

Session organizer:
***Prof. Vyacheslav Kafarov**, Industrial University of Santander, Bucaramanga, Colombia*

Viatcheslav V. Kafarov is the Director of the Center for Sustainable Development in Industry and Energy, the Professor at the Faculty of Chemical Engineering and the Director of Post Graduate Programs of the Industrial University of Santander, Colombia. He obtained a PhD. in Chemical Engineering from Russian University of Chemical Technology - D.I. Mendeleyev - Moscow, Russia in 1985, and Dr.-Ing. habil. in Technical Science at Martin Luther University Halle-Wittenberg , Germany in 1993. Since he entered at Industrial University of Santander in 1995 he develops research in the field of bio-diesel, bio-hydrogen, second and third generation biofuels production, sustainable development and Life Cycle Assessment for biofuels production, process integration and exergy analysis. He has been involved in a number of national and international research projects in biofuels and in sustainable development, most recently in international networks CYTED 306RTO279 - New technologies for biofuels production - UNESCO code 330303,332205,530603,330399 and CYTED 307RT0324 - Hydrogen: Production and Purification; Storage and Transport - UNESCO code 332202. He is author and co-author of more than 80 papers and 7 books.

SDWS2011.0113 Biodiesel Production by Non-Catalytic Supercritical Methyl Acetate Using Jatropha Oil: Optimized and Thermal Stability Study

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Abstract

In the present study, non-edible Jatropha oil was utilized in non-catalytic supercritical methyl acetate reaction to study the effects of reaction time, reaction temperature and molar ratio of methyl acetate to oil in producing optimum yield of Fatty Acid Methyl Esters (FAME) or commonly known as biodiesel. In addition, due to employment of high temperature in supercritical reaction, thermal stability of methyl oleate in supercritical methyl acetate was investigated. Besides, the influences of impurities normally found in oils/fats such as water and free fatty acids were examined as well. The experiments were designed by using Response Surface Methodology (RSM) analysis to investigate the effects of each individual variables and interaction among the variables on the yield of biodiesel. Results from optimization study showed that optimum yield of 71.9% could be achieved in supercritical methyl acetate reaction, with optimum conditions of 32 minutes for reaction time, reaction temperature of 400°C and 50 mol/mol molar ratio of methyl acetate to oil. Furthermore, the mathematical model developed was also found to be adequate and significant to predict the optimum yield of biodiesel. On the other hand, in thermal stability study, it was demonstrated that FAME is stable at low temperature and short reaction time while it was substantially reduced when operated at high reaction temperature due to thermal decomposition during prolonged reaction time. The effects of water and free fatty acid studies revealed that the presence of these two substances on the reaction has insignificant effects on the yield of FAME. As for conclusion, this study has shown that supercritical methyl acetate reaction is a promising new route in biodiesel processing with comparable performance relative to conventional methanol-based process.

SDWS2011.0435 Evaluation of Several Routes for Obtaining Fuels, Lipids and Monosaccharides from Third Generation Energy Crops Under Biorefinery Concept

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Abstract

As an oil refinery, a biorefinery uses all biomass components for obtaining high value usable products. Besides lipids, microalgae biomass contain significant amounts of protein, carbohydrates and other metabolic products. In the present study, the authors defines routes for obtaining monosaccharides and lipids from microalgae biomass of the Amphiprora sp. and Navicula sp., through the implementation of acid based cell disruption methods, Soxhlet extraction, Organosolv and transesterification in situ.

The routes were defined and compared based on the percentage of lipids and monosaccharides obtained. For acid hydrolysis route -Soxhlet extraction several times of acid hydrolysis and extraction were evaluated. The best results for this route were obtained using times of two and sixteen hours respectively. By Organosolv - Soxhlet extraction route, lipid efficiency obtained was 48% and in situ Transesterification the highest percentage of ART was 1.67%. Furthermore, kinetic parameters were determined for extraction and transesterification in situ for Navicula sp., Obtaining a constant K = 0.0003 for reducing sugars and K = 0.02 for degradation products. Using infrared spectroscopy the absorption peak compared relevant over time, which corresponds to the absorption of carbonyl group, characteristic of biodiesel. Organosolv routes - Soxhlet extraction and transesterification in situ - Soxhlet extraction showed higher production of lipids and monosaccharides, respectively.

SDWS2011.0790 Third Generation Energy Crops Cultivation Effect of Carbon/nitrogen Ratio

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Abstract

The effect of the carbon / nitrogen ratio in biomass productivity of Chlorella vulgaris was studied in laboratory-scale, by modifiying the acetate and nitrate concentrations in mixotrophic cultures. In order to find the appropriate carbon/nitrogen ratio which improves productivity, the concentrations of sodium nitrate in the medium were changed (0, 0.97, 1.94 and 2.78 mM of NaNO3) keeping steady the acetate concentrations used in

the previous stage. Nitrogen reduction had a positive effect on biomass production. There were also outstanding results using 20 mM acetate for all the treatments except 0mM. Results highlight the productivity observed at the 20 mM acetate: 0.97 mM nitrate (C: N 100:35%), which was higher in biomass and chlorophyll productivity. All treatments also had significant differences from the afternoon of day 1 until the end of the experiment. The best run (100:35) reached the maximum productivity (approximately 0.69 g L^{-1} day^{-1}) due to the metabolism of C/N in C. vulgaris.

This work it's part of the "Bioprospecting Colombian Microalgae for biodiesel production" code 2008D32006-6710 funded by the Ministry of Agriculture and Rural Development, with the participation of the Universidad Industrial de Santander, the Colombian Petroleum Institute ICP-ECOPETROL and Morrosquillo Institute Corporation.

SDWS2011.0912 Biofuels Sustainability Evaluation Through the Supply Chain

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Abstract

The transportation sector is currently facing tough challenges, mainly as a result of its overwhelming dependence on fossil fuels, in particular due to the current high and increasing prices, security of supply, and the need to reduce its impact on the environment, especially greenhouse gases emissions. The response to these problems is by no means easy, due to the significance of the transportation sector to economic and societal development, economic and/or environmental impact of potential solutions, and possible different local and international strategies for an efficient implementation of viable alternatives. Besides increasing the efficiency of transportation vehicles, for example using hybrid cars, the development and production of alternative fuels has attracted a lot of interest, particularly those based on renewable raw materials such as biodiesel and bioethanol.

From a sustainable development point of view, biodiesel and bioethanol produced from renewable resources seems to be a good option. However, the production of these biofuels raises their own problems. For example, the presently used feedstocks for their production are limited or they can interfere directly with the human food chain, either through the use of arable land meant to produce food or through the direct utilization of food crops used for their production. Another problem is the intensive deforestation that can occur to create new arable areas for the dedicated production of these or other innovative crops.

This work looks at the contribution of biodiesel and bioethanol to sustainable development using quantitative measures. A small set of sustainability indicators is proposed to evaluate and compare various biodiesel and bioethanol feedstocks through their supply chains. A comparison is made also with petroleum diesel and gasoline. Although this work does not attempt to identify which feedstock and/or process is the best, its conclusions may be valuable to practitioners and policy makers in making or supporting biofuels policies and/or implementation and development strategies.

SDWS2011.0914 Raceway Cultivation of Isochrysis Galbana for Biodiesel Production

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Abstract

Sustainable production of renewable energy is being hotly debated globally since, unfortunately, the first generation biofuels, primarily produced from food crops, cannot realistically satisfy even a small fraction of the existing demand for transport fuels. These concerns have increased the interest in developing second generation biofuels produced from non-feedstock. For that reason, biodiesel production from microalgae has gained renewed interest recently. The objective of this work is to explore the potential of producing biodiesel from an autochthon microalgae I. Galbana (T-ISO). For that reason, Isochrysis Galbana (T-ISO) was cultivated for biodiesel production. The system consisted of two methacrylate ponds, 11 mm thick. The pond has a base of 140 x 40 cm and a height of 40 cm.

The influence of initial concentration of inoculum, stirring and CO_2 supply on the growth of I. Galbana (T-ISO) were analyzed. The results indicated that the stirring improves the growth rate and the other two factors had no significant effect on final cell density.

After the culture, the obtained biomass was used to produce biodiesel by basic-catalyzed transformation with previous oil extraction. For the transesterification, the microalgal oil was mixed with methanol (12:1 methanol to oil molar ratio), and sodium hydroxide (1% g NaOH/g oil) and heated at 62 °C for 3 h in a reactor. The best culture resulted in a biomass concentration of 0.305 g/L with a FAME content of 12.5%. Thus, oil produced by I. Galbana should be a suitable feedstock for biofuel production.

SDWS2011.0928 Process Integration Study of a Biorefinery Producing Ethylene from Lignocellulosic Feedstock for a Chemical Cluster

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Abstract

The energy and material needs of human society are increasing while at the same time fossil resources are in decline and increasing greenhouse gas emissions are influencing the world's climate. In order to fight climate change and decrease dependence on fossil resources, fossil hydrocarbons in synthetic products and liquid fuels can be substituted by renewable feedstocks. One way to achieve this transition is the biorefinery concept, which involves the conversion of renewable biomass into a spectrum of marketable products, including chemicals, fuels, heat and electricity.

High efficiency is very important in order to profitably implement biorefinery concepts. Heat integration can help to increase the overall thermal efficiency of a biorefinery by distributing heat between sources of excess heat and heat consumers. Therefore integration of biorefinery concepts into industrial clusters can be advantageous for many reasons. Another advantage is that existing infrastructure such as piping, processing and storage facilities, Air Separation Units (ASU) and heat distribution systems can be utilised.

The chemical cluster investigated in this paper consumes a large amount of ethylene, of which 200 kt/year are imported. The rest is produced in an on-site conventional naphta steam cracker plant. One way to produce ethylene from renewable feedstock is catalytic dehydration of bio-ethanol. In the short term, it is likely that bio-EtOH dehydration for the production of ethylene will be established in regions with cheap access to bio-EtOH, e.g. Brazil, where ethanol has achieved BTU parity with fossil-based fuels. In Europe and the US this trend is expected to occur after the commercial introduction of lignocellulosic ethanol. Therefore the integration potential of a lignocellulosic ethanol plant is also investigated in this paper. Thus the paper investigates and quantifies the potential for heat cascading between a lignocellulosic ethanol process, an ethanol dehydration process, an dthe background chemical cluster, using Pinch Analysis as a tool.

The paper is based upon results from Aspen Plus simulations of the lignocellulosic ethanol and the ethanol dehydration process. These process models were used to analyse process integration opportunities using pinch analysis tools. Process integration possibilities on three levels were identified: internal integration each of the two separate processes, integration of the processes with each other and integration the two processes with the existing cluster. For analysing integration with the existing cluster, Total Site Analysis (TSA) methodology was used.

The study showed that internal energy efficiency measures like implementation of Mechanical Vapor Recompression (MVR) and Feed Effluent Heat Exchange (FEHX)

have large savings potential. Savings of up to 38 % utility steam by integrating the lignocellulosic ethanol production process with the ethylene dehydration.

SDWS2011.0929 Reactive Distillation for Process Intensification in the Biodiesel Production

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Abstract

Biodiesel is a sustainable fuel derived from renewable feedstocks such as animal fats, plant oils or recycled waste cooking-oils from the food industry. It combines sustainable characteristics with high performance and environmental benefits especially when it is obtained from cooking oils or non-edible oils feedstocks, which are less expensive and avoid the sensitive "food versus fuel" debate. Anyway, their high content of free fatty acids (FFAs) limits the application of the current commercial technology, the alkaline-catalyzed transesterification. In fact, the FFAs react with the catalyst to form soaps, thus consuming the catalyst, reducing the biodiesel yield and hindering the product separation.

The above problems can be overcome by treating the feedstocks with alcohols under conditions that promote the esterification. The esterification reaction of a fatty acid and an alcohol is an equilibrium reaction, which requires an acid catalyst, a large excess of alcohol to achieve a high FFA conversion and separation steps to separate the product from catalyst and unreacted alcohol.

The development of solid catalysts with enhanced activity is the main topic of current research on the subject, aiming to simplify the separation step of the process, the development of multifunctional reactors, which integrate chemical reaction with the in situ separation of products, being the following upgrading that can lead to an efficient large-scale production process.

Reactive distillation (RD) is a suitable way for process intensification when reactions limited by equilibrium constraints are involved, since one or more of the products are continuously separated from the reacting system. A RD unit usually consist of three sections: reactive, rectifying, and stripping zones. An accurate modelling is crucial to optimally design a RD unit.

In this work, the esterification of a fatty acid with an alcohol in the presence of a heterogeneous catalyst is simulated as a case-study using ASPEN Plus V 7.1. The performance of a conventional plug flow reactor was compared with that of a RD process. The proper kinetic data were taken from the literature and the RD simulation was based on the equilibrium stage model. The variation of some key process parameters such as the reactant feed molar ratio, distillate rate, reflux ratio, etc., is a useful tool that enables to point out the conditions when process integration can be advantageous in terms of esterification yield.

SDWS2011.0930 Design and Techno-Economic Evaluation of Biodiesel Production from Microbial Oil

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Abstract

Motivation for the paper: Sustainable utilisation of renewable raw materials including food industry wastes could be achieved through the development of viable bioprocesses and biorefineries. Biofuel and chemical production from renewable resources that do not compete with food crops will facilitate the gradual replacement of petroleum. The development of biorefineries for biofuel and chemical production will be based on the efficient integration of microbial bioconversions with chemical conversion processes. However, the sustainability of the technologies developed on lab-scale should be evaluated in order to assess their potential commercialisation. The evaluation should begin with process design and techno-economic evaluation to assess the production cost of the proposed process.

Objective: This work is focused on the evaluation of renewable carbon sources and specifically food industry wastes as fermentation feedstocks for the microbial production of single cell oil (SCO) that could be used as raw material for the production of biodiesel. In this way, vegetable crops could be replaced by carbohydrate-rich waste streams for biodiesel production. Design and techno-economic evaluation has been employed so as to evaluate the cost-effectiveness of this process.

What was done - How it was done and validated: The formulation of process flow sheets and the experimental results used in this study were taken from literature-cited publications. Different processes for the production of biodiesel via transesterification of microbial oil have been designed. The microorganism used in the fermentation stage was Rhodosporidium toruloides. Biodiesel production was carried out via direct utilisation of microbial biomass or through extraction of microbial oil from microbial biomass. The processing schemes that were evaluated utilise glucose- or starch-rich streams as raw materials. The design and costing study was carried out using the software SuperPro Designer (Intelligen, Inc.).

Major results: The processing options proposed for the production of biodiesel have been evaluated based on the same annual production capacity and operation time. The results demonstrate that the use of non-food renewable resources could become a viable option for biodiesel and/or chemical production. The biodiesel production cost from each processing scheme was directly related to the level of SCO accumulation during fermentation.

Conclusions: The results presented in this study propose ways of replacing vegetable oils for the production of biodiesel. The combination of experimental work with techno-economic analysis will indicate the processing routes for the production of biofuels and chemicals from renewable resources.

SDWS2011.0932 Consistent Assessment of the Energy and Economic Performance of Second Generation Biofuel Production Processes Using Energy Market Scenarios

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Abstract

This paper proposes a consistent way of assessing the energy as well as the economic performance of second generation biofuel production using energy market scenarios.The methodology is illustrated for production of synthetic natural gas (SNG) from biomass. Commonly applied thermodynamic performance indicators (such as first and second law thermodynamic efficiencies) for second generation biofuel processes do not represent the processes' complexity to a satisfactory extent. During biofuel production a number of products and services can be co-generated and the production process often requires import of additional energy services such as electricity and heat in addition to the fuel supply. This needs to be reflected by a well-defined performance indicator enabling a comparison between different process setups for a specific fuel alternative as well as between competing fuel products. A marginal production perspective is proposed for the definition of a general performance indicator in this paper, recalculating all services to primary energy and comparing the energetic value of all net input to output of the process on a system level as illustrated in the following equation:

$$eta_{sys} = (Q_{biofuel} + P_{el,exp} / eta_{el,elmarg} + Q_{heat,exp} / eta_{q,heatmarg}) / (Q_{wood\ fuel} + P_{el,imp} / eta_{el,elmarg} + Q_{heat,imp} / eta_{q,heatmarg})$$

The terms P_{el} and Q_{heat} represent the net power and heat import/export for the process under consideration and obviously appear only either in the numerator or denominator. Relating to the marginal production technology for the energy services makes it necessary to specify the energy system background against which the process under consideration is to be evaluated. In this paper the Energy Price and Carbon Balance Scenarios tool (ENPAC) developed at Chalmers is used for this purpose. The tool allows definition of consistent future energy market scenarios based on user input such as fossil fuel prices and charges for emitting CO_2. This makes it possible to outline potential cornerstones of future energy markets for the evaluation of the economic robustness of different process alternatives. An additional output of the tool is the marginal production technology for both heat and electricity with its corresponding state-of-the-art efficiency. This data is used as input for the performance indicator definition above thereby extending the capability of the tool by enabling a scenario-specific comparison of the

processes' thermodynamic performance. For scenarios with combined heat and power technology for heat production, the system efficiency definition becomes more complex as is discussed and illustrated in the paper. The usefulness of the approach is illustrated for production of synthetic natural gas (SNG) from biomass. The shortcomings of common performance indicators are also discussed.

SDWS2011.0934 Biofuels in Colombia: Present and Future

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Abstract

The high sun radiation levels and rich water recourses in Colombia are important factors for the competitive production of biofuels based on crops such as sugarcane, sugar beets, cassava, African palm and other natural feedstocks. These crops can be harvested for all year, thanks to country's climatic conditions. Colombia is the 5-th producer of palm oil, 7-th producer of sugarcane and 12-th producer of ethanol in the world. Currently, Colombia produces bioethanol from sugarcane and biodiesel from palm oil. Sugar mills and palm oil producers have the most organized and developed producer associations and scientific research centers. Fuel ethanol production started in late 2005 and palm oil biodiesel production in late 2007. Colombia's blending requirements are for 8 percent ethanol for gasoline and 8.5 percent biodiesel for diesel. Country has a high potential to increase the biofuels production, taking advantage of its natural resources and its capacity to extend the existent crops for biomass production without any deforestation. The perspective of biofuels in Colombia is promissory thanks to the government intervention creating the appropriate legislation to promote its production.

Nevertheless, if the biofuels production goals would be accomplished, Colombia will becomes in a bioethanol exporter and one of the Latin-American countries leader in the development of systems to produce energy from clean and environmentally friendly sources.

An analysis of biofuels modern trends and future needs, with basis in the existent legislation and including some aspects such as the sustainable development, energy balances, environmental impacts, use of renewable resources and social impact, was made in this work.

SDWS2011.0944 Bioehtanol Production and Power Generation for Co-Production

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Abstract

The reduction of carbon dioxide (CO2) emission has become a major target in efforts to suppress global warming. Biomass usage for fuel has attracted increased interest in many countries due to it characteristics. Especially, many researchers expect the possibility of bioethanol for substitution of petroleum. Bioethanol loses less energy and exergy potential during chemical reactions for ethanol production because it is produced through merely energy conversion by chemical reactions. However, after fermentation, the product contains a large amount of water, which prevents increasing heat value of product. Therefore, separation process of production ethanol-water mixture is required to get pure ethanol for fuel. In practice, distillation is widely used for the separation of this mixture. However, conventional distillation process is a well-known process as an energy consuming process and also pure ethanol as fuel cannot be distilled by a distillation column because ethanol and water form an azeotropic mixture. To separate pure ethanol from ethanol-water mixtures by distillation, it is necessary to use an entrainer (azeotroping agent). This means that it is necessary to separate twice and to get three products, leading to increased further energy consumption. As alternatives to distillation, membrane separations or pressure swing adsorption (PSA) have been investigated to achieve an efficient separation. However, in many cases, they have paid little attention to the overall process scheme or have developed heat integration processes based on conventional heat recovery technologies. As a result, the minimum energy requirement of the overall process has not been reduced. Thus, the price of product bioethanol still remains high as compared to fossil fuels.

Nowadays, by reconsidering the energy and production system from improvement of energy conversion efficiency and energy saving point of view, concept of co-production of energy and products has been developed. However, to realize co-production, it is necessary to analyze and optimize heat and power required for production in each process. To achieve coproduction, authors have been developed self-heat recuperation technology based on exergy recuperation.

In this paper, coproduction system of bioethanol and power based on self-heat recuperation technology is proposed and the relationship between energy of production and water content of biomass is discussed by using commercial simulator.

Special session: Understanding environment- society interactions for sustainable development

Consumer demands, human behavior, perceptions and objectives influence the way we (prefer to) arrange our environment. Changes in the environmental system may subsequently influence human demands and objectives. People and policy makers experience and observe events and developments in the environment, and respond (also influenced by external events, developments and the media) through acting in and influencing our environment. Environment and society are inherently interrelated. Better understanding of these reciprocal relations helps to explore the nature of sustainable or unsustainable decisions, allowing to adapt to possible unsustainable practices and steer towards sustainable transition pathways. It may help in exploring the (un)sustainability of strategies by looking at the strategy's robustness under several climate change scenarios and societal scenarios (changing perceptions). Making strategies not only climate proof, but also future proof.

Papers focusing on understanding (changing) human behavior (consumers, individuals or policy makers) in relation to sustainability issues are welcome. Multiple domains and topics may be discussed including energy, water, waste, agriculture and the building sector.

Session organizer:
***Ms. Astrid Offermans**, Maastricht University, Maastricht, Netherlands*

Astrid Offermans (MSc) studied General Social Sciences at Utrecht University, the Netherlands. She completed her Master-program 'Social interventions and policy' cum laude and with clear pass. In 2006, Astrid started working at the International Centre for Integrated assessment and Sustainable development (ICIS), Maastricht University, the Netherlands. She worked on the BSIK project 'Perspectives in Integrated Water Management' on the integration of research results from different academic disciplines and the development of integrated scenarios for water management in the Netherlands. In 2008 Astrid started her PhD on integrating social Perspectives into a methodology to assess the sustainability of different water management strategies. Her PhD is part of the Deltares project "perspectives in Integrated Water Resources Management in River Deltas". Besides, Astrid was also involved in the EU- MATISSE project where she worked on the integration of social and cultural values in (agent based) models for integrated sustainability assessments. In 2007 and 2008 she co-organized 'sustainable Tuesday' in the province of Limburg, the Netherlands, and in 2010 she co-organized an interactive simulation session at the conference 'Deltas in Times of climate change' in Rotterdam, the Netherlands to explore sustainable water management strategies under an uncertain future. Finally, she is a teacher of the course 'Sustainable development, an introduction' and teaches and coordinates the course 'Globalization, environmental change and society' at University College Maastricht, the Netherlands.

SDWS2011.0037 Interrogating Water Governance Approaches in India (The Case of Water Provision in the City of Hyderabad)

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Abstract

Population growth, the rapid pace and scale of urbanization, the large share of water used in agriculture, climate change, poor governance and resource mismanagement are some of the reasons commonly cited as being the roots of water scarcity. As a result of these driving forces, many urban areas such as the city of Hyderabad in India have difficulties to sustainably provide water for their citizens. Although Hyderabad has been supplied with a number of natural and artificial lakes and tanks, the demand for urban water in the city surpassed the available supply sources in the Musi catchment. Some low priority areas in the city receive water for a few hours on alternate days.

This calls for strategic water provision to sustain a healthy environment in cities and slums, and to meet basic human needs and rights by addressing the water scarcity problem. In doing so, there is a widespread recognition of the need for holistic and integrative approaches to water governance. Yet, the challenges of water governance are enormous when it comes to bureaucratic implementation, the sustainable management of water resources, and the provision of water services. Different interpretations of integrated management, competing interests among different sectors/stakeholders, power dynamics and lack of capacity building are some examples of the challenges facing water governance.

Focusing on the process of decentralization, this paper investigates the issues associated with water governance approaches in the state of Andhra Pradesh and the city of Hyderabad. Taking the complexity of interaction among actors at different scales and levels into account, the paper interrogates the core ideas behind the current contemporary approaches. The outcome of this qualitative research study is used to explore the water governance system and the potential entering points for societal changes towards sustainable transition pathways, and in this case, sustainable water provision for the citizens of Hyderabad.

SDWS2011.0089 The Role of Land-Based Sector Climate Change Mitigation in North East Scotland in Supporting Sustainable Development: Challenges and Opportunities

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Abstract

This paper explores the scope for Greenhouse Gas (GHG) emissions reduction and carbon sequestration in the rural land use sector (Land Use, Land Use Change and Forestry (LULUCF) in NE Scotland. It explores the interactions between the biophysical possibilities within the land use mix and the institutional and economic architecture within which policy instruments are designed and new land use practices undertaken, focusing on opportunities for new forestry planting as a means of reducing GHG emissions. Initial appraisal suggests that there is a significant gap between scoping estimates of biophysical and financial opportunities for carbon sequestration in the forest sector and the actual outcomes to date. The paper addresses issues in designing and delivering policies to support reduced emissions and increased sequestration in the LULUCF sector with reference to NE Scotland, given the Scottish Government's 42% reduction target for 2020. We draw on four recent studies undertaken by the authors to explore the farm-forest frontier and new forestry where carbon sequestration is a significant object. The prior research raises a number of important challenges which will be investigated in depth. The current evidence base is inadequate to determine farm level emissions with any accuracy owing to the limitations of spreadsheet-based carbon calculators but it is possible to build 'bottom-up' estimates which apportion emissions to different enterprise types. These estimates can be used to expose the intrasectoral composition of the regional greenhouse gas 'balance sheet' for the rural land use sector. The institutional architecture is only partly in place to support the needed changes, in that although the RDP supports afforestation, informal institutions and, in particular, farmer antipathy, militate against afforestation even on relatively unproductive farmland. Further, except where there are win-win options for the farmer, such as better timing of nitrogen application, there are no economic instruments to reduce emissions. Ground truthing also indicates that there are likely to be major efficiency gains in emissions reduction if tradable solutions are pursued. The scope for enhancing the policy means is considerable and, if rural land use sector carbon could be offset against farm-produced renewable energy, a flow of resource to the relatively disadvantaged hill areas would be likely.

SDWS2011.0244 Learning to Adapt to Climate Change in Participatory Settings

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Abstract

The scientific expectation for the future is that the climate will change. In what way and on what time scale is still under scrutiny, and remains a estimation at this point in time. To map possible developments in climate over the coming century, scenarios that describe possible developments of climate over time have been developed. By combining these scenarios with explorations of policy solutions to anticipated problems caused by climate change in a computer model, can help exploring consequences of possible solutions in the future. In order to find a long-term solution that also is supported by all stakeholders involved, exploring and understanding each other's needs and considering the perspective of another stakeholder may lead to a convergence in the problem definition. A common problem definition enables the process of finding a solution, that is supported by all the stakeholders concerned with the problem. To define this process of finding solutions for problems according to individual needs of stakeholders, the concept of social learning can be used. Several projects have aimed to integrate stakeholder perspectives through participatory methods, for example discussion groups, informative sessions, and games that simulate reality. The character of these sessions, whether they are intended to be informational, explorative, or aiming at creating a integrated understanding of a problem, also defines the possibility for the learning outcome. Combining the insights from social learning (how is learning in groups facilitated and how does it work?) and the way the interaction is given shape (how are participatory sessions set up and used in a problem-solving or explorative strategy?) provides a framework to analyse and predict social learning outcomes of participatory sessions.

SDWS2011.0538 The Dutch Dominant Perspective on Water: Risks and Opportunities Involved

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Abstract

Water management faces challenges to cope with future uncertainties in our environmental - and social system. Uncertainties in our environmental system relate to (changes in) drivers and pressures and their effects on the water system, like the effects of climate change on water availability. Uncertainties in our social system relate to changing perceptions, demands and objectives of various stakeholders.

Changes in our environmental and social system are often characterized by strong interaction; people observe and interpret changes in the environment and subsequently change their environment through their behavior or policy measures. Our view on environmental issues and the desirability of different goals and objectives is an output of what we have learned thought history and how we currently evaluate and balance people, planet and profit. These views, or perspectives, tend to be dynamic and changeable over time. Therefore we will also change our evaluation of currently chosen measures and their effects in the future. Given these perspectives dynamics, the challenge is to identify a (water management) strategy that is able to cope with uncertainties in our environmental system, but also with uncertainties in our social system.

To this end, paper presents the 'perspectives method'. Derived from Cultural Theory, this method aims to analyze and classify social perceptions and responses to provide more insight in the risks and opportunities involved in our current beliefs system. Furthermore, the paper reports on the results of an empirical research to assess present perspectives on water management among Dutch water professionals. 152 respondents filled in a comprehensive questionnaire, with a diverse palette of perspective related questions, varying from trust in technology, to the perception of drought, to the role of water in spatial planning. The results are analyzed via the perspectives method offering valuable information on dominant beliefs that are broadly shared among respondents, and sub-dominant (but significant) deviations from the dominant view. This analysis clarifies topics of agreement and disagreement among Dutch water professionals, and opportunities and threats for long term water management.

SDWS2011.0831 Scenario Based Learning Regarding Contested Articulations of Sustainability the Example of Hydropower and Sweden's Energy Future

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Abstract

Providing electricity from renewable sources is of key importance both to reduce depletion of fossil fuels and reduce emissions of greenhouse gasses. Many of the renewable energy technologies are not ideal for electricity networks. Reservoir hydropower is most ideal as it can store energy efficiently, and can be made quickly available in cases of peak loads.

Reservoir hydropower generation has considerable impact on the landscape. Reservoirs and dams are perhaps the most visible elements, but the effects of a regulated flow of rivers on the river ecosystem, and the ecology of the river banks, is considerable. In Sweden, hydropower has a long tradition of being an arena for environmental

controversy. Historically, various economic interests collided, but nowadays river basin ecology and sports fisheries are important issues to (Cf. Kaijser/Hedin, Jakobsson, 2002).

Swedish Government has high ambitions regarding climate change: it aims at becoming the first fossil free country within 40 years. Unlike the traditional image of Swedish society, there is no consensus on the hydropower issue but a fortified dissensus. An exchange of arguments on the issue is virtually absent.

This paper describes an experiment that has been carried out in the first half of 2010. A scenario approach was developed combining external scenario's and internal value based scenarios. Scenarios were developed to describe the future of (hydro-) electricity production in Sweden. The scenarios served as input for a stakeholder workshop. The main aim of this workshop was to contribute to the understanding that stakeholders have of each other's position and future world views and to reach clarity on the impacts of various options for hydropower development. The workshop was successful in terms of participation and evaluation of participants.

SDWS2011.0680 Public Perception of Risk on Nuclear Installations

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Abstract

Nuclear energy use is today notoriously dependent on public perception and opinion. Many OECD countries points out that nuclear energy will have a increasing role on the energy supply offer, in part due to its capacity to reduce risks of global climate change and local pollution. This directs to a case where experts are convinced of its importance on sustainability, while the public, often based on fear, rejects it. Moreover, public opinions are reinforced by growing evidences that there is no needed to be essentially rational to reach a correct decision. It is, however, broadly recognized that acceptance is the key to a nuclear renaissance.

When researching public opinion, the use of exploratory analysis seems to fit well the actual purposes for the scientific research and stakeholders decision needs. A previous interview with Brazilian public has provided some data for analysis, to investigate social groupings and sketch Brazilian's public opinion on nuclear energy use. This questionnaire was briefly structured in a way so that exploratory analysis could be possible. All 35 questions were to investigate the following aspects in the public: 1) Economic, religious and social profile; 2) Interactions with other sources of information; 3) Relevant circumstances on nuclear energy policy; 4) Cognitive factors; 5) Emotional factors and 6) Declared position on nuclear power plant construction. Aspects 3, 4 and 5 directly compose individual's decision on nuclear acceptance.

These aspects are defined in a conceptual map. This model's structure may change with the development of the exploratory analysis. Present models of risk perception recognize the controversial characteristics of risk, where it is assumed its subjective/objective duality. In the presented model, these subjective and objective

characteristics are well represented by the circumstances/emotional factors and cognitive factors, respectively.

Correlations are being tested with the help of SmartPLS software, using AVE (Average Variance Extracted) composite reliability statistic, among other calculations. Exploratory analysis was then performed with SPSS (Statistical Package for the Social Sciences) software and new groupings, when applicable, where added to the model.

Special session: Energy and Buildings Efficiency for Sustainable Future: from smart buildings to sustainable behaviors

The energy consumed in buildings in industrialized nations represents near half of the global energy consumption and the quarter of greenhouse gases emissions. This consumption could be seriously reduced by acting on the design of the buildings, including more efficient architectural choices, materials and equipments. But it can also be seriously limited by acting on the use of the energy through the energy management adapted to the inhabitants' behavior.

This session aims at reviewing challenges in designing energy-saving buildings and in using and managing smart buildings. The current scientific discussions among the followings will be presented in this session:

Design of sober buildings: How laws and labels can be decided and implemented to be a tool in order to reach the international commitments about decreasing of the energy consumption? What are the experience feedbacks checking the actual energetic performances of the used buildings? What are the potential energy savings all over the life cycle of a building?

Users' behavior: How energy efficiency can be improved by taking into account the users' behavior in the design of buildings? What kind of tools of energy management can be implemented in buildings in order to keep under control the energy consumption in one hand and to satisfy the users' requirement in the other hand? How to design and implement relevant services for energy savings?

Energy prices on the retail market: How to imagine, decide and implement new energy pricings for the retail market in order to induce the users to have sustainable sober behaviors? Different policies for energy pricing have been experimented. How to analyze the impact of such pricings upon the behaviors and the sustainability of the behaviors' changes if they exist?

The session is open for presentation of studies and projects dealing with energy in buildings. Technical studies of system design as well as economical and social studies of how to educate and incite changes in inhabitants' behaviors are welcome.

Session organizer:
***Prof. Mireille Jacomino**, Grenoble Institute of Technology, Grenoble, France*

Mireille Jacomino is professor in the Energy, Water and Environmental Sciences Engineering School at the Grenoble Institute of Technology, France. She is PhD (1989) from automatic control department of Grenoble. Between 2002 and 2008 she was vice director of the Electrical Engineering Scholl responsible for the design of the Energy, Water and Environmental Sciences Engineering School. She teaches automatic control, combinatorial optimization and discrete events simulation. She is especially interested in transferring her experiment in supply chain management to energetic systems. She is particularly implicated in the field of home automation energy management. She is involved in several research projects dealing with control both energy sources and loads

in order to deliver the right service to the user at the right time and the lower cost. Solar energy is particularly studied as local source for the buildings in connection with power grid.

SDWS2011.0337 Energy Plus Standard in Buildings Constructed by Housing Associations?

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Abstract

Motivation

The building sector is already familiar with the energy efficient designing and construction of single-family houses. Low energy standards are nowadays also penetrating the sector of housing estates. Nevertheless there can be a difference between the standardized and tool-based calculation of the energy demand done by the housing association and the real occurring energy demand influenced also by the users. In order to learn lessons from pilot-projects, a scientific monitoring is useful. Therefore a concept for a 2-year energy monitoring of an energy plus house designed and constructed by a housing association was developed and realized.

Objectives

The objective of this work is to evaluate, if the building designed and constructed by a housing association could achieve the energy plus house standard. From the view of the housing association the energy plus apartment house was defined as a building were the tenants do not have to pay for the operating energy costs and moreover can use a possible financial surplus for other operating costs. However, from a technical point of view an energy plus house produces more energy than is used for heating and electricity.

Method

The building (585 m², 6 apartments) has a specific heating energy demand of 9 kWh/(m².a) and is supplied via a semi central ventilation system with decentralized heat pump technology, meaning that only electricity is needed for heating and hot water production. On the roof there is a 9.45 kW_p photovoltaic plant (Sanyo HIP-210) which provides the generated energy to the public electrical grid. A monitoring concept was developed and realized, monitoring the electrical energy demand of the building, the electrical energy production by the PV-modules and thermal energy flows of the central part of the ventilation system (with supply air pre-heating and brine pre-heating) and of one reference apartment (decentralized ventilation system and brine heat pump).

Results

The monitoring is still in progress, however the first year goes from Dec. 09 to Dec. 10 and the results of this first year will be presented in the paper. Until now a first period of measurement longing from Dec. 09 to Apr. 10 was evaluated. It resulted in the fact that

18.4% of the electricity demand of the building could be covered by the PV. In this period the electricity demand was 12.238 kWh, whereas 2.262 kWh were provided to the electrical grid. The radiation on the tilted surface of the PV-modules was 21.467 kWh, resulting in an efficiency of utilization of 10.5%. From an economically point of view 49.1% of the electrical operating costs of the apartment house could be covered by the electricity which was sold to the electrical grid (costs: 0.15 €/kWh_{el} (assumed), subsidy: 0.40 €/kWh_{el} provided to the grid for 10 years).

This work should demonstrate and validate a first and practical step of a housing association towards one criteria of sustainability.

SDWS2011.0229 Eco-Design of Buildings Using Thermal Simulation and Life Cycle Assessment

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Abstract

Energy efficient building concepts have been developed and are further studied to reduce costs and improve comfort. Such buildings are designed to minimize heating, cooling and lighting energy loads, so that attention is now paid on the energy consumption related to inhabitants' behavior (use of appliances) and life cycle issues: fabrication of materials, construction, maintenance, dismantling and waste treatment. It is therefore important to study these aspects, both in new construction and renovation projects.

In this context, thermal simulation has been linked to life cycle assessment in order to evaluate a global environmental balance of a building and compare alternatives, constituting an eco-design tool. This methodology is presented, as well as validation elements in the form of inter-comparison of different models.

The application of this method is illustrated on a case study: two attached passive houses built in Picardie, France. The envelope is highly insulated and air-tight, ventilation being provided with heat recovery and an earth-to-air heat exchanger. A solar domestic hot water system and an electric heat-pump are also implemented.

The results show the contribution of different life cycle stages in the environmental impact indicators (e.g. energy demand, global warming potential, water consumption, waste production…) as well as the influence of occupants on the performance.

As a perspective, further research is planned regarding control strategies in such low energy buildings, accounting for the temporal variation of the electricity production mix and related environmental impacts.

In conclusion, the energy and environmental performance of a building depends both on its design and occupants' behavior. Quantifying impacts may help to identify priorities and provide decision makers with advice along the life cycle of a construction.

SDWS2011.0399 From the "Technical Energy Efficiency" Concept to a Human Centred "User Energy Efficiency" in Buildings

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Abstract

In the context of the engineering research of more and more efficient building, as passive house or Energy plus building, the occupants have become a central actor of building system. First because of the thermal impact as internal gains in those well isolated structure but also as energy consumer and building user.

In this aspect, the energy consumption is strongly link to user activity and requires to have a more global point of view of the system in order to success a well accepted energy management. In this way, the energy efficiency concept have to be specified in order to integrate also the use behaviour and use comfort

Through our platform PREDIS MIB (Management and Intelligent Building) which is a renovated building which is the result of and environmental process designing, we have study how the building system «take care» about the user variability in term of comfort, feelings, etc... Indeed, in this project we have analyse that first during the design process the question of how is the use in the building was not deeply study and the effort of study was to have an performing building, that is to say an small energy consumer building. But regarding the feed back after at least one year of living, we have seen that the engineering scope to have a building efficient was to the detriment of use adaptation. For example, lots of equipment settings have not take account use presence or use reaction, generating of lot of waste energy. By this way, we succeed to suggest some failures, «mis settings» and «mis design» of system regarding the use of it in order to avoid some over consumption and unacceptability from the inhabitants.

The purpose of the work we is to distinguish in energy efficiency concept the part link to settings and equipment efficiency (which we will call technical energy efficiency) and all the interaction concerning the service giving to user and how useful it is for the person(which we will call user energy efficiency. In this distinction, we'll refer to the end use efficiency and hedonic efficiency defined by A Lovins (Lovins, 2004). In fact traditional engineering aspect forget unfortunately the purpose of the system which is to give an service, preferring focuses on the pure energetic performance of the system.

Also, we suggest that our concept of «user energy efficiency» is defined as a multi-objective ratio between the comfort perceived and the energy consumption of the equipment or system.

With this consideration in mind from the design part of the building process, we expect to improve the acceptability, the use and also the energy responsibility of the user.

SDWS2011.0420 Heterogeneous Ipv6 Infrastructure for Smart Energy Efficient Building

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Abstract

In the context of increasing developments of home, building and city automation, the Power Line Communication (PLC) networking medium is called for unpreceeding usage. Our view of the future building networking infrastructure places PLC as the central point. We show in this paper that even if Wireless Sensors Networks (WSN) are good candidates in several cases of the sensor and actuator networking infrastructure, PLC is mandatory in several place of the smart-grid metering and command infrastructure. Also PLC will serve the infrastructure on the sensor/actuator side when the energy requirement cannot be fulfilled by autonomous battery and capacitor based nodes. PLC may provide the numerous bridges necessary to sustain a long lifetime (years) for the WSN infrastructures. This new role of PLC networking will be possible only if the inter-operability between all media and technology is made possible. Thanks to the design of converging IPv6 networking layers, we show that full inter-operability is already possible even in very tiny constrained networking devices. Moreover, low energy PLC, will be able to provide smart grid monitoring without impacting the overall energy balance.

SDWS2011.0481 Aspects Regarding Prediction of Housing Energy Consumption

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Abstract

Energy consumption in the residential sector represents an important part of the total electricity demand. In this context, a proper prediction of energy demand in housing sector is very important.

The purpose of this paper is to predict the next day energy consumption for different services in a house. The best monitoring interval for appliances is determined, also.

The energy consumption in housing is strongly related to human behavior which shows the need to take into account a priori knowledge (historical data) about the services. One aspect to be considered when predicting energy consumption is the type of service: temporary (e.g. oven, microwave, lightning) or permanent (e.g. refrigerator, freezer). For temporary services, the prediction refers to the starting probability of the appliances, while for permanent services, the aim is to determine the energy consumption.

The first step for predicting is to determine the best monitoring time interval in terms of getting the best prediction. An algorithm was developed for this purpose. Also, different data segmentations were proposed in order to improve the prediction.

The proposed algorithm is applied for temporary and permanent services in the house. The permanent services are expected to have a shorter monitoring interval and a better prediction. Also, the prediction will be improved after merging the data segments. A benchmark of houses have been used so that the proposed algorithms are performed in real life historical data.

SDWS2011.0495 Energy Integration of Systems Associated to Buildings: Example of a Mixed Cooling System

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Abstract

The necessity of setting up an effective world energy policy led industrial counties to fix as objective to reduce the consumptions or the CO_2 emissions of a factor 4 before 2050. The building sector represents an important part as well of the energy consumption as the CO_2 emissions. It is often mentioned that the improvement of the energy performances of buildings takes place in three steps: reduce heat demand, increase system efficiency, and use renewable energies. This approach is not satisfactory because it is also important to consider global energy efficiency and other criteria. It is the aim of “energy integration”.

As far as energy integration in the context of buildings is not well-defined, it seemed important to us to propose a definition «Operation to satisfy the energy demand in buildings by using a combination of heat sources and systems with the best global efficiency defined from energy, environmental, socioeconomic and life quality criteria ". Due to the complexity of this issue, only the use of numerical modelling and optimization tools allows to achieve energy integration.

It is a contribution to the energy integration of buildings as far as we do not consider simultaneously all the systems, the heat sources, the heat demands, and the performance criteria. We nevertheless defined and illustrated the method of energy integration with the example of a mixed cooling system for buildings. It’s based on a thermoelectric mechanical supply-exhaust ventilation system, and on a ventilation system using night-cooling. The performance criteria are the energy consumption, the comfort of the occupants and the financial cost. The numerical results were obtained thanks to the coupling of a dynamic simulation software of the energy systems (TRNSYS) and an optimization tool (GenOpt).

The interest to mix night-ventilation and a thermoelectric cooling is double. It allows on one hand to reduce the electric consumption of the thermoelectric system, and on the other hand to reduce the flow-rate for night-ventilation. The energy efficiency of modules

requires making a compromise between power and coefficient of performance. The approach of the energy integration is more global by considering three criteria of optimization: the thermal comfort of the occupants, the annual electric consumption (fans and thermoelectric system) and the financial investment based on the number of thermoelectric modules. The optimized parameters are based on the design and sizing of both systems: flow-rates during day and night, geometry of heat exchangers, number of thermoelectric modules and supply air temperature. The solution defined with the dynamic multicriterion optimization method takes into account strong interactions between both cooling systems. This global approach is more efficient than the usual approach which would consist in designing and sizing both systems in an independent way.

SDWS2011.0498 Smart Grid and Renewable Energy: a New Role for Homes and Offices But Also New Issues for Research

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Abstract

Homes and offices are key elements in the electric grid because they consume a large part of the electricity production in European countries (65% of the total electric consumption in France, for instance). Because of the increasing part of renewable energy in electricity production, which is difficult to control, consumers will have to become more involved in the grid management by reducing but also by adjusting their consumption in order to reach an equilibrium between production and consumption on the grid. Homes and offices represent the largest sink for demand side management. Other consumers are mainly companies; it is more difficult for them to control consumption because of timetable constraints. Globalized demand side management is constraining for home and office occupants because, without support, it leads to cognitive overload. Therefore, homes and offices should incorporate power managers through sensing and controlling capacity. Nevertheless, housing is quite a different application for control than others. Indeed, housing is actually a housing system comprising of a construction, appliances but also inhabitants, which is very dependant on the environment. Because of all these elements, it is suitable to assume that each housing system is unique from the power management point of view. Uniqueness of housing systems involves a set of new issues in control system science: it is necessary to develop new tools and algorithms for globally optimized power management of the home appliances, able to anticipate difficult situations but also able to take into account the actual housing system state and the occupant expectations. This global control approach leads to the concept of smart home, which is more ambitious that home automation. It should help to keep the balance between consumption and electricity production on the home scale but also at building,

neighborhood and grid scales. Smart homes should be able to take into account external signals, like energy prices or unbalancing orders, and to modify the home appliance behaviors to compromise between occupants's expectations and external actor wishes. Moreover, uniqueness also requires cheap installation and maintenance costs because economy of scale is not possible. It means that the new tools and algorithms will have to be easy to install thanks to auto-discovery and auto-learning capabilities, easy to reconfigure and easy to repair. These issues involve sensing capabilities and intuitive human machine interfaces. The proposed paper points out the new research area related to smart homes and offices with power management capabilities. Issues and examples of solutions for power management of smart homes will be provided in the full paper.

SDWS2011.0843 Advanced Platform for the Home Energy Management System (Hems) Development

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Abstract

Purpose of the work

Home Energy Management System is an important element of Smart-Grid development. The CEA-INES has developed a generic simulation tool for the energy management system. The developed software is called **M2C**, standing for **M**ulti-**M**odels Multi-**C**omponents. In this paper, the objectives and the proposed approach adopted for the development of M2C will be presented.

Approach

The objective of the M2C software is to develop an advanced tool for the energy management in general and Home Energy Management System in particularly. This tool can be used for sizing and simulating the different components of the system, but also for developing optimized control of the HEMS.

- Multi-components: M2C is able to consider different power system configurations. As a result, it offers the user the possibility to build its own system by defining its components from a models library, the simulation and control time frames, as well as the desired energy management strategy.
- Multi-models: Simplified component models can be used for computing the system control in a reasonable calculation time, while advanced models are used for simulating the operation of the different components, taking those calculated controls into account.
- Interaction with real equipment: Thanks for zigbee network; M2C could control the real equipments and the sensor system. In this platform, each physical equipment will be associated with a smart device, M2C will control this component thought home zigbee network.

Scientific innovation and relevance

In order to guarantee the possibility to consider a wide range of system configurations, the energy management platform M2C has been developed using an **acausal approach**: the components' state variables are determined at every time steps by solving an equation system modeling the energy transfer;

The system **control** is determined from the **energy management strategy** given by the user. Such optimization based control may take into account advanced forecasts of the renewable resource, the user habit.

The management of the simulation and control time frames makes possible the implementation of the M2C software for real-time control applications.

Results

The M2C software is now operational, and already includes a component model library which will be completed in the future. The first simulation results demonstrate the benefits from the optimal energy management for HEMS systems; also M2C has already been used for component sizing.

Conclusions

The objective consisting in developing generic software for the home energy management system including photovoltaic generation has been achieved. The M2C software is now operational and is used in many research projects carried out at CEA-INES for HEMS development.

SDWS2011.0288 Energy Efficiency Potential of Intelligent Lighting Controls in Buildings

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Abstract

As buildings are world-wide responsible for a large fraction of energy use (for heating, cooling, ventilation, lighting, etc.), efforts are necessary to improve their energy performance. Toward this end, better (more energy-effective) lighting systems and associated optimal control strategies could contribute not only to reduction of luminaires' electrical energy use, but also reduce buildings' cooling energy demand.

In this context, the present contribution specifically introduces a computationally-based energy performance analysis of a simulation-supported approach to lighting systems control in buildings. Using real-time sensing and numeric lighting simulation, this system can dynamically control the position of window blinds and the status (on/off, dimming level) of the luminaires. The control system possesses an internal digital representation consisting of room, sky, and occupancy models. The building model entails information about building geometry, furniture, location and size of windows, reflectance and transmittance properties of surfaces, as well as the position of virtual sensors that

monitor pertinent performance parameters such as illuminance levels, light distribution uniformity, or glare indices.

To explore the energy efficiency potential of this lighting control approach, five different control scenarios were considered and virtually implemented in an office building. Scenario one considers the use of luminaires during the office hours to achieve task illuminance levels of at least 500 lx, independent of daylight. The electrical lights are on during the working hours and no shading is deployed. Scenario two is similar to scenario one. However, in this case shades are deployed according to a predetermined schedule. Scenario three involves the use of daylight-responsive dimmable luminiares to achieve task illuminance levels of at least 500 lx. Scenario four is similar to scenario three. However, in this case the shades are deployed according to a predetermined schedule. Scenario five uses simulation-assisted lighting and shading systems control as per the above description. For these scenarios, the electrical energy use for lighting was computed and compared. Moreover, the implications of the scenarios for the building's heating and cooling demand were explored.

The results of this study show the considerable energy saving potential of the simulation-assisted control strategy. Moreover, this strategy provides a better basis for the integration of multiple performance indicators (including those pertaining to visual comfort, thermal comfort, and energy use) in the control process.

SDWS2011.0403 Energy-Efficiency Opportunities in the Residential Sector and Their Feasibility

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Abstract

Energy-efficiency improvement is a promising strategy to both achieve energy security and sustainable goals, particularly the reduction of CO2 emissions that contribute to climate change. Motivation for the paper is to address a question of what would be the real impact of energy-efficiency improvements on the reduction of GHG emissions through the deployment of energy-efficient technologies.

To begin with, the paper identifies global abatement opportunities to get an understanding of how efficiency improvements can impact on CO2 emission reduction, using DNE21+ model. DNE21+ is a bottom-up, technology-oriented, model in which the total system cost of energy is minimized for the period of 2000–2050 under various constraints, such as an economy-wide CO2 emissions cap and a carbon price imposed on some specific sectors. If the world were to successfully implement every negative- or zero-cost measure, their theoretical potential would be 8.9 Gt of CO2-equivalent in 2020 — about 20% of global emissions projected for that year.

A successful deployment of appliances with high efficiency will be a key to realize the potential because countries like India and China are expected to experience strong

growth in residential energy demand in the coming decades. These countries offer great opportunities to reduce CO2 emissions through deployment of highly efficient energy-using technologies. Achieving the full potential of energy efficiency, however, has proven elusive, due to a variety of factors, such as lack of information, people's bonded rationality, high initial costs of investment and energy subsidies. So, we discussed why and how much the efficiency gap exists, focusing on the several electric appliances, including refrigerators, televisions, lighting, and air conditioners. From an investment perspective, energy-efficiency choices fundamentally involve investment decisions and people implicitly suppose shorter payback period or higher discount rate in their investment decision. From an economic perspective, however, the energy savings usually outweigh the upfront investment, so that these opportunities carry a net economic benefit over their lifetime, even without any additional CO2 incentive.

Finally, we assess the impact of people's short term perspective in energy efficient investment. On the basis of a reasonably large literature review on implicit discount rate or payback period observed in people's purchasing behavior, sensitivity analysis was performed for the CO2-reduction potential of replacing all appliances with specific appliances that are already known to be cost-effective and energy-efficient. As a result, we found that consumer's short-sighted behavior hamper wider deployment of energy efficient technologies.

SDWS2011.0078 The Subjective View of Energy in the Urban Built Environment: What Are the Social Factors That Affect Our Interaction with Energy?

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Abstract

Retrofitting the UK domestic built environment presents an outstanding opportunity to cut CO_2 emissions, reduce national energy demand, and improve building performance. However, empirical data shows that post-retrofit energy savings are often short of their potential gains. A number of technical factors may help explain this gap, but difficult to quantify social factors are also significant and often under-emphasised in public policy. The research presented in this paper seeks to identify social factors relevant to energy consumption in the UK, and thereby improve our understanding of how home occupants interact with energy. For this research, the "Q Methodology" was employed and 64 "Q Statements" were generated from 118 returned questionnaires administered in Cambridge, UK. The broad social themes identified were: renewable/sustainable energy supply; retrofitting; energy conservation behaviours; and contentment with current energy consumption. The identified social barriers were: location of home; lack of knowledge; waiting for better performance/aesthetics; house restrictions (listed status or no cavity

walls); and occupant opposition. Future research will use these results as part of a wider "Q Study" to be carried out in Manchester and Cardiff.

SDWS2011.0157 A Contemporary Interpretation of Energy-Efficient Passive Environmental Controls in Buildings

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Abstract

The cooling energy demand in middle Europe is rapidly increasing, due in part to developments regarding climate change and urban heat islands. Conventional cooling systems are energy-intensive and problematic from the environmental point of view. Development of alternative (energy-efficient) alternatives for space cooling in new and existing buildings is thus of paramount importance both environmentally and economically. One innovative possibility to address this challenge is to explore the potential of technologically revisited and updated passive cooling techniques, which are primarily based on outdoor day-night temperature amplitudes and buildings' inherent thermal inertia. This possibility was explored within the framework of a recently conducted research project ("naturally cool"). Thereby the primary ingredients of passive cooling (thermal mass and amplitudinal variation of outdoor temperature) were optimally harnessed via a sensor-supported predictive (simulation-assisted) system control strategy.

The research project involved the prototypical implementation (and a two-year testing period) of the proposed approach in a real setting, consisting of three office spaces. Two offices were technologically adapted, where as the third office provided a reference case. Actuators were installed for the remote control of windows, shading elements, and luminaires. Additionally, in one office phase change materials as well as a ceiling fan was installed to probe extending both the room's thermal inertia and the adaptive thermal comfort range. The main objective of this prototypical implementation was the proactive control of relevant system components (window, shades, luminaires) such that overheating is avoided. Thus, even at relatively high outdoor temperatures, acceptable indoor climate conditions could be maintained on a near-zero energy basis (without the need for mechanical cooling systems). The predictive simulation-powered control approach operates as follows: the control unit regularly predicts (using numeric performance simulation) the indoor climate implications of various control options (i.e. alternative positions of the control devices such as windows, shades, and luminaires). The results of the parametric simulations are then compared and evaluated (based on the user-defined objective functions), such that an optimal control strategy can be identified and realized.

Project results indicate that a well-orchestrated application of the proposed strategy allows for the realization an energy-efficient, low-cost, and user-responsive alternative to conventional energy-intensive and expensive cooling systems in buildings.

Special session: Sustainability in Energy and Water supply in Developing Countries: a Humanitarian Crisis

Researching on technology for the environment and society is an essential activity within the research applied to International Cooperation for Sustainable Development.

We refer to "technology for self-reliance" for all the processes, the structures and the products aimed at developing a "sustainable design and development" finding the basis on technological principles, instruments and models.

This session aims at investigate on technology systems related to:

- Permanent area of crisis or of social tension both urban and rural;
- Rural and small scale solution for energy and water supply systems;
- No environment-impact energies in developing countries;
- Local chlorine production;
- Energy and Water supply systems for disadvantaged groups;
- Renewable energy small Enterprises and employment opportunities for disadvantaged groups.
- People become active actors in their lives without developing a dependence strategy. Self-reliance means building productive social relationship, but not dependent relationship. Self -reliance processes must guarantee the ecological and social self-reliance of its component.

From experience it is known that the sustainability aspect of energy and water needs is often not sufficiently addressed by those who provide assistance in humanitarian or natural crisis response operations in post-conflict and post-disaster situations. Despite the fact that the main emergency aid agencies and organizations have included substantial elements of sustainable energy and water supply in their policies and plans, implementation is often late or insufficient.

In emergency and post-emergency situations, many of them extended during several years and even decades, the environmental impact of the temporary settlements is often not recognized, in particular the use of wood and other biomass as fuel can be locally devastating. Energy supplies are usually not among the first priorities faced by relief agencies, which tend to focus initially on food, shelter, water and sanitation.

Sustainability has become a priority in international affairs, and on many regional, national, and local agendas. Though visions of sustainability vary across regions and circumstances, a broad international agreement has emerged that its goals should be to foster a transition toward development paths that meet human needs while preserving the earth's life support systems and alleviating hunger and poverty – i.e. that integrate the three pillars of environmental, social and economic sustainability. This

should be achieved through forms of governing that are empowering and also sensitive to the needs of future generations.

Session organizer:
***Prof. Andrea Micangeli**, Sapienza University of Rome, Rome, Italy*

Andrea Micangeli is an Assistant Professor, at CIRPS (Interuniversity Research Centre for Sustainable Development), University of Rome "Sapienza", he is the co-ordinator of "Autonomy and Environment related Technologies Research Unit" and Scientific co-ordinator of national and international research projects in Italy as well as at Saharawi Refugee Camps (Algeria), Gaza Strip, Solar Thermal energy in Venezuela, Uganda, Rwanda, Burundi, and in Italy the Solar Energy use in 15 jails in the last years he coordinated research and development project in Iraq (Water and Sanitation), Afghanistan (Autonomy for Disabled), on renewable energies against desertification in Chad / Cameroon and micro hydro in Chiapas (Mexico). Teaching Activities (at the Faculties of Engineering and Psychology and in 6 post graduation Masters) and R&D Activities in the fields of Renewable Energies and Local development are carried on within academic programmes and/or international emergency programmes.

SDWS2011.0292 Large-Scale Ecosystem Rehabilitation and Poverty Reduction Programmes: Ex-Post Sustainability Assessment of a Chinese Case Study

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Abstract

Environmental degradation and rural poverty entrenchment are often intimately interlinked and together comprise a major contemporary global challenge. Recent 'area development programmes' applying integrated watershed management approaches have purportedly achieved success in halting and reversing degradation across extensive areas, whilst also improving rural livelihoods. However, the evolving and modern nature of such large-scale participatory approaches means that whilst project sustainability may be postulated, there have been few comprehensive studies to assess enduring impacts beyond completion.

This paper presents an ex-post sustainability assessment of a case-study project in the People's Republic of China reviewed against (i) the project's own completion report sustainability statements; and (ii) a synthesised sustainability framework developed from a review of contemporary literature. The project performed soundly against both frameworks. Temporal and spatial impacts were evident ex-post, enhanced by the

project's initiation (direct and indirect) of regional policies; however some process-related components were identified as potential leverage points for future improvement. Emerging from the assessment, five key areas for potential future project focus are discussed. Further research is being undertaken to better understand emerging principles which may be applicable to other regions facing similar challenges.

SDWS2011.0442 Optimization and Lay Out of a Chlorine Self-Production Plant for Applications in Gaza and Tanzania

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Abstract

The purpose of this study is to optimize the energy consumption during the production of sodium hypochlorite via electrolysis process (OSEC:On Site Electro Chlorination) and make the energy process independent. One of the main objective is to assess whether it is possible to recover the hydrogen produced, usually discarded, during the electrolysis of a saline solution in order to use it in a fuel cell. The energy produced by such cells can be used to reduce the energy consumption of the production of sodium hypochlorite or other purposes. It was first made an evaluation of the possibility to make a purification of hydrogen by a membrane system working up to 10 Atm. In order to make the process energetically independent a photovoltaic generator was designed to work optimally with the OSEC System. Then it was studied the automation through the inclusion of a control system. This feature can limit the activity of the operator just to monitoring and routine activities. Finally the economic analysis showed the advantages of applying the new optimized system, especially in Developing Countries as Tanzania.

SDWS2011.0649 The Role of Gis Technology in Monitoring Sustainable and Participatory Management Model of the Forest Resources in the Logone Valley Between Chad and Cameroon

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Abstract

In the Sudano-Sahelian zone the natural environment is deteriorating at a worryingly rhythm. Despite of the measures taken by the local authorities and supported by the international community there is still an intensive and not sustainable exploitation of the

forest resources. This is particularlyevident in the Logone Valley, along the border between Chad and Cameroon, since wood and coalstill represent the main economic activity for the people living in this area. An international project, sponsored by the European Commission and carried out by the Italian NGO ACRA, is aimed to remedy this serious situation. The main aims of the project are to promote the multifunctional role of forests and to improve the functional efficiency in supplying ecosystem goods and services. The specific goal of the project is to promote a sustainable and participatory management model ofthe forest resources of the Logone Valley, in order to encourage the development of eco-friendly economic initiatives among the forest cooperatives and organizations. The implementation of a GIS as a project support is functional to create an instrument for themonitoring of the activities promoted by the program, to share the results with the organizationsinvolved easily and to elaborate forest management plans. During 4 years of project ACRA local technicians have collected data regarding activity monitoringand benefits achieved on the forest resources within 134 villages in order to appreciate changes yearby year. The data collected has been organized in database and GIS maps that were also used toverify the achievement of the project goals by European Commission and sponsors. This results in a very appreciated and user friendly instrument of management and data representation by both local citizens and authorities. In order to guarantee the sustainability of the project, local technicians havebeen trained on database and the GIS use for future applications.

SDWS2011.0320 Raes Project: Towards Sustainability in Developing Countries

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Abstract

Throughout the world, but mostly in developing countries, there are presently regions where energy supply is far from acceptable. This can compromise the socio-economic progress of those places. Innumerous authors affirm that the lack of access to electricity is a key factor in perpetuating poverty around the world, fact confirmed by international energy organizations as well as some of the most important global financing structures like the World Bank, the International Monetary Fund or the International Finance Corporation, who are nowadays giving priority to improve energy infrastructures in developing countries; nearly 75% of Sub-Saharan Africans (550 million people), do not have access to electricity and in South Asia, there are 700 million people (representing 50% of the country population) in the same situation, 90% of which live in rural areas.

In addition, another crucial issue when analyzing energy systems in these countries is the energy demand, which is completely different from what is observed in the

developed regions like Europe or North America. According with the International Energy Agency (IEA), the households in many non-OECD countries still rely heavily on traditional, non-marketed energy sources, including wood and waste, for heating and cooking.

This paper presents some preliminary results of the Remote Autonomous Energy Systems (RAES) implementation to a remote isolated African village, more precisely, in Angola. After characterizing the current village status, two scenarios were considered: an energy efficiency one and a following potential welfare one. The first one considers the current demand with efficient uses and appliances, representing an yearly energy saving of 47%. A second one, considers an evolution of both public buildings and households demand, which will imply a yearly increase in energy needs of 163%, while the peak energy demand will only increase 18%.

The ground-breaking proposal in this work is the achievement of an energy systems model which merges the energy services approach with sustainable development concerning developing countries, based on a pathway definition through an innovative indicators methodology.

SDWS2011.0794 Tosia as a Communication Platform for Stakeholder Interaction and Decision Support

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Abstract

For the forest-based sector (FBS) sustainability is not a new concept. It has evolved from a focus on mass-based sustainable wood production to a much broader evaluation of the environmental, social and economic sustainability of the entire Forest-Wood-Chain (FWC). While a range of methods and tools have been used to assess specific aspects of the FBS, none of these approaches cover all sustainability dimensions or entire FWCs, and few of them are either easy to use or suitable for stakeholder interaction and/or decision support. To address these shortcomings, ToSIA (Tool for Sustainability Impact Assessment) was developed to assess the sustainability impacts of changes in FWCs. In ToSIA, FWCs are defined as chains of processes (e.g. transport), which provide products and services (e.g. round wood). Sustainability impacts are determined by quantifying environmental, economic, and social sustainability indicators for every process along the FWC. Changes in sustainability impacts are then calculated for alternative chains. These changes are “what if”-scenarios of interest to stakeholders: What if taxes rise? What if

forestry is affected by land use changes? What if employees become scarce in remote areas? ToSIA offers a transparent and consistent methodological framework to assess these impacts in the FBS. It provides decision support to diverse groups of stakeholders (e.g. forest managers and policymakers) through the connected Comparison function and analysis tools for Multi-criteria Analysis and Cost Benefit Analysis. In the Northern ToSIA project, the tool was developed to serve two interlinked roles: first as a decision support system to assess alternative scenarios, and secondly as a communication platform for stakeholder interaction. In Malå, Northern Sweden, ToSIA was used to evaluate the sustainability impacts of competing land uses in forestry and reindeer husbandry on local Sami livelihoods and other stakeholder groups in the region, as a basis for facilitating stakeholder interaction and addressing impacts of different interests. Similarly, in the Cairngorms National Park, Scotland, the tool is providing the evidence base, and a platform for stakeholder consultation, for woodland owners, managers, industry representatives and environmental groups, to develop new policies that encourage woodland expansion across the Park. ToSIA applies an innovative sustainability impact assessment concept as an objective communication platform for stakeholder interaction and decision support.

SDWS2011.0071 Tourism Practices and Approaches for its Development in the Uttarakhand Himalaya, India

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Abstract

Uttarakhand Himalaya is known for its natural beauty and pilgrimages. These have been attracted to the region for centuries. The hill resorts such as Mussoorie, Nainital, Almora, Ranikhet and many mores are the major centers of tourist attraction. The scenic and panoramic view of the mainland of Uttarakhand further accelerated the scope of tourism. The rivers Ganga, Yamuna, Saryu, Koshi and their numerous tributaries arise from the glaciers of the Great Himalaya in Uttarakhand and give a distinct sense of tourism practices. Similarly, the presence of pilgrimages as four dhams is the major attraction for the pilgrims. Tourism in a broader sense has existed for a long time in the Uttarakhand Himalaya in the form of pilgrimages to Hindu sanctuaries that are located high up in the mountains. Mountaineering, trekking, river rafting, rock climbing and skiing are being the major attraction for tourist in the region. These forms of mass tourism have a huge impact on the environment and on the local social structure. Presently, the trend of tourism is transforming into adventurer tourism. Skiing is being developed in Auli (district Chamoli) as winter sports. Trekking in many natural places and river rafting in the Alaknanda and Bhagirathi rivers are attracting tourist at a large scale. Tourism has emerged as a smog free industry and biggest source of revenue generation in worldwide.

But, it has both socio-economic and environmental implications. Socio-cultural transformation can be seen due to the mass tourism. Similarly, the economic development as establishment of the new avenues, employment generation and earnings of foreign currency is one of the major functions of tourism. It has a negative impact on environment too. Degradation of forestland in and around the tourist places and garbage problems due to booming up of tea-stalls and shops and as well as mass tourism are the major environmental problems. This paper examines the tourism practices and evaluates the possible enhancements towards a sustainable tourism in the Uttarakhand Himalaya. The modes of tourism are discussed broadly and suggestions are given appropriately for sustainable development of tourism. It reveals that the pilgrimage tourism has been practicing here for centuries. Presently, mass tourism as mountaineering, trekking, skiing and river rafting is being common. The practices of tourism have a significant impact on the economy as many of the small towns emerged as the major service provider centers and the economy of the region grew tremendously. But, at the same time, its impact fell badly on the environment and the tourist places and pilgrimages have received severe environmental implications. Data were taken from the secondary sources and references cited in text were well taken from the published materials.

Renewable electricity generation systems I

SDWS2011.0329 Virtual Power Plant Optimization Within Liberalized Market Environment

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Abstract

One of the most significant novelties regarding the liberalization of electricity market is connection of independent power plants to the both distribution, and transmission network. Due to immense incentives, most of these new power plants are fueled by renewable energy sources. Nevertheless, the feed-in incentives have an expiration date after which renewable power plants are supposed to become non-favorized agents on the market.

Since the power outputs of wind power plants and solar power plants are rather stochastic, a new concept of virtual power plant is developed. A virtual power plant is composed of several renewable power plants and usually at least one conventional power plant. Each power plant has its own unique technical and economic parameters. Primary aim of power plants affiliation is risk diversification.

This paper considers market behavior of virtual power plant composed of wind power plant, solar power plant and conventional gas turbine power plant with installed capacity of 9.6, 6, and 5.7 MW, respectively. At first, power plants were connected to distribution network. After the merger of all three power plants to a single legal subject, the virtual power plant is connected to transmission network where it sells the produced electricity.

Expected wind and solar power plant productions are based on available actual wind power plant data and the official insolation data for the Šibenik county, respectively. Gas power plant production cost is modeled by linear three-part cost curve.

Virtual power plant has bilateral contract which has to be fulfilled. The considered time horizon is one week, divided to 168 hours. In each hour the amount of delivered electricity may be 10% higher or lower than the one in the contract, but at the end of the week the amount of delivered electricity has to be equal to the contracted one. Since the production of renewable power plants is dependable on wind and insolation characteristics, the objective function is to minimize the production costs of gas turbine power plant which are comprised of fuel costs and start-up costs. Constraints include wind and solar power plant production, ramp of gas turbine, gas turbine technical minimum et al.

Lots of different scenarios are developed and analyzed, and significant conclusions are derived.

SDWS2011.1017 Operational Lessons Learned from the New Eco 110 3 MW

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Abstract

This paper presents the main lessons learned during the operational experience of the first unit of the ECO 110 that was installed in fall 2009. Built on the ALSTOM PURE TORQUE™ concept, a rotor support concept that protects the gearbox, it boasts 3MW with a 110m rotor diameter for higher energy yield in sites with low to medium wind conditions. The lessons learned can be categorized in tree main groups: design for pre-operation, design for reliability, and design for maintenance.

Design for pre-operation includes all these design requirements related to the manufacturing, transport and installation of the systems that impacts directly in the core design of the wind turbine. The base design of the ECO 110 included at the early stages many design features to increase effectiveness during transportation and installation, such as modular nacelle design to ease transportation, and remarkably low top head mass to allow use of conventional cranes.

Design for reliability has been a key area of focus during the development of the ECO 110. Building on the experience of almost 1,800 wind turbines of the previous platforms, the ECO 110 main components have been upgraded in terms of reliability performance keeping the well proven base technology from its predecessors. Excellent experimental results have been obtained on the drive train main components thanks to the ALSTOM PURE TORQUE™ concept, a special structural and mechanical layout that protects the drive train from bending moments thus providing only torsional loads to the gearbox. This significantly improves the gearbox reliability, providing important savings to customers during the wind farm lifetime. Other design for reliability examples include the nacelle layout where one of the transformer side is in direct connection with the air flow, and where both the power cabinet and the transformer are in a lateral position isolated from the drive train area to reduce vibrations and mechanical failures.

Finally, design for maintenance includes all the considerations included in the pre and post design stages so as to enhance the operation and maintenance of such large wind turbines. ECO 110 includes special features like improved ergonomics systems and direct access from the nacelle to the rotor that reduces time of turbine maintenance works.

The new ECO 110 of Alstom opens a new era of large onshore wind turbines in which pre-operation, reliability and maintenance need to be thoroughly analyzed at the early stages of the design to optimize the life time performance and cost of the wind turbine.

SDWS2011.0357 Analysis of the Behaviour of Biofuel-Fired Gas Turbine Power Plants

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Abstract

Combustion technologies are being pushed towards the utilisation of alternative fuels that can be used reliably and efficiently, because of different reasons, e.g. price evolution of natural gas, availability of renewable sources, environmental strategies and pollutant emissions. The research on combustion of different biofuels as alternative is highly needed and promoted by the energy policy of several countries.

The main aim of this study is to simulate and analyse the behaviour of gas turbines for power generation using different fuels that can be obtained from renewable sources (biogas, syngas, bioethanol) considering different substrates (e.g. energy crops, MSW). Behaviour of gas turbines in a Brayton cycle is simulated both in an isolated operation and in combination with a Rankine cycle (combined cycle). Methane is used as reference since it is the most common fuel in gas turbine power generation installations. The performance of gas turbines using the considered biofuels is studied in comparison with the reference case regarding energetic and exergetic efficiency of the simple/combined cycle gas turbine facility, CO_2 emission per produced energy unit, and economical cost of the energy generated.

Design, analysis and optimisation of thermodynamic cycles and different potentially interesting configurations have been analysed using PATITUG, a specific software for thermodynamic analysis produced at ETSII-UPM. Once the optimal cycle parameters have been defined, calculations for the power plant have been carried out using GT-PRO - a commercial software that includes data about many real gas turbines - considering the commercial turbines that are more adequate for the optimum conditions obtained in the previous phase. A complete analysis has been performed, including the simulation of off-design conditions.

Gas turbine efficiency, i.e. without considering the energy consumed to produce the fuel from biomass, when using syngas is even higher than that obtained using natural gas (1-2%). This efficiency improvement is more notorious in a combined cycle (and its higher even considering the power consumption of gasification). Taking into account the obtention processes of fuels from biomass, the efficiencies of a simple Brayton cycle run with biogas and syngas are 2-3% and 8-9% lower than the reference case, respectively. Nevertheless, syngas offers the possibility of introducing pre-combustion capture, which can reduce CO_2 emissions (≈90%), though decreasing of the global energetic efficiency, i.e. considering gasification, capture and other auxiliaries (5-6% compared to syngas without CO_2 capture). The energy consumed in gasification decreases when increasing the

LHV of the substrate. When using bioethanol, exergetic destruction is higher than for any other fuel (7-10% higher than with methane), but there is a reduction in emissions compared to biogas or syngas (without capture).

SDWS2011.0110 Investigation for Transient Impaction of Wind Farm Under Lightning

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Abstract

Fossil fuels have created serious problem to the environment and to our wallets, the emphasis on controlling carbon dioxide emissions and stabilizing the fluctuating fuel cost has led to renewed development in renewable energy. Current forms of renewable energy include solar, hydro, wind, thermal, etc… while wind energy has the greatest potential for future development and application. There will be at least 600 new wind turbines in Taiwan's west coast within the next 10 years. The total power output could reach more than 1500MW. As wind farms grow in scale and wind turbine's grow in rated capacity, the safety issues of wind turbines have become an increasing concern. According to a statistical analysis on wind turbine damage, the major cause for damage are lightning strikes, since wind turbines are located in areas around the coast or in vast empty areas where lightning strikes occur often and the wind turbines are the tallest buildings around in Taiwan. It is required to simulate and analyze these phenomena to improve the capabilities of wind turbine systems to withstand against lightning strikes, and to preemptively suggest relevant units to take appropriate lightning protection steps and minimize losses. This paper aims on lightning strikes in the Taiwan region, to research on the transient phenomena caused by strikes on wind turbines and its related power systems, and provides a detailed analysis on the possible damages and dangers caused to the wind turbines and its related power systems during a strike. Firstly, all useful data are collected, including international standards and research papers for lightning protection on wind turbines, related Taiwan region lightning strike information, the wind turbine grounding architecture, and the system modeling for the entire wind farm and power system for simulating the lightning strike transient. Secondly, EMTP is used to simulate the transient effect of the system when connected to different power systems, to discover the dangers faced by the wind turbine during a lightning strike, and to propose possible improvement. Lastly, the results are analyzed and a series of suggestions is proposed as an appropriate wind turbine protection mechanism for systems in the Taiwan region, and for future references regarding this subject. According to the simulation results in this paper, the major conclusions are induced below: 1. To prevent human dangers, the grounding for power system and tower should be interconnected, to allow the nacelle to be under an equivalent voltage, to protect personnel from contact with voltage differences. 2. Only the

high voltage side of step up transformer in wind turbine should be equipped with arrester for better transient overvoltage reduction. 3. When the wind turbine is struck by lightning, there is no visible difference in the transient state of the system bus under different short capacity.

SDWS2011.0451 Specifics of Integration of Wind Power Plants into the Croatian Transmission Network

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Abstract

The installed capacity of wind power plants operating in Croatia is about 70 MW, which is less than 2% of 4000 MW of overall installed capacity in Croatia. This percentage is much lower than in most developed European countries. Nevertheless, according to the register of renewable energy resources, there is over 5000 MW of future wind power plant applications in Croatia. Extremely extensive wind power utilization causes problems in power systems which have not been prepared thoroughly for large wind power plants. Since the decisions for power plants locations are not centralized anymore, the transmission system planning is facing new uncertainties. Private investors are generally not interested in the transmission system stability and other problems Transmission System Operator (TSO) has to face. The objective of this paper is to provide a deep insight in the issues of large-scale wind power plants connection to the transmission grid. An extremely accurate and detailed model for assessing voltage level and power flows has been developed as the result of many projects involving wind power plants connection to the Croatian transmission network. It addresses problems with large-scale wind power plants integration into the Croatian transmission network. To analyze the extent of the wind power plants' impact on the transmission grid, the whole Croatian transmission network is modeled according to real network states from the history. Several scenarios have been taken into consideration, simulating worst case scenarios TSO might face in the future. These scenarios are based on practical experience and are as follows: maximal recorded system load (winter), maximal recorded system load (summer), minimal system load and large hydropower plants generation, minimal recorded load, large hydro power plants generation and large energy transit. Several analysis, proposals and conclusions have been made: congestion dependent disconnection/generation limitation of wind turbines, inclusion of energy buffer, e.g. reversible hydro power plant and comparison with results from traditional method, analysis of investors cost for wind power plants, as well as proposal of a new shared cost scheme. The paper provides two original contributions: definition of uniform scenarios for planning and analysis of wind power plants connection to the Croatian transmssion system and new stimulative shared investment cost scheme for future generation investors.

SDWS2011.0271 **An Overview of Energy Storage Systems Considering Renewable Energy Applications**

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Abstract

Intermittent nature and variable power output levels of wind energy sources represent major obstacles to their integration within the existing conventional electrical power grid which requires uninterrupted (highly reliable) and smooth power delivery. At the same time, it would be desirable to provide additional electrical power to cover for grid peak loads. In order to improve both the reliability of wind power systems and on-demand power availability, various storage systems such as those based on batteries and ultracapacitors, flywheels, and compressed air storage have been considered in literature (see references listed below) and applications. The aim of this work is to review and compare the aforementioned energy storage systems in terms of efficiency, investment and maintenance costs, energy/power capacity, and reliability, in order to provide guidelines for their application in contemporary wind energy systems. Also, some aspects of storage system modeling related to energy management system design will also be outlined.

Energy planning I

SDWS2011.0098 Possibility for CO2 Emissions Reduction in Croatian Energy Sector by Application of Heat Pumps and Solar Thermal in Households

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Abstract

Depending on available technologies many scenarios can be made to achieve greenhouse gases emissions reduction. This paper describes a scenario whose goal is to reduce CO_2 emissions in Croatian energy sector by applying heat pumps and solar thermal in households. The scenario has been made and simulated in EnergyPLAN software developed at Aalborg University, Denmark.

Main idea is to meet a portion of heat demand in households with heat pumps (50 per cent) and solar thermal collectors (20 per cent), and main feature is effectiveness of heat pumps and solar thermal from emissions reduction aspect compared to effectiveness of natural gas or oil driven boilers. In order to do such comparison an entire energy transformation chain has to be taken into concern. This feature is included in preliminary calculations which have shown reductions of CO_2 emissions (by 4.05 per cent) and primary energy supply (by 3.2 per cent). Regarding to Energy Sector Development Strategy of the Republic of Croatia which assumes commissioning new power plants, further analysis has been made to estimate CO_2 emissions reduction rates by the year 2020. The analysis will show whether previous results can be achieved or even improved with commissioned power plants. To achieve such results optimal heat pumps' COP (or SPF) will also be calculated by the analysis in this paper. As a conclusion economic assessment of the scenario has been made to decide whether it can be cost effective.

SDWS2011.0116 The Competitiveness Analysis of Different Energy Types for Utilization in Households

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Abstract

The scope of the study was the competitiveness analysis of utilisation of different energy shapes for space heating, hot water preparation and cooking in households of Bosnia and Herzegovina, based on the simulation model ENPEP methodology. The model is appropriate for technical and economical analyses of energy systems. Energy consumption receipts and energy transformation process costs (the process that change

final energy (fuel oil, electricity and similar) to useful energy shape (heating, hot water and cooking)) were used as backbone methodology.

This model has analysed all categories of family houses, the types of space heating and hot water preparation – central and local heating. Energy consumption for cooking has been analysed only in those family houses that had central heating. Analyses are adapted to existing technologies for the base year 2005 while for 2015 it has been estimated new technologies (geothermal heat pumps, heat systems and hot water by pellets as well as hot water in solar collectors), together with energy efficiency measures (family houses insulation) for two climate zones (cold and warm zone).

SDWS2011.0590 Strategic Electricity Planning Decisions.

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Abstract

Over the last decades, models and concepts related to sustainable electricity planning decisions have been changed according to the society goals and to the energy policy objectives and concerns. Regardless of all these changes, optimization models always played an important role for supporting complex planning decision making in different economic sectors, from which the particular case of the electricity industry stands out. Planning based on optimization models remains an essential tool able to accommodate sustainable development concerns, generating optimal electricity scenarios at central and company level and supporting strategic decision making.

This study addresses energy policy and strategic central decisions, presenting a long-term model for electricity planning. A mixed integer non-linear optimization model is described and applied to a mixed hydro-thermal-wind power system close to the Portuguese electricity case. Through scenario analysis, the expected impacts in terms of costs, CO_2 emissions and external energy dependence are evaluated for a 10 years planning period.

Based on the assumed cost information and on the imposed technical restrictions, the obtained results put in evidence the importance of coal power plants combined with new hydro power investments for minimum cost scenarios. The combination of wind power with new CCGT is foreseen mainly for CO_2 restricted scenarios but always supported by new hydro power investments. In general, the increasing investment on renewable energy sources is observed for every scenario mainly due to the constraints imposed to the model translating the European objectives for the sector. Simulations are presented in order to demonstrate the use of the proposed model on supporting strategic energy/environmental decision making and on analysing issues such as the potential savings of wind energy, the possible combination of hydro-wind power strategies and the impact of wind power on the operating conditions of thermal power plants.

SDWS2011.0884 Towards 100% Renewable Energy System: the Case of Macedonia

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Abstract

The most important problems which energy sector faces in Macedonia are unfavourable energy mix with high prevalence of lignite, strong dependence on energy import, poor condition of the energy systems and high degree of inefficiency in energy production and use. In 2005, the share of renewable energy sources (RES) in the final energy consumption was 13.8%, mainly biomass and hydro. This paper investigates the prospects for realization of a 100% renewable energy system in Macedonia by making use of the EnergyPLAN model. This model accounts all sectors of the national energy system which are needed to be considered in the case of high penetration of the renewables. Special attention has been given to the intermittent sources, pump storage hydro and electric vehicles. The assumed dynamics for the RES share is 50% in 2030 and 100% in 2050. It has been shown that 100% renewable energy system in Macedonia can be achieved with the high penetration of wind and electric vehicles used as storage.

SDWS2011.0903 100% Renewable Energy Planning

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Abstract

It can be anticipated that the impacts of peak oil will force us to reply more and more on renewable sources. Targets of renewable energy generation at national or regional levels have been initiated and monitored world wide. Buildings, as one largest energy end user, needs to progress dramatically in terms of micro generation, demand reduction and energy storage. Recently, a number of researchers, NGOs and even governments are formulating the transition paths towards 100% renewable energy system. However, future 100% renewable energy system should been seen not only as a supply changes but also dramatic change in the demand side, and moreover changes towards integrated planning. Future buildings may act as power plants by incorporating renewable energy generation such as solar, wind, geothermal and harvesting power at the point of use and store for later usage in order to achieve energy self-sufficient. As a result, future buildings energy consumptions will be customized to match renewable energy supplies. To plan a 100% renewable energy system is a complex undertaking. There is a lack of integrated planning process and simulation tool, especially focusing on demand side techniques. This paper presents a planning process covering site analysis, demand side management procedure, planning objective and constraints. A dynamic simulation model is created to analyse and evaluate performance of the energy system on hourly time step over a design year.

Simulation results and discussions around a 100% renewable buildign energy systems are given at end of the paper.

SDWS2011.0611 Potentials for Energy Savings and Long Term Energy Demands for Croatian Households Sector

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Abstract

Households sector in Croatia represents one of the largest consumers of energy today with around 75,75PJ, which is almost 29% of Croatia's final energy demand. Considering this consumption, implementing different mechanisms that would lead to improvements in energy efficiency in this sector seems relevant. In order to plan future energy systems it is important to know what are future possibilities and needs regarding energy demand for different sectors. Through this paper long term energy demand projections for Croatian households sector will be shown with a special emphasis on different mechanisms, both financial, legal but also technological that will influence future energy demand scenarios. It is important to see how these mechanisms influence, positive or negative, on future energy demand and which mechanism would be most influential. Energy demand predictions in this paper are based upon bottom-up approach model which combines and process large number of input data. The Model will be compared to Croatian national Energy Strategy and certain difference will be presented. One of the major conclusions shown in this paper is significant possibilities for energy efficiency improvements and lower energy demand in the future, based on careful and rational energy planning. Different financial, legal and technological mechanisms can lead to significant savings in the households sector which also leads to lower greenhouse gas emissions, lower Croatian independence on foreign fossil fuels and higher possibility to cower demands with renewable energy.

Water treatment I

SDWS2011.0128 The Role of Ecotoxicological Evaluation in Changing the Environmental Paradigm of Wastewater Treatment Management

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Abstract

The major problem in controlling wastewater discharges is related to its toxicity and ecotoxicological evaluation became as relevant to the protection of ecological systems as chemical specific evaluation after the implementation of the Water Framework Directive. Wastewater Treatment Plants (WWTP) discharge complex effluents to the receiving waters raising special concern. Direct toxicity assessment strategy can be an added value when we face complex effluents for which many chemicals cannot be quantified and/or interactive effects are likely to be significant. The EU project (2010-2012) "Integrated approach to energy and climate changes: changing the paradigm of wastewater treatment management" (LIFE08 ENV/P/000237) was set up for a WWTP discharging into Tagus estuary (Portugal). The main objectives of the project are to implement a tool to optimize the management of WWTP in terms of energy efficiency and environmental impact and to reduce the environmental costs of the treatment process.The aim of the ecotoxicological survey is the evaluation of the effectiveness of the treatment process in reducing the toxicity and the protection of the biological treatment through the setting up of adequate ecotoxicological methodologies and the selection of a battery of tests to be used in the characterization of WWTP wastewaters. To characterize the wastewater in the different treatment phases, a battery of tests with organisms bearing different functions at the ecosystem level was used. Acute and chronic aquatic toxicity tests were performed using Pseudomonas putida, Vibrio fischeri, Pseudokirchneriella subcapitata, Thamnocephalus platyurus, Daphnia magna and Lemna minor as test organisms, and a blend of aerobic bacteria. Knowing that the ecological relevance of species and test exposure is questionable in routine ecotoxicological evaluation, the results of such an approach should help building an adequate testing strategy for the ecotoxicological effects of WWTP discharges. The results of the first phase of this program will be reported. These results demonstrated not only that the treatment efficiently reduced wastewater toxicity toward the selected test organisms, but also that the use of an ecotoxicological approach can contribute to the environmental management of the Treatment Plant.

SDWS2011.0193 Mathematical Model of Wastewater Decolorization in a Trickle-Bed Reactor

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Abstract

Our aim is to present a mathematical model of a biofiltration process in a trickle-bed reactor and the comparison of its numerical results with experimental data.

Generally, biofiltration can be defined as a process of removing pollutants from waste waters or waste gases by microorganisms. In our case, we focus on removal of organic dyes from textile industry waste waters by a white-rot fungus Irpex lacteus. The use of the fungus has two main advantages: 1) it is able to degrade substances that cannot be removed by other types of microorganisms, 2) it is wide-spread in nature and thus it is low-cost.

We developed a dimensionless mathematical model of the process based on the continuum approach. The model consists of mass balances of a substrate, which enablesthe fungal growth, and a dye, which is to be degraded, in the fungal biofilm and in the waste water. The biofilm is simulated as a two dimensional domain while the liquid film is represented by a boundary condition. Biomass growth, decay and erosion are also considered by means of an equation describing the biofilm surface movement.

Using COMSOL Multiphysics, we performed parametric studies based on the comparison of the simulated and experimental dye concentrations to obtain values of the key model parameters. The agreement between the simulations and experiments for such found values was sufficient. Therefore, our model can be used to simulate the behaviour of a laboratory scale trickle-bed reactor for different input dye concentrations.

Many various mathematical models of biofilms were created, but they mostly deal with bacterial biofilms. Our mathematical model is able to describe the performance of a trickle-bed reactor with a fungal biofilm in such an easy way as possible but keeping the necessary degree of complexity.

SDWS2011.0346 Model Based Evaluation of Operating Parameters on Canon Process in a Membrane Aerated Biofilm Reactor

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Abstract

Nitrogen compounds such as Ammonium are the main parts of industrial wastewaters, the treatment of which is critical for preventing oxygen depletion and water intoxication. Generally the conventional methods of nitrification and de-nitrification

applied for nitrogen removal. In the beginning of these processes, Ammonium oxidizes to nitrite and then nitrate converts into gaseous nitrogen by utilizing an external carbon source. Recently, new methods such as anaerobic ammonium oxidation (ANAMMOX) and completely autotrophic nitrogen removal over nitrite (CANON) are being utilized in order to achieve a not only better performance but also higher efficiency. These methods are so useful for wastewaters with high amounts of Ammonium and low carbon contents. CANON process is combination of Anammox and partial nitrification processes occurring in a single reactor, in which Nitrosomonas like aerobic ammonium oxidizers and Planctomycete like Anammox Bacteria perform two sequential reactions under Oxygen limited conditions. In this research, performance, advantages and disadvantages of CANNON process are investigated in gas lift sequencing batch reactors (SBR) and membrane aerated bio-film reactors (MABR). Then the CANNON process in MABR is simulated by the use of ASM3 model. The CANNON process in MABR is based upon competition between nitrite and ammonium oxidizers for oxygen and nitrite oxidizers and Anammox organisms for nitrite. The DO concentration, bio-film thickness and ammonium surface load were significantly effective elements influencing the CANNON process performance in a MABR whereas, affinity constant and bio-film density are ineffective in that regard. By solving kinetic and velocity equations via Matlab software at different periods of time, concentration changes of nitrite oxidizer, ammonium oxidizer, Anammox organism, reacting substances and products were calculated and analyzed. Therefore, optimal concentrations determined. This stimulation was done for a feed of wastewater containing 20-200 mg- N/L Ammonium nitrite. For lower than the 2 mg-N/L and nitrate of 40-80 mg-N/L it was shown that concentration changes with time were very similar to those reported by others available in the literature. In conclusion, applying CANNON process renders the old nitrification units new and optimal route causing flexibility in process control strategies proposed. In addition, higher nitrogen removal via designing compact reactors led to decreased cost of investments. Therefore, the oxygen transfer and Biomass retention considered as two of the most adequate options in achieving optimization of such processes.

SDWS2011.0406 Graphene Applications for Oil-Spill Cleanup and Waste-Water Treatment

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Abstract

Atomically thin (1 A^o thickness), very high surface area (2600 m^2/g) and the meso-poric structure make graphene a stronger candidate for adsorption-based applications. Presence of oxygen containing functional groups over its surface can attract functional impurities like dyes, metal ions etc. from different types of industrial wastewaters. In the present work, we utilized the potential of the graphene properties in producing clean water

from dye containing and crude oil containing contaminated water, in separate experiments. Obtained results confirm graphene's efficacy in producing substantial figures ruling out some conventional adsorbents in removing the contaminants from the surface and inside of water. Maximum sorption capacity of graphene was found to be 131 g-oil/g-graphene for a 39^{o} API gravity crude oil. An overall amount of 300 grams, approximately, of the oil was sorbed by one gram of graphene in six cycles with a substantial recyclability. Effect of graphene density was also studied using theoretical and experimental results. Different methods for the recovery of sorbed oil were employed and compared. Furthermore, contaminated wastewater from textiles containing substantial amounts of methyl orange was treated with graphene where graphene was observed exhibiting a removal efficiency of 98% (and a maximum adsorption capacity of ~84 mg-dye/g-graphene). Adsorption isotherms were analyzed using Langmuir, Freundlich, and other different types of isotherms and results were tabulated accordingly. Moreover, the effects of temperature, PH and adsorbent dose on the adsorption capacity were studied through extensive experimentation. Present research confirms the use of graphene as an environmentally benign adsorbent for multiple applications.

SDWS2011.0877 Pilkington Active Glasstm as Photocatalyst for Water Treatment: Photocatalytic Ozonation of Dichloroacetic Acid in Aqueous Solutions

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Abstract

The performance of a heterogeneous photocatalytic ozonation system (TiO_2/UVA/O_3) was evaluated on the degradation and mineralization of dichloroacetic acid (DCAA) as a contaminant in aqueous solutions by means of a planar reactor. The commercial product "Pilkington Active^{TM} glass" (PAG) was used as the immobilized TiO_2 photocatalyst and it was irradiated by near UV light in this study. The synergistic interaction between ozone and the photoactivated TiO_2 surface was discussed and highlighted. Furthermore, the influences of initial concentration and temperature on the degradation rate of DCAA and the ozone consumption level during the oxidation process were investigated. The concentrations of dichloroacetic acid and chloride anions produced during degradation were measured using ion chromatography. The mineralization of dichloroacetic acid was evaluated by TOC (total organic carbon) measurements.

The degradation of dichloroacetic acid by photocatalytic ozonation in our heterogeneous system showed good agreement with the kinetics of first order reactions with respect to dichloroacetic acid. However, at initial concentrations of dichloroacetic acid both higher and lower than 1 mM, the initial degradation rates were found to be slightly different. Under our set-up conditions, higher initial concentrations of

dichloroacetic acid and higher temperatures increased the initial degradation rate and, the level of ozone consumption during the photocatalytic ozonation treatment. Moreover, photocatalytic ozonation exhibited high potential in the mineralization of dichloroacetic acid. It was observed that more than 90% of the dichloroacetic acid decomposed during the oxidation period was mineralized to carbon dioxide molecules and chloride anions. It was also shown that, stable chlorinated organic intermediates were not produced during the photocatalytic ozonation of dichloroacetic acid. Moreover, the oxidation of chloride ions into other species was considered negligible throughout the treatment duration.

SDWS2011.0222 Waste Water Recycling System for Municipal Solid Waste Incinerator Using Waste Heat

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Abstract

Most municipal solid waste (MSW) generated in the Tokyo metropolitan area is appropriately incinerated. Exhaust heat generated in the incinerators can be recovered to drive steam turbines, thus producing electrical power that can be distributed back into the power grid. However, a large amount of water is required to suitably treat the gas emissions of incinerators, i.e., for reducing temperature and scrubbing. In fact, a large-scale incinerator can require up to 500 t/day; from environmental and economical viewpoints, it is essential to reduce water consumption and recycle wastewater. In addition, approximately half the total energy generated by incinerating MSW remains unutilized and dissipates from the steam turbines as low-temperature waste heat, therefore it is also necessary to effectively utilize waste heat.

In light of the above-mentioned issues, we developed a wastewater recycling system that uses low-temperature waste heat. Using waste heat (temperature: ~65°C) from the steam turbines, wastewater is distilled under reduced pressure. The distilled water is reused in the incinerator and the concentrated liquid is desalinated and desiccated using additional waste heat. Calcium removal equipment was newly developed to inhibit scale formation before distillation. Calcareous seed crystals are synthesized using calcium ions and CO_2, which are contained in the wastewater and the gas emissions of incinerators, respectively. The seed crystals can inhibit scale formation on the heating surfaces in the distiller. This developed system can contribute to CO_2 stabilization.

The developed recycling system was tested in an actual incinerator. Clean water was successfully recovered and the concentrated liquid was safely solidified, although the quality of the wastewater fluctuated. The recovered water was safe and reusable, and the recycling system was closed. It is estimated that the developed recycling system could reduce costs by approximately 1,000,000,000yen/year in one large incinerator.

Renewable electricity generation systems II

SDWS2011.0482 Fossil Fuel Savings, Carbon Emission Reduction and Economic Attractiveness of Medium-Scale Integrated Biomass Gasification Combined Cycle Cogeneration Plants

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Abstract

Thermal conversion of biomass into a gaseous fuel by means of gasification is nowadays considered as one of the most attractive technology for CO_2 emission reduction and fossil fuel savings. This is mainly due to a high level of power generation efficiency of potential power plants. In order to demonstrate saving potential and economic profitability of biomass to energy conversion projects, there are required conceptual design, optimization and feasibility studies. It has been already demonstrated in projects ARBRE (UK), Värnamo (Sweden) and Güssing (Austria) that a variety of technological schemes of power plants can be designed and successfully operated with the medium scale reactors. On the other side the number of commercial applications of integrated gasification plants is still insignificant. This is mainly due to high initial investment costs and some technical problems of burning the low calorific value syngas in equipment designed for natural gas operation. Nevertheless the technology is being still regarded as an attractive one and there are many on-going research and development activities in the field.

The main idea of this work is to analyze the performance of a system where conventional natural gas (NG) fired gas turbine combined cycle is integrated with gasification plant through supplementary firing of the producer gas (PG) in a heat recovery steam generator. Such plants would promote a wider use of gasification technology without problems with the fueling of gas turbine by the low calorific value fuel.

The paper theoretically investigates the system made up of fluidized bed gasifier, SGT-100 gas turbine and bottoming steam cycle. Different configurations of the plant are being examined. The performance of the gas turbine is investigated using in-house built Engineering Equation Solver model. Steam cycle is modeled using GateCycle simulation software. A comparison is made between systems with PG and NG fired turbine. The results obtained were compared in terms of electric energy generation efficiency, CO2 emission and fossil fuel energy savings. Finally there was examined an economic effectiveness of the project of modernization of existing coal fired municipal heating plant. The results show that the co-firing of NG and PG in gas turbine based cogeneration plant leads to a relatively high efficiency of electricity generation from biomass and high savings of carbon emission and energy of fossil fuels. This is also an economically attractive technological option. The attractiveness however depends on financial

stimulation coming from current greenhouse gas emission reduction and renewable energy policies that have been adopted by the European Community.

SDWS2011.0749 Control of Wind Turbines for Frequency Regulation and Fatigue Loads Reduction

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Abstract

The size of wind turbines is continuously increasing. Nowadays, turbines of 5 MW with a rotor diameter bigger than 120 m exist, especially designed for offshore wind farms. This significant evolution of the rated power and size causes two main problems in the design of wind turbines and the integration of the produced electrical energy in the power grid. Firstly, main mechanical components fatigue loads have to be reduced, in order to allow the use of less material when manufacturing these components, to obtain a more reliable working and to reduce maintenance time. Secondly, as the proportion of wind power in the power grid is increasing, like the classical power generators, wind turbines must also take part in the primary regulation of frequency.

The objectives of the work presented in this paper have been to design and analyze a discrete-time LQG controller which considers the two problems mentioned before. The wind turbine rotational speed and the generated power are controlled using the electromagnetic torque and the pitch angle as control variables. The rotational speed and electrical power references are generated in a higher control level depending on the wind speed and a frequency droop. The LQG controller is tuned in order to keep rotational speed and electrical power variables as close as possible to their reference values and to damp the torsion load fluctuations in the drive-train.

The controller has been designed in Matlab and has been tuned and simulated in a simple linear simulation model in Simulink. Then, it has been implemented in a C program, to test it as an external controller on the Bladed commercial wind turbine simulation tool. Our controller has been compared to another one that has not been designed especially to reduce drive-train loads.

Results show that the designed discrete time LQG controller leads to a good regulation of the produced electrical power in order to contribute to the primary frequency regulation. Moreover, it reduces significantly fatigue loads in the drive-train, in comparison with a controller that does not take into account this objective when designed.

Wind turbine control objectives such as the contribution to frequency regulation and the reduction of fatigue loads are usually considered individually, designing different

controllers. Our work shows that these objectives can be taken into account in the design of a unique multivariable multiobjective controller.

SDWS2011.0123 Valuation of a Concentrating Solar Power Plant Under Uncertainty

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Abstract

The present paper values the profitability of a concentrating solar power plant project as a compound real option under the incentive scheme established by the Italian decree of Ministry of Economical Development on the 11/4/2008. The compound real option is composed of three stages, such as (i) the potential purchase of the land and collection of authorization and permits, (ii) the potential construction of the plant and (iii) the possible upgrading of the plant. The Real Option Value (ROV) is calculated starting from a Net Present Value (NPV) of the investment, using a traditional DCF method on estimated data through a 25 years evaluation, and implementing it with the binomial tree approach on a discrete-time basis. Volatility is computed with the Montecarlo simulation, choosing some NPV drivers as stochastic, such as specific production and investment costs, and using the Lognormal Net Present Value Approach based on historical data through a 10 years evaluation horizon. As the stream of cash flows are rather steady, thanks to the fixed revenues of the incentive schemes and constant operating costs, its volatility is low and this limits only to a modest extent the additional flexibility that could be provided by the real option approach, resulting in a ROV which is not significantly higher than the NPV. Application to cases with higher volatility results in more significant ROV.

SDWS2011.0263 Developments for Future Implementation in Dish-Stirling Technology

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Abstract

The dish-Stirling technology for power generation, using a Stirling engine fed with a renewable energy such as solar, means a promising development regarding electricity generation. The value of efficiency of this technology, around 30% of normal direct solar radiation, is the highest when compared with other solar energy generation systems. The dish-Stirling technology has been in development during more than 25 years, but so far it has not achieved enough advancement to be really competitive with other renewable energy technologies. The competitiveness must take into account economic and environmental issues. A state-of-the art review has been carried out in order to identify

the developments needed to guarantee the feasibility of using the dish-Stirling technology for energy production, further than demonstration facilities that have been operated so far. The economic feasibility of dish-Stirling depends highly on equipment amortization, so the continuous operation of the system is a key factor. It would also improve the environmental impact since it means to decrease the environmental load of facility construction, due to the fact that this facility would be used for more time than exclusively operating from sun energy. The developments enabling this use are, on one hand the system hybridization, in such a way that guarantees the operation of the system with other energy sources when solar is lower than nominal operation value or is not available. On the other hand the thermal storage, providing system operation with stored energy during some periods such as transients. The stored energy would be obtained from excess of sun radiation in relation to nominal operation value. In this paper, a complete review of literature concerning state-of-the-art and developments of dish-Stirling technology has been carried out, presenting the most outstanding issues considered for future implementation.

SDWS2011.0563 Mathematical Model to Develop a Solar Concentrator Type Scheffler Coupled to a Stirling Engine

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Abstract

This paper develops and applies a new geometric model for estimating intercept factor of a solar concentrator type Scheffler (CSTS), based on geometric and optical behavior of the concentrator in Cartesian coordinates. With incorporating the thermal model of a receptor cavity was done numerical examinations for determine the technical feasibility of attaching the CSTS to a Stirling engine power 3 kW. The numerical validation of mathematical model of the CSTS is made from experimental results reported for the concentrator WGA500 and receiver of the CNRS-PROMES system.

The numerical results of the scans allow get dimensions and design features for a minimum CSTS reflector surface and heat loss. That unlike a parabolic dish concentrator that meets the same demand thermal receiver CSTS operates a 89.7 ° inclination fixed position, thus reducing thermal losses offsetting the decline of the intercept factor from 0.99 to 0.95 with an increase in the area of 0.5 square meters of reflector but incorporating advantages Stirling engine operating in a fixed position.

Environment and Energy policy and management

SDWS2011.0226 Composite Index for Measuring Level of Introduction of an Integrated Product Policy in Countries Under Certain Circumstances

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Abstract

Integrated Product Policy (IPP) is an approach which seeks to reduce the life cycle environmental impacts of products from the mining of raw materials to production, distribution, use, and waste management. IPP focuses on those decision points which strongly influence the life cycle environmental impacts of products and which offer potential for improvement, notably eco-design of products, informed consumer choice, the polluter pays principle in product prices. It also promotes instruments and tools which target the whole life cycle of products.

The aim of this paper is to propose methodology for developing of Composite Index for measuring level of introduction of an Integrated Product Policy in countries under certain circumstances,

Composite index is developed as a mix of pressure and response indicators derived from available data combined with the set of proposed IPP indicators from the literature. Special response indicator for countries under certain circumstances is proposed, as a sum of the levels of transposition of relevant IPP related directives into legal system.

Composite index aims in measuring, monitoring, analyzing and comparison of the level of introduction of an IPP policies in countries.

SDWS2011.0380 Sustainable Energy Management - New Approach

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Abstract

Sustainable development is a comprehensive concept of development which was adopted in order to preserve the planet's resources to an extent that will satisfy the needs of present generations without compromising the ability to meet the next generation of the same needs. The concept is comprehensive, multidimensional, and multidisciplinary and opens possibilities for different models of its application in practice.

Studying the concept of sustainable development is based on the considerations of range of issues, mechanisms, solutions and critical views. Currently there exists no unique concept of sustainable development that can be universally applied to all areas of human

activities around the world, so that it is necessary to examine it in the definite sectors that are of interest to a specific range of problems.

The proposed model of sustainable energy management is designed to provide a management model that can be acceptable to both the individual companies, and to the states or to certain regions that make up the geographical, natural and economic environment. Sustainable energy management model is based solely on determining the most appropriate way of managing the system of future energy production and consumption, with stressing the most important objectives in the field of sustainable energy development, and the overview of the ways in which these goals are attainable, and the control of the complex process of applying the methodology of assessment of the achieved degree of sustainable development. Only in this way it is possible to plan, organize, monitor and control the complex process such as energy management in the modern world.

SDWS2011.0733 Compliance with Building Regulations in Energy Efficiency: Post-2006 New-Build Dwellings in the Uk

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Abstract

The UK Government has revised building regulations in 2002, 2006 and 2010, towards more stringent energy efficiency standards and ultimately the target of 'zero carbon' new homes from 2016. However, non-compliance has been reported. This paper aims to: reveal levels of compliance with energy building regulations, in the case of UK new-build dwellings; examine the evolution of such compliance; and explore underlying issues. In total 376 new-build dwellings were investigated. The compliance revealed was poor, at a level of 35%, accompanied by 43% grey compliance and 21% grey non-compliance due to insufficient evidence of achieving required carbon emissions reductions. This profile has however improved over the period 2006-2009. Issues explored were centred on: incorrect compilations and/or insufficient submissions of carbon emissions calculations by builders/developers; inappropriate timings of such submissions; and a paucity of proper checks by building controls. The findings contribute important evidence to future review of energy efficiency policy.

SDWS2011.0769 Forestry and Reindeer Husbandry in Northern Sweden - the Malå Case Study in the Northern Tosia Research Project.

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Abstract

The Swedish case study, i.e. the Municipality of Malå, is one of four case studies formed within the project that includes case studies in Finland, Norway and Scotland. This case study evolves around Malå a small settlement in Northern Sweden where the Malå Sami village has most of its activities.

At present forestry thrives together with electric power plants, active outdoor life, mining industry, car testing, tourism, entrepreneurs, etc. Alongside these activities, reindeer husbandry has been present in the area for centuries. To sustainably be able to keep reindeer husbandry in the area, large areas of grazing land is needed. A continual increase of other competing land use activities might put the survival of the Sami village at risk. As the utilization of the area for other purposes increases one has to ask how much encroachment a Sami village can stand to be able to survive. In 2006 there were approximately 11 reindeer husbandry companies in the Malå Sami village. The Municipality of Malå has an area of 1 600 km^2, and the number of inhabitants is about 3 500.

The aim of the case study is to evaluate effects of changes in forest management and its impact on forests and reindeer husbandry in this area.

Three scenarios of forest management are compared with forestry and reindeer husbandry as it is today – business as usual:

1. Land use with emphasis on nature conservation (key habitats and protective areas)
2. Land use with emphasis on reindeer husbandry
3. Land use with combined emphasis on reindeer husbandry and nature conservation as restriction on forest management.

The scenarios within this case represent possible management changes in forests. The impact of these changes on the forestry wood chain, its dependent enterprises, and the Sami village will be evaluated.

Activities in the forestry- wood and reindeer husbandry chains are evaluated as indicator values that present social, environmental and economic performance. The outcome of each scenario is based on calculations using the forest simulator RegWise and the Tool for Sustainable Impact Assessment (ToSIA), developed in the FP6 programme EFORWOOD. ToSIA enables comparisons of the performance of each scenario for a set of indicators and also an identification of the hot spots in each scenario or chain of activities (processes).

SDWS2011.0633 International Framework Concept for Ship Waste Management Along the Danube

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Abstract

The river Danube and its catchment area are an invaluable and unique ecosystem, and an international waterway of growing importance at the same time. Although inland navigation is an environmentally friendly means of transport, waste generated onboard the vessels may harm the river's ecosystem if discharged illegally. The management of ship waste along the Danube is currently characterized by different approaches of the ten riparian countries, which all have aimed at improving the local situation of ship waste management through the provision of waste reception facilities. This has resulted in inconsistent solutions for the users of the system, first of all, inland waterway transport sector. Several studies propose the establishment of a harmonized ship waste management system for the Danube. Their focus has been laid primarily on gathering information about the current situation and identifying objectives for ship waste management. However, these studies have lacked the financial power and common (political) decision for the elaboration and implementation of a harmonized system. The project WANDA (WAste management for inland Navigation on the DAnube, SEE Programme, 2009–2012) aims at closing these gaps, considering that the establishment of a sustainable ship waste management concept along the Danube can help overcome the constraints imposed by national borders. The project ensures a sustainable approach in line with the environmental requirements and simultaneously supports transnational coordination through: a) elaboration of national ship waste management concepts, b) implementation of pilot actions, c) elaboration of a financing model based on the polluter pays principle. This conference contribution presents one of the most important outputs of WANDA, an International Framework Concept for ship waste management, which addresses the current problems and potential challenges to be tackled and aims at establishing an acknowledged standard for the development of ship waste management efforts in the Danubian countries. It focuses on international harmonization, with special attention to four areas: legal and technical frameworks, coordination, monitoring and financing. The contribution highlights all the relevant background information (waste reception facilities, waste management systems in operation: Rhine, Sava, etc.) as well as future activities (proposal for implementation, coordinated development of facilities, harmonized monitoring system, etc.).

SDWS2011.0924 Microalgae as Sustainable Alternatives for Biofuel Manufacture

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Abstract

In recent decades, the world has been confronted with an energy crisis, associated with irreversible depletion of traditional sources of fossil fuels and accumulation of greenhouse gases in the atmosphere leading to global warming. With the urgent need to replace the dwindling reserves of crude oil, biodiesel and biohydrogen have emerged as interesting alternatives – and be obtained namely via microalga-mediated routes. Microalgae are eukaryote, ubiquitous microorganisms that possess a huge metabolic plasticity – and can produce both forms of biofuel. Their oil productivities are much higher than those of higher plants, and no high quality agricultural land is required; they can indeed be cultivated in brackish and waste waters, and require only sunlight and a few simple and readily available nutrients (e.g. CO2, NH4+, NO3- and PO43-), thus minimizing environmental impacts. Likewise, molecular hydrogen is easily converted to electricity in fuel cells and liberates a large amount of energy per unit mass in a non-polluting manner – and can be released from water via photosynthesis, at the expense of only solar energy. However, implementation of microalga-based systems to produce biodiesel and biohydrogen has been economically constrained by their still poor volumetric efficiencies – which imply excessively high costs, as compared with petrofuel prices. Technological improvements of such processes are thus critical – which require a combined approach on the biocatalyst and bioreactor levels. Several bottlenecks indeed exist at present that preclude the full industrial exploitation of microalgal cells; they will be reviewed and critically discussed in this presentation. Such bottlenecks derive e.g. from scarce knowledge on the mechanisms that control regulation of gene expression, few species that have been subjected to successful genetic transformation, low maximum cell density attainable, poor efficiency in harvesting, and difficulties in light capture and use.

Waste Management and Recycling

SDWS2011.0142 Eco-Rubber: Innovative Used Tyres Recycling and Rubber Sintering Process for Eco-Friendly Urban Equipment Fabrication

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Abstract

ECO-RUBBER project (www.eco-rubber.eu) is a CIP Eco-innovation project (subprogram Entrepreneurship and Innovation Programme) aimed to implement a real industrialization of an eco-friendly tyre recycling and rubber sintering production system to place on the market high-quality recycled-rubber urban products. However, the recycled rubber powder obtained from tyre recycling in the current grinding plants should be improved for the sintering process projected. It is therefore necessary to adapt the present grinding lines to obtain a recycled rubber powder with a narrow distribution and practically zero levels of contaminants (textile fibbers, steel and sand). It is also necessary to define and design the urban product to be manufactured as a case study, determining all requirements in order to test the product obtained during the sintering process. The type of mixer and the results of using different additives will also be evaluated. Finally, the sintering process will be developed to complete industrialization process. To eliminate the emotional barriers to the use of urban furniture made of recycled rubber, an eco-label will be implanted, highlighting the benefits of the use of this kind of recycled material.

Thus far, textile decontamination and grinding plant is working. Pre-heating and sintering conditions and material properties have been defined and urban concept selected and designed. A bollard was chosen. In first place, an analysis of European standards was carried out obtaining dimensional specifications. The next step was to choose the final shape taking into account subjective perception of users. A resistance assessment test for pedestrian parapets was chosen and Finite Element impact analyses were carried out to optimize the design and hence minimize material usage. 3 models with the same external geometry but different inner hole diameters (50, 70 and 90 mm) were tested. The dynamic analyses showed that Von Mises stresses were below the yeld limit for the 3 models choosing the one with less material. Upcoming steps are the design of bollard mould for sintering, selection of the mixing and dosing equipment as well as the pre-heating chamber.

It is important to highlight that the proposed process have important environmental benefits: reductions in energy consumption of 88 % and in greenhouse gas emission of 72 % are expected. Less than 5 % additives are needed. Moreover, sintered rubber could re-enter the recycling process proposed.

SDWS2011.0500 Recycling and Recovery of Post-Consumer Plastic Solid Waste in a European Context

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Abstract

The disposal of waste plastics has become a major worldwide environmental problem. The USA, Europe and Japan generate about 50 million tons of post-consumer plastic waste each year. These waste products were previously dumped in landfill sites, which is a non-sustainable and environmentally questionable option. The number of landfill sites and their capacity are moreover decreasing rapidly and in most countries the legislation on land filling is becoming increasingly stringent. Two sustainable alternative disposal routes are possible, i.e. recycling or energy recovery.

Several European Directives concern the plastic waste issue and the requested waste management, and are briefly discussed in this paper.

New sustainable processes have emerged, i.e. a mechanical treatment for recycling post)consumer plastic waste as virgin or second grade plastic feedstock, and a thermal treatment to recycle the waste as virgin monomer, as synthetic fuel gas, or as heat source (incineration with energy recovery). These processes are environmentally friendly and avoid the massive land filling, where the non-biodegradable plastics remain an environmental burden for centuries.

This paper reviews the waste management options for plastic wastes by recycling and thermal processing (pyrolysis, gasification and incineration with energy recovery). A combination of all disposal routes remains necessary to achieve the most eco-efficient, effective waste management solution.

SDWS2011.1008 Optimization of Municipal Solid Waste Transport in the City of Niš - Environmental Benefits

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Abstract

The focus of this paper is the analysis of environmental impact of Municipal Solid Waste transport in the city of Niš before and after optimization. Detail method of transport optimization was presented in this paper. In this paper used Clarke-Wright savings method for optimization transport. In the optimization procedure, detailed measurement and analysis of the existing waste management system parameters are first

conducted in the field. Indicator parameters which were taken into account for environmental analysis are: CO_2, SO_2, NOx, CO and particulate matter emissions. It could be seen from this paper that by optimizing transport of municipal solid waste, except cost reduction, reduction of CO_2, SO2, NOx, CO and particulate matter emissions could be also achieved. Since MSW management in the city of Niš represents very serious problem, due to lack of money as well as appropriate strategy, the optimization of MSW transport is first step toward the improvement the whole system of integrated solid waste management.

SDWS2011.0591 Azov Sea Contamination by Dumps and Landfills

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Abstract

The problem of piling up and utilization of waste is one of the most important problem for big cities, such as Mariupol with the population of about 500 thousand. For a long time Mariupol inhabitants bring the garbage to the dump of solid domestic waste. Now dump (the area of 13,26 hectare, amount of garbage is about 30 mln. t) situated on the left bank of the river Kalmius being 7 km far from its fall into the Azov Sea. Due to accumulation of domestic waste a great number of nitric oxides, carbonic oxides, sulphur oxides, ammonia, different organic combination and products of their interaction with other substances are being thrown into atmosphere.

The flows of dumps have been examined. The samples were taken from 10 different places of the dumps. And it was found out the most availability of phenol in the sample 8 – 51,12mol/l. High content of iron was discovered in the sample 4 – 95,16 mol/l. When total number of microbes was being defined, the sample 6 had a maximum index – 620 kol/l. the sample 3 showed high content of coliforms: 840 kol/l. Besides that, samples 1, 3, 4 and 10 showed different viruses examination of parasitic indexes of liquid flows showed ova helmints: Enterobiusvermicularis, Ascarislumbricoides, Diphyllobothriumlatum, Taeniarhynchussaginatus, Taeniasolium, Ancilostomaduodunale, Echinococcusgranulosus, Strongyloidesstercoralis.

To solve this problem we have offered the method of anaerobic fermentation. The advantage of this method consists of that its usage does not hurt the environment. During the decomposition of domestic waste by anaerobic fermentation the biogas containing up to 60 % of methane is emanated and that allows to use it as a local fuel. During decomposition of 1 ton solid domestic waste average 100-200 m^3 of biogas can be received. Depending on the content of methane the lowest warmth of combustion of dump biogas makes 18-24 MJ/m^3.

While the anaerobic fermentation is taking place the organic substances are decomposed without oxygen. This process of fermentation has two stages. At the first stage the organic polymers are decomposed to more simple combinations under the

influence of natural conjunction of variety of species of anaerobic bacteria: volatile fatty acids, alcohols, hydrogen and oxygen oxides, formic acids, methyl alcohol. At the second stage methane-forming bacteria convert organic acids into methane, carbon dioxide and water.

Anaerobic fermentation of solid domestic waste gives the opportuning to render harmless to microorganisms, ova of helmints. Implementation of this project will allow to prevent and remove the contamination of the Azov Sea, toxic chemical combination, spreades of dangerous diseases of microbic and parasitic nature, as well as to receive biogas, suitable for local fuel.

SDWS2011.0324 Application of the Taguchi Method for Design of Experiments for Optimization of the Dissolution Process of Weee for the Production of Metal Powder

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Abstract

The present paper aims to apply the Taguchi method in an attempt to thoroughly study the dissolution of Waste Electrical and Electronic Equipment (WEEE) for the production of commercially valuable metals' powders. This method can indicate proper design of experiments and statistical analysis of results regarding the qualitative effect of each dissolution parameter. At a second stage, the quantitative influence can be assessed, using multiple regression analysis and analysis of variance (ANOVA), thus enabling the determination of the parameter that has the most significant effect on the process.

Printed circuit boards (PCBs) from personal computers were used as a raw material. Their selection among the wide variety of WEEE could be attributed to their unique features, most notably the fact that they contain metals such as Cu, Zn and Ni in considerable amounts. Firstly, a series of pre-treatment steps were carried out in order to obtain samples suitable for further testing. Those samples were subjected to various analysis (XRD, XRF, TG, particle size) for their substantial physicochemical characterization. Proceeding to the main experimental part, the Taguchi method for design of experiments was applied for the selection and optimization of the parameters affecting the dissolution of metals. The parameters studied were the concentration (0,5M to 6M) of the solvents (HCl_{aq}, HNO_{3aq} and H_2SO_{4aq}), the temperature (40-90^{0}C) and the reaction time (1-2h). The determination of the value range of the formerly mentioned parameters was based on previous experiments that plainly vindicated their adequacy. The results of the currently indicated experiments clearly demonstrate that each parameter affects in a different way and percentage.

SDWS2011.1019 **Waste Fluorescent Lamps Recycling**

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Abstract

The aim of this paper was to identify possible improvements of fluorescent lamps recycling technology to produce broken glass categorized as non-hazardous waste, and to effectively remove phosphorus powder contaminated with mercury, providing reuse of aluminum as secondary raw.

This paper investigates and compares the effectiveness of mercury removal by recycling fluorescent lamps in 2 plants with the intent to improve existing technologies. Due to the high mercury residual content in eluates of the sample from the plant A and B, removal of mercury is examined by heating in laboratory conditions to improve mercury removal. These results indicate that optimizing the speed of the drum and upgrading additional drum heater can improve recycling technology and reduce amount of mercury. Considering the energy and economic aspects, the optimum heating is shown at 80 ° C with retention time of 15 minutes.

Water policy and the energy-water interaction

SDWS2011.0131 Multicriteria Decision Aid to Sustainable Hydropower Design

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Abstract

European leaders signed up in March 2007 to a binding EU-wide target to source 20% of their energy needs from renewable sources, including hydro power plants (HPP) by 2020. To meet this objective the EU leaders agreed on a new directive on promoting renewable energies, the Directive on Electricity Production from Renewable Energy Sources, officially named 2001/77/EC, amended as 2009/28, and widely known as the RES Directive (RESD).

At the same time, the EU adopted in October 23, 2000 the Water Framework Directive – WFD (2000/60/EC), which is establishing a framework for Community action in the field of water policy. It commits EU member states to achieve good qualitative and quantitative status of all water bodies by 2015. The directive defines status of a body of surface water as determined by the poorer of its ecological status and its chemical status, where ecological status refers to the quality of the structure and functioning of aquatic ecosystems of the surface waters.

Can these objectives be conflicting? Achieving a good qualitative and quantitative status before any other objective presumes a "non-deterioration principle" of the existing ecological status, which requires an extremely careful environmental impact assessment of potential new infrastructure at river systems, especially those already having favorable status. Thus, if "precautionary principle" would be applied, the new water infrastructure construction, primarily hydropower plants, would rather be avoided then implemented - unless designed mitigation measures secure avoiding deterioration of the existing ecological status.

Several projects have been developed afterwards in order to minimize conflicts between the two directives - as example one of the ongoing ones is CH2OICE, aiming at developing a technically and economically feasible certification procedure for hydro power generation facilities of high environmental standard. They often provide a list of key criteria to be taken into consideration when deciding on the impact minimization of new ones or certification to existing plants.

This paper aims to providing a multicriteria decision aid to decision makers during the design process, providing support to decisions on site selection and plant technical and operational parameters (structures and related physical alterations, flow management, management of water level, sediment management, management of fish passes, etc.), based on of the effects of the HPP on the indicators defining the ecological status of the affected water body.

SDWS2011.0215 Preliminary Research on Energy-Water Nexus in Beijing

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Abstract

We are looking forward to visualizing the water from source to service, and to destination in Beijing using Sankey diagram. The energy-water nexus is emphasized in our researches. The methodology, and definition and data is described, the result based on Sankey diagram is showed and discussed. Some preliminary conclude remarks are made. The resource for water supplying in Beijing is very constraint and we are going to use more and more high-energy-consumption water such as underground water and long-distance water. The major part of water consumption is household usage and the situation is in line with the development of economy in Beijing. To control the energy use for water, two options can be taken, which are reducing water usage and shifting to low-energy-consumption water. The water for energy industry is an important contributor for water for whole industry in Beijing, with the electricity sub-sector is the biggest one. Further task:1) To improve the data accuracy through field survey and more references reading, and expert opinions collection. 2) To expand the content of irrigated (green) water used to produce food products that are imported into Beijing. Key words: Beijing, Water, Energy, Sankey

SDWS2011.0315 Cross-Domain Interactions in Water and Energy Systems: a Case Study of Masdar City

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Abstract

Urban water and energy systems are in the process of expansion and growth in many parts of the world. With increasing pressures on water and energy supplies, policy makers are enacting water and energy efficiency measures, and developers insert new types of technologies into larger systems that have many legacy sub-systems and components. In many renewable energy supply systems (such as bio-fuels, hydropower, and concentrated solar power), water is an essential element. Similarly, the water systems require ever more energy as desalination, tertiary recycling and long distance conveyance systems are put in place. Thus, as water and energy systems get increasingly coupled, and within an urban context have complex socio-technical inter-dependencies, it has become important to identify the specific interactions that exist in order to better inform design and planning decisions. A clear understanding of the interdependencies of water and energy domains

(traditionally designed and operated independently) is vital for achieving increased efficiencies, avoiding unanticipated effects, and ensuring long-term sustainability.

We create a framework in which the water and energy systems are first described across their entire spectrum of the value delivery chain. All the segments from production to end-use and disposal are carefully considered, and each is described through both technical (engineering design related) and social (economics and management) parameters. The interactions are then captured through a combination of multi-domain matrices, directed graphs and causal loop diagrams that make explicit the technical and social inter-connections and feedbacks within and across the domains. The framework is then applied to a case study of Masdar city. Masdar, in the outskirts of Abu Dhabi in the United Arab Emirates (UAE), is targeted to be a sustainable, zero-carbon, zero-waste community that will depend on renewable energy sources a new development.

In the case study, three specific interactions are explored in depth: First, the energy intensity of the entire baseline planned water system ranging from production to disposal) is quantified. Next, using the general interdependencies that are identified through the framework, a few variants to the baseline water system plan are considered that include the possibilities of various source types (desalination, ground water abstraction, recycling) and architecture options (on-site/distributed, centralized, hybrid). The water and energy implications of the variants are discussed in detail. Lastly, economic considerations are factored and we investigate how the choices can differ with objectives that are least cost only, least energy only, and least water and energy only basis.

SDWS2011.0833 Economic Operation and Evaluation of Short-Term Hydroelectricity Generation Scheduling

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Abstract

This paper proposes an optimization model for solving a hydro scheduling problem to achieve economic operation. The scheduling strategy is to optimize the conversion efficiency of hydro turbines. It is proposed that electric utility should also consider the water value of hydroelectricity from the economic contribution on the total costs of generation. The economic value of hydroelectricity can be evaluated from the average and marginal costs of generation of an electric utility. The solution algorithm has been successfully tested with the daily scheduling data of the Bhumibol hydropower plant in Tak province, Thailand.

The power output and water discharge characteristics of each hydroelectric unit are formulated from the hill diagram as a piecewise quadratic function, with accounting for head variations. Given weekly water drawdown requirement for irrigation purpose, the hydro scheduling problem is considered on an hourly basis. The objective function is

proposed to be either water discharge minimization or energy generation maximization. The former is essential when water storage is limited. The latter is proposed to account for turbine flow characteristics of each hydroelectric unit. Regardless of the objective, the equality constraints are power and energy balances as well as water drawdown. The inequality constraints are generating capacity limits, turbine flow limits, and reservoir volume limits. Note that water spillage is neglected. The problem is formulated as a quadratic programming problem and solved by using MATLAB. The power output of each hydroelectric unit can be optimized by using a lambda-iteration method, which is modified from the economic dispatch problem. The benefits of economic operation in terms of water savings and energy surplus, compared with the existing scheduling plan, are assessed.

Upon solution, the proposed optimization model can save water up to 0.95 million cubic meters per day, the average water savings was 0.17 million cubic meters per day, and the total water savings was 1.39 percent of annual water drawdown. Meanwhile; the energy surplus was up to 216.05 MWh per day, the average energy surplus was 41.84 MWh per day, and the total energy surplus was 1.37 percent of annual energy generation.

The weighted marginal and average costs were defined to properly reflect time-varying electricity demand. It was calculated that the hourly marginal costs were varied from 1.5534 to 2.5848 Baht/kWh, while the hourly average costs were varied from 1.0057 to 1.7293 Baht/kWh. The annual weighted marginal and average costs were 2.2204 and 1.5136 Baht/kWh, respectively. It can be stated that the marginal and average costs are proportional to the hourly peak loads so that the economic values of hydroelectricity in Thailand were high during summer and low during winter.

SDWS2011.0349 The Importance of Population Characteristics and Market Structure in Determining the Benefits of Establishing Tradable Water Rights

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Abstract

Many agricultural areas face depleting groundwater resources, which farmers rely on to increase productivity through irrigation. While many intuitively appealing policy solutions have been offered and implemented, these policies are not necessarily mutually exclusive, and their interactions may have synergistic or antagonistic effects on overall societal goals.

This research is motivated by the situation in North Gujarat, India, where a mix of recently enacted water productivity and rationing policies has helped to reduce groundwater use in private groundwater markets, but in an inefficient manner. Tradable water rights (TWR) are often suggested as an equitable and efficient solution to problems in the private (and often monopolistic) markets, and this work analyzes the interactions

between market characteristics and other water policies. It assumes a situation in which private groundwater markets exist, and village-level water use must be reduced, focusing on two questions: What are the marginal effects of moving to TWR, and how are they contingent on a variety of policy settings and uncertainties?

These questions are addressed using a simulation framework in which a population of smallholder agents buy and sell water in (possibly monopolistic) water markets. Agents can grow a water inefficient crop, and/or a water efficient crop that also requires capital investment. Farmers are assumed to maximize profits subject to water prices determined by policy or water markets, and to capital constraints, which are affected by subsidy and loan policy. While the agent-level model is simple, a systematic exploration in system parameter space allows us to study quantitative outcomes and to characterize qualitative relationships that arise from the interaction of policies, under varying populations. Additionally, the model developed lays groundwork for analyzing related situations by supplying the model with new data or enhancing different components as needed (eg, allowing for risk aversion).

Early results suggest the impacts of transitioning from monopolistic to competitive markets vary heavily according to the structure of the buyer-seller network and the magnitude of water restrictions required to make extraction sustainable. This suggests that, while establishing TWR can bring many benefits to smallholders, it is not guaranteed to do so and any ex ante assessments of such a transition must consider details of the local agro-ecology and other policies.

SDWS2011.0335 Taking the Exergy as a Guide to Allocate Environmental Costs of the Water Framework Directive Among Users: the Case of the Ebro River Basin

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Abstract

The authors presented in previous SDEWES conferences the Physical Hydronomics (PH), a novel methodology based on a thermodynamic property which is exergy. Particularly, this property can be also defined to a water flow by using the sea as the reference to exergy calculations. Total exergy of a water flow (B) obviously depends on the flow (Q) and the specific Exergy (b), which is a function of temperature, pressure, height, velocity and composition, all of them physical parameters. So, in the framework of the Second Law of Thermodynamics, this methodology makes possible to include economic aspects, in the sense of finally evaluate the energy quality of different ecological status of water bodies, and the costs to restore them (or Environmental Costs, according to the objectives pursued by the Water Framework Directive -WFD-). Main advantage of PH with respect to other techniques is that, as it is based on physical

parameters, it allows assessing the quality degradation (or contamination) but also to the natural resource one (water consumption). But the highest contribution of PH is that it could assess those costs among diverse water users, according to the degradation provoked by their water catchment and further return.

The basis of the PH application is found in stretching a river, in order to define its exergy profile. To do that, a river basin simulator is required, in order to build up a detailed hydrological model. In this work, it has been carried out with the help of the Aquatool-DMA simulation software. Water demands, groundwater masses, and even non-point pollution have been considered in the simulation. From the water flows and physico-chemical parameters obtained, the river exergy profiles can be represented along its length, for different scenarios (diverse periods and ecological statuses). Then, it is possible to calculate the cost (in exergy and therefore in money values) to fill in the distance between two hypothetical situations of the river, corresponding to present and ideal (objective) pictures of the river. Regarding the cost allocation between the users, in this paper a new strategy was followed: new ecological statuses were simulated for individual users, in order to find out the appropriate cost assessment.

The work includes the results of PH application on the Ebro river Basin. The analysis shows that, except from local points, the environmental objectives stated by the WFD can be reached without serious problems in the simulated period (2002-2007). The environmental costs concerning to quality (contamination) are quite similar for different users (urban, industry, farmers, hydropower). Nevertheless, if degradation is only focused to water consumption (quantity term of exergy degradation), obviously irrigation use obtain the higher figures.

Sustainable development

SDWS2011.1016 Intech a Multidisciplinary Open Access Publisher

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Abstract

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SDWS2011.0149 The 'Puzzle' of Incumbent Firms' Reorientation Towards Sustainability: a Contextualized Issue Life-Cycle Model and a Case Study

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Abstract

This paper contributed to the understanding of issue evolution by, first, introducing the conceptual Haddon Matrix as a cognitive map that allows for the understanding of how a particular issue can be framed in relation to an industry and offering a related proposition; and by, secondly, reviewing natural history models of social problems and issue life-cycle models to propose a Multiple Streams Model of Issue Evolution. By drawing on the multiple streams (Kingdon, 1984) and helix metaphors (Etzkowitz and Leydesdorff, 2000) the model overcome a key limitation of previous models: linearity. One important characteristic of the model advanced here is that it allows for a combination of quantitative and qualitative methods of processual analysis, and remains faithful to Pettigrew's (1997) guiding assumptions of processual analysis: (1) embeddedness, studying processes across a number of levels of analysis; (2) temporal interconnectedness, studying processes in past, present and future time; (3) a role in explanation for context and action; (4) a search for holistic rather than linear explanations of process; and (5) a need to link process analysis to the location and explanation of outcomes.

SDWS2011.0203 Shifting (Regional) Tourism on a Sustainable Path: Dilemmas and Experiences of a Carribean Island

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Abstract

Tourism is a crucial economic sector for most islands, especially developing islands such as those in the Caribbean Sea. This paper focuses on the sustainability challenges of one islands of the Netherlands Antilles, Curacao. So far, tourism has developed unsustainably on Curaçao, as on much of the world's micro-state islands. Numerous foreign investors favouring mass low-cost tourism development prefer to operate in countries where sustainability legislation is underdeveloped or un-enforced. Political actors create often such environments to maximize foreign investments. Although this is empirically widely acknowledged, there is yet no conceptual framework that enables academics to explain theoretically the situation of sustainability legislation shortage on so many developing islands. This paper contributes to the knowledge and literature on sustainable development by proposing such a framework. The paper illuminates how the

Competitive Prisoner Dilemma Game, developed under Game Theory, can explain the failure (so far) of political actors on Curaçao to adopt laws that would enable a sustainable tourism development. Most importantly, Game Theory also suggests interesting lock-out strategies for countries stuck into this dilemma. Game Theory reveals that the key for change is in a solidarity orientation of political actors across developing islands. The paper explains how this would work and how this could be achieved by formulating a set of specific policy recommendations.

SDWS2011.0478 Comfort, Mobility, Growth, Efficiency – Conceptual Frames Or Blinders for Disciplinary Engagements in Sustainable Transition Processes?

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Abstract

In the literature on transitions to a low carbon or sustainable society consumer preferences and fundamental economic mechanisms are very often seen as serious obstacles to sustainable solutions. These obstacles are supported by specific and rather basic notions derived from the discipline based approaches taken in research but also in public and political discourse emphasising certain phenomenon as e.g. consumers striving for improved comfort, citizens identifying mobility with freedom, societal economies building on a growth paradigm, and industrial processes focusing on cost reductions and efficiency.

The paper will survey four notions and corresponding theoretical concepts: comfort, mobility, growth, and efficiency highlighting their specific contexts within scientific discipline and philosophical envisioning. Their historic contingency will be highlighted as well as how they have been part of socio-technical visions related to some specific epochs in societal development. While some scientific disciplines and political discourses take for granted such historic projections and help reproduce them as difficult to reject or neglect, the paper's idea is to open for a demystification and deconstruction of these core concepts by identifying their specific historic relations and emergence and relations to new socio-technical regimes. Examples of new technologies are challenged by these established regimes and are forced to produce visions of a changing society to sustain their appearance and performance hereby either aligning with or bringing in alternatives to transition processes.

All four concepts have been assigned a rather fundamental role in the formation of a post-war consumer society based on a well-fare model of society where consumption was created as the core engine of development and transformation of societal institutions. While such models and conceptual framings of society and its institutions are not easily transformed and will survive during a long period of controversy, identifying their historic routing opens for criticism and the potential of developing alternative visions.

SDWS2011.0603 Training Key- People in Sustainable Development Within the Higher Education at Distance Framework

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Abstract

Based on our experience, we expound the need to expand the reach of the education on sustainable development not only to young students but also to planners, trainers, project managers and decision-makers. These are key-people that, at this moment, have a bearing on the ways that the resources are extracted and used, as well as on the mechanism of social organization that can favour a sustainable way of life for the people.

Higher Education is the educational field in which this training can be carried out on an intensive way and with a wide reach. Specifically, the Postgraduate Program Courses (Specialist and Master Degree) are university offers opened to a life-long learning processes for professionals in service. If this training is, furthermore, carried out using distance education methodology, the learning processes turn out to be more accessible for the users, as it allows to use a vast range of means offered by the ICT, eliminating the need of face to face educational process and allowing, at the same time, flexibility on both, timetable and curriculum.

The sustainable approach is a complex point of view that requires the contribution of several knowledge fields (Ecology, Economy, Ethics…). Consequently, a higher education program that pretends to deal with in an integrated way must do it through interdisciplinary teams and programs.

Taking in account these considerations, our University has been developing, since 1990, a two-years International Postgraduate Program in Environmental Education and Sustainable Development, addressed specially to these key-people. Since 1996, the Program is held on the UNESCO Chair in Environmental Education and Sustainable Development framework. In the course of this 20 years, we have trained several hundred key-people from Europe, America and Asia, involved in environmental and development management. The subsequent monitoring has been indicating that this training has had a huge multiplier effect. In some cases our graduates have developed new postgraduate courses in their own universities. In another cases, the assets and services management has been influenced in a quick and direct way by the learning, knowledge and action criteria derived from our Postgraduate Course.

To extend this information, we present a poster where our learning method is shown in detail, as well as some relevant data that confirm its utility and pertinence in a

sustainable development training program through interdisciplinary processes, accessible to a wide range of professionals in service.

SDWS2011.0791 Imposition Or "The Will of the People"? the Idea of Justice in Community Wind Energy Projects

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Abstract

Community wind energy schemes imply some form of "ownership" of the turbines by the neighbouring local community. However, in the context of community energy projects little work has been done on what "ownership" actually involves and how it is defined, how it is fostered so that people consider themselves to be owners, and the symbolic and cultural significance of being a collective owner in such schemes. The objective of this research was to offer some enlightenment on these issues, and thus provide information on the impact being a community owner has on a local person's attitude toward a proposed wind turbine. Qualitative fieldwork was undertaken over the course of a year at two places – the Isle of Skye, and South Yorkshire – where community wind energy projects had been proposed, prior to their application for planning permission. In-depth interviews, observation and historical research were utilised, before being analysed using ATLAS.ti. This research shows that a perception of ownership of wind turbines by the local community does not necessarily require a financial stake, but rather is dependent on feeling as if the scheme is being controlled by and done for the community. The concept of ownership itself was shown to have a strongly symbolic element that was derived from its cultural importance and because it was being organised locally and collectively. The research also draws attention to how opinions of a wind turbine's landscape impact may be influenced by this notion of ownership and being an owner. The symbolism of local, collective ownership influenced local residents' visions of a wind turbine on the landscape. To those that felt that the turbine would "belong" to the community, it was to become an icon of community identity and justice. Those who felt disenfranchised from the ownership, or had significantly different values regarding the appropriate use of the rural landscape, perceived any future turbine as an imposition and a symbol of injustice. The main conclusions illustrate that attitudes toward landscape impact are much more about what a person believes to be 'behind' a wind turbine in terms of the practices, meanings and values of how it is implemented, more so than it is about physical aesthetics. Local community ownership has the potential to improve the landscape symbolism of a wind turbine, but only if efforts are made to ensure it is truly inclusive of everyone living locally.

Biofuels I

SDWS2011.0443 Sustainable Production of Biobutanol from Lignocellulosic Raw Materials

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Abstract

Biofuels from renewable raw materials are needed due to the concerns about the environmental issues and tightening legislation to reduce CO_2 emissions. The strong promotion to use renewable energy instead of fossil based fuels is also one reason for the increased production and use of biofuels. In addition, biofuels have beneficial effects on the energy security, economic and socioeconomic issues. Besides of economic issues, it is important to take into account also environmental and social impacts of the biofuel production. Sustainability of a process can be evaluated by this kind of triple bottom line analysis.

Fuel properties of butanol are superior compared to ethanol. Biobutanol may be produced by the acetone-butanol-ethanol (ABE) fermentation. Feedstock materials for biobutanol production are diverse, including e.g. by-products, wastes and residues of agriculture and industry. The ABE fermentation process contains two anaerobic stages in which acetic and butyric acids, carbon dioxide and hydrogen are first produced in the acidogenic phase. Then the bacterial culture undergoes a metabolic shift to the solventogenic phase and acids are converted into acetone, ethanol and butanol. Final products are then recovered from the bacterial cell mass and from other suspended solids and by-products.

Biobutanol production has still some limitations and development work is required before an economic and efficient production process is achieved. The main challenges for the economic competitiveness are price of raw materials, low product yield due to product inhibition, and cost-effective downstream processing.

In this work the target is to obtain new knowledge on the biobutanol production process and to develop a more efficient and sustainable process. Costs can be reduced by using e.g. lignocellulosic by-products or waste materials with an efficient pretreatment method. The aims are to develop the pretreatment method such as enhanced enzymatic or chemical hydrolysis for lignocellulosic material, and to evaluate the sustainability of the new process chain.

SDWS2011.0469 The Production of Bio-Ethanol in Large-Scale Fermenters : the Study of the Complex Mixing Phenomena

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Abstract

China has embarked upon an important programme for producing fuel-ethanol by fermentation of non-grain feedstock. The current target is set at 2 million ton/year of ethanol, with cassava mostly used as starch feedstock.

The fermenters used in the industrial production have diameters and liquid levels in excess of 15 m. The agitation and mixing of the fermentation broth is important for the efficient operation of the reactor. This broth is a non-Newtonian suspension with viscosity around 0.5 to 1 Pa.s, and a solids concentration of about 20-25 vol%.

Mixing of the broth in the fermenter is achieved by the combined action of:

-a set of horizontal shaft impellers, near the bottom of the flat bottom fermenter

-an external recycle flow; and

-the gas-induced mixing by CO_2-bubbles formed during the bio-reaction.

Although there is ample literature available on the evaluation of impeller-induced mixing (mostly using vertical shaft mixers), the combined mixing effects have not yet been studied in detail.

Since it is difficult to acquire experimental information from the industrial fermenter, the objective of the present work is to develop a phenomenological model, validated against experiments in a scaled-down pilot tank, where the different mixing contributions can be simulated, either in single effect or in combination.

Tracer experiments are used to determine the rate of mixing and the mixing times, whereas additional model parameters such as bubble distribution and hold-up, effect of recycle flow in single or multiple location, dead zones, etc. are also determined.

As a result, the model will be fully defined, useable for the scale-up of industrial fermenters, and providing a full set of operational data that can be used to validate CFD flow predictions.

The paper will review the available literature, describe the phenomenological model approach, illustrate the initial experimental results and apply them in a the modelling and scale-up procedure.

SDWS2011.0572 New "White" Biodiesel Production Via Catalytic Hydroprocessing of Waste Cooking Oil

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Abstract

Oil, coal and natural gas currently cover most of the world energy needs. Nevertheless, fossil fuels are questionable from an economical, sustainable and environmental point of view. For these reasons scientists have turned their interest to biofuels.

A new technology based on hydrotreating of Waste Cooking Oil (WCO) for a new type of biodiesel production has been developed in the CPERI/CERTH. The WCO was mainly collected from local restaurants as well as households; after extensively being used for frying, without limiting the product yield and quality.

Biodiesel production is performed in a small-scale hydroprocessing pilot plant of CPERI/CERTH. This hydroprocessing pilot plant can be used for both hydrotreating and hydrocracking applicatoins as it offers a wide range of operating pressures and temperatures. The total liquid product is collected daily and analyzed within CPERI/CERTH. The analyses include density, simulated distillation, elemental analysis (carbon, hydrogen, sulphur, nitrogen and oxygen). The optimal hydroprocessing catalyst as well as operating conditions (temperature, pressure, H_2/WCO etc) defined offer a total liquid product which contains over 85% of molecules within the diesel boiling point range. The diesel fraction of this total liquid product, to be called "white" biodiesel, has improved fuel characteristics (cetane number, oxidation stability, heating value etc).

The technology is currently demonstrated in a large-scale hydroprocessing pilot plant of CPERI/CERTH aiming to produce a sufficient quantity of the "white" biodiesel for road testing and pilot utilization in a garbage truck of the Municipality of Thessaloniki, Greece. Finally, it should be noted that this new biodiesel production technology is extremely appealing as it employs existing refinery infrastructure and expertise, offers feedstock flexibility, leaves no byproduct and above all is economically attractive.

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SDWS2011.0669 Potentials of Lignocellulosic Bioethanols Produced from Hardwood in Taiwan

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Abstract

The hardwood forest covers 1,120,400 ha in Taiwan, roughly of 30 % the overall land area in Taiwan. Their fast growth and adaptability toward various soil and climate conditions make them good candidates as feedstocks for bioethanol production. This study evaluated acacia and eucalypt as feedstocks for bioethanol production in Taiwan

Steam explosions of acacia and eucalypt were conducted using 3×3 cm chip. Acidic steam explosion (1.5 % w/v H_2SO_4) was employed at 190^oC for 10 min. Unbleached and bleached kraft pulps were also prepared for comparisons. Wood chemical properties for the raw hardwoods, steam exploded and kraft pulps, like lignin content, kappa numbers, pentosans, and alpha celluloses, were also analyzed as well.

For the saccharification of exploded or kraft pulps, enzyme formulations with endoglucanase, cellobiohydrolases and xylanase activities were applied with two dosages: 2 and 6 percents weights to dried pulps. They were equivalent to 1.45 to 4.37 IU endoglucanase/mL, 0.13 to 0.375 IU cellobiohydrolases/mL, and 1.19 to 3.58 IU xylanase/mL reaction solutions.

Optimal hydrolyzed glucose yields were 986.3 mg and 831 mg per gram of pulp alpha cellulose for acidic exploded eucalypt and acacia pulps. For fully bleached kraft pulp, the yields were 892 mg per gram of pulp alpha cellulose for eucalypt pulp. We also found that the hydrolysis efficiencies were negatively impacted by lignin and xylan contents of pulps.

Simultaneous hydrolysis and fermentation (SHF) were also conducted using Saccharomyces cerevisiae D5A under 38^oC and pH 5 at shake flask level with 1 % (w/v) yeast extract and 2 % (w/v) peptone. After 170 hours, 70.72 and 65.21 gram of ethanol were produced from acidic exploded acacia and eucalypt pulps. 66.31 and 97.04 gram of ethanol were produced from acidic exploded acacia and eucalypt pulps. The above yields are based on per kilogram of oven dried wood. The overall potential of bioethanol production from the hardwoods in Taiwan was also estimated.

SDWS2011.0677 Alternatively Potential Development for Local Energy Crops of Bioethanol in Taiwan: Energy, Environment and Cost-Benefit Aspects

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Abstract

In order to evaluate Taiwan's bio-ethanol crop cultivation development potential, our research team, with the assistance of the Agricultural Research Institute, Council of Agriculture, the Council of Agriculture's Agricultural Research and Extension Stations, specialist agricultural contractors and Taiwan Sugar Corporation, undertake comprehensive recording of cultivation resources and cost inputs data from 2007 to 2010 (including cultivation, harvesting, transportation, warehousing, etc.) of four energy crops – corn, sweet potatoes, sugarcane and sweet sorghum –based on Product Life Cycle Assessment method. Data from experimental bio-ethanol production was used to model the production efficiency of large-volume, commercial production, so as to establish a comprehensive model for evaluating the energy inputs, greenhouse gas emissions and production costs of cultivating bio-ethanol crops in Taiwan. On the basis of the analysis of energy consumption, greenhouse gas emissions and cost benefit of Taiwan domestic bio-ethanol production.

There will be a comprehensive supply of E3 bio-ethanol in 2011 in Taiwan and the government is studying to offer some subsidies for energy crops cultivation by using fallow land. With government subsidies, we see the potential of bio-ethanol development. The evaluation of net carbon emission, corn, summer sweet sorghum, and sugar cane all have lower greenhouse gas emissions than gasoline (94 grams CO2e/MJ). Using sugarcane ethanol to replace gasoline could decrease 1.25 kg CO2e per liter. In addition, the net energy balance is larger than one, which means energy output is greater than energy input, and the outcome signifies energy conversion efficiency. The cost of bio-ethanol crop production is about US$0.69~0.99 per liter for four energy crops. Among these four crops, sugarcane ethanol is most competitive with imported ethanol and others energy crop ethanol in this study. As to This paper will separately look at various aspects of overseas biofuel efforts, policy goals and promotion strategies, together with Taiwan's nation biofuel policy, and analyze energy balance, greenhouse gas emissions and production costs as reference for Taiwan's national biofuel industry policy.

SDWS2011.0294 Biodiesel: Ethanolysis of Rapeseed Oil

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Abstract

Biodiesel is an ecological fuel for combustion engines. It is produced by the transesterification of triglycerides contained in the vegetable oils by low molecular alcohols. The reaction is usually carried out at homogeneous catalyst, but this way has several disadvantages therefore nowadays research is turned to heterogeneous catalysis. The most used alcohol is methanol, but it has some disadvantages: toxicity and difficulty to be produced from renewable raw materials, therefore there is a tendency to use ethanol. On the other hand, ethanol has lower reactivity in comparison with methanol during transesterification, which is caused by longer carbon chain.

This paper introduces and compares biodiesel preparation by ethanol from rapeseed oil using homogeneous (KOH) and heterogeneous catalyses. The transesterification is carried out in the batch reactor equipment with cooler. The ester phase (biodiesel) is gained from reaction mixture by separation after transesterification, removing of catalyst and ethanol excess. The course of transesterification was monitored by concentration of intermediates (mono-, di- and triglycerides) in the reaction mixture. The properties of the ester phase and the side product (the glycerol phase) such as the yield and the content of metals for the both phases, the viscosity, density, acid number etc. of the ester phase and other properties were monitored.

Homogeneous catalysis. In the case of homogeneous catalyst, the effects of various reaction conditions such as the reaction temperature and time, the catalyst concentration, the molar ratio of ethanol to oil, the temperature of deethanolisation on the quantity and quality of both phases were studied. Data were evaluated by the linear regression on the statistical basis of multivariable systems. The final linear models were verified by independent experiments and they are able to predict the biodiesel quantity and quality in the dependence on reaction conditions.

Heterogeneous catalysis. The K-based heterogeneous catalysts were prepared by impregnation with different concentration of potassium. The catalysts were characterized by XRD, BET, Hammett indicators, TPD-CO_2. The main problem of the application of heterogeneous potassium based catalysts is the leaching of metal species and thus the contribution to homogeneous catalysis. This phenomenon is not sufficiently described up to now. The leaching of alkali species is very often omitted in literature. Thus, the omitting of the leaching species was discussed.

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Decarbonisation/Emission markets

SDWS2011.0246 Abatement Costs of Greenhouse Gas Emissions in Upper Austria

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Abstract

This paper presents the main results and conclusions of the scientific research project „Analysis of CO2e abatement costs in Upper Austria". The assessment covers the quantification of abatement costs (MACs) of greenhouse gas emissions (CO2, CH4, N2O) of various energy efficiency and fuel switch measures putting special emphasis on the heat, electricity and transport sector in Upper Austria in the period from 2010 to 2030. The evaluated energy efficiency measures include, among others, thermal renovation activities, improving building standards, promoting efficient vehicles and enhancing domestic appliances. Additionally the fuel switch measures incorporate the increased utilization of renewable energy sources for heating systems, vehicles and for the generation of electricity. Abatement costs are defined by a cost-benefit ratio which displays the monetary input necessary for the emission reduction of one ton of CO2e. The ecological improvements of these measures or technologies are assessed with regard to a business-as-usual scenario. Additionally, the absolute reduction potentials of the analysed measures (in tons of CO2e) for each year and for the entire period are evaluated. This multi-criteria approach reveals the economic efficiency and the ecological effectiveness of the considered methods with regard to (a) GHG emission reductions, (b) the improvement of the overall energy efficiency and (c) the competitiveness of a fuel switch towards renewable energy sources. Furthermore, the MACs resulting from 31 energy efficiency measures will be compared to 25 technologies focussing on fuel switch measures. Thus, a direct comparison of the concepts of energy efficiency and the intensified utilization of renewable energy sources is possible. The measures examined within the project have a total CO2e reduction potential of 5.23 million tons CO2e in Upper Austria in the year 2030 (corresponding to about 21% of the GHG emissions in Upper Austria). Drawing upon the findings of this study, policy recommendations can be elaborated and the necessary improvement of the regulative framework can be implemented.

SDWS2011.0350 The Mutual Influence of Environmental Management Systems and European Emission Trading Scheme on Corporate Environmental Planning: a Multiple Case Study Analysis of the Italian Pulp and Paper Industry

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Abstract

The European Emission Trading Scheme (ETS) is designed to be a flexible and efficient mechanism to encourage carbon intensive industries to reduce CO2 emissions cost-effectively. Similarly, Environmental Management Systems (EMSs) are well established tools designed to improve the efficiency of the environmental performance of companies. Up to now, many studies have been carried out (separately) on the impacts of the ETS and EMSs on corporate organization and environmental planning. Of these, only a few empirical research studies have analyzed the environmental strategic planning of firms and allowance management set up in response to the ETS. At the same time, only a few studies on the adoption of voluntary regulation have analyzed the specific impact of EMSs on planning. In this framework, the relationships between strategic planning, ETS management and EMSs are still incomplete and their implications not fully understood. This study tries to identify whether the involvement of a firm in the ETS and the adoption of an EMS, favors the generation of corporate strategic synergies in terms of internal resource management and planning. Due to the availability of short time frame and, sometimes, a lack of conclusive findings, a multiple case study emerged as the most suitable approach. Therefore various Italian pulp and paper companies involved in the EU ETS were interviewed and analyzed. These companies were chosen on the basis of the number of allowances allocated by the National Allocation Plan (NAP), and on the adoption of environmental certifications such as EMAS or ISO 14000. We found that organizations that integrate ETS management and EMS tend to establish satisfactory standards and procedures that are relevant for environmental monitoring and compliance, as well as determining corporate organizational management. However, despite some mutual synergies, they are not sufficient for determining corporate environmental planning.

SDWS2011.0684 Reducing the CO2 Emissions in Croatia's Cement Industry – the Pre-Calciner Model

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Abstract

Cement industry is one of the largest carbon emitting industrial sectors in the world. It contributes to about 5% of worlds anthropogenic CO_2, and because of that is an important sector for CO_2 emission regulation strategies. During the cement manufacturing process almost 90% of CO_2 is emitted from two thermo-chemical processes which occur in the process of cement production. One is the calcinations process, which contributes with 50% of CO_2 emission, and the other is the combustion of the solid fuels, which contributes with 40% of CO_2 emission. Remaining 10% of CO_2 are emitted during the transport of raw material and some other production processes. The only way to reduce the CO_2 emission from the calcination process is to use alternative raw materials, but till now there are no such materials from which that kind of cement, with at least as good performance and durability characteristics as the current portland-based cements, could be produced. That is why, for now, the only way to reduce the CO_2 emission is to use more fuel efficient technologies. The best available technology, the one with the lowest energy consumption, for the cement manufacturing today, is the use of a rotary kiln together with a pre-calciner. The pre-calciner is a separate furnace in which the calcination process occurs, and after that the material goes to the rotary kiln where the clinkering process occurs. This improvement in the energy consumption, by simply dividing the calcination and the clinkering process, can be calculated also as a CO_2 emission reduction. The purpose of this paper is to present the possibility of CO_2 emission reduction in Croatia's cement industry, by using the best available technology for cement production.

SDWS2011.0868 Forest Fires and Greenhouse Gas Emissions: Part of the Solution Or Part of the Problem?

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Abstract

Forest fires are part of the natural silviculture cycle, but they are also a major climate change forcing agent through its greenhouse gas emissions, particulate emissions and surface albedo change. The fourth IPCC report (2007a) acknowledges that "there is a large potential for future alteration in the terrestrial carbon balance through altered fire regimes", it devotes only half page to the issue of forest fires in its 1200 pages report on physical science basis on climate change. Nevertheless, the panel's working group III (IPCC 2007b) argues in its Summary for Policymakers that "Forest-related mitigation

activities can considerably reduce emissions from sources and increase CO2 removals by sinks at low costs, and can be designed to create synergies with adaptation and sustainable development."

In the present study, we are looking at ways by which the reduction in forest fire incidence and spread can be linked with economically and socially viable carbon sequestration through carbon immobilization in situ, either with net energy gain or without the net energy expense, associated with all alternative carbon sequestration strategies considered today. Three strategies are examined and compared against each other: (i) slow pyrolysis/gasification that produces combustible gas and leaves porous, active charcoal that can be mixed with the soil locally; (ii) fast pyrolysis that is optimized for biofuel production, but also leaves the carbon residue of lesser soil activity, but potentially longer lasting and (iii) immobilization of biomass without heat, but still clearing up the space for new growth and stimulating net carbon sink. All three strategies avoid hauling biomass to greater distances, thus limit the need for additional fuel in its operations. They are not mutually exclusive and can be mixed to an optimal, region dependent ratio.

An average of about 2.5 GtC/yr (or about 5.0 GtC_{eq}/yr) are emitted due to forest fires, in a 1997-2004 period (Werf 2006), which represents about 4% of the total net primary production (NPP). Previous analyses (Matovic 2010, Woolf et al 2010) have shown that maximum avoided emissions of the order of 1.8 GtC_{eq}/yr are possible. Here we analyze what percentage of that total can be achieved by reduction of wildfire events, and to what extent that reduction would be practical.

SDWS2011.0527 Forecasting in the European Carbon Market

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Abstract

In an effort to meet its obligations under the Kyoto Protocol, in 2005 the European Union introduced a cap-and-trade scheme whereby mandated installations are allocated permits to emit CO_2. Financial markets have subsequently developed that allow companies to trade these carbon permits. For the EU to achieve reductions in CO_2 emissions at minimum cost, companies must make appropriate long-term investments and policymakers design optimal pollution reduction policies. In response to these needs, economists have attempted to statisticaly model the market in an effort to understand its workings. However, the European carbon market (EU ETS) has many institutional features that potentially impact on daily carbon prices (and associated financial futures). Hence the carbon market has properties that are quite different from conventional financial assets traded in mature markets. In this paper, we use dynamic model averaging (DMA) in order to forecast in this newly-developing market. DMA is a recently-developed statistical method which has three advantages over conventional approaches.

First, it allows the coefficients on the predictors in a forecasting model to change over time. Second, it allows for the entire forecasting model to change over time. Third, it surmounts statistical problems that arise from the large number of potential predictors that can explain carbon prices. Our empirical results indicate that there are both important policy and statistical benefits to our approach. Statistically, we present strong evidence that there is substantial turbulence and change in the EU ETS market, and that DMA can model these features and forecast accurately compared to conventional approaches. From a policy perspective, we discuss the relative and changing role of different price drivers in the EU ETS. Finally, we document the forecast performance of DMA and discuss how this relates to the efficiency and increasing maturity of this market.

SDWS2011.0920 Overcoming Regulatory Barriers to the Implementation of Supply-Side Management Aspects of Renewable Energy Policies: Tradable Green Certificate Schemes and Feed-In Tariffs Revisited

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Abstract

Concerns about energy security and the negative environmental externalities of fossil fuel use have elicited a range of responses from governments around the world in their attempt to increase the total share of alternative sources of energy in the energy mix. Renewable energy's potential to address these concerns is evidenced by the fact that in its response to the G8's call for "guidance on how to achieve a clean, clever and competitive energy future" in 2008, the International Energy Agency (IEA) reported that the replacement of current technology with renewable energy could reduce CO_2 emissions by 50% by 2050.

The major obstacle to increasing the share of renewable in the energy mix however, has been the stranglehold that fossil fuels enjoy in the modern economy. The situation is further exacerbated by technological barriers to the widespread development and deployment of renewable energy which makes its cost of production prohibitive and uncompetitive relative to cheap and abundant supplies of fossil fuels. Governments around the world have implemented an extensive range of measures to redress this state of affairs. The implementation of mechanisms for pricing carbon (taxes and market instruments) which are essential in levelling the playing field, however, have turned out to be problematic as policy mechanisms have been diluted in response to opposition from powerful lobbies from the energy intensive and fossil fuel sectors. As a consequence, the framework for implementing policy for increasing renewable energy capacity has to a large extent relied on fiscal incentives and direct regulation.

This article focuses on two instruments that are increasingly being used by governments to foster the development and uptake of renewable energy - tradable green

certificate schemes and feed-n tariffs. It examines some of the constraints that have circumscribed the effectiveness of their regulatory framework.

Australia's experience with these instruments will be used as a case study. Their implementation has been characterised by a disjointed patchwork of policies operating in different states. The state based tradable green certificate regimes were consolidated into a unified national framework for the first time in 2009. These have not been helped by the absence of a centralised policy framework for pricing carbon.

Issues addressed include - the extent to which these instruments can be harnessed to realize their full capacity in an environment with a weak/non-existent carbon pricing framework; the sustainability of fiscal incentives as a policy driver in a post-GFC world; a critical evaluation of the policy-instrument mix issue from an efficiency perspective.

The dismantling fossil fuel subsidies will be examined, and possible ways of tackling this will also be considered.

Thermal power plants & WBalkICT project

SDWS2011.0191 Redesigning Gas and Steam Combined Cycles for Low Btu Syngas Fuels

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Abstract

The utilization of low BTU syngas fuels in conventional gas turbines and gas and steam combined cycle equipments has been studied by the authors over the last years. As a result of this work, the effects of using different fuels of the referred type on the performance of a gas turbine combustor were assessed.

Following this research line, the present work analyzes the challenges of using syngas fuels on the major equipment of a conventional combined cycle designed for natural gas fuel. First, the most relevant constraints imposed by the new fuels on to the conventional power plant are identified. This leads to setting up a list of the necessary modifications of the existing pieces of equipment, some of which need to be replaced by others with higher capacity. Then, according to the new operating conditions, a more in depth analysis of the suggested modifications is provided.

The modifications proposed in this work can be regarded as general rules for redesigning existing combined cycle power plants. To this aim, the effects of fuel substitution on the gas turbine, heat recovery steam generator and steam cycle of a reference power plant are analyzed, combining the use of commercial codes and in-house models of performance. This analysis is carried out for a set of representative syngases derived from vegetal and fossil raw fuels. Again, the main restrictions found in the original equipment are identified and the performance of the unmodified plant working with the new fuels is reported. Then, the performance of the plant using the modified/replaced equipments is given.

The conclusions permit forecasting the work that needs to be done if the present combined cycle plants are to be adapted to syngas fuels along with the expected performance of these modified plants.

SDWS2011.0580 Marginal Abatement Cost Curves for Coal-Fired Power Plants in Europe: CO2 Reduction Potential for 2020

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Abstract

This study has analysed the cost-effectiveness of CO_2 abatement for the projected population of coal-fired power plant (CFPP) in Europe in 2020. Since in Europe nearly a

third of the electricity is generated by CFPP, this population covers a large fraction of the greenhouse gas emissions of the power sector in Europe. The results of the study are presented in Marginal Abatement Cost Curves (MACC). The curves illustrate the emission reduction potential of four major abatement measures applied to the population of existing units and new constructions in the period 2010 to 2020.

The population includes units from countries with a significant share of electricity generated by coal. The main data source for the population model is the IEA Clean CoalPower Database, which was further cross-checked with country specific data sources and with information from personal contacts of the project contributors. The baseline emission of the population in 2010 is determined at 830Mton. This corresponds to 17% of the total CO_2 emissions in Europe.

The four major abatement measures for coal-fired power plants assessed are: Carbon capture and storage (CCS), biomass co-firing (BCF), combined heat and power (CHP), shift to supercritical units (S2SC). The results from the MAC model demonstrate that CO_2 emissions from the population in 2020 could be reduced by 6.8% below baseline at a negative cost and by about 13% if all four considered measures are implemented. This corresponds with a total reduction potential of 97Mton CO_2.

The main conclusions for the abatement measures are:

- CCS has a great potential for reducing emissions (40% of the total potential), but at the highest cost of all measures considered (62€/tCO_2).
- BCF is not cheap (with an average of 29€/tCO_2) and cannot be considered as a structural solution for the sector. But, it can be an option if sources of cheap (waste) biofuel are available and with the help of subsidy mechanisms (e.g. green certificates) and specific market instruments (e.g. carbon credits). BCF is more expensive for smaller units due to higher specific investment costs and O&M costs.
- CHP is interesting when applicable and at negative cost (with an average of -7.3€/tCO_2). Local heat demand has to be seriously considered when investigating suitable locations for new construction. The emission reduction potential presented is only a best estimate. A more detailed bottom-up investigation is recommended to fine-tune the applicability of CHP.
- S2SC has the largest abatement potential (42.6% of the total potential) and at negative cost (with an average of -6.6€/tCO_2).

SDWS2011.0448 Domestic Lignite Emission Factor Evaluation for Greenhouse Gases Inventory Preparation of Republic of Serbia

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Abstract

This paper presents the evaluation of emission characteristics of low calorific Kolubara open pit mined lignite. The samples of Kolubara Basin coal were carefully selected to cover a wide range of net calorific value, ash and moisture content, in order to ensure the coverage of wide spectra of the expected lignite qualities that are usually supplied to Serbian thermal power plants. Data base with results of complete proximate and ultimate analysis together with a number of physical-chemical analyses for the set of selected coal samples is formed.

In accordance with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, it is recommended that more precise and reliable data characteristics of the locally used fossil fuel should be introduced in GHG inventory preparation.

Performed correlation analysis indicated that linear correlation exists between the net calorific value and the ash, moisture, and the content of combustible matter in the coal samples. The analyses also indicated a linear correlation between carbon and hydrogen content and the content of combustible matter in the representative coal samples. From obtained set of results was possible to determine the dependence between the carbon content as well as the emission factor and the net calorific value of the coal. For the range of coal with net calorific values taken in the consideration in this analysis ($6 \leq Hd \leq 10$ [MJ/kg]), derived correlation gives considerably higher values for the emission factor (30.8 – 28 [tC/TJ]) compared to the standard IPCC recommended value for lignite of 27.6 [tC/TJ].

Relevant correlations were also used as a project basis for the introduction of a system for continuous monitoring and homogenization of quality of coal and the analysis of the effects that the introduction of this system would have on the balance of GHG emissions.

SDWS2011.0489 Co-Firing Bosnian Coal with Wooden Biomass – from Experimental Research to Trial Run on Large Utility (110 MWe)

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Abstract

Paper presents **research into cofiring of Bosnian cola types - brown coal and lignite with wooden biomass, focuesed on ash-related problems and emissions**. The research was aimed to optimize percentage of the switching coal by wooden biomass in two large coal-based power stations in Bosnia and Herzegovina; the Kakanj power station (2x110 MWe, 1x230 MWe) supplied by brown coal and the Tuzla power station (1x100 MWe, 2x200 MWe, 1x215MWe) supplied mostly by lignite.

For purpose of the experimental research in laboratory, an electrically heated entrained pulverized-fuel flow reactor was used. The co-firing trials in laboratory were running under different conditions in the reactor; varying the process temperature between 880 ºC and 1550 ºC, excess air ratio between 0.95 and 1.4., and also varying air distribution. Coal-biomass mixtures at 93:7%wt and 80:20%wt were tested. Both for lignite-wooden biomass and brown coal-wooden biomass co-firing, there were no significant ash-related problems if the blend with 7%wt of wooden biomass was used provided that the process temperature did not exceed 1250 ^{o}C. From the other side, adding biomass to the brown coal for the co-firing at temperature 1550 ^{o}C, which is actual temperature in the boilers with slag tap furnaces in the Kakanj power station, slag flow over ceramic surface was improved. It was identified that not only nitrogen content in the co-firing blend but also volatile content and particle size distribution of the coal-wooden biomass mixture influenced on NO_x emissions. Reduction of SO_2 emission was detected for all co-firing regimes. In addition to the reduction of SO_2 due to the lower sulfur content in the coal-biomass blends tested, the brown coal-sawdust co-firing generated a further reduction of SO_2 due to the higher sulfur capture rate than for coal alone. Finally, significant reductions of CO_2 found by calculation for the blends tested, due to the low ranking of Bosnian coals. It was found that 7%wt of wooden biomass can be used in combination with coal in both power stations without risk to the combustion process and with benefits through emissions reductions.

Based on this laboratory research findings, a trial run of co-firing on a large-scale utility is being realized - at the Kakanj power station unit 5 (110 MWe). The trials run were adopted to the switching 7% of the brown coal per mass by wooden biomass, supplied from the nearby sources of wooden sawdust by contractual supplier. Blend of coal and wooden sawdust is prepared at the coal depot, where the supplied fuels are mixed by coal exchavators before being transported to the boiler. The fuel mixture is introduced into the furnace over the mills and coal burners. 15-days trial runs of coal-wooden biomass mixture 93:7 %w was to confirme the opportunity to use co-firing regimes in regular operation of the Kakanj power station.

SDWS2011.0823 Improvement of Environmental Aspects of Thermal Power Plant Operation by Advanced Control Concepts

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Abstract

The necessity of the reduction of greenhouse gas emissions, as formulated in the Kyoto Protocol, impose the need for improving environmental aspects of existing thermal power plants operation. Improvements can be reached either by focusing on efficiency increase or by implementation of emission reduction measures. Investments in refurbishment of existing plant components or in plant upgrading by heat recovery systems, by flue gas desulphurization, by primary and secondary measures of nitrogen oxides reduction, or by biomass co-firing, are usually accompanied by modernisation of thermal power plant instrumentation and control system including sensors, equipment diagnostics and advanced controls.

Impact of advanced control solutions implementation depends on technical characteristics and status of existing instrumentation and control systems as well as on design characteristics and actual conditions of installed plant components. Evaluation of adequacy of implementation of advanced control concepts is especially important in Western Balkan region where thermal power plants portfolio is rather diversified in terms of size, type and commissioning year and where generally poor maintenance and lack of investments in power generation sector resulted in high greenhouse gases emissions and low efficiency of plants in operation.

This paper is intended to present possibilities of implementation of advanced control concepts, and particularly those based on artificial intelligence, in selected thermal power plants in order to increase plant efficiency and to lower pollutants emissions and to comply with environmental quality standards prescribed in large combustion plant directive.

SDWS2011.0999 Expert System for Training Wb Tpps Operators in Balkan Lignite Efficiency Burning.

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Abstract

As part of the historical inheritance and due to the unfulfilments recorded during the transition period, the energy utilization in the Central and Eastern European Countries, including West Balkan countries is far behind the West European countries. The EC Directive on Energy Efficiency (2006/32/EC) provides a good framework for strengthening European wide co-operation on energy efficiency. In EC "Action Plan for Energy Efficiency" – SEC (2506) 1073, EC underlined that opportunities offered by Information and Communication technologies play a crucial role in large energy and environmental benefits, including GHGs effect mitigation needed under the Kyoto Protocol. The main focus of the paper is for WBCs Thermal Power Plants using fossil fuels, with high contributions to energy losses, noxious emissions, including GHGs. The paper is based on the in running scientifically development of such a problem, in WBalkICT SEE ERA NET EC project. An important part of fuel supply for West Balkan TPPs is "problem of lignite burning in Balkans"; the "bad" lignite used in WBCs TPPs has approx. 50% humidity and 20% ashes. The present paper present an Expert System dedicated to TPP burning efficiency monitoring, used for TPP operators training and having the following attributes: i) an improvement –as originality- of the general burning equation, by completing the well known equation with percent values of the nitrogen oxides concentrations, with spatial presentation of this equation, Noxious Pyramid, that consolidates the image about analyzed thermodynamically burning processes; ii) graphical mathematical visualizations of the burning zone in a three-dimensional representation(CO2, CO, CO2) with the visualization of the operation point and related measured and computed burning parameters; iii) various process parameters expertisation; iiii) part of TPP operator theoretical evaluation(multimedia / theoretical lessons, case studies for normal/abnormal operation of the technological process, questions with multiple responses, etc); iiiii) part of Expert System, for simulation of the technological process with different operation regimes, in normal or damage situations.

Water system analysis

SDWS2011.0681 "waterpraxis" as a Tool Supporting Protection of Water in the Sulejów Reservoir

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Abstract

Waterpraxis as a tool supporting protection of water in the Sulejów Reservoir

Sulejów Reservoir was creating by impounding the Pilica River (the longest left hand side tributary of the Vistula River) in 1973. It is typical lowland, low volume reservoir (15,5 km long, at full capacity the reservoir has an area of 22 km^2, average depth is 3,3 m) with major fluctuations of water level.

Dam reservoirs constructed on lowland rivers suffer numerous environmental and water quality problems. Eutrophication resulted from the river phosphorus supply, effects with a disturbance of the ecological balance of the ecosystem and occurrence of blue-green algae blooms during summer. Mass appearance of blue-green algae not only threatens the quality of tap water but also disqualifies the reservoir as a recreational area.

Sulejów Reservoir is a classic example of a degraded artificial lake, which is reflected in the deteriorating ecological status.

The major source of the actual state of the Sulejów Reservoir eutrophication is the excessive quantity of nutrients, particularly phosphorus compounds flowing both from point and diffuse sources. The quantity of phosphorus absorbed from rivers is one of the major causes of the emerging threats, however recreational areas and flows of rain water can accelerate the processes as well.

One of the most serious threats to the environment in the reservoir drainage basin is the insufficient technical infrastructure development and unsolved sewage management in the areas adjacent to the Sulejów Reservoir.

The environmental threats are also caused by the farming management. Its impact on the environment is associated ill-equipped farms lacking appropriate technical infrastructure (sewage system), not applying good agricultural practices and intensification of agricultural production.

Another very important obstacle to the correct management of the reservoir is a complex system of governance. This applies both to areas around the lake and to reservoir waters. In addition, insufficient amount of funds provided for the needs of municipalities (expansion of water and sewage system, building and modernization of sewage treatment plants or building ecotone zones) significantly delays the investments that are crucial for maintaining good reservoir water quality.

"Waterpraxis" project, partly funded by the Interreg IVB BSR Programme 2007-2013, focuses on developing water management practices, as well as on preparing water protection action plans and measures for selected pilot sites around the Baltic Sea Region. The project will be carried out in transnational cooperation among authorities and

scientific partners and will lead to concrete improvements in sustainable river basin management in the region.

SDWS2011.1012 Improving Efficiency of Water Systems

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Abstract

The paper will feature practical examples of how researchers and engineers from academia, public and private companies are currently dealing with reducing water losses and energy consumption, demand management, and other efficiency-related topics. The first part of the paper will address the efficiency trends and performance indicators in the water industry, followed up by a brief description of the technology solutions addressing these key efficiency topics.

Two case studies regarding hot-spots leakage prediction, complex pumping scheduling energy optimization including demand forecasting will be further presented. In particular a case study from United Utilities in UK regarding leakage hot-spots detection will be discussed by demonstrating use of hydraulic models, measured pressure and flow data and optimization technique. The second case study from a water utility in Spain will focus on demonstrating methodology and results for pumping scheduling optimization in order to minimize energy use in the water distribution system.

The last part of the paper will focus on the key modelling and data requirements aspects of these projects.

SDWS2011.0845 Minimization of Water Use in the Food Processing Operations

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Abstract

Water is used in food processing industries for various purposes. This gives rise to wastewater of different qualities and quantities being discharged back into the environment as effluent. Therefore, there is a need for water use optimization in food processing industries to avoid high toxicity of effluent, reduce the contamination of natural water sources and save the cost of wastewater treatment. Differential evolution (DE) is employed in this study to solve the problem of freshwater usage in food processing operations. DE is a very simple population-based, stochastic function minimizer and very powerful at the same time. DE handles continuous, discrete and

integer variables. In terms of constraints, DE can handle multiple constraints. The objective of this study is to minimize freshwater usage by maximizing the reuse of wastewater in the food processing operations. There is a significant increase in the water reuse in the food industry using differential evolution. Out of total freshwater inflow 8.322t/h, 4.595t/h was reused for the source of freshwater investigated.

SDWS2011.0683 Analysis and Evaluation of Water Resources Management System in the Baltic Sea Region (Bsr), on the Example of Poland.

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Abstract

The study describes the formation of river basin management plans in Poland in terms of recognition of barriers and solutions to facilitate the review and the revision of the planning documents, which, according to the requirements of Directive 2000/60/EC of the European Parliament and the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, hereinafter referred to as the Water Framework Directive (WFD), should take place until 22 December 2015, and thereafter every six years.

The following elements have been analyzed:

- planning approach (methods and procedures for planning),
- structure of the planning institution and its internal and external connections,
- participation and the role of the public and the interested parties in planning decision-making process,
- way to integrate and incorporate the objectives of environmental, economic and social policy of the country and region established in the context of climate change into the river basin water management plans.

The study allows the comparison of the existing management system in Poland and the water resources management with similar systems operating in other European Union countries. Preparation of this paper was based on expert analysis of the following acts:

- Act of 18 July 2001 on Water Law (Journal of Laws of 2001 No 115 item 1229 with amendments),
- Act of 3 October 2008 on the sharing of information on environment and its protection, public participation in environmental protection and the environmental impact assessment (Journal of Laws of 2008, No 199, item 1227).
- Act of 27 April 2001 Environmental Protection Law (Journal of Laws of 2008, No 25, item. 150).

- Act of 21 December 2000 on the inland waterway (Journal of Laws of 2001, No 5, item 43),
- Act of 4 September 1997 on departments of governmental administration (Journal of Laws of 1997, No 141, item 943).
- The impact of the WFD has been lowest at the local level (communes), the main reason for this being the disproportion, in terms of size, between urban areas and river basins. Awareness of the demands of the WFD is highest at the national and regional levels since water management is primarily the concern of these two levels.

A number of problems do however remain, in particular with respect to taking further measures to coordinate the water management and spatial planning sectors. The most significant problem in the context of WFD implementation in Poland is the complexity of the legal system as well as low level of economic resources that have been allocated to the process.

SDWS2011.0963 Development of the Austrian Water Sector During the Past Decades from a Financial Point of View

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Abstract

The Austrian water supply and sanitation sector has a long tradition from about more than 250 years. Anyway the most important and deciding steps regarding a national wide water sector, that also covers the rural areas, took place within the last 50 years. Nowadays the mostly public water services of Austria's municipalities cover around 93% of the population for both, water supply as well as sanitation. The development of appropriate technologies, operation skills, administration, specific education, legislation and standardisation as well as financing tools was rather a bumpy and curvy road rather than a straight way to success an the stakeholders gained various experience, how to create and run a sustainable water sector.

The Austrian water support scheme ensures and supports the efficient implementation of measures for a proper wastewater disposal including industrial wastewater, as well as the guarantee for a sufficient local water supply. The efforts of the past already led to an enormous improvement of the water quality of the Austrian lakes and rivers. Nevertheless further suitable measures are essential, in order to dispose the communal and industrial wastewater correctly and to supply the population sufficiently with hygienically perfect drinking water.

The presentation shall provide an overview regarding the best practice cornerstones and the lessons learnt, which occurred during the development of the Austrian water sector: Which steps have been reasonable, which one disabled the progress, and which one finally led to success.

Moreover, a detailed insight to the Austrian water funding scheme will be given; about its tasks, the costs and the benefits. In this context the output of the latest economic analysis of the Austrian communal water services will be presented, which gives clear information about the costs of construction, operation, and maintenance of water supply and waste water utilities in a country like Austria.

The countries of the Balkans are fairly similar to Austria in terms of many points like population density, landscape, climate, principles of law, etc.. That's why their stakeholders, who are currently involved to the establishment and restructuring of the water sector, could be interested to learn about Austria's experience of the past decades.

The presentation will be delivered by Kommunalkredit Public Consulting (KPC), who has been the dedicated manager of the Austrian support scheme for water supply and sanitation since 1993 and has joined its client, the Austrian Ministry of Environment, right from the establishment of the current funding scheme law in 1993 and continuously gives advice in case of needed adaptations.

SDWS2011.0164 Hydrodynamic Model of the Open-Pit Mine "buvač" (Republic Srpska, Bosnia and Herzegovina)

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Abstract

The limonite ore body "Buvač" is located in Republika Srpska (in north-eastern Bosnia and Herzegovina) as a part of "Omarska" iron ore deposit. This ore body dates from Carboniferous period, with average thickness of 20 m and surface area of 3 km^2. In this limonite ore body there are aquifers rich in water: in alluvial sediments, Pliocene sands, limonite ore body and karstified rocks.

Extraction of limonite and associated sediments at "Buvač" deposit is being performed under complex hydrogeological conditions, thus in the final exploitation phase the open pit depth is going to be 150 m. Lowering of mining level will basically disclose all water-bearing sediments, which must be previously drained, in order to provide level stability, as well as equipment and mining staff protection during the deposit exploitation.

Projecting of the dewatering system of the open-pit mine "Buvač" is based on the use of hydrodynamical model of groundwater regime.

Creating the hydrodynamical model of the open-pit mine "Buvač" was made in phases, which began by basic interpretation of collected data, along with schematization of the groundwater flow and flow conditions, and finally, forming and calibration of model.

Natural factors are of crucial importance in model conceptualization. They are: type and characteristics of the represented geological units, distribution of water-bearing and impermeable units, seepage characteristics of porous media and mechanism and regime of groundwater flow.

Basic characteristics of the analysed hydrogeological units are their unequal horizontal distribution and variable thickness. As a result of these conditions groundwater flow is dominantly three-dimensional, especially on contacts of alluvial sediments and ore body, and ore body and limestone.

Hydrodynamical model was created as multilayer model with eight layers. Calibration of the hydrodynamical model is the starting point for making prognosis calculation in order to create the most optimal system of open-pit mine protection from groundwater. The results of model calibration indicated that the rivers Gomjenica and Bistrica, precipitation and inflow from karstified rocks are the primary sources of recharge of the limonite ore body "Buvač".

Biofuels II

SDWS2011.0109 Water Reuse and Recycle in a Sugar-Ethanol Plant According the Quality of the Streams

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Abstract

On the past years, biofuels has emerged as an energy source option for low carbon road transport, and its demand will increase by more than 100 % over current levels, by 2020. Considering the first generation biofuels, ethanol from sugar cane can be regarded as the best option, due to its lower production cost and low GHG emissions per unit of energy produced. This is why Brazilian sugarcane based ethanol is expected to come into high demand by countries seeking to fill low-carbon biofuels requirements.

However, several authors have concerned with the high water consumption of biofuels production, which could even bring social conflicts for the use of this resource, especially water withdrawn from rivers, lakes and underground, as is the case of that consumed by the sugar cane plants.

The objective of this work is to bring proposal for the reduction of water consumption in the industrial sugar-ethanol production considering demand and supply quality restrictions. Stream Qualities were obtained from the literature of sugar cane sector. The quantity of water demanded by the process and by the other side, the available streams for reusing were obtained based on a simulation of a standard sugar cane plant that produces sugar and ethanol.

Direct reuse of water has been adopted as the first measure to reduce water consumption. A trial and error methodology has been used where it has been supposed that the higher quality demands were supplied by the higher quality available streams. In the case that the available currents did not reach the demand quality the need was supposed to be supplied by taking water from a standard treatment plant. Only in the case where no currents were available, the withdrawal from external sources was considered.

From this analysis, a matrix of water management in the sugar cane plant was obtained, from where it was obtained a value of 638 l/t of cane that could be directly reused. The reused currents were mostly constituted by condensate vapor from juice evaporation and sugar crystallization stages. The water coming from the filter cake washing was also considered. Indirectly, 176 l/t of cane would be covered trough the recycled streams conditioned in the water treatment plant. Finally, an external withdrawal of 405 l/t of cane would be required to cover the deficit water needs of the plant. The value obtained is lower than the established goal for the sugar cane industry in the State of Sao Paulo, which is 1000 l/t of cane.

SDWS2011.0162 Exergetic Analysis of a Biodiesel Production Process from Jatropha Curcas

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Abstract

As fossil fuels are depleting day by day, it is necessary to find out an alternative fuel to fulfill the energy demand of the world. Biodiesel is considered as an environmentally friendly renewable diesel fuel alternative. The interest in using Jatropha curcas L. (JCL) as a feedstock for the production of biodiesel is rapidly growing. Because of its toxic nature, Jatropha curcas' oil does not compete with the food sector and its price is low and stable.

In the last decade, the investigation on biodiesel production was centered on the choice of the suitable raw material and on the optimization of the process operation conditions. Nowadays, research is focused on the improvement of the energetic performance and on diminishing the inefficiencies in the different process components. The method of exergy analysis is well suitedfor furthering this goal, for it is a powerful tool for developing, evaluating and improving an energy conversion system.

In this work, we identify the location, magnitude and sources of thermodynamic inefficiencies in a biodiesel production process from Jatropha curcas. This information is used for improving the overall efficiency of the system and the design of the process.

SDWS2011.0372 Bio-Oil Production from Humulus Lupulus Via Slow Pyrolysis

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Abstract

Fossil fuels have large fraction for usage among the energy sources. However they have many disadvantages such as high cost, limited sources and environmental problems. Because of these reasons tendency to renewable energy sources have increased. Biomass, natural material including carbon, hydrogen, oxygen, and nitrogen is an attractive renewable energy source due to its abundance, low cost and high energy value. Biomass resources contain various materials for instance energy crops, forestry residues, organic wastes, agricultural residues. Pyrolysis is the most used thermochemical process for conversion of biomass into valuable products. The products obtained from the pyrolysis of biomass are solid, liquid and gas.

In the present study, pyrolytic behavior of Humulus lupulus was studied in a fixed bed reactor with a heating rate of 10^0C min^{-1} in the presence of N_2 atmosphere. The effect of pyrolysis temperature was investigated at 450^0C, 500^0C and 550^0C. The characterization of solid product (bio-char) and liquid product (bio-oil) was performed by spectroscopic and chromatographic techniques. Char was analyzed by FT-IR spectroscopy, BET and SEM while bio-oil was analyzed by using column chromatography, GC-MS and FT-IR spectroscopies. After detailed characterization, experimental results showed that liquid products are available to evaluate as valuable chemicals and environmentally friendly synthetic fuels whereas solid products can be used as activated carbon for wastewater treatments.

SDWS2011.0629 Anaerobic Co-Digestion of Whey and Cow Manure

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Abstract

Anaerobic co-digestion is an attractive waste treatment process in which both pollution control and energy recovery can be achieved. Organic, agricultural and industrial wastes are good substrates for anaerobic co-digestion because they contain high levels of easily biodegradable materials. Renewable waste materials are convertible to useful energy forms like biogas. Additionally, biogas as renewable energy source plays an important role in reducing greenhouse gases because it is a „carbon neutral“ fuel.

Different organic substrates are co-digested to generate a homogenous mixture as input to the anaerobic reactor in order to maximise methane production, increase process performance, realize a more efficient use of equipment and cost-sharing by processing multiple waste streams in a single facility.

The aim of this study is to assess the quantity and quality of biogas produced by co-digesting whey and cow manure. Dairy industries in Croatia usually do not proceed with investments for recovery of the valuable constituents contained in whey and, despite of the different possibilities of whey utilization, it is discarded as waste effluent. This represents a significant loss of resources and causes serious pollution problems. The potential of anaerobic co-digestion of a mixture of whey and cow manure has been evaluated by using batch reactor under thermophilic conditions (55 ^{o}C). The research is directed at identifying methods to make biogas production feasible on small dairies and farms. The major advantages of this process are low cost, high energy efficiency and process simplicity compared to other waste treatment methods.

SDWS2011.0816 Biodiesel Production Process Optimization Using Sodium Hydroxide and Sodium Methoxide

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Abstract

Today fossil fuels as always take up 80% of the primary energy consumed in the world and up 95% of energy consumed in transport sector. It causes enormous greenhouse-gas emission, global warming and climate changes. Fuels derived from biomass sources are environmental friendly and, expanding their use is a very promising way for reducing the petroleum-based fuel proportion in transport and reducing the greenhouse–gas emission from road and non-road vehicles. Biofuels are classified as first-, second- and third-generations biofuels. The most well -known first-generation biofuel is biodiesel. Biodiesel is an alternative fuel produced by the transesterefication of vegetable oils, recycled cooking greases and animal fats. Process of transesterification of lipids takes place by using homogenous basic, homogenous acid, heterogenous basic, heterogenous acid, or enzymatic catalysts and methanol or ethanol. The yield of the desired product as well as the economical and ecological aspects of biodiesel production depends on quality of the catalyst and other transesterification parameters such as amount of catalyst, molar ratio of methanol to oil, reaction temperature and reaction time. Most popular catalysts are potassium hydroxide, sodium hydroxide and sodium methoxide. In this study we have used high quality rapeseed oil for the optimisation of biodiesel production by use of sodium hydroxide and sodium methoxide as catalysts. As it is seen in Table 1 the catalysts show very similar activity and we can't find advantage for one or other.

SDWS2011.0825 Torrefied Biomass Pellets Through the Use of Experimental Design

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Abstract

Traditional biomass pellets are susceptible to fines production during handling and transportation, moisture absorption, biological degradation, low specific energy content, off-gassing and poor flow and handling characteristics. In response to these perceived product flaws, a new set of test pellets was created to address these deficiencies. A two-level three-factor full factorial design of experiment (DOE) was constructed to measure the response to the quality of biomass pellets. Particle size, moisture content and

torrefaction temperature were chosen as the three factors in the DOE. Two sets of pellets were created to allow for a variety of destructive tests to be carried out. These tests included tensile strength, abrasion resistance, moisture content, moisture absorption and evaporation, ultimate and proximate analysis and the effects of torrefaction.

The new pellets displayed superior results to existing pellets. The pellets had an ultimate tensile strength of 3.38-17.06 MPa. In comparison, the competing pellets had ultimate tensile strengths of only 2.61-3.78MPa. The abrasion resistance of the pellets was 100, and no fines were created. The density of the pellets was found to be between 1281 and 1368 kg/m^3. Although pellets did absorb between 10-30% of their original mass in water over an approximately 24 hr period, they were able to shed that same water and return to within 5% of their original air dry moisture content in a similar period of approximately 24 hours. This validated the claim of hydrophobicity. The pellets also maintained their shape and a great deal of their strength. Torrefaction yielded pellets that had up to 22.09 MJ/kg on an as received basis and up to 23.15 MJ/kg on a moisture and ash free (MAF) basis. The models that were formulated through the responses of the DOEs suggested that torrefaction temperature was the most significant factor input that varied the responses of tensile strength, GCV, mass loss, and hydrophobicity of the new pellets. These models provided a way of further optimising the pellets to allow for the best product to be formed allowing for the closest competition possible to coal.

Pellets were made that address the 5 key issues identified with the current state of the art of biomass pellets. Transportation issues are reduced by increasing the density of pellets to an even greater density than currently done. The energy per unit volume is then further increased by the torrefaction of the material which removes the non-combustible volatiles, which allow for a specific energy increase. These characteristics are all granted to plain biomass by means of a new innovative pelletisation method that uses no more than a 5% increase in energy content in the torrefaction process. In addition the excellent strength and handling characteristics are all achieved without the use of a binder.

Energy systems I

SDWS2011.0017 Sustainable Energy Reform Comparison in Bilateral Finnish - Mediterranean Regional Collaboration

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Abstract

Motivation to this article lies on the recent fast progress of the alternative renewable energy systems. To these belong systems like biomasses, municipal solid wastes-to-energy and the new algae oil systems, solar, offshore and onshore wind and the geothermal powers. These technologies, e.g. have taken the fast advances in EU during the last years. As the objective to the article and to the comparison are also the new environmental and chemistry point of view aspects in reformed energy system steps for the future. The comparisons are carried out on bilateral collaboration level at first. Important now, is to find more countries to more effective collaboration in alternative energy system applications and in their renewed environmental requirements. In March 2007, there were signed a binding EU-wide target to substitute 20 % from present energy to the y. 2020 by the renewables. To the changes in energy origin have influenced the lowered amounts of non-renewable natural resources like fossil fuels. The improved environmental, health and chemistry regulations like REACH in EU, have influenced in the demand of the cleaner energy technologies. Based on the new energy systems, the levels of the green house gases have had a lowering tendency in EU. The renewable energy supports, in an exceptional way, thus the global efforts against the climate change and other chemical pollution. There have been planned, biogeographically alternative renewable energy systems. To certain countries, like to Finland, which lies on the rather cold and evergreen forest biomass region, and, e.g. to Egypt which lies on the dry and sunny desert and windy coastal areas, there have been developed locally suitable energy systems. Around, e.g. above mentioned regions, there have existed, however, still only limited technological comparisons, case examples and common collaborative knowledge-change in results. For that reason, we will now to gather the available information and results for the increased chances in collaborative bilateral projects in renewables progresses. Based on results, this summarizing article will increase the awareness in progress steps, in development and in collaboration opportunities. Finally, the overview will be a concluded survey and charting on the bilateral collaboration needs along the focused north-south Finnish - Mediterranean overview axel.

SDWS2011.0167 Evaluation of Climate Change Impacts on Energy Demand

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Abstract

Previous climate change research has documented the effects of linking mitigation and adaptation, in the energy sector in order to better understand the costs and benefits of a synergistic approach to a comprehensive energy and climate policy. However, there is still a lack of integrated assessment of mitigation and adaptation, particularly at national level. This paper may contribute to fill this gap, identifying the interactions between climate change and the energy demand in Macedonia.

The analyses are conducted using the MARKAL model, calibrated for Macedonia. A special focus is addressed on energy demand in commercial and residential sectors (mainly for heating and cooling), where climate change effects are considered to be most noticeable. Three different cases will be developed: 1) Base Case, which gives the optimal production capacity mix of alternative generating facilities, taking into account only country's development plans (without climate change); 2) Climate Change Damage Case, which introduces the climate changes by adjusting the heating and cooling degree days inputs for the residential and commercial energy-demand sectors, consistent with existing national climate scenarios, holding the generating capacity mix fixed to the optimal capacity levels from the Base Case; and 3) Climate Change Adaptation Case, in which the optimal capacity mix for adaptation to the climate change will be determined in MARKAL, by allowing for endogenous capacity adjustments in the model.

Finally, the changes in residential and commercial energy demand, the changes in the mixture of energy generation resources in the adaptation case, as well as climate change damages and the benefits and costs and net benefits of the adaptation will be identified. This approach to adaptation will also make it possible to identify the partial adjustments to both, development and climate change, as well as the interaction between the two with respect to future investment in the energy sector.

SDWS2011.0257 Role of the National Energy System Modelling in the Process of the Policy Development

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Abstract

Strategic planning and decision making, nonetheless making energy policies and strategies, is very extensive and has to follow multiple and often contradictory objectives. During the preparation of the new Slovenian National Energy Programme proposal complete update of the technology and sector oriented bottom up model REES-SLO2 (Reference Energy and Environmental System of Slovenia version two) has been done. Within the new model the comparison and assessment of various strategies on the demand and supply side with calculations of a long term energy and emission balances and economic evaluation has been enabled. A linear network model of the national energy system for decision support was developed in MESAP (Modular Energy System Analysis and Planning) environment. MESAP open structure was used to build the model addressing the most relevant questions. During the model development, special attention was given to the aggregation of the data in accordance with statistical standards for data classification, also fully compatible with international reporting standards. The open structure model enables to consider driving forces (demand determinants) which are at present the most important: value added and volume of physical production in economic activities, transport work, building font structure, space heat demand distribution, number of households, dwelling surface, penetration of energy efficient appliances in households and other details like surfaces of schools, hospitals, etc. Economic activities are disaggregated by branches, manufacturing industry and service sectors are further disaggregated on a branch level. Parallel competitive technologies have been included in the model. This was done where fuel switching is expected or where considerable energy efficiency improvements may differ significantly by strategies. Parallel modelling enabled accurate estimation of induced costs and environmental impacts.

Within this paper the main technical, economical and environmental characteristics of the Slovenian energy system model REES-SLO2 are described. Also, the possibilities for the improvement of the model and its role in the policy follow-up process are discussed.

SDWS2011.0379 Energetic and Ecological Analysis of Life-Time Cycles of Nuclear Power Station Compared to Integrated Wind Farm

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Abstract

In the paper Authors analysed still actual issue of energetic and ecologic evaluation of existing energy production technologies during their life-time cycles. Based on the results of researches and scientific works topics specified below are discussed. These topics described detailed in are related to analysis and comparison of life-time cycle of nuclear power station of 1410 MW_{el} of installed electrical capacity with equivalently integrated wind power plant with individual mills power of 0,6 MW_{el}, 1,5 MW_{el}, 2,5 MW_{el} and 4,5 MW_{el} respectively.

- Description of analysis' methodology covering all stages of the life-time and including:
- decomposition of discussed technologies for individual sub-systems and components as well as their division to branches of machines', constructions' and electro- technologies,
- mass and energy balance in accordance to the first law of thermodynamics,
- introduction of terms of cumulated material and energy expenditures as well as cumulated emissions
- principle of equivalent installed capacity.
- 2. Description of applied mathematic model and simulation program "EN STREAM"
- together with structure of worked out data bases.

3. Presentation and discussion of most important calculations' results related to installed capacity as well as to produced electric power during the productive stage, including such parameters as:

- specific material and energy expenditures as well as emissions' loads,
- cumulated material and energy consumption of particular life-time cycles,
- utilisation level of the peak capacity,
- theoretical and practical coefficient of installed capacity utilisation,
- coefficient of recycling utilisation of wastes,
- coefficient of final disposal of wastes.

SDWS2011.0377 The Role of Heat Pump Systems in the Reduction of Primary Energy Needs in Urban Areas

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Abstract

This work is focused on the planning of rational heating systems for urban areas.

From the sustainability viewpoint, district heating is an important option to supply heat to the users in urban areas. The energy convenience of such option depends on the annual energy request, the population density and the efficiency in heat production. Among the competing technologies geothermal heat pumps (both open loop and closed loop heat pumps) play a crucial role.

The procedure here considered proposes district heating as the initial choice for all the users. The optimal system design involves the selection of the users (or groups of users) to be connected to the network. For the users not connected with the network the installation of heat pumps is considered. Total primary energy request is considered as the objective function to be minimized.

The paper aims to evaluate the exergetic cost of heat supplied through heat pumps system. Such evaluation is not trivial, as it must include proper analysis of the system performance. In the case of densely populated areas an additional parameter affects the result: the subsurface thermal degradation caused by an installation on the surrounding installations, which affects their efficiencies. This impact is calculated through a thermo-fluid dynamic model of the subsurface. For this reason, various scenarios corresponding to different values of the annual heat request, distance between users, groundwater level and velocity are considered.

The application to an Italian town is considered as a test case. Primary energy request is evaluated for the entire urban area. It is shown that the optimal configuration from the primary energy consumption is significantly different than the economic one, with less users connected with the network and numerous applications of heat pump systems, especially for those users far from the thermal plant characterized by small heat request.

A sensitivity analysis on the subsurface parameters is also performed in order to show their impact on the configuration of the optimal system.

SDWS2011.0778 Cod and Temperature Stress-Tests in a Micro Microbial Fuel Cell

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Abstract

Microbial Fuel Cells (MFC) stands up amongst one of the most promising technologies for the future energy demands. Until today, most studies have been focused on their architecture and components. However, scarce information has been published regarding to the biocatalyst properties, i.e.: biofilm properties, specific activities, microorganisms behaviour, stress responses, etc. In order to spread the use of microbial fuel cell, these devices should be reliable for powering electronic devices or as sensors, which nowadays mainly mean a stable response of the microorganisms.

In this work, COD and temperature stress-tests were studied. The results of these tests were recorded during the transient state and once the steady state was reached. The MFC consisted of a two-chambered micro-scale MFC, using a Sterion membrane to separate the electrodes. The surface area of both electrodes was 4.65 cm^2 and in the cathode a catalytic layer with 0.5 mg Pt/cm^2 loading was deposited. The anode volume was 0.95 mm^3.

Regarding to the temperature test, its value was cyclically modified between 20 and 40 ºC with stepwise increments of 5ºC. As expected, the increase in the temperature increased exponentially the cell voltage. This is because the microbial metabolism, and therefore the electricity generation, depends exponentially on the temperature. Comparing the results obtained for the same temperature, but in different cycles, no hysteresis was observed despite of the cyclic temperature modification. This result indicates that the temperature stress-test did not affect the behaviour of the micro-scale MFC used in this work.

In order to study the response of the system under COD peaks, the influent COD concentration was stepwise modified from the typical COD, approximately 100 mg COD /l, to 3.000 mg COD /l and later on reduced stepwise again to 100 mg COD /l. In these test, it was observed that the higher the COD concentration, the higher the cell voltage generated, being the electricity yield an almost constant value of 1±0.1 mV/mg COD removed per hour. However, hysteresis was observed for the reverse scan and a hysteresis loop was traced. This was explained because during the reverse scan the microorganisms were able to use the amount of enzymes previously synthesised to degrade the COD. In order to study how long lasts this situation several stress-test were carries out along one week, observing that this situation was maintained during a couple of days recovering then the typical behaviour. The hysteresis observed in the high COD stress-test indicates that the COD concentration produces changes in the performance of the system on the short term. This must be taken into account, because one of the applications of the MFC is as sensors, and this dependence of the signal with the previous events would affect its reliability.

Acknowledgment

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Regional planning, Cooperation and Research

SDWS2011.0075 Maps of International Research Collaboration in Renewable Energy

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Abstract

An innovation model providing a solution for climate change and sustainable economic growth is required. In this scenario, renewable energy is one of the most promising technologies. Its research requires a considerable amount of R&D expenditure and various core technologies. Therefore, international research collaboration is effective for prompt and efficient development. With countries and organizations contributing to the rapid growth of knowledge, the meta-structure of international research and collaboration has become ambiguous. Not many previous studies have been conducted on changes in geopolitical structures of renewable energy research by using objective data. Therefore it becomes increasingly difficult to formulate international science and technology policy which encourages international collaboration. This paper will first aim to use objective data and create research network diagrams (MAPs) that enable us to see both the distribution of worldwide research competency and the relationship of international collaboration in renewable energy research. MAPs will be a knowledge base to help design a policy for international research collaboration. Second, this paper attempts to specifically detect where a valley of international collaboration exists. This paper also discusses effective policies to bridge the valley by identifying various factors that would create and support strong international relationships. Co-authorship analysis is used in this paper. We focus on fuel cell and solar cell technologies which are the most rapidly growing fields of knowledge. Bibliographic information of 68,000 academic papers and 34,000 citations are included in our analysis. First, a rapid increase in the number of papers published and a rise in the international co-authorship rate in renewable energy research are observed. Second, the maps show a well-balanced structure between North America, Asia, and Europe. Third, a valley in Asia is found on the MAP of international research collaboration. The collaboration between research organizations within Asia is not as strong as within other regions, despite the recent rapid increase in their research competency. It appears that their potential has been untapped. Forth, Factors that contribute to research collaborations identified. Those factors include the introduction of international research collaboration programs and the development of a knowledge network. Finally, this paper identifies core organizations which work as a hub or a connector in the network. As a conclusion, the way to map the global structure of research competency and collaboration is developed in this paper. This paper suggests the development of “Asia Research Area” which encourages research collaboration especially in Asia.

SDWS2011.0731 **The Application of a Sustainability Impact Assessment Tool to Support Regional Sustainable Development Planning in North Karelia, Finland**

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Abstract

In Finland, about 28 % of the total energy consumption comes from renewable sources with a large contribution from woody biomass. Utilisation of woody biomass is expected to increase in the future as set out in the Finnish long-term Climate and Energy Strategy, in the regional Forestry Programmes and related local policy documents. In this paper we focus on the Forest-Wood Chains in North Karelia, Eastern Finland, projecting scenarios for 2020 where the use of forest biomass for energy production occupies greater shares compared to today. Different economic, social and ecological indicators were selected through stakeholder involvement and evaluated using the Tool for Sustainability Impact Assessment (ToSIA). ToSIA assesses sustainability impacts by quantifying changes in indicator values which are linked to processes of alternative production chain. In this way, comparisons can be made between a baseline and alternative scenarios which may consist of changes in production chains, alternative policy implementation or changing external drivers such as the future global economic development. The data collected for the chain were mainly from regional and national statistics, scientific publications, and expert opinion. The scenarios reflect alternative forest resource utilization strategies as considered in the regional Forestry or Climate and Energy Programmes of North Karelia. They include targets of how much forest wood chips will be produced and used. Impacts of alternative target implementation on greenhouse gases, employment and production costs have been assessed with ToSIA. The increasing use of forest wood chips provides regional employment and business opportunities. Alternative production chains differ in direct greenhouse gas emissions and the net GHG benefits are quantified through comparison with fossil fuel based energy production. The results of the sustainability impact assessment are evaluated jointly with stakeholders to support the regional decision making process. The embedded multi-criteria analysis module makes stakeholder preferences visible and offers a basis for discussion and compromise finding processes. The use of ToSIA in the preparation of the regional Energy & Climate and Forestry programmes demonstrated that the tool and its balanced sustainability assessment provides a transparent scientific assessment of decision alternatives, which supports achieving regional sustainable development targets.

SDWS2011.0760 Etrera: a Project for Europe-Tunisia Cooperation on Fuel Cells and Hydrogen Technologies

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Abstract

The project "Empowering Tunisian Renewable Energy Research Activities" (ETRERA) is funded from European Community-FP7 under REGPOT-2009-2 Action, an action finalized to empower the research cooperation in innovation between the European and the Mediterranean countries.

ETRERA project is aimed at the creation of a research network on renewable energies involving as primary actors the Tunisian "Research and Technology Center of Energy" (CRTEn), and three European entities: 1) Institute for Advanced Energy Technologies "N. Giordano" of the National Research Council of Italy (CNR-ITAE); 2) Polytechnic School of Nantes University (Polytech'Nantes), France; 3) Innova Business Innovation Centre (InnovaBIC), Italy.

The three years project started in 2010. Today, the project partners are involved in coordinated activities to reinforce the research structure of CRTEn. A new research lab dedicated to research on polymer electrolyte fuel cells is under construction at CRTEn. The recruitment of four researchers, with abroad working or studying experience, and one engineer was carried out to increase the research capacities and the human potential of CRTEn. The experience of CNR-ITAE and Polytech'Nantes on fuel cells and hydrogen technologies, spanning from material preparation to the system integration, will be shared by exchange of researchers, the organization of seminars and collaborative research activities on polymer electrolyte fuel cells. Dissemination will be carried out through a set of actions aimed at increasing the visibility of the partners and related research activities to obtain a wide dissemination of the project results to scientific community and European and Tunisian industries.

The first year activity was dedicated to the set up of the collaborative structure, to the recruitment of researchers, to the design of a polymer electrolyte fuel cell (PEFC) test station and the acquisition of components for its realisation. In the second year the CRTEn researchers started their activity and the CRTEn PEFC research group is growing.

We report here our experience and the results obtained in the first 18 month of the project.

SDWS2011.0822 The Evolution of Research and Development Collaboration Networks in the Eu Framework Programme in Response to Sustainability Challenges

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Abstract

The global community in the 21st century is confronted with a range of sustainability challenges. A series of international environmental agreements have called attention to the importance of ecological issues worldwide and urged fundamental changes in political and economic frameworks to respond to these challenges. Consequently, the recent R&D focus is increasingly turning to such technology areas in relation to environment and energy to develop proper solutions for these problems. However, only global initiatives can combat these sustainability problems effectively due to the inherent transboundary characteristics of underlying ecological issues. Therefore, implementing the global R&D networks enable researchers to bring together different sets of resources and complementary approaches to the international issues on energy and environment over the geographical boundaries. In this regard, the EU Framework Programme (FP) is a well-known instrument that enhances international R&D collaboration. The new era of ecological challenges has introduced a shift in the FP's funding framework of related technologies, too. While EU provided a comprehensive funding for energy, environmental protection and transport related R&D within a thematic priority of "sustainable development, global change and ecosystems" under FP6, each of the areas, Energy, Transport, and Environment, has become an independent topic in the FP7.In this regard, this paper analyzes how global partners cooperate with each other under EU FP to solve the sustainability issues using the social network analysis (SNA). Particularly, it is investigated how the segmentation of research fields affected the structure of R&D partnership for the related technologies in the course of the transition from FP6 to FP7. Moreover, the paper incorporates an in-depth investigation of network characteristics for each respective thematic area, in order to indentify the main actors of the open R&D innovation in response to ecological challenges. Finally, the study explains EU policies, which might affect the evolution of R&D collaboration networks in those technology fields. Findings from the study will contribute to understanding how the relevant policies influence the structure of R&D collaboration activities and which strategies have been applied to enhance innovation networks and R&D capabilities.

SDWS2011.0636 A Social Learning Approach to Raising Environmental Awareness at the Catchment Scale: the Eye Brook, England

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Abstract

As reflected in the proceedings of this conference, there has been considerable wide-ranging scientific research into sustainability issues associated with climate change adaptation and mitigation, water management, renewable energy generation and other issues associated with declining resources and increasing population growth and consumption. It is widely recognised that there remains a need for a more effective means of raising popular awareness of these issues, and their urgency, so that the results of this research are translated into widespread behavioural change.

This paper describes a four-year (2006-2010) project in the 67km2 Eye Brook catchment in central England and takes an innovative social learning approach that is inclusive and popular. The project recognises, values and capitalises on three knowledge cultures: scientific, local and historical.

Scientific knowledge is associated mainly with the Allerton Project research and demonstration farm at Loddington in the centre of the catchment where scientific research into environmental issues such as catchment management, farming, soil and nutrient management, water quality, and wildlife conservation has been carried out since 1992 in the context of agricultural business. The scientific research involves universities and other UK research organisations. Local knowledge is represented by farmers and other rural workers, local naturalists, historians and others. Historical knowledge comes from members of the catchment community, including elderly residents with memories of a largely pre-fossil fuel economy, and from academics outside it. The premise is that improved knowledge of land management history increases popular awareness and 'ownership' of environmental problems and opportunities.

The project included a series of events, individual and group research, an annual newsletter, and a book bringing together the results of the project. A primary school teaching pack was also developed, using the same integration of knowledge cultures to raise awareness of sustainable development with local children and their parents. Researchers, local people and historians contributed to all activities, increasing social cohesion within the catchment, and the community's shared awareness of sustainable development issues.

Activities included mapping the area required to provide food locally for one catchment parish, and mapping the area needed to provide local energy (woodchip and biodiesel), based on a survey of actual household energy consumption, highlighting the relative demands of food and energy on natural resources. The project also examined trade-offs in ecosystem services such as food production and water quality. By raising

awareness of sustainable development, the project has provided a foundation on which practical measures are currently being actively developed.

SDWS2011.0330 Rural Sustainable Development Through Integration of Renewable Energy Technologies

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Abstract

Increase of the share of renewable energy sources in rural regions, integration of different local energy sources and optimization their use according to local specificities and constrains is an important goal to sustainable development of the region; with beneficial effects for job creation, CO2 mitigation and others. The focus lies on locally available resources, such as biomass, wind, hydro, photovoltaic, solar thermal or geothermal energy. The overall goal is to cover 100 % of the regions' energy demand by renewable and locally available sources. A software model named DOIRES (Determining Optimum Integration of Renewable Energy Sources) is prepared for defining the optimum local combination of renewable energy technologies according to the specific conditions, needs and particularities of the selected regions.DOIRESis a mathematical programming optimization tool subject to suitable equality and inequality constraints. The model has taken into account appropriate technologies for integrated renewable energy system and it is designed for an energy planning of a time horizon of up to 20 years. The model is used for defining the optimum local combination (integration at regional level) of renewable energy technologies according to the specific conditions, needs, particularities of the target region examined at each case. In presence of conflicting objectives, multi-criteria analysis is used to select a compromise option that enhances sustainability. DOIRES allows for an optimization starting from a base of several possible configurations of potential technologies to be exploited for energy production in the target region under study and leads, under suitable constraints and sustainability indicators, set by the user according to the pursued goal, in an edge of best compromise configuration. Metodology proposed resulted to be succesfully applied in an rural Albanian region.

Pollution modelling

SDWS2011.0114 The Pollution Transport Models Using the Fractal Geometry

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Abstract

A transport of miscible pollutants is very complicated phenomena. The question of how to quantify contaminant transport in natural geological formations has been a central focus of research for decades. Usually we suppose that it is governed by a differential equation of dispersion which is based on the Fick's law of diffusion. This system is called Fickian's transport.

Laboratory experiments have enabled fundamental understanding of transport behaviors, aided in formulation of conceptual pictures of transport, and provided a basis to test quantitative modeling approaches. However, largely because of the many scales over which geological heterogeneity occurs, these experiments have proven to be of limited applicability to large, field-scale domains. Tracer transport experiments at the field-scale, on the other hand, are fraught with uncertainty and the inability to control boundary and other operating conditions.

Classical methods based on the FEM or FDM schema often fail when applied to pollutant transport. The advective term causes instability of the pollution front and also a so-called numerical dispersion is a very serious problem. These problems led to the development of a whole series of methods that use different approaches. The particle methods are the typical methods which are used to overcome this problem.

There is another basic problem which is based on the governing equation. The Fickian laws were the basement of the development of the governing equation of the transport of pollution but the experimental results show that these equations have only limited validity and that they cannot describe all aspects of this phenomenon. The theory of the fractals geometry seems to help us to describe more precisely the mentioned aspects.

The paper is focused on implementation of theory of fractal dispersion and its connection with method of random walk to minimize mentioned liabilities. For solution of ground water flow, which is needful to solve in the same time with problems of transport, we used the method of boundary elements in the sense of dual reprocity (DR-BEM) as the most optimal method for assessment flow velocity. These two methods were used for forecasting diffusion of pollution in ground water with much better results than the models before.

SDWS2011.0407 Measurements of Traffic Induced Pollution in the City of Niš

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Abstract

The air quality in urban areas is one of the main influences on the overall quality of living in modern cities. It is known that the traffic is the single largest pollutant in Europe. Therefore, proper treatment of this component of pollution is very important for precise estimation of pollution levels.

In this paper, specific methodology for measurement of roadside CO_2 concentration, as the tracer gas, is shown. TESTO 454 gas analyzer have been used for CO_2 concentration measurements. The wind speed and direction have been measured on several locations in the City of Niš, considering that pollution distribution is globally determined by wind characteristics, and for wind measurements cup anemometer was used. For wind data collecting, specific measuring system was developed, a well as the software needed.

Traffic intensity have been measured on six major crossroads. The data obtained were used to estimate the traffic generated CO_2 emission on the major streets in Niš. Special attention was given to the atmospheric stability conditions. Given methodology shows possibilities for further implementation of other pollutant components measurement. This will allow tracking of main pollution pathways.

SDWS2011.0587 Modeling Undesirable Outputs in Efficiency Evaluation for Power Systems in China: a Network Dea Analysis

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Abstract

To mitigate climate change and reduce carbon dioxide emissions has become a worldwide common topic. Power system is the largest source of CO_2 emissions from fossil fuel combustion. Therefore, to improve the efficiency and reduce the emission of power system is one of the critical fields for climate change mitigation. A power system includes generation, transmission, distribution and retail divisions, with different way to improve efficiency. For the generation department, more electricity generated means

higher efficiency, but for the distribution part, less power grid input means higher efficiency with a given output. Together with the desirable outputs, power systems also produce undesirable outputs like carbon dioxide in generation, line losses in transmission and distribution. Therefore, improving the overall efficiency should take the complicated relationship between different departments into account. Because regions differ in energy structure, technical level and economic development, it is difficult to give a comparable evaluation to the efficiency of different systems while the undesirable outputs are considered.

This paper takes 31 provinces, autonomous regions and municipalities of China as decision making units, conducts a two stage network DEA model to evaluate the efficiency of power systems in 31 provinces. The inputs of the first stage include labor, installed capacity, fuel (including coal, oil and natural gas); while outputs include total electricity generated, industrial added value, and CO_2 emissions as undesirable output. The inputs in the second stage include the electricity grid domain input, labor; while outputs are service area, the number of customers and the circuit loss as undesirable output.

By analyzing the evaluation results, the paper reaches the following conclusions. Firstly, the total electricity generated influences the efficiency of power supplied provinces significantly. Secondly, the fuel structure affects the efficiency of power system greatly. Finally, there is no necessary connection between the thermal power proportion and the efficiency. To sum up, in view of energy saving and emission reduction, network DEA model can evaluate the overall efficiency of power systems more objectively when carbon emission is considered, subsequently it can provide better decision support for policy makers.

SDWS2011.0595 Particle Concentrations in Urban Microenvironments: a Discussion Upon the Main Influential Parameters

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Abstract

In the last decades several scientific studies attempted to demonstrate adverse health effect caused by the exposure to aerosol particles. A debate on the worst particle property, both in terms of dimension and chemical composition, is still unresolved. Whichever the particle characteristics mainly related to the health risk, the short-term exposure to high particle concentrations represents a further important parameter to be considered in human exposure assessment studies. Transportation modes and urban microenvironments may significantly contribute to the daily total exposure through short-term exposure to

particle concentrations elevated if compared to elsewhere. Hence, it is essential to be able to measure particle concentration variations through high-resolution time-measurements

In the present study a discussion upon the influential parameters affecting particle concentration in urban areas is reported. Street geometry, traffic mode, wind speed and direction effects were analyzed through an experimental campaign performed in different streets of an Italian town. To this purpose a high-resolution time measurement apparatus was used in order to capture the dynamic of the freshly emitted particles.

Number, surface area and mass concentrations and distributions were measured continuously along both the sides of street canyons and avenue canyons. The combined effect of street geometry and wind direction may contribute strongly to dilute the fresh particles emitted by vehicles. Higher wind speed was found to decrease concentrations in the canyon. Traffic mode also seems to influence exposure concentrations. In particular, submicrometer particle mass concentration was higher as the traffic is more congested; otherwise, coarse fraction dominates mass exposure concentration along street characterized by a more fluent traffic, showing a typical resuspension modality.

SDWS2011.0617 Particulate Matter (Pm) Indoor – Outdoor Relationships in Buildings in Bor, Serbia

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Abstract

There is still lack of data in the Republic of Serbia, dealing with the air particulate pollution comparing with EU countries. Consequently, there is lack of information about the relationship between particulate pollution inside and outside the buildings for housing or in public institution building. Studies, related to the particulate pollution research, have been only carried out in the past several years. The main objective of this paper is to show the indoor/outdoor relationships between PM (PM_{10}, $PM_{2.5}$) concentrations in downtown buildings. The Bor town is assumed as representative of hot spot urban-industrial environment inSerbia.

PM concentrations in ambient air were monitored at the central monitoring site Park, while indoor PM concentrations were monitored at four public institution buildings (1. Hospital, 2. Museum, 3. Kindergarten and 4. Institute) during 2009 – 2011.

According to our results, it is obvious that exposure to particulate matter in hospital and kindergarten is high, with more than 50% of all daily mean values of PM_{10} above limit (50 $\mu g/m^3$). Further research should be carried out in order to fully confirm these findings and identify additional determinants of PM concentration.

SDWS2011.0762 How Sustainable Agriculture Can Improve Groundwater Quality: a Model Study for a Soil and Aquifer Pollution Case

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Abstract

Motivation of the paper - Intensified use of nitrogen based fertilizers in agriculture has resulted in a significant increase in nitrates in Romanian soils and groundwater. The first estimate of nitrate vulnerability of Romanian soils performed in 2003 established 255 areas (corresponding to a total agricultural land area of 6500000 ha) as “nitrate vulnerable zones” or NVZ. Nitrogen-nitrate concentration measurements from phreatic aquifers indicate values well above European admissible limits (50 mg/l) in most agricultural regions of the country.

Purpose - Here we propose a coupled model which describes the physical transport and biogeochemical dynamics of the water and nitrogen compounds in a soil-water -plant-groundwater system.

Design/methodology/approach - The coupled model is applied to understand the mechanism of soil pollution and predict the nitrogen-nitrate concentration in a shallow unconfined aquifer in Romania, in a typical agricultural area. Our model takes into account the following mechanisms: water infiltration into an unsaturated porous medium, production and leaching of nitrates, nitrate transfer from an agricultural system toward the aquifer's watertable, and the dispersion of nitrates in the groundwater. The main bio-chemical processes occurring in the upper, unsaturated soil are mineralization and immobilization of nitrogen, nitrification and denitrification. In our model the nitrogen cycle is described by a system of differential equations with N-NO3, N-NH4 and organic nitrogen concentrations as unknowns and nitrogenous fertilizers, nitrate roots plant uptake, rain intensity, water velocities in pores, and soil water content as transfer functions parameters.

For the flow in the unsaturated soil we numerically integrate Richards equation considering the moisture retention characteristics for different soils using optimized Mualem-van Genuchten parameters. The nitrogen uptake of plants is modeled as a Michaelis-Menten transfer function.

Findings - We calibrate our model and analyze the influence of the fertilizer, soil type, crop type and rotation schedule, precipitation, irrigation regime and aquifer flow rate on the temporal and spatial evolution of the nitrate pollutant plume.

Originality/value - Our goal is to lower soils and groundwater pollution with nitrates by creating an optimal balance between the amount of chemical fertilizers and water applied to crops on one hand, and the amount of nitrate and water used by plants on the other, taking into account the above variables. We propose that this type of analysis can

be used to minimize the impact of nitrogenous pollutants on groundwater quality, an important step in creating a more sustainable agriculture.

Thermodynamics in Sustainability

SDWS2011.0250 Exergy Diagnosis of Coal Fired CHP Plant with Application Of Neural and Regression Modelling

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Abstract

The paper presents problems of exergy diagnosis of CHP plant with the application of mathematical modelling. Mathematical models of the processes that proceed in energetic machines and devices are more often applied. However, in many cases these processes are very complicated. In such cases, the exact analytical models should be equipped with the auxiliary empirical models that describe parameters difficult to model in a theoretical way. Such models can be qualified as hybrid ones. Identification of empirical consists of the development of models mapping the relations between inputs and outputs of the analyzed process. The identification of models can be based on results of industrial measurements or special measurements as well as can be based on simulative model of the process. Regression or neural empirical models obtained by means of the identification process are rather simple and are characterized by relatively short computational time. For this reason they can be effectively applied for simulation and optimization of steering and regulation processes as well as for control and thermal diagnosis of operation (eq. power plants or CHP plants). In the paper regression and neural models of thermal processes developed for systems of operation control of thermal plants are presented. Theoretical-empirical model of processes proceeding in coal fired CHP plant have been applied. Simulative calculations basing on these models have been carried out. Results of simulative calculations have been utilized for the exergy diagnosis of considered power plant. The diagnosis procedure let to investigate the formation of exergy costs in interconnected components of the system of CHP as well as investigate the influence of defects in operation of components on exergy losses in other components.

SDWS2011.0474 Exergy of Comminution and the Crepuscular Planet

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Abstract

In previous papers published in “Energy”, we proposed a model for an exhausted Earth crust -the Crepuscular Earth- representing a degraded planet where all materials had been extracted and dispersed, and all fossil fuels had been burned. The mineralogical composition of our model for the crepuscular upper crust contains 324 substances, 292 are minerals and the remaining are mainly diadochic elements included in the crystal structure of other minerals.

The importance of having a model of degraded planet is crucial. It allows us to assess the current natural capital on Earth and the velocity at which we are degrading the resources. Both factors might be used for managing efficiently our minerals heritage, and have a time picture of the velocity at which we are approaching the "commercial end" of the planet. From the point of view of the Second Law of Thermodynamics, the Earth is gradually approaching to a degraded planet of minimum exergy, with the absence of fuel and non-fuel mineral deposits.

Exergy is a physical property, rather than an ad hoc indicator. It is sensible to quantity (mass) and quality (ore grade and composition) of the mineral and has energy dimensions. In fact, exergy measures the minimum quantity of useful energy required to provide a system for building it from its constituent elements found in a given reference environment. If we choose the model of our Crepuscular Earth as a reference environment, the mineral´s exergy becomes a perfect candidate for having universal units to manage the world´s abiotic resources.

The chemical exergy pays attention to the different chemical composition of the mineral in the mine and their chemical parents in the Crepuscular Planet. Meanwhile, the separation exergy pays attention to the concentration (ore grade) of the mineral with respect to the same substance as found in the bare rock in the Crepuscular Planet. It describes thermodynamically the very well described relationship between energy consumption as a function of ore grade.[See for instance, Page and Creasey, 1975]

However the cohesion energy is always present in any mineral. Thus, we should add another exergy term, that is the exergy needed to break the binding forces among solids such as hydrogen bonds, surface energy and hydration forces, etc. These forces are strong enough to require physical comminution processes like crushing, grinding, and milling.

Thus we have two main questions to answer: 1) what should be the reference level for cohesion energy in the Crepuscular Planet and 2) how to calculate the cohesion exergy for any mineral or rock. The object of this paper is to answer these questions.

SDWS2011.1014 Cfd Simulation of Entropy Generation in Pipe for Steam Transport in Real Industrial Plant

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Abstract

The success of methods to increase the energy efficiency, to a large extent depends on the efficiency of individual elements, devices and apparatus, which in the system. Energy efficiency operation of each of the elements of the system can be achieved with good design, which requires knowledge of the processes that take place in the device. The pipes are an integral part of every industrial plant.

The objective of this paper is to illustrate the CFD simulation of entropy generation in one part of pipe for steam transport in complex industrial plant, like a way of reducing irreversibility production in pipe. The irreversibility of any pipe is due to two factors, the transfer of heat across the stream to stream temperature difference (heat transfer irreversibility) and the frictional pressure drop that accompanies the circulation of fluid through the apparatus (fluid friction irreversibility).

In this paper analyzed the pipe for steam transport in rubber industry. The superheated steam at the pressure 10 bar is a fluid that transfers the energy from the steam boiler to the apparatus in the factory. For a defined geometry of pipe, we have created his model, and as results are represented the fields of entropy generation due to heat transport and fluid friction, and the total volumetric entropy generation.

SDWS2011.0954 Exergy Analysis of Electricity Generation by the Medium Temperature Geothermal Resources: Geothermal Power Plant Velika Ciglena Case Study

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Abstract

In the Republic of Croatia there are some medium temperature geothermal fields (between 100 and 180 ^{0}C) by means of which it is possible to produce electricity. However, only recently concrete initiatives for the construction of geothermal power plants have been started. In previous papers, the possible cycles for geothermal fields in the Republic of Croatia are proposed: Organic Rankine Cycle (ORC) and Kalina cycle. Also, on the example of the most prospective geothermal field, Velika Ciglena - 175 ^{0}C, comprehensive energy analysis and preliminary exergy analysis for the proposed energy conversion cycles are performed. On the basis of analysis both the most suitable cycle for this and for other geothermal fields in the Republic of Croatia is proposed. It is ORC which in case of geothermal field Velika Ciglena has better both the thermal efficiency (the First Law efficiency) and the exergy efficiency (the Second Law efficiency): 14.1% vs. 10.6% and 52% vs. 44%. This can be explained by relatively high temperature of geothermal water (175 ^{0}C) and of air for cooling (15 ^{0}C). The obtained results are very interesting and at first act confusing, because recent papers in the technical literature claim dramatic efficiency advantages for Kalina cycles over ORCs. With aim to final confirmation that the ORC is better than Kalina cycle, in this paper an extensive exergy analysis will be performed for conditions of Velika Ciglena geothermal field. Also, results of exergy analysis of cycles will be used to assess their performance and pinpoint sites of primary exergy destruction. Exergy destruction throughout the plant will be quantified and illustrated using an exergy flow diagrams, and compared to the energy flow diagrams. Exergetic efficiencies of major plant components will be determined in an attempt to

assess their individual performances. In the end, a thermodynamic optimization of better cycle will be performed in order to reduction of geothermal fluid specific consumption.

SDWS2011.0766 Working Fluid Selection in Steam Cycle with Heat Recovery Steam Generator

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Abstract

In heat recovery steam generators (HRSGs) the temperature differences between an inlet flue gases temperature and a steam turbine inlet temperature are significantly lower in relation to those differences in conventional steam generators. So a pinch point phenomenon limits a working fluid mass flow and consequently the flue gases in HRSG can not be sufficiently cooled. To avoid a high HRSG flue gases outlet temperature a multi pressure HRSGs are used with a water as working fluid. To obtain a high thermodynamic efficiency of a steam cycle with HRSG the water as working fluid must have a high pressure. So to find out an influence of the working fluid selection on thermodynamic efficiency a thermodynamic model of a single pressure HRSG is made. Analysis is made for water and for various organic working fluid. The thermodynamic efficiency of the cycle as well as pinch point phenomenon are taken into consideration. Thermal efficiencies of a plant are presented in dependance of a steam turbine inlet pressure and temperature. The data presented in this paper can be used to determine the optimal working fluid with respect to the HRSG flue gases inlet temperature as well as to select the optimal steam turbine inlet pressure and temperature of the working fluid in order to maximize the power plant thermodynamic efficiency.

SDWS2011.0761 Thermoeconomic Analysis of a Hybrid Energy Generation Unit at a Gas Pressure Reduction Station

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Abstract

The paper deals with a hybrid energy generation unit installed at a natural gas pressure reduction station. The key elements of the system are a turboexpander and a co-generation unit with a gas engine. The turboexpander utilizes the potential of pressurized inlet gas to generate mechanical energy, which is finally converted into electricity in a generator. This solution is a significant improvement to the conventional pressure reduction process, based on throttling in so-called pressure regulators. However, changing

from the throttling to the expansion process implies a substantial temperature drop, which has to be compensated for in order to avoid liquid phase or hydrate forming in natural gas at the turbine outlet. Pre-heating of the natural gas prior to the expansion can be performed based on various heat sources; the solution analyzed in the paper is a co-generation unit with a gas engine, fired with a minor part of the expanded gas flux. The CHP unit provides the required process heat and contributes to the system electricity production.

The analyzed system constitutes a hybrid energy generation unit driven by two sources: the chemical energy of the combusted gas flux and the physical exergy of pressurized inlet gas, which can only be identified by means of the second law analysis. In the paper, the energy and exergy balances have been built and the relevant thermodynamic quality indicators have been defined. The presented case study has shown that the ratio of the produced electric energy to the chemical energy of the combusted gas reaches a high value of about 0.8, which is possible due to the 'latent' pressure potential utilization. This potential has been identified using the exergy analysis, and the calculated exergy efficiency of the system is less than 0.5.

Furthermore, the exergy cost has been calculated and allocated to particular fluxes, and the cost formation process has been analyzed in order to detect the sources of irreversibility in the system. The presented case study results show that the primary source of irreversibility is the excessive level of temperature in the heat production system of the CHP unit, and the resulting high temperature differences in heat exchangers, which therefore have a low exergy efficiency ranging from 0.19 to 0.67.

The thermoeconomic analysis performed indicates that the performance of the pressurized gas exergy recovery systems could be enhanced if low-temperature heat sources, such as waste process heat or geothermal sources were available in the area of the planned gas pressure reduction station.

Water resources I

SDWS2011.0735 Groundwater Vulnerability Gis-Based Models for the Qualitative Assessment of Coastal Aquifers.

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Abstract

Qualitative assessment of groundwater resources in coastal aquifers is considered as an environmental issue of paramount importance in the Mediterranean basin. This is mainly because they are directly interrelated to the development of the local communities which exploit these aquifers in question.

This paper discusses the application of a GIS-based aquifer vulnerability model for a coastal aquifer in Northern Greece. The vulnerability index was developed with respect to the contamination potential of the aquifer in association with the increasing concentrations of nitrate and chloride ions. Therefore the most applicable tools for this regional aquifer were proved to be the DRASTIC and GALDIT vulnerability indices for the assessment of the aquifers susceptibility to nitrate and chloride ions respectively. The investigation included the interpretation of field data (geological, hydrogeological, climatological and hydrological) and visualization of the model outputs with the aid of interlinked GIS tools. The produced vulnerability maps proved that both DRASTIC and GALDIT can be used for the production of reliable vulnerability mapping which in turn can be used by the water managers or water authorities in order to develop appropriate groundwater resources exploitation planning for the sustainable use or smart mining of the underlying aquifer system.

SDWS2011.0082 The Use of Rain Water in Thailand; Case Study Bangsaiy Municipality, Ayutthaya

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Abstract

Abstract—Rainwater has been widely use in developing countries including in Thailand. In the study area, Ayutthaya, rainwater is not much in use due to the quality, abundance and low tariff of municipal water supply. However surveys of residents show that there is interest in using rainwater as drinking water. The community purchases

bottled water and treats water by boiling or by on-site purification devices. A high level of demand for rainwater use was found in this study and this is attributed to past practices and a local culture of using rainwater. It was found that more than 90% of respondents were interested in using rainwater if it was of good quality. Piped water tariffs are currently very low in the range of 4 to 5 Thai Bahts per m^3. Approximately 70% of household from questionnaire surveys were satisfied with the current tariff. However, it should be noted that the true cost of water should be 9-11 Bahts per cubic meter. The survey showed that 63% of respondents who currently purchase bottled water are interested in using rainwater as drinking water if its quality is good.

SDWS2011.0122 Dew, Fog and Rain Water Collectors in a Village of S-Morocco (Idouasskssou)

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Abstract

The coastal region of south Morocco presents a chronically shortage of drinkable and fresh water. Since 1994, in the Mirleft area, inhabitants are facing a critically drought event. In 2007, only 49 mm of rain was recorded. However, measurements in the same year showed that the dew yield was on order of 40 % of rain fall. In order to show to the local population the interest of recovering dew water in addition to rain water, a small village (Idouasskssou), 8 km from Mirleft and the Atlantic ocean, was equipped with three pilot condensers of 136 m^2total surface area. A local organization (IMRJANE) collaborated to ensure a good integration of the project by the village inhabitants. A concrete tank at ground level with a flat horizontal surface, easily accessible for inhabitants and also a model for traditional Morocco terraces roofings, has been equipped with two lines of condensers (40.6 m²). All materials were from local shops. Only the special radiative and hydrophilic coating was coming from non local resources (see www.opur.fr). The top of a second tank, aside the first one, was renovated and covered with a 21.2 m² two slopes steel roof, insulated and painted with the same special dew coating as above. These roofs represent a condensation surface comparable to that of a very little house. A third condenser, with 73.8 m² surface area, was implemented directly on the ground, ensuring minimal work and cheap implementation costs. Dew water production during 6 months, from 15-12-2008 to 31-07-2009 (137 dew events, 47 % of days) was more than 3800 L (0.2 mm/dew day). It is important to note that, while the devices are specifically designed to condense dew water, they also harvest rain and fog, thus providing to the population a valuable water resource. As a matter of fact, during fall 2009, the village was not connected to the national water network and the collectors were the only source of water of the village.

SDWS2011.0168 The Integrated Studies for Managing Scarce Water Resources Areas (Case Study Sana'A Basin)

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Abstract

Sana'a Basin have experienced to a continuous decline of groundwater levels from about 30 m in the early 1970s, to more than 200 m below ground surface during the last decades, where the abstraction of groundwater has increased dramatically to more than ten times. Assessment of Water Resources of the Sana'a Basin covering the Strategic Options for the Sustainable Development of the Basin's Water Resources has been carried out, within a framework of a recent integrated water resources management policy studies. The mathematical modeling technique has been applied to provide the tools that would assist in defining the development and management strategy of the limited groundwater resources in a sustainable manner. A Conceptual Model was designed according to the actual Groundwater Dynamic Flow System in the Basin as one complex hydraulic unsteady state system with hydraulic interaction between the simulated layers. The prevailing different hydrological boundary conditions, including the Constant Head, the General Head, Permeable, Closed, Recharge, and the Drain Boundary, were defined, edited and imported to the Model. Steady and transient State Calibration Runs were carried out, where the values of the calibrated conductivity and storage coefficient for the both simulated layers were computed and tested. Four groundwater development Scenarios were simulated representing the present condition of water resources and the future socio-economic management action plan. The output for each simulated layer for each Scenario, for the year 2020 was evaluated covering; the detailed water balance components for each budget zone, the predicted groundwater level, the expected groundwater recoverable contour head, and the over-exploitation areas. These outputs gave a complete evaluation of the expected relative severity of the groundwater position, and the aquifers' depletion in several locations. Accordingly, the different options have been proposed to respond to the issues and constraints facing the water resources in the basin; supply management options, demand management options, institutional and capacity building options. This study proposes a complete action plan in a scientific approach, towards sustainable solutions, and an effective tool for decision-makers for setting priorities for adequate management of the limited water resources. The integrated technique adopted in this work study can be applied for managing the water scarcity, which is the predominate issue in arid and semi arid countries.

SDWS2011.0356 How Sustainable Are Engineered Rivers in Arid Lands?

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Abstract

Important rivers in arid lands share these characteristics: The headwaters are fed by snowpack in the mountains. Hundreds of kilometers downstream, where the climate is arid or semi-arid, water meets fertile soil and supports irrigated agriculture and human settlements. This is how civilizations in Mesopotamia, Egypt, China and the Americas emerged and flourished for thousands of years. Over the course of the last hundred years these rivers have been changed by human engineering. Rivers were dammed to capture water in reservoirs that support electricity generation, irrigated agriculture and riverine cities. Today engineered rivers face new challenges. Climate change urgently needs to be considered in water management. Reservoir sedimentation needs to be quantified. Both factors are likely to reduce water supply, while population growth increases water demand. This raises important questions: How will reduced water supply and increased water demand impact river basins? Can we do more with less? How sustainable are engineered rivers in arid lands?

River engineering started in 1916 with the construction of Elephant Butte Reservoir in the Rio Grande, a river shared by the United States and Mexico. We use our research in the Rio Grande to analyze the impacts of climate change, reservoir sedimentation and urban growth on water quantity downstream from Elephant Butte. Observations to date document that the Rocky Mountains snowpack is melting earlier in the year, rain is replacing some snow storms, and the April snow pack is containing less water. The descending branch of the Hadley Circulation will expand northwards and the resulting climate throughout West Texas and Northern Mexico will be drier as the century proceeds. Sedimentation has reduced storage capacity by 23.16 percent. Population in the economically important parts of the basin has doubled every twenty years since the 1950s. We found that changed crop patterns, improved irrigation techniques, repair of urban distribution systems and realistic water pricing can conserve 40 percent of surface water without economic loss, compensating for the impacts of climate change, reservoir sedimentation and population growth during normal years. However, shortages during drought periods will be severe.

To conclude we suggest that the impacts of climate change, reservoir sedimentation and improvements in water management be studied in other arid regions. Examples of engineered rivers facing similar challenges include the Ebro (Europe), Nile (Africa), Yellow (China), Murray-Darling (Australia), and Sao Francisco (South America).

SDWS2011.0758 Drinking Water Quality in Ankara: a Monitoring Study

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Abstract

Complying with the drinking water standards and maintaining the drinking water quality at an acceptable level is very important for public health. Hence, regular monitoring of the parameters which are the indicators of water quality is crucial. Following the event of severe drought experienced in 2007, it was decided to use Kesikköprü Reservoir as an additional supply source for the city of Ankara. Thereupon, there have been debates on the quality of Kesikköprü Reservoir water with the claims that some parameters, primarily sulfate and arsenic, were not complying with the quality standards and therefore there was a threat to public health. The present study aims to determine whether the water quality in the distribution network in Ankara exceeds water quality standards, and to assess the status of water quality in Ankara. To this end, monthly samples were collected from the taps of consumers of 24 districts as distribution network water and also from the Kesikköprü Reservoir as source water, and were monitored in terms of certain water quality parameters within the period between July 2008 and June 2009. Sulfate concentration in Kesikköprü Reservoir water was measured as 300-500 mg/l and this high sulfate concentration in the source water led to high sulfate values in distribution system. On the other hand, the arsenic concentration in Kesikköprü water was analyzed between 9-11 µg/l which is lower than the expected high arsenic concentration in Kızılırmak water. Moreover, monitoring of THM and HAA in distribution network were carried out to observe DBPs formation. The highest THM concentration was observed as 109 µg/l for Bilkent in June 2008. Although for some districts and some months throughout the year THM concentration was higher than the EPA Stage-I (80 µg/l) and Stage-II (40 µg/l) limits, mean annual THM concentrations for districts in distribution system satisfies the standards. Furthermore, the highest HAA_5 concentrations were determined as 75.02 µg/l for Dikmen in February 2009. However, annual average HAA_5 in any of the districts did not exceed USEPA limit of 60 µg/l. Nonetheless, total/fecal coliform bacteria, which are the indicators of microbiological contamination, were detected in distribution system between the months of July 2008 and January 2009. However, the coliform bacteria did not appear with the increasing residual chlorine in the distribution system since January 2009. Results from this study are variable between months; some months indicate deteriorating water quality in the distribution system while other months indicate almost complete satisfaction with the water quality standards. Overall; due to Kesikköprü raw water, sulfate content appears to be the major concern in the water quality when considered the one-year monitoring period.

Cogeneration/Trigeneration and District Heating

SDWS2011.0259 Cogeneration – Investment Dilemma

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Abstract

Cogeneration (Combined Heat and Power, CHP) is an economically and socially justified process of energy generation. Energy companies, which operate in a liberalized energy market, are faced with several crucial investment decisions, considering factors such as energy sources availability, feed–in tariffs, market positioning and consumers' satisfaction. Research analyses profitability of the CHP project in the city of Rijeka, which is about to provide district heating for University campus, Hospital and active private consumers together with further sales of electricity. Results indicate the project profitability with use of the feed-in tariffs and assured sale of the electric and thermal energy.

The CHP conceptual design considers specificities of the technological process and total energy needs, with typical daily load curves for the electric and thermal (gas) energy, based on archived data. Economic analysis gives profitability indicators, regarding operational costs and savings as well as available national feed-in tariffs. Analysis takes into account energy sources price variability and different electric energy purchase and selling price ratios.

The conceptual design of the CHP connection and integration into the distribution power system involves calculation and setting of a relay protection system, power flow calculations as well as impact on short circuit currents and electric energy quality parameters. In addition, revitalization project of the existing CHP comprises necessary adaptive actions in the distribution power system.

Monitoring of the issued distribution power system part is based on a traditional SCADA (Supervisory Control and Data Acquisition) system. A proposed real time monitoring system uses synchronized phasor measurements. Real time monitoring enables the CHP island operation, with uninterrupted electric and thermal energy supply of critical consumers (e.g. hospital) in case of a serious disturbance.

SDWS2011.0261 Solar Trigeneration: a Transitory Simulation of Hvac Systems Using Different Typologies of Hybrid Panels

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Abstract

Energy savings on buildings applications and renewable energy technologies are two concepts very close. Several typologies of installations are used commonly but new installations are been developed to get high efficiency systems. During summer, when irradiation is higher, is the moment with low demand, and vice versa in winter. The adsorption and adsorption machines permits to use the heat flow to cover cooling loads. Combining these technologies with solar thermal collectors we obtain a solar cooling installation. In the Mediterranean climes, solar installations have a lot of problems in summer working conditions due to the high temperatures in the panels. Using this heat flow with an absorption (or adsorption) machine is possible to avoid these problems. On the other hand, hybrid panels (thermal and electrical) produce a cogeneration which can be supplemented with the addition of a solar cooling system to get the solar Trigeneration. This hybrid system could provide the HVAC (heating and cooling loads) and electricity needed in a house. A significant difference between an adsorption and absorption machine is the input flow temperature coming from the panels. Usually, absorption machines require higher temperature to work correctly. Otherwise, absorption machines usually have better efficiency than adsorptions. So a deep study must be done to conclude which machine and working conditions are more adapted on each climate. Moreover, different typologies of collectors can be used to provide heat flow to these cooling machines. Depending on the temperature required by the machine and the partial working conditions there will be more interesting to use flat plate or concentrating collectors. This article integrates hybrid panels to solar cooling to obtain the Trigeneration effect. The aim of this document is to evaluate the performance of a Trigeneration installation in different locations of Europe. This installation will be compared using different typologies of hybrid panels (flat plate, vacuum tubes and parabolic collectors) and different cooling machines. The transitory simulation with Trnsys will permit to see the working conditions and to optimize all components in the installations (the storage tanks, solar surface, and all components in the installation). Solar cooling has been well documented by some authors like Desideri, Kursad, etc. but on this article the integration of different hybrid collectors will provide more information about these installations. With this study, an optimal size of each component will be found on a family house placed in different location of Europe. To compare different typologies of panels will conclude the optimal one on each location. The electrical efficiency in the photovoltaic cell is improved due to the cooling effect. Here it will be study this benefits. Also it will be study the working conditions using constant flow pumps and variable flow pumps.

SDWS2011.0530 Tactical Techno-Economic Analysis of Electricity Generation from Forest, Fossil and Wood Waste Fuels in a Heating Plant

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Abstract

Conventional electricity generation has various environmental effects that may cause global warming. Renewable energy fuels are thus more favorable because they have nearly zero emission. Forest energy fuels, among the various renewable fuels, finds increasing usage, concurrent with developing technology. In this study, the electricity-generation ability of a heating mill has been investigated. With this aim, energy data of heating plant from the southern Finland were collected for a tactical decision-making horizon of 2 months. From the collected data, the electricity generation problem was solved using optimization of different types of energy fuel mixes. The optimizations were based on the electricity requirement and market prices of the experiments.

Electricity market prices have changed quite rapidly in past years, which makes important to produce and sell additional electricity because it is important factor in heating plants' profitability. Increasing electricity production affects profitability greatly in shorter period. Recently, the political decision has been made that electricity selling price of heating plants is supported so that the market price is constant for production of heating plants. In this study, it is assumed that high cost efficiency of electricity production can be reached by right energy fuel mix and the energy-fuel mix delivering problems can be avoided by decision support methodology. Recently Palander & Vesa (2009) have studied same kind of issue in respect to emission prices (CO_2).

A fuel procurement scheduling problem for electricity generation and heat production was considered as a dynamic system. The problem included the allocation of number of fossil, peat and wood-waste fuel procurement chains with release and due dates into a heating plant. The economic evaluation of the energy fuel mixes was made using minimization of raw material procurement costs, maximization of electricity revenues and maximization of heating revenues.

Due to the combinatorial complexity of the research problem, the adaptive technique was used to solve the integrated system with industrial relevance. The reformed energy flow model proved to be more effective than the model developed by Palander and Vesa (2009), because in the new model, the forest fuel mix delivering could be taken in consideration more precisely. This resulted from the fact, that demands of electricity generation were modeled with the separate variables in the reformed model. Different properties of the decision-support methodology are discussed and illustrative "putting a price on electricity generation" -examples based on real-life industrial data are presented.

SDWS2011.0834 District Heating Network Design and Configuration Optimization with Genetic Algorithm

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Abstract

A DH system includes heat generation, distribution and utilization. The heat generated in a heating plant is delivered through the DH network to the end users. The DH pipeline investment cost accounts for a significant part of the whole DH system cost. The optimal routing of DH pipeline and optimal pipe diameter based on the design and operation conditions are essential to achieve economic saving and energetic /exergetic consumption reduction. In this paper, the configuration of a DH network which connects from the heat generation plant to several end users is optimized. Each end user in the network represents a small distribution network with different number of buildings. The small network at the end user is optimized first to achieve minimum annual heat loss. The optimized annual heat supply from each end user is used as input for the larger network configuration optimization. The connection between the heat generation plant and the end users can be represented with mixed integer and the pipe friction and heat loss formulations are non-linear. In order to find the optimal DH distribution pipeline configuration, optimization algorithm that handles the mixed integer nonlinear programming problem has to be chosen. A Genetic Algorithm is applied to optimize the larger DH distribution pipeline configuration based on the design and operation condition in terms of economic aspect. Upon the establishment of the optimal network connection, the pipeline diameters are further optimized with non-linear programming.

SDWS2011.0737 Trigeneration Plants in Italian Large Retail Chains: a Calculating Model for the Tpf Projects with the Evaluation of All the Incentivizing Mechanisms

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Abstract

Trigeneration plants in Italian large retail chains: a calculating model for the econometric evaluation of TPF projects

The object of research is an energy and economic analysis of the exercise of trigeneration systems based on a calculation model developed for engineering applications in the field of for large retail chains in Italy. Particular attention has been devoted to the validation of the model for third party financing projects.

The analysis is carried out in comparative form, considering all the currently used forms of the Energy Performance Contracts and the ongoing incentivizing mechanisms to support tri-generation plants. The study, in fact, is based on an econometric energy model of calculation of CCHP systems whose operation is validated on a case study described in detail.

The simulation procedure has as its starting point an energy audit platform specifically developed for the analysis of air-conditioning systems found in some specific categories of large retail chains.

The study of plant configurations is then implemented in a second automatized model that develops complex scenarios of heat, cooling and electrical energy production, compares their behavior with curves of consumptions and extrapolates the resulting economic flows, according to the preset parameters depending on some external variables such as energy prices.

The simulation variables that can be introduced can be divided into three main categories: the specifications of the contracts offered by the ESCOs (first out, first in, shared savings, guaranteed savings and chauffage); the electricity prices imposed by currently available Italian law schemes (the "ritiro dedicato" with partial or total sale of energy to the grid, the "tariffa onnicomprensiva" that's an all-comprehensive fee to the produced energy), and finally, all the possible incentivizing mechanisms for the trigenerating technology chosen (green certificates, "tariffa onnicomprensiva tracciabile e non tracciabile" the all-comprehensive fee for oils with a traceable and untraceable origin).

The system also calculates scenarios for systems of all sizes and characteristics, by varying the data input through the platform of energy audits. In this way, it's possible to optimize the size of CCHP systems, the operating conditions, the shares of supply of produced energy and the technologies for the production of cold.

The results have been summarized in 50 scenarios that appear quite varied. The development of two types of cash flow (ESCo-side and client-side), also during the contract period and in that post contract period, highlights the economic advantage in the trigeneration plants management for both parties and makes possible to determine not only the sensitivity of NPV respect to the mentioned variables, but also the options of contract needed to verify the feasibility of this type of TPF projects.

SDWS2011.0995 Micro-CHP Design Tool for Design and Economical Assessment of Cogeneration Applications

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Abstract

Polygeneration denotes the combined production of power and heat (CHP – Combined Heat and Power) and power, heat and cooling (CHCP – Combined Heat, Cool and Power) in a single system, increasing the primary energy source conversion efficiency (90% about). The micro-polygeneration, related to small plants (< 50 kW_{el}) for residential and small commercial applications, is a high potentiality technology, with an impact of the same order of magnitude of nuclear power actually installed worldwide. It is foreseen that µ-CHP/CHCP plants power installed will increase up to 60 GW_{el} in EU15 by next 20 years.

On the other side, designing a small application is not an easy task and the calculation of economical convenience requires a deep knowledge of technologies and energy load profiles. From these considerations, a complex design tool, focused on µ-CHP/CHCP, has been developed in order to assess technical and economical characteristics for residential and small commercial (restaurants, hotels, etc.) applications.

Starting from input data as electricity, heat and cold load profiles, energy tariffs, location, etc., the software is able to simulate 3 plant schemes for CHP and 4 for CHCP, selecting the best configuration for the specific application in terms of economic return.

A case-study, i.e. a small (3000 m^3) hotel in Rome, is analyzed simulating the 3 µ-CHP schemes: optimal performance are obtained with a 7 kW CHP engine installed with a 50 kWh thermal storage and a 40 kW backup boiler. By this plant configuration, almost the complete supplying of electricity and thermal load required by the user (percentage of user's electrical energy produced by cogenerator = 71%, percentage of user's thermal energy produced by cogenerator = 87%) is assured with a very good financial performance of the investment (NPV = 100.8 k€, IRR = 18.9%).

Energy efficiency

SDWS2011.0287 The Estimation of Energy Efficiency for Hybrid Refrigeration System

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Abstract

One of the purposes of technical development of refrigeration systems is to increase their energy efficiency. The issues of energy efficiency improvement can be broadly divided into two directions: the first direction concerns the improvement of a refrigeration system components such as compressors, heat exchangers, refrigerant used, and their configuration in the system, and the second direction is connected with optimization of operations and combining different cooling systems for their optimal use in the facility.

In this paper, a hybrid cooling system has been defined as a combination of at least two cooling systems, each of which operates for the needs of a common object such as the cold room, the tunnel, the building, the technological process. Moreover, the principle of operation of each of the cooling systems is based on a different concept, this means that for example the hybrid system is considered a combination of: compression and cryogenic cooling system, compression and absorption cooling system, compressor and adsorption refrigeration system, absorption and adsorption cooling system. It should be emphasized that the circuits of the systems are not connected and the cooling systems can operate independently.

The evaluation and selection of the best operation strategy of the hybrid cooling systems may be determined based on technical, economic and environmental criteria. With regard to the refrigeration systems their energy efficiency may be used as a criterion for the assessment.

This article will present a method for estimation of the energy efficiency of hybrid cooling systems. The calculations of energy efficiency of the hybrid refrigeration system eg. compressor-cryogenic refrigeration system, are performed with the use of the results of experimental investigation. Based on the results of experimental investigations and theoretical-empirical model, the cooling capacity and the energy consumption for the hybrid system are obtained.

In this paper the coefficient of performance COP for hybrid refrigeration system is proposed for the estimation of energy efficiency. This COP with the same coefficient for only compression or cryogenic freezing system is compared. The suggestion of use and calculations of exergy and cumulated energy consumption indicators are proposed, too. The influence of cooling parameters of the systems for the results of the energy efficiency estimation is also taken into consideration.

SDWS2011.0430 Energy Efficient Production – Interdisciplinary, Systemic Approach Through Integrated Simulation

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Abstract

The increase of productivity has been the main requirement for planning of production facilities in the past. In this respect the reliability, flexibility, cycle time and the quality of the production process played a significant role. This trend, however, is currently being challenged through emerging issues such as energy efficiency and life cycle costing. These issues have arisen due to the increasing uncertainty in energy supply through political dependencies, the tightening of EU-demands considering CO_2-reduction and lastly through growing pressure of the media and increasing public ecological awareness.

An interdisciplinary cooperation with a life-cycle-costs oriented approach therefore offers itself as the appropriate method for achieving energy- and resource saving of industrial processes and facilities. This approach is currently applied within the framework of the research project INFO (Interdisciplinary Research for Energy Efficiency in Production) at the Vienna University of Technology. The project is supported by the Climate and Energy Fond and aims to realize a systemically integrated model of an energy efficient production facility from the micro level (comprising the production process and the machine tool) to the macro level (involving the production layout and the facility including building elements and building services). Thereby, the project consists of five main phases (analysis, modeling, coupled modeling, optimization, and implementation) in which processes, machines, and the building will be addressed.

In this paper we demonstrate the results of the implementation of an integrated simulation approach for a specific industrial facility. The analysis of production processes and energy flows of the existing facility will be used for modeling the different levels starting from machines and production systems, also covering user behavior and building services related requirements, to the building envelope and the micro environment of the facility. The models will be assembled and the optimization options demonstrated.

SDWS2011.0972 Potential of Waste Heat in Croatian Industrial Sector

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Abstract

Waste heat recovery in Croatian industry is of the highest significance regarding the national efforts towards energy efficiency improvements and climate protection. By recuperation of heat which would otherwise be wasted, the quantity of fossil fuels used for production of useful energy could be lowered thereby reducing the fuel costs and increasing the competitiveness of examined Croatian industries. Another effect of increased energy efficiency of industrial processes and plants is reduction of greenhouse gases i.e. the second important national goal required by the European Union (EU) and United Nations Framework Convention on Climate Change (UNFCCC).

Paper investigates and analyses the waste heat potential in Croatian industrial sector. Firstly, relevant industrial sectors with significant amount of waste heat are determined. Furthermore, significant companies in these sectors are selected with respect to main process characteristics, operation mode and estimated waste heat potential. Data collection of waste heat parameters (temperature, mass flow and composition) is conducted. Current technologies used for waste heat utilization from different waste heat sources are discussed and compared. Considered facilities are compared with regard to exhaust temperature, mass flow and heat. Mechanisms for more efficient and more economic utilization of waste heat are proposed.

SDWS2011.0614 Catching on the Rebound: Determination of Rebound Effects in Energy Economics

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Abstract

A particular reason for paying more attention to the distinction between the demand for energy sources and the demands for the services that these energy sources provide has arisen recently with increased interest in what in the energy literature is referred to as the rebound effect. This term is used to describe the finding that with increased energy efficiency for various products used to produce energy services (such as appliances that produce space heating or lighting), the savings in energy consumption that products

embodying this higher level of energy efficiency are expected to elicit is typically, or at least frequently, not observed.

The generally accepted measure of the direct rebound effect is given by the elasticity of the demand for energy services with respect to energy efficiency. There is no standard approach for obtaining estimates of this measure because in most cases neither energy efficiency nor energy services are directly observed or measurable. We focus on the use of the negative of the own-price elasticity of energy demand for this purpose since, despite some serious shortcomings, it is becoming increasingly widely used as a measure of the rebound effect.

We argue that a fundamental problem with use of the own-price elasticity of energy demand as a measure of the rebound effect is that models on which such measures are usually based are inappropriate for this purpose. In our paper, we show that what is required to examine rebound effects without using various contrivances that are of dubious value is a model that takes account of consumer demand being for energy services rather than for energy sources. Using a consistent theoretical framework, we develop such a model, which includes a direct role for energy efficiency in determining energy demands, even though energy efficiency may be predetermined at the time that current-period energy demand decisions are made. Hence, this appears to be a much more conducive environment for determining rebound effects. Within such a model, the usefulness of using own-price elasticities of various energy demands to measure direct rebound effects, and even of using various cross-price elasticities to measure (some) indirect rebound effects, becomes apparent.

Estimation of our model using time-series data on energy expenditures and prices for the residential sectors in Canada and in the UK, yields estimates of rebound effects that are compared to, and found to differ from, those obtained using previous approaches. Although our data series do not contain information on energy services that were consumed by households, we are able to provide empirical estimates of direct rebound effects that are still based on own-price elasticities for particular energy sources, and as such are relatively easily obtained. Our method would appear to have widespread applicability.

SDWS2011.0818 The Economic Valuation of Investment in Electricity Conservation

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Abstract

The paper presents an economic study of the potential for energy conservation in Israel. We analyze energy conservation policies targeted at the household sector, focusing on the economic feasibility of scrapping old household electrical appliances, and considering the effect of such policies at both the household and the macro-economic

level. The results of our analysis show that the most conducive appliance in this context is the air conditioner (used for both heating and cooling). A scrapping program for old air conditioners passes a Cost Benefit Analysis (CBA) even when external benefits are excluded from the calculation. When external benefits are included, scrapping programs for both washing machines and dishwashers pass the test as well. According to our findings, the annual economic benefit of a program involving the scrapping of 100,000 air conditioners, 45,000 dishwashers and 15,000 dishwashers per annum over ten years ranges from 246 million New Israeli Shekels (NIS) in the first year of implementation to 693 million in the tenth year. Most of the savings are derived from the scrapping of air conditioners.

SDWS2011.0641 Comparative Cost Study of Manual Versus Automated Photovoltaic Cleaning for Offshore Platforms

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Abstract

In order to generate electricity to operate telemetry and valve control in remote locations such as offshore oil facilities, in particular wellhead towers, ADMA-OPCO has implemented photovoltaic (PV) technology which was found the most suitable generation method for remote locations. Nevertheless such technology suffers today with lower efficiency than traditional electricity generation techniques; hence it is most important to keep these modules running at their maximum output. PV efficiencies in offshore applications have been reduced due to two main factors which are dust and bird droppings leaving behind a significant reduction in PV output power, hence causing a negative impact on the system's performance which is a critical issue to the oil industry. The only way to retrieve back the maximum power generated by the panel is to clean them which is currently done manually and is expensive. Hence, a proactive, cost effective and bird deterring solution is required to ensure cost efficiency for deploying this technology. In designing such a solution for the well-head towers, several factors need to be taken into consideration such as lack of distilled water, power source accessibility, space availability and maintenance. To resolve some of these issues, the cleaning system should consume low power and require minimal maintenance. In this paper two solutions are presented and a cost comparison is completed compared to the traditional manual cleaning. Currently there are three viable solutions for the offshore environment of the United Arab Emirates (UAE):- Manual Cleaning, Microcontroller (PIC) Based Cleaning and Programmable Logic Controller (PLC) Based Cleaning. This paper presented a detailed cost comparative study for PV cleaning systems in the offshore UAE region. It is well noted that an automated system is an important solution to overcome the problem of dust accumulation and bird droppings which were found to have a negative impact on the PV

performance, hence effecting the efficient operation of telemetry and valve controls for the Oil and Gas industry. The cost comparison proved that over an extended duration the automated system is more cost effective than the manual cleaning that is currently undertaken (payback period of approximately 2.5 years). However implementing such technology will require a high initial cost from the company.

Sustainability analysis and measurements methodologies

SDWS2011.0021 A Method to Apply the Eco-Efficiency Concept on Biorefining Systems

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Abstract

Motivation for the paper

Eco-efficiency is an important tool for sustainable development and indicates an empirical relation in economic activities between environmental cost or value and environmental impact. The useful and flexible concept of eco-efficiency is currently applied to a wide range of industries. IEA Bioenergy Task 42 has a definition of biorefinery (IEA, 2008): "Biorefining: the sustainable processing of biomass into a spectrum of marketable products and energy." Biorefinery comprises of multiple technologies able to break down biomass resources and residues and form value added energy and material products. Since the vision is to develop the biorefinery to replace products of the current petroleum refinery technically and commercially, there lies an ultimate need to develop and compare the eco-efficiency of biorefinery configurations.

Objectives

The paper aims to discuss disputing biorefinery economic-environmental issues and capture the relevant environmental and economical parameters for evaluating eco-efficiency of biorefinery systems for this emerging sector.

What was done

Eco-efficiency indicators have been developed specifically for biorefining industry. This paper aims to contribute through the development of a framework for sustainability indicators as a tool for performance assessment and improvements.

How it was done and validated

A crucial aspect of the methology is the capturing of relevant dimensions for calculation of the required indicators. The following are steps taken in developing the indicators: (1) selection of the corporate boundaries where inputs and outputs will be considered, which have relevant influences for meaningful eco-efficiency calculations of a biorefinery; (2) identification of the biorefinery system issues which will hamper sustainable development; (3) identification of flows for indicators derivation.

Major results

It reveals the 5 main eco-efficiency indicators that should be taken into account for effective assessment of the sustainability of a biorefinery.

Conclusions

A framework of the eco-efficiency indicators is developed for a biorefinery. The possible arising issues and comparison restrictions are described. More and better indicators to reflect the biorefinery eco-efficiency is essential for decision-makers and the progress of this industry in future.

SDWS2011.0199 Eco-Innovation Measurement for Energy Efficiency

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Abstract

Eco-innovation works towards designing sustainable processes in terms of added value (social aspect), cost reductions (economic aspect) and environmental protection (ecological aspect). These three aspects are the three pillars of a broader objective which has to be a basic concept in any R&D and innovation initiative in energy efficiency.

In this scenario, conventional indicators and metrics for innovation measurement are not suitable because they do not take into account all three aspects simultaneously in a balanced analysis. For this purpose, an innovative integrated system of measurement, based into the "saving/employment/investment" curves, is offered and the results of its empirical application to a case study are analyzed. This integrated methodology leads to a need to asset technology innovation in energy efficiency, promoting the long-term eco-efficient production based on eco-innovation criteria.

Europe needs to make the change from a "catch-up" model of economic growth and development, to a model of "forging-ahead". The use of an integrated eco-innovation system of measurement, as the savings/employment/investment curves, can actively contribute to this change for the innovation investments selection in energy efficiency technologies with a sustainable long-term vision

SDWS2011.0236 Sustainability of Chemical Processes: Evaluation of Novel CO2-Based Synthesis Routes of DMC

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Abstract

This paper reports on a research aiming at developing sustainable processes for the production of diethyl carbonate (DEC) and dimethyl carbonate (DMC) using carbon dioxide (CO_2) as a raw material. Organic carbonates have a high market potential, currently limited by their hazardous production technologies, due to the use toxic raw materials and intermediates such as phosgene and carbon monoxide. Using CO_2 as a raw

material has several advantages; it is non-toxic, in abundant supply, and leads to innovative routes for producing commodity chemicals. The new synthesis methodology under development is, therefore, aiming at reducing the hazard of solvents and chemicals, conventionally used for DEC and DMC production. To facilitate this goal, new, effective catalysts for DEC and DMC syntheses are sought after, and safe, environmentally friendly reaction pathways and energy-efficient processes are explored. However, to fully evaluate the sustainability of the new process, there is a need for a comprehensive evaluation of the full environmental, economic and social impacts of the new process routes and intermediates. Sustainability is measured by metrics and indicators of the equilibrium state between economic success, social acceptance and environmental protection. However, available sustainability indicators, such as the IChemE sustainability metrics as well as Life-Cycle Assessment and carbon footprint studies tend to evaluate already existing industrial products, processes and facilities. There is a need to define indicators to measure the complex set of potential impacts already in the process design and laboratory testing/piloting phase. The Design for Environment (DFE) and, recently, the Design for Sustainability (D4S) frameworks have developed useful guidelines to be used in consumer product development, however have limitations in the use chemical synthesis design. The Green Chemistry and Engineering (GC&E) principles are also useful guidelines for "benign by design" chemical process planning; however, they remain on the conceptual plane. DFE/D4S and GC&E tools will be tested for the case of innovative CO_2-based DEC/DMC reaction routes under study. The paper will explore the limitations of these tools in evaluating the sustainability of chemical processes and argue for the need to develop a new Design for Sustainability tools for chemical process design.

SDWS2011.0898 Organizational Resilience: for Organizations' Sustainable Development

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Abstract

Introduction

Events such as the August 2003 blackout that affected North America made governments aware that it had become essential to develop a culture of resilience within organizations in order to overcome any disruptions. The World Conference on Disaster reduction in Hyogo, in 2005, was the base for new reforms for many governments. Indeed, its strategic goal was "the development and strengthening of institutions, mechanism and capacities at all levels […] that can systematically contribute to building resilience to hazards". Within this context of high organizational sensitivity towards perturbations, the Organization of Civil Protection of Quebec (OCPQ) launched a government initiative to increase the resilience of its essential systems.

Methodological principles

Organizational resilience has been defined as “a system’s capacity to maintain or restore an acceptable level of functioning despite perturbations or failures”. The methodology developed by the Centre risque & performance to assess resilience is based on four steps:

1)Portrait of the system

2)Study of outputs and inputs of the system

3)Characterization of failures’ system management

4)Evaluation of resilience

Coordinated by the OCPQ, this study has been achieved while benefiting from the expertise of 17 departments and partner agencies of the Ministry of Public Security in Quebec. Results This first study confirms that it is possible to transfer the methodology in an operational context and apply it to the problem of essential systems’ resilience. The analysis had to be adjusted, considering the broad scope of a study applied at a governmental level. Therefore, the study parameters had to be adapted and the large amount of results has forced the development of analytical criteria for prioritization, to be used in further analysis. However, it quickly appeared that the need to obtain results on the assessment of the resilience of these critical systems was essential, without even going through all the steps of the methodology. Therefore, the concept of assessing resilience continuously has been implemented based on the four key principles: knowledge, acceptance, anticipation, planning. Thus, organizational resilience truly represents the ability of an organization to properly manage any disruption and ensure to provide an acceptable level of resources and services.

Conclusion

The joint statement of MM. Obama and Harper last February clearly showed the need to assess resilience in terms of ability to handle disturbances and thus to go beyond the concept of resistance to major events: “We intend to strengthen our resilience – our ability to mitigate, respond to, and recover from disruptions”. The studies performed in Quebec fall directly within that axis. They pave the way towards developing operational mechanisms for the implementation of resilience in many organizations.

SDWS2011.0973 Accounting for Sustainability in Bengal: Examining Arsenic-Removal Technology Using Process Analysis Method

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Abstract

The presence of arsenic in groundwater has been recognised as a global problem since the 1990s when it was discovered to occur in over 70 countries. The world’s most severely affected region is the Bengal basin (Bengal), located in West Bengal, India and Bangladesh. It has been suggested that 100-300 million people in that area are exposed to

varying amounts of arsenic, through water for drinking and other domestic use, and through agricultural products. Effects of long-term human exposure to arsenic include harm to the nervous system, reproductive problems and various cancers. This is a public health hazard that primarily affects the rural population.

Many different technologies are available to remove arsenic from water supplies, but their use in particular applications may not always be appropriate for local social/cultural, economic or environmental reasons. Having a standard method of assessment that could be used to evaluate the sustainability of each technology could significantly improve the selection of suitable water treating and thus reduce the exposure of a large population. The Process Analysis Method (PAM) derives sustainability indicators which encompass economic, sociocultural and environmental aspects through identifying the issues associated with impacts of the technology on these aspects. Gauging the level of sustainability is achieved by identifying and measuring the relevant indicators and placing them into a metrics model.

The objective of this study is to use the PAM to create holistic sustainability assessments that can be used to compare centralized water treatment systems with local/household arsenic filter technologies currently used in Bengal. This presentation will discuss the arsenic problem South Asia faces, the method (PAM) and its usefulness, the metrics/framework built to use as a comparison between community level filter technologies and household level, some issues and problems encountered, and suggestions for future work.

SDWS2011.0050 The Urban Sustainable Development in European Union Through Ranking: a Tool for Governance Or a Report of Territorial Disparities?

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Abstract

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Key words: urban sustainability, sustainable development, governance, environment, indicators, European Union, local policies, planning, institutions.

Sustainable development is a major topic in urban policies, especially in European Union where many states and local institutions have implemented strategies about environment and sustainability.

In the aim to observe disparities between cities in the European Union as far as sustainability is concerned, we draw up an analysis and a ranking of European cities, those of more than 400 000 inhabitants. For those treatments, there are qualitative indicators concerning political options like, among other things, local Agenda 21 or bike rental systems and quantitative indicators which concern statistics like local transport fees, annual number of pollution days, green spaces area. Those data permit us to elaborate

statistical treatments to gather cities through their profile and create an overall ranking linked to results on all indicators, through a sustainability index like other rankings established by environmental or economical organizations in different countries as, for example, Sustainlane in United States, Forum for the Future in United Kingdom or the Australian Conservation Foundation in Australia but methods are different because in our study, we make typologies, geographical interpretations and use as much binary data as quantitative data which strengthens governance influence as main vector of sustainability.

We observe that the comparison or the evaluation of sustainable urban development policies can give contradictory results because dependent on choices of indicators and methods of analysis. We can notice that political voluntarism is more consequent in most populous cities because of a higher exposure but sensitivity concerning environment and sustainability is the result of geographical and above all, political arguments.

A geographical trend exists with a North of Europe and German speaking-countries which seem more sustainable than South of Europe or British Isles. Nevertheless, we have cities which have a "sustainable behavior" in all parts of Europe and it is the same thing for cities "not sustainable", so, we can obviously deduce that main political orientations or sensitivities of mayors and local elected representatives are better arguments for an "expanding" sustainability.

Through that communication, we expect to show disparities concerning sustainable urban development on all levels of decision. Those treatments and rankings could help institutions to solve disparities and it could be a tool for cities to develop and improve themselves in all fields of sustainability. European Union, which skills are really substantial could be a good regulator in this field, in harmonization with its main directions but all institutions are concerned.

Energy planning II

SDWS2011.0321 Using Logic Models to Explain Sustainability in Power Systems

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Abstract

The transition from our society to one led by the Sustainable Development principles calls for novel planning methodologies and techniques. These, must be capable of contributing to power systems planning by providing solutions for a mix of electricity generation technologies, considering their economic, ecologic and social aspects. While stand-alone economic modeling has ruled in the past, more recent literature already addresses the need to limit GHG emissions according to Kyoto's goals. However, the social concerns and opportunities associated with these technologies remain often unexplored. The proposed work aims to help filling this gap.

Previous work of the Research Team addressed the social sustainability concept on electricity planning decisions. Following this, and building upon other archival research data, semi-structured interviews will be used with participants to be selected from the academia, industry and NGO's environment with valuable knowledge in power systems state-of-the-art technologies and policies. The guidelines for the interviews are (i) general energy policy concerns (example: technical aspects such as reliability of the system under high penetration of non-conventional generation technologies, external energy independency on long term, relevant criteria for achieving social sustainability and the associated social performance for candidate technologies) and (ii) criteria (whether or not related to social concerns) that influence general population acceptance on candidate electricity generation technologies..

As a result of these semi-structured interviews, information will be used, in future work, in three ways: (i) for the evaluation of the technologies' contribution for social sustainability, based in multi-criteria methodologies; (ii) as technical restrictions in the long-term optimization planning models; (iii) for building survey questionnaires or case studies on social acceptance of technologies, which will confirm or not the experts' intuitions and are likely to give important feedback for future acceptance or opposition to projects.

SDWS2011.0957 Evaluation of Municipal Energy Planning Contribution for the Fulfilment of Regional Planning Strategies

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Abstract

The development of energy planning strategies is a key factor to achieve EU climate protection targets. A local perspective provides a better analysis and implementation of both energy saving initiatives and renewable energy sources, thanks to a more detailed analysis of energy demand and supply, also in terms of spatial and time distribution. Furthermore, a balance between the centralised decision-making process and the local implementation level is needed to foster renewable energy generation. The aim of the paper is to investigate and focus on the contribution coming from municipal energy planning for the fulfilment of regional planning strategies. The study presents the results of 12 municipal energy plans developed for urban areas located in Marche Region, in the centre of Italy, whose inhabitants cover about 40% of the whole region. The different energy saving initiatives analysed have been developed either in private or in public sectors following the regional energy planning guidelines. In particular, the mentioned guidelines are mainly i) energy savings on demand side ii) introduction of renewable energy, ii) efficiency in energy production through the increasing of distributed generation. The specific cost per unit of saved energy and the avoided CO_{2eq} emissions have been assessed for each initiative analyzed. The potential Green House Gas (GHG) emission reduction derived from the energy saving actions under study has been evaluated for all the areas analyzed, considering a 5 year time period to implement all the initiatives developed. GHG Local Targets have then been compared to regional goals defined in the Regional Energy Master Plan in order to understand how a municipal energy planning can help to: i) better estimate and adjust regional goals, ii) improve regional strategies and iii) identify priorities within regional energy Agenda. Particular attention has also been paid to understand the different responsibilities and capacities of local energy planning in respect of regional policies. Finally, low carbon measures that need to be coordinated at both municipal and regional level have been identified.

SDWS2011.0273 New Investments in Electricity Generation Plants for Sustainable Energy: Nuclear Or Renewable Sources?

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Abstract

Nuclear power stations do not burn fossil fuels to produce electricity and consequently they do not produce polluting gases. Many supporters of nuclear power production say that this type of power is environmentally friendly and clean and some countries, like Italy, want to invest in new nuclear power plants. So, the electricity generation stations based on renewable and nuclear sources can be considered complementary in terms of environmental impact and investments in renewable energy sources (RES) can be conditioned by the presence of nuclear power plants. There is a lack of empirical works in the fields of investment in renewable energy source and, in particular, in the discrimination among countries which generate with nuclear plants and countries that do not. Our aim is to analyze the driving of investment in renewable energy source, in particular if they depend by national income and technological efficiency. Furthermore, we investigate the divergences of renewable investment in countries with or without nuclear power plants. This paper addresses these issues by means of a dynamic panel analysis of the renewable investment in a sample of 28 countries with distinct economic and social structures as well as different levels of economic development. The data are the annual time series from 1980 to 2007. They include the natural logarithmic of Total Renewable Electricity Installed Capacity, that we consider as proxy of renewable investments; Gross Domestic Product in PPP (2005 US dollar); Total Primary Energy Consumption per Dollar of GDP (Btu per Year 2005 U.S. dollars) as proxy of technological efficiency, and Nuclear Electricity Net Consumption. We use a dynamic specification of the equation that allows for slow adjustment. A widely used methodology for dynamic panel modeling applies General Method of Moments (GMM) estimators of Arellano and Bond (1991). For countries without nuclear power plants the investment in renewable depends only by GDP. In the nuclear countries we find that investments in renewable sources do not depend by GDP or net nuclear electricity consumption. The results suggest that investments in renewable or nuclear power plants are really economically complementary and they are independent by technological efficiency.

SDWS2011.0277 Sustainability Assessment of Increasing Renewable Energy Sources Penetration - Jp Elektroprivreda B&h Case Study

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Abstract

In this work, sustainability assessment is applied on an example of a real power system, the power system of JP Elektroprivreda B&H (JP EP B&H). Existing generation portfolio of JP EP B&H consists of thermal (coal only) and large hydro power plants (HPP), with the installed capacity ratio of 69,3%:30,7%, respectively, with a negligible share of power in small hydro power plants (sHPP). Renewable energy sources (RES) are becoming increasingly significant sources of energy. The community is looking more and more towards RES, as a tool for economy and climate stabilization regarding fuel prices and growing concern for presence of greenhouse gases (GHG) in the atmosphere. The main objective of this paper is to investigate optimal share of RES to be introduced into the power system. According to the Master plan of JP EP B&H an appreciable share of new installed capacity is planned to be in wind, sHPP, biomass and solar power stations by year 2025. Analysis, which takes into account three different scenarios, was made. Low, medium and high scenarios are defined according to the percentage share of new RES introduced into the power system of JP EP B&H, 6 %, 12 % and 20 %, respectively, under the assumption that new RES include all HPP of installed capacity up to 20 MW per unit. The percentage share of RES is considered according to the total existing installed capacity of the power system of JP EP B&H.

Effects to the sustainability are considered by environmental (CO2 indicator, SO2 indicator and NOx indicator), economic (energy costs indicator, investment indicator and avoided damage indicator) and social criteria (social impact indicator, diversity indicator and development of industry indicator). The results of the indicators are discussed by single criteria analysis, by simple mutual comparison of sub-indicators of all options under consideration.

According to evaluated indicators and the performed analysis, it can be concluded that scenario of introducing 20% of new RES into the existing power system of JP EP B&H by year 2025 will bring the best effects to the sustainability of the considered case study, but is a very ambitious objective for B&H.

SDWS2011.0662 Contribution of Re-Regulation Reservoirs Considering Pumping Capability to Environmentally Friendly Hydropower Operation

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Abstract

Motivation

According to the Spanish Order ARM/2656/2008, by which Instructions for hydrological planning are established, the ecological flows won't be considered as a use but as a constraint, imposed to every water use. The ecological flows regime must include the minimum and maximum flows distributions and the maximum allowable rates of change of flows at each river reach.

The environmental constraints may reduce the capability of the hydropower plant to adapt its power production to the energy prices profile. It should be noted that hourly market prices are signals that reflect the benefits that each generated kWh provides to the electric system operation.

A re-regulation reservoir placed right downstream of the power plant may contribute to reduce the impact of said environmental constraints on the plant hydropeaking capabilities. Moreover, adding pumping capability between the re-regulation reservoir and the main one could contribute both to reducing the size and environmental impact of the re-regulation reservoir and to improving the economic feasibility of the project.

Objectives

The objective of this paper is studying the contribution of re-regulation reservoirs both to fulfilling the environmental constraints and to reducing their economic impact; and the advantages that could be obtained by adding pumping capability between both reservoirs.

Methodology: what and how was done and validated

For these purposes, a revenue-driven optimization model is used. The model is based on mixed integer linear programming and considers the option of starting-up or shutting-down the plant at any stage of the time horizon, while releasing the environmental flow through the bottom outlets. In both cases, it is assumed that the water discharges from the re-regulation reservoir can be controlled by varying the opening of its bottom outlet. The power-flow relation is modeled as a piecewise linear curve both in generating and pumping mode. The model is therefore more suitable for hydro plants where the head variation with respect to the nominal gross head is not significant, within the time horizons considered. In this paper, more emphasis is given on the contribution of re-regulation reservoirs (considering pumping capability) to an environmentally friendly and efficient hydropower operation rather than on the accuracy of the optimization model.

Results and conclusions

The model has been applied to a Spanish hydropower plant. The optimal operation schedule of the hydropower plant has been obtained for different operating conditions,

environmental flows, ramping rates, sizes of the re-regulation reservoir and pumping capacities. The results obtained highlight the contribution of the re-regulation reservoir to fulfilling the environmental constraints and to reducing their economic impact; and the advantages derived from adding pumping capability between both reservoirs.

SDWS2011.0734 Large Scale Integration of Wind Energy by Financial Mechanisms for Support of Pumped Hydro Storage Installations

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Abstract

Intermittent nature of the renewable energy sources (RES) like wind, solar and waves is one of the limitation factors for their higher penetration in the networks. This problem was firstly recognized in the autonomous networks as RES penetration in those systems easily reached technical limits. Now, similar problems are facing big power systems when RES penetration exceeds certain levels. Effective use of energy storage could solve the intermittency problem and it could increase RES penetration. Today the most widespread storage in power systems is the pumped or reversible hydro storage (PHS) which has many advantages and can provide multiple services in transmission, distribution and generation markets (e.g. support to RES integration, grid up-grade and ancillary services, load shifting etc.). Currently, all services in electricity market are not properly regulated and commercialised so there is big uncertainty how investments in energy storage will be recovered. Several EU documents support the development of measures that could provide confidence to those investing in storage so that they will be able to realise benefit from their investment.

In this paper we propose development of Feed-in tariffs (FIT) for Pumped Hydro Storage as support to RES integration and we discuss the necessary market organization for their successful application. Proposed FIT for PHS is also tested in market environment trough developed mathematical models and by use of the historical market data.

Proposers of FIT for PHS systems should take into account the local particularities of possible development of PHS and according to that, they should propose one or several levels of FIT. Supported level of FIT and limit on load factor of turbines in PHS, for particular energy system, should be optimized according to desirable level of excess production from RES or according the needs of security of energy supply provided by PHS.

Agriculture, Food

SDWS2011.0658 Energy Productivity Improvement in Forage Maize Farming with Data Envelopment Analysis (Dea) Technique

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Abstract

This study investigates the energy productivity of farmers, to find efficient and inefficient ones and to indentify the wasteful uses of energy in forage maize production using Data Envelopment Analysis approach. Data were collected from 83 forage maize farms by a face-to-face interview in October and November 2010 period. Farms were selected based on random sampling method in Golestan province, Iran. Energy values were calculated by multiplying the amounts of inputs and outputs by their energy equivalents with the use of related conversion factors. The input oriented BCC and CCR DEA models were used to estimate the energy efficiencies of farmers. The results showed that total energy input and energy productivity were found around 59.8 GJ ha-1 and 0.22 kg MJ-1, respectively. The energy use efficiency, defined as energy produced per unit of energy used, was 2.26. Based on the present study, an average 9740 MJ ha-1 from total energy input could be saved without reducing the yield if the farmers follow the results recommended by this study. About 21% of farmers were found to be technically efficient, and the technical, pure technical and scale efficiency scores of farmers were estimated to be 0.774, 0.861 and 0.823, respectively. The contribution of electricity input from total saving energy was about 61% which was the highest share followed by diesel fuel (23%) and chemical fertilizers (8%) energy inputs. Accurate use of electricity, diesel fuel and chemical fertilizers would be useful not only for preventing from energy dissipation, but also for reducing negative effects to environment, human health, maintaining, sustainability and decreasing production costs. Finally, the DEA technique is confirmed as a very useful tool for benchmarking and improving the energy productivity in agricultural systems.

SDWS2011.0688 The Actual Trends of Olive Growing in Albania

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Abstract

The olive tree (Olea Europaea) owns the status of national patrimony in Albania. The olive plantations' area in the past has been dictated by the Agricultural Policies. The most notable increase belongs to the period 1975-76. A general characteristic for the period 1945-1990 was its cultivation in marginal lowland areas, hills and plains. The highest efficiency in Olive production is reached mainly in the Southern and Central regions. After 1990, the olive farming has been highly impacted with the economical system shifting. Its interest in the economical aspect is going to be very important in the near future. A national scheme for the intensification of olive farming by increasing the planted area to 60 000 ha, or 20 million olive trees, is developed by the Government. Our study presents an overall view of actual trends of olive farming, olive industry, environmental problems born by its farming and its olive mills by-products, and finally the role that the government have to play in that sector.

SDWS2011.0730 Future Energy Consumption in Turkish Agriculture

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Abstract

Energy has an important role in economic and social development, but rural energy development policies that focus on agriculture. Agriculture has a dual role as an energy user and as an energy supplier in the form of bio energy. This energy function of agriculture offers important rural development opportunities as well as one means of climate change mitigation by substituting bio energy for fossil fuels. Despite this dual role, the energy consumption economics in agriculture has generally received very little attention in developing countries. The main reason for that is data shortage.

In Turkey being a developing country, the energy consumption in the agricultural sector is not extensively explored due to this data shortage. Therefore this paper aims to estimate future energy consumption in Turkish agriculture.

This study is based on annual diesel and electricty consumption data in the agricultural sector for the period 1970-2006. In study, the univariate Box-Jenkins

technique was used to obtain a short-term energy consumption forecast for Turkish agriculture. Univariate forecasts can be obtained using simple and common models with only a few coefficients. In practice, univariate ARIMA models may outperform the more data-demanding multiple-series regression models in terms of forecasting accuracy. Considering the lack of data on energy consumption in Turkish agriculture, univariate modelling is a useful forecasting technique because forecast performance is proportional to the information contained in the forecasting method.

Turkish agriculture, agricultural production is highly dependent on fossil fuels. Because of the energy shortage, ways must be found to increase agricultural production, productivity, competitiveness and sustainability through more effective use of fossil fuel energy. The limited energy supplies also make projecting future energy consumption in Turkish agriculture important. The ARIMA models were determined to be (8,1,13) and (1,2,4) respectively. According to the model's results, diesel consumption is predicted to be over 4 million tonnes in 2020. The average growth rate of diesel consumption is 2.17% per year for the coming years in the agricultural sector. Also, electricity consumption is reach to 10991 GWh in 2020 and average growth rate is 4.84% per year during the period. This result implies the need to find effective substitutes for energy or alternative energy-reducing technologies to produce high yields while utilising minimum amounts of energy.

SDWS2011.0996 Optimization of Medium and Cultivation Conditions for Beta-Galactosidase Production by Lactic Acid Bacteria

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Abstract

Lactose is a disaccharides formed by galactose and glucose that is found in milk. Lactose intolerance or lactose mal-absorption is a common problem in humans, due to the absent or reduced β-galactosidase activity in the small intestine. Lactic acid bacteria (LAB) such as lactococci, streptococci and lactobacilli are generally recognized as safe organisms. They are regarded as good sources of β-galactosidases, especially for functional food applications and diverse biotechnological properties. With this information, species of LAB were isolated from raw and fermented milk samples with the hope of selecting β-galactosidase-producing starters for production of yoghurt and other dairy products such as cheese. The LAB isolates were identified as Lactobacillus plantarum, Lactobacillus fermentum, Lactobacillus bulgaricus, Lactobacillus casei, Lactobacillus brevis, Leuconostoc mesenteroides, Lactococcus lactis and Streptococcus thermophilus. Identified LAB were screened for the production β-galactosidase. All the test organisms produced β-galactosidase enzyme with the highest β-galactosidase

production at 18h of incubation with initial pH of 5.5 , in medium containing lactose as carbon source, 2% Mg+ at 45ºC for S. thermophilus while L. fermentum had its highest β-galactosidase at 35ºC. The crudeβ -galactosidase enzyme had high enzymatic activities. The results showed that lactic acid bacteria are capable of producing β-galactosidase enzymes; therefore they can be used in food and diary industries, since they are food-grade organisms and can also be used to prevent microbial contamination in milk processing and other dairy products.

SDWS2011.0757 Implementation of the European Union's Nitrates Directive in Turkey

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Abstract

The European Union (EU) Nitrates Directive (91/676/EEC) aims to reduce water pollution caused or induced by nitrates from agricultural sources and to prevent further such pollution. The Directive seeks to ensure that the objectives are met by requiring that Member States identify waters affected by pollution and waters that could be affected by pollution and that they designate these areas as nitrate vulnerable zones (NVZ) based on the results of the monitoring requirements in the Directive. In these zones, the Member States must draw up action programmes which contain mandatory measures concerning agricultural practices, including stipulation of the maximum amount of manure that can be applied to land every year. Member States are also bound to establish at least one code of good agricultural practice which is implemented on a voluntary basis outside the vulnerable zones, and is mandatory within them.

Turkey being a candidate country to EU requires heavy cost investments in achieving approximation with EU Environmental Acquis. The objective of the study is to assess the legal, administrative and technical measures needed and to evaluate the costs required for the adaptation of the EU's Nitrates Directive in Turkey. A description of the technical measures and investment cost assessment related to the implementation of the Nitrates Directive in Turkey are described. As Turkey has not yet designated NVZs according to requirements of the EU Nitrates Directive, three scenarios (low-cost, medium cost and maximum cost) were developed to estimate the capital investments needed for implementation of the Directive. According to the low-cost scenario the nitrate vulnerable zone comprises 18 provinces. The medium-cost scenario considers 18 provinces under the low cost scenario, plus six additional provinces, four of which are situated in the Black Sea region. The maximum cost scenario that is regarded as a conservative scenario considers the whole country as the nitrate vulnerable zone. Based on the developed scenarios, the low cost scenario designating 8 provinces as NVZs and

requiring a total investment of EUR 270 millions for the period 2007-2023 has been selected by the Ministry of Environment and Forestry within the EU Integrated Environmental Approximation Strategy for Turkey.

SDWS2011.0815 Reducing Gaseous Emissions and Microbiological Contamination in Stable Environment Using Photocatalytic Tio2 Coating

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Abstract

Agriculture is a significant source of environmental pollution. High concentrations and emissions of agricultural air pollutants are related to human and animal health and ecological damage. Therefore an effort has been developed to keep seeking new ways to reduce the production of pollutants created as by-products of especially animal production.

This paper presents current results of experiments with the photocatalytic titanium dioxide (TiO_2) coating – in reduction of gases concentration (ammonia, methane, nitrous oxide) and microbiological contamination in a stable environment. Experimental measurements are performed in a laboratory and simultaneously in a pig house of experimental farm. The laboratory tests are conducted in the plexiglass containers with pig liquid manure samples from pig house, active area with photocatalytic TiO_2 coating and with the source of radiation. Monitoring of gaseous emission and microbiological contamination changes depend especially on the time and on the radiation source. The partial results of laboratory tests are used for optimalisation of pilot plan experiment. The pilot plant experiment is performed in two identical mechanical ventilated sections of the pig house. In one of the sections, the walls were painted with the photocatalytic TiO_2 coating and effect on indoor air quality (gases concentration, microbiological contamination of air and areas, air temperature and humidity) is regularly monitored.

Till now obtained results from laboratory measurements show a reduction emissions of monitoring gases between 4 % - 26 %. Quantitative microbiological determination of the number of colony-forming units of thermotolerant coliform bacteria and enterococci is demonstrated by the disinfecting efficiency of TiO_2 - the number of microorganisms decreased by up to 3 log orders. A similar trend was found for measurements at the experimental farm to that for laboratory experiments in terms of the values of the quantities observed.

Buildings I

SDWS2011.0422 Sustainable Leichtlehm Construction Used for Rapid Recovery Following Chile's 2010 Earthquake and Tsunami

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Abstract

The earthquake and following tsunami that struck Chile in February 2010 destroyed more than 370,000 homes and left more than 2 million people homeless. As well as implementing rapid alleviation schemes, it is equally important to deploy an effective plan towards the creation of a long-term solution for these local communities in order to ensure their future welfare. This paper shows one of the post-earthquake initiatives that has sustainable development as its main goal. Having special interest in the Cobquecura rural area (located 43km from the epicentre), a group of school friends decided to go further than the basic element delivery and emergency home construction and build a sustainable society based on eco-constructed houses that would present a definite solution for the affected local families. The type of house delivered replaced the adobe-based construction, being the main technique in the area for centuries due to its simple, economic and natural characteristics, as well as its acoustic and thermal isolation properties. However, it lacks anti-seismic advantages, so the German Leichtlehm technique (Light Straw-Clay technique) was used, which consists on a wooden structure, filled with this light mixture of straw and clay. The construction benefits from the anti-seismic properties of wood combined with the isolation properties of straw and the bonding and fire resistant properties of clay. It was fundamental that the local people would have easy access to the basic elements and also that the construction process was simple enough to be built by them, in that way also contributing to the empowerment of the community and the sense of accountability for each villager involved. The project consists in the creation of a village of 4 of these sustainable houses, together with a community centre with an orchard and also an eco-technology based wastewater treatment plant. Stakeholder involvement has been crucial to the success of the project and its validation, as well as the government's support in terms of funding. All the main decisions have been taken together with the future dwellers, the local authorities and the community in general. As a result, a new sustainable community is arising after the disaster, and a new way (at least in Chile and most of South America) to approach post-disaster alleviation is gaining terrain in a culture that has little or no expertise in planning for a sustainable future in rural areas, which in this case is delivering a definite home to 24 people of 4 different families. This paper concludes with reflections on ways in which

initiatives like this could be of significant help towards an uncertain natural phenomena future, and towards the empowerment of rural communities in order to a more sustainable future and also contribute to the reduction of rural-urban migration.

SDWS2011.0578 Energy Performance Rating of Dwellings in Malta

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Abstract

In recent years, energy performance rating of buildings in Europe has become an important aspect, and more so following the publication of the Recast Energy Performance in Buildings Directive 2010/31/EU. Since its accession in 2004, Malta has made several steps to abide by the Directive and to prepare the market for the introduction of energy certification of buildings. The first stage of these efforts has focused on residential single-zone buildings, whereby national software has been developed and training of assessors has been carried out since 2009.

This work has focused on implementing the Energy Performance Rating of Dwellings in Malta (EPRDM) software on a new residential block, and comparing the results obtained to Design Builder-Energy Plus software. The aim was to evaluate the performance of the EPRDM software, which is based on monthly averages, to a more analytical software that is based on hourly calculations. The objective was to confirm the suitability and robustness of the EPRDM, when used in real-life projects and to identify any areas where improvements may be made.

Results showed that heating requirements in such new buildings take the bulk of the energy demand, even though Malta is situated in the Mediterranean where temperatures are mild. This was attributed to the high U-value of internal single-walls. It was also seen that cooling in summer is a necessity to ensure a reasonable temperature within the building block. Water heating carries a significant load since most Maltese dwellings today, use electrical boilers for water heating. Energy required for ventilation is the least important, since dwellings in Malta depend on natural ventilation in every room. Results have also showed a varying difference in energy requirements between the different apartments.

Although the EPRDM is a statistical software that is based on monthly averages, it performed quite well for single-zone buildings and produced results that were comparable to those of Design-Builder Energy-Plus software. A number of observations have been made, which included the need for more elaboration on the calculation procedure adopted for cross-shadowing of vertical objects on the building, better flexibility for choosing the orientation of buildings and calculation of convective heat losses due to wind effect. Future versions could also include a factor to cater for the electrical consumption of appliances within the building, as well as revising the methodology used for calculating occupancy levels, which is too generous for apartments.

Given that no sufficient energy performance certificates have been issued in Malta, benchmarking has not been made yet. The paper has therefore attempted to propose an energy rating for dwellings in Malta, based on different energy efficiency scenarios that may be implemented in the building. These included efficient lighting, wall insulation, heat pumps for water heating and solar systems.

SDWS2011.0600 Energy and Economic Savings in Using Geothermal Heat Pumps

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Abstract

In the last years, the world energy demand increase was largely driven by residential and commercial sectors, due essentially to higher required indoor environment standards.

Recently, a challenging research trend has been developed to employ deep foundations for energy purposes, that is as heat exchangers buried in the ground. Such systems are the so-called geothermal heat pumps (GHP), made by the heat pump circuit with two external loops: the primary loop, in contact with the ground, and the secondary loop, accounting for the distribution system within the building. The carrier fluid in the primary loop enables heat transfer with the ground. The secondary loop is composed by the indoor heating/cooling system.

In this paper a technical-economical feasibility study has been conducted on residential buildings, heated and cooled by a geothermal heat pump equipped with energy piles to estimate the energy potential advantages resulting from this technology.

The analysis has been carried out for different climate locations and building energy needs. Building energy needs evaluations have been performed according to the current European standard ISO 13790:2008, and the energy pile system performance has been calculated by the PILESIM2 software.

The economic analysis has been accomplished considering the heat pump driven by either electrical grid or photovoltaic panels. The Primary Energy Saving (PES) indices have been calculated comparing the actual GHP systems to the traditional ones, together with their sensitivity to thermal and cooling loads at different climate locations. As an example, by using an average COP of 4.6 and an EER of 3.6, the PES as a function of the cooling to the heating load, between 0.1 and 5.0, ranges from 55% to 30%, whereas lower COP and EER values give rise to smaller, but always meaningful, PES values. In addition, economic savings and reduction of greenhouse gases (GHG) have been calculated resulting from the GHP use.

The results of this investigation allowed specifying the remarkable capability of low enthalpy geothermal systems, equipped with energy piles, in saving money and GHG

emissions. Anyway, the results are strictly related to the climate conditions and to the building energy classes.

The cost effectiveness compared to the traditional systems according to the usual benefit-cost ratio standards is estimated.

SDWS2011.0699 Non-Linear Method for Sustainability Assessment of Residential Building

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Abstract

Nowadays, the resident buildings represent a significant segment of the total energy consumption. Technology development level dictates the use of fossil fuels, consequently making buildings as the large consumers of natural resources and harmful greenhouse gases generators. Sustainable development presents the way of resident buildings' development that can ensure the satisfaction of our needs, while not endangering future generations to meet their own needs. This paper presents the mathematical procedure for the determination of overall sustainability index of the selected options for four residential buildings in Belgrade for the agglomeration of economic, environmental and social indicators. Nine criteria (sub-indicators) were selected and calculated for all chosen objects, three for each indicator. The agglomeration of normalized sub-indicators is obtained by selection of the appropriate linear ($\theta=1$) or nonlinear function ($\theta>1$). In order to investigate the effect of nonlinearity on the agglomeration of the sub-indicators the change in nonlinearity was introduced in the procedure. In this exercise the special cases are introduced with different degree of nonlinearity. The overall sustainability index and its standard deviation were calculated for different value of the parameter θ and each option. The functional dependence between the sustainability index and the associated standard deviation of the θ parameter (characterizing the way of normalization) was obtained. The first step of sustainable development planning is to calculate the current value of the sustainability index for all options. The analysis of nonlinear and linear normalization influence to the sustainability index is presented in this paper. Also, more accurate calculation of overall sustainability index was obtained by choosing appropriate the parameter θ, for which standard deviation of the calculated index would have the minimum value.

SDWS2011.0207 Interactive Software for Building Automated Systems Towards Effective Energy and Environmental Management

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Abstract

The current financial and economic crisis as well as the wider environmental pressures put energy back at the heart of European Unions (EU) action. Indeed, ambitious targets have been set for 2020 (20-20-20 energy policy package), aiming to foster European economy to more sustainable energy paths. In this context, the penetration of energy efficiency technologies in the building sector plays an active role among the EU efforts to promote a low-carbon economy. This is particular true for Greece, which has recently incorporated the 2002/91/EC directive on the energy performance of buildings as well as the related procedures and modalities.

In recent years, integrated building automation systems are applied to control lighting, cooling/heating, ventilation etc. Although these systems has become increasingly popular, the necessity for intelligent tools and methods, to provide remote control and real time monitoring of building energy consumption, facilitating green buildings development, remains.

The aim of this paper is to present prototype software tools for data collection, organization and generation of statistics, regarding buildings energy consumption and economic impact, enhancing the interactivity of building automated systems (based on Dupline Fieldbus). Moreover, these smart tools have the ability of running different scenarios for the optimisation of electrical consumption, aiming at an integrated energy and environmental management of the building, taking into consideration the buildings profile and energy end-users behavioral profile.

The pilot appraisal is focused on the remote control of active systems in the tertiary sector buildings, such as air-conditioning system, especially during the summer peak hours, while maintaining desirable comfort. It should be noted that the tools developed could contribute to the achievement of energy and cost savings for different types of load, such as lighting and heating, after appropriate modifications.

Hydrogen production and use technologies

SDWS2011.0520 Chemkin-Based Numerical Study on Hydrogasification Mechanism of Pulverized Coal and Hg Speciation Transformation in a Hydrogasifier

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Abstract

The process of the zero-emission carbon (ZEC) concept, which was first proposed by researchers at the Los Alamos National Laboratory (LANL) and Louisiana State University, U.S.A., is generally referred to as the LANL ZEC technology. Recently, increasing attentions have been paid to ZEC technology for the amount of its CO_2 emission can be nearly zero and the efficiency can reach not less than 70%. Hydrogasification of pulverized coal is the core process of ZEC, however, the gasification mechanism and the progress of mercury speciation transformation during the reaction is not understood precisely. The purpose of this paper is to set up a detailed chemical kinetics mechanism (CKM) of hydrogasification for pulverized coal in an entrained flow hydrogasifier to predict the influence of different reaction conditions on the reaction product and the influence on the evolution of Hg. Firstly to do that, chemical equilibrium calculation (CEC) of hydrogasification for biomass is done by ChemKin 4.0 and the results are compared with the experiment data from literature to ensure the accuracy and reliability. Then CEC is used to predict the influence of different reaction conditions, such as pressure, temperature and H_2/coal mass ratio, on the reaction product including Hg speciation. Thirdly, the CKM hydrogasification mechanism for pulverized coal including 238 elementary reactions is set up and calculated by ChemKin and the results are compared with the experiments from literature to check the feasibility of the mechanism. Fourthly, the CKM is used to predict the process of Hg speciation transformation under different reaction conditions to find out how those factors influence the form of Hg. The experiments could be properly reflected, based on the detailed comparisons, by both the CEC and the CKM methods, so they can be used for further predictions. The predictions show that the main existing form of mercury in an entrained flow hydrogasifier is gaseous element; the increase of pressure will both increase the progress of mercury oxidation and the conversion ratio of carbon; the oxidation of mercury will be restrained and the gasification will be promoted with the increase of H_2/Coal ratio. The CEC believes that increasing reaction temperature will restrain the oxidation of mercury and the progress of gasification while the CKM believes that increasing reaction temperature will promote the oxidation of mercury, and the gasification will be accelerated. The results from CKM should be the practical guidance since the reaction rate is taken into account.

SDWS2011.0644 Morphological Control of Catalyst-Loaded Pvdf Macrocapsules for Better Hydrogen Generation by Nabh4 Hydrolysis

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Abstract

A cobalt loaded macrocapsule as the catalyst for hydrogen generation was synthesized and characterized. Two different phase inversion methods were used for catalyst loading, 1) Metal particle method (MP method), and 2) Metal salt method (MS method). In MS method, poly(vinylidene fluoride) (PVDF) porous macrocapsule membranes immobilized with metal salt (cobalt(II) chloride hexahydrate) catalyst were prepared using non-solvent induced phase inversion method. In MP method, the cobalt-boron catalyst was initially prepared by mixing $NaBH_4$ and cobalt (II) chloride hexahydrate, and was added into PVDF-DMF solution. The macrocapsules were synthesized by using a coagulation bath containing different proportion of water and isopropanol with NaOH and $NaBH_4$ as an additive. The effects of controlling parameters such as different additives and composition of non-solvents were studied on the morphology of macrocapsules as well as hydrogen generation rate. The structure and physicochemical properties of the metal catalyst loaded macrocapsule membranes were characterized using SEM and EDX. The results showed the mcacrocapsules synthesized by using metal salt methods with high concentration of isopropanol and metal salt having great efficiency in hydrogen generation. It was observed the macrocapsules holding the same efficiency after many runs of hydrogen generation.

SDWS2011.0782 Hydrogen Production by Acidogenic Fermentation of Waste Carbohydrates

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Abstract

The high prices reached by fossil fuels and the increasing pressure in the environment quality are accelerating the change from the traditional energy resources to sustainable ones. Every year a considerable amount of organic wastes is generated. These organic wastes are constituted of a great variety of compounds, being the most important one the carbohydrates which annually represents about $135 \cdot 10^{12}$ tons. One of the best

ways to convert these organic wastes into energy is through the acidogenic fermentation processes, where the substrates contained in the wastewaters are transformed into hydrogen and a liquid stream containing Short Chain Fatty Acids (SCFA).

In the Mediterranean countries, agro-industries play a significant role, being one of the most representatives the winery industry. The winery wastewaters are characterised by the presence of significant amounts of soluble and easily biodegradable substrates. Nowadays, these substrates are considered as waste, but they could be used as interesting raw materials for the production of hydrogen through the acidogenic fermentation process.

In this context, the aim of this work was to study the feasibility of the hydrogen generation from waste carbohydrates contained in winery wastewaters. To do this work a typical winery wastewater was characterised, being its major components glucose and fructose. Because of these characteristics the acidogenic fermentation of glucose and fructose was studied.

A synthetic winery wastewater was fermented under acidogenic conditions in a 3 L volume batch reactor inoculated with a mixed culture. The pH was set at 5 and the temperature at 35º C. From the results obtained in these experiments, the hydrogen and SCFA yield were determined, being the hydrogen yields 0.76 and 0.86 mol/mol subtrate for the glucose and fructose respectively, and the SCFA yields the following: $Y_{Acetic\ acid}$ 0.78 and 0.68, $Y_{Butyric\ acid}$ 0.25 and 0.13, $Y_{Lactic\ acid}$ 0.55 and 0.57, $Y_{Propionic\ acid}$ 0 and 0.01 for the glucose and fructose respectively.

From the results obtained in these experiments the following conclusion can be obtained: It is possible to transform easily the substrates contained in the winery wastewaters into hydrogen gas and short chain fatty acids by acidogenic fermentation. This option open a new door for recovering the energy contained in the substrates contained in the wastewaters (mainly sugars) which were traditionally oxidized to CO_2, with the subsequent air pollution and energy consumption, in the wastewater treatments plants.

Acknowledgment

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SDWS2011.0691 Alkaline Electrolyser with Large Porosity Metal Foam Electrode Characterisation

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Abstract

The systems for hydrogen production is todays the most recent area of interests all over the world. Because of carbon dioxide (CO_2) mitigation and commercial availability,

systems which combines photovoltaic (PV) modules and electrolysers are in the focus of research. In this paper it was shown detailed characterisation of alkaline hydrogen production based on the metal foam as the electrodes. With chosen nickel (Ni) as an electrode material, electrode catalytic activity is determined, but numbers of important parameters that influence the process remain to be analysed such as electrolyte temperature, electrolyte concentration, electrolyser operating voltage, electrolyser operating current density and electrode porosity. The electrodes porosity allows an electrolyte to flow through a three-dimensional (3D) electrodes. Furthermore, the velocity of two-phase flow of gas bubbles and liquid electrolyte mixture can be controlled outside of electrolyser by centrifugal pumps. This characterisation is primarily performed to improve electrolyser efficiency. All of these influences were shown in experimental electrolyser UI characteristics diagrams and mathematical model of empirical model parameters.

SDWS2011.0353 Design and Optimization of Hydrogen Networks

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Abstract

Hydrogen Network (HN) optimization is a branch of process integration that focuses particularly on conservation and efficient management of hydrogen in industry. It responses for increasing trends of hydrogen demand for various applications ranging from hydrotreatingprocesses to energy production and fueling. Primary beneficiaries of efficient hydrogen management are petroleum refineries because of their high demand for hydrogen needed for production of cleaner fuel. Therefore, substantial reduction of hydrogen consumption has both economical end ecological importances. Such reduction can be achieved by a proper redistribution of hydrogen among hydrogen-using processes that is commonly referred to as reuse and recycle. In addition to that, purifying and compressing equipment can be used to increase availability of hydrogen by improving key parameters of hydrogen streams (e.g. hydrogen concentration and pressure).

Most optimization approaches reported to date address both material- and cost-oriented targeting while relying on fixed parameters of hydrogen sources and sinks. From various techniques being used so far mathematical programming has the advantage of dealing with complex, mixed integer programming (MIP) models that are often encountered in HN optimization. However, more realistic problems involve numerous nonlinearities (e.g. models of processes, purifiers, compressors etc.) that generally increase the solution difficulty.

This paper describes the approach of design and optimization of hydrogen networks using mixed mathematical programming and stochastic techniques. Proposed method consists in solving optimization model of predefined HN superstructure with two levels of computations. As opposed to previously reported ones, this approach uses variable inlet

and outlet parameters for each hydrogen-consuming process instead of fixed values. Two-level targeting consists in cyclic transformation of nonlinear terms into linear ones using Adaptive Random Search (ARS) and solving obtained MIP model until optimal solution is found. The use of non-fixed parameters generally improves the feasibility of the model in a manner similar to inequality constraints. Moreover, it allows to introduce detailed and more realistic models of network elements (i.e. processes, regenerators) and provides flexibility in creating HN scenarios and targeting objectives (e.g. minimization of hydrogen consumption, cost-effectiveness). Method has been tested on several HN scenarios.

SDWS2011.0525 Hydrogen Generation from Water by Means of Mechanochemically Activated Aluminum

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Abstract

Search for hydrogen sources for feeding hydrogen-air fuel cells is the important part of the hydrogen energy problems. One of the most convenient methods for hydrogen generation is based on oxidation of aluminum by water. But it is known that aluminum does not react with water under ambient conditions through the formation of the thin oxide film on its surface. However, the addition of such metals as gallium, indium, tin et al. to aluminum leads to increase its reactivity. But the hydrogen generation rate of this specimens is too low (10-20 ml/[g·min]). That is why the new double-stage method of aluminum activation was developed: 1) treatment of aluminum surface by the gallams (alloys on basis of gallium); 2) mechanochemical activation in high-energy ball mill. This method allows to reach the hydrogen generation rate up to 1000-3000 ml/[g·min].

In this work the kinetic parameters of the reaction of mechanochemically activated aluminum with water (hydrogen generation rate and hydrogen yield) is studied depending on the gallam amount and composition, reaction temperature and the possibility of activated aluminum application in hydrogen microgenerators for feeding hydrogen-air fuel cells is researched.

The source of aluminum was the commercially available aluminum wire instead of granular aluminum (analytical grade) used in.

In addition, in this work the problems of decline in value of activated aluminum are considered through the decrease of gallam amount or replacement of some amount of gallium and indium by cheaper metals, such as tin, zinc et al.

Energy economics

SDWS2011.0418 The Electricity Prices in European Union. the Role of Renewable Energies and Regulatory Electric Market Reforms

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Abstract

The liberalization of electricity markets in Europe aims to increase competition, thus decreasing electricity prices for the final consumers. However, the promotion of European electricity generation from renewable energy (RES-E) could have an opposite effect on electricity prices.

A controversial debate has arisen about the effects of RES-E prices on household electricity prices. In general terms, renewable energy technologies increase generation costs with regard to conventional generation, thus increasing electricity prices. Moreover, the development of RES-E is mainly driven by public renewable support schemes, most of them financed via the electricity market, which increases the retail electricity price.

Nevertheless, it is necessary to consider that a higher use of renewable energies could reduce the electricity final prices because its promotion stimulates the generation of renewable energy which is characterized by lower variable costs than fossil conventional technologies.

Moreover the regulatory reforms in the EU Electricity Market could also have effects on electricity prices. In fact the liberalization of generating and retailing activities could increase competition thus reducing electricity prices, although the achievement of competitive prices depends on the number of enterprises and the tendency of consumer to switch.

In the described context this paper explores the impact of several economic variables on household electricity prices in the European Union. In fact we propose panel data models with the aim of explaining the household electricity prices as a function of several economic variables related to renewable energy sources and electricity market regulation. We use a panel data set provided by Eurostat and covering 27 EU countries during the period 1998–2009 and our results suggest that electricity prices increase with the deployment of RES-E and also with emissions of energy industries. Moreover, environmental costs related to CO_2 emissions in electricity generation have a significant negative effect on prices and our findings related to the effect of liberalized electricity market on prices do not fulfill our initial expectations.

SDWS2011.0554 Sustainable Development and Energy Sector Regulatory Models

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Abstract

The need for the inclusion of sustainable development issues in regulatory decision making highlights the importance to expand or modify traditional regulation models frequently used in some segments of the energy sector value chain (especially in transport and distribution). These models have indeed been criticised on grounds of their emphasis on cost and financial efficiency. Aspects like the security of supply and climate change are major concerns of policy makers and must be properly assessed and integrated in the regulatory environment.

The British Energy Regulator (OFGEM) already emphasises this quest for sustainability focusing on aspects like the transition to a low carbon economy, the need to protect consumers, to promote energy saving and to ensure the security of supply and the environmental protection. The recent OFGEM study "Project Discovery" proposes some regulatory measures directly related to the sustainable development duties of the energy regulators but mainly addressing the wholesale market. The Portuguese Energy Services Regulatory Authority (ERSE) presents also some measures aiming to promote the environmental efficiency of the regulated energy companies. Likewise, the Spanish Energy Regulator (CNE) refers to the importanceof addressing environmental issues and to the possible internalization of environmental costs on the energy systems.

It seems then, that the European Energy Regulators are already aware of the need to expand traditional regulation beyond pure financial analysis. However, the sustainability concept is still strongly related to the environmental dimension alone and with the internalization of these externalities on the cost functions to be used. This paper presents firstly a comparative study of different regulatory models for several European countries, focusing on the energy sector (electricity and gas), in order to assess how sustainable development issues are dealt with.Special attention is given to UK, as a paradigm of the liberalization process in Europe, and to the Portuguese and Spanish regulatory systems. Secondly, the cost variables included in the regulatory models are analysed exploring the possibility to explicitly include on those models impacts related to the social and environmental dimensions of sustainability. The main impacts and criteria proposed to be included are described and their integration on the regulatory models are analysed comparing the possibility of either resourcing to a monetization processes or to multi-criteria tools.

SDWS2011.0666 Epex Intraday Market Development and Evolving Trading Schemes for Energy Storages

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Abstract

Overview The European Power Exchange (EPEX) spot market generally enables power generation companies to optimize the dispatch of their facilities and short-term deviation of the schedule of load forecasts. The intraday market allows closing open positions between the day ahead auction and the delivery time. Regarding the liquidity of the market, traded volumes have developed considerably by about 50 % each year. Since January 2010 the power generation from renewable sources subsidized by the Renewable Energy Act has to be traded by the transmission system operators on the spot markets. Deviations between generation forecasts and actual feed-in will be published and traded either on the day ahead or intraday market.

Questions arise with the late development of the intraday market. How will the market and prices react concerning volatile trading activities of the market participators? To which extend are bidding strategies established? What might happen to alternative markets? Does this development lead to the participation of further actors in the market and therefore to incentives to foster innovative business cases or technology market integration like energy storages?

Methods The basis of this investigation represents the evaluation of literature and available data of the transmission system operators (TSOs) and the EPEX. Investigation is basically carried out according to a market analysis. Using the market data the development of the potential of the intraday market will be evaluated. By means of determination of drivers and causalities, dependencies on markets, prices and volumes of trades can be demonstrated. Subsequently this study deals with the motivation of actual and potential market participants to trade intraday under the consideration of legal aspects. The courses of prices and volumes seen on the EPEX intraday market during a trading period give additional information about bidding behaviour and optinal strategies to participate in the maket.

Results and Conclusions Since 2010 system operators are obliged to sell the volume of power generated by renewables on the spot market, which means also intraday deviations, to least possible costs. The bidding behavior is influenced by risk optimization according to the risk aversion of the company. Lately also power trading companies started trading power intraday. The most influencing factors on intraday prices are price signals from the previous day ahead market and forecast deviations of the generation from renewables. The expansion of installed capacity of the renewables tends to lead to a greater volume of intraday trades. The improved liquidity of the intraday market and increasing stability of the price volatility enhances new forms of actors and utilization of the market, e.g. the coverage of market oriented storage use against price risk in the day ahead market.

SDWS2011.0382 Assessment of Co-Benefits from Cdm Projects for India's Power Sector

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Abstract

Energy-related Clean Development Mechanism (CDM) projects contribute to reduce air pollutants in addition to CO2 emissions. This paper evaluates the co-benefits of coal-fired generations CDM projects which are currently in registration and validation with a power generation mix linear programming model in India's power sector from 2006 to 2031. Two scenarios are developed to identify impacts of the CDM projects. The results across the scenarios show four remarkable results. First, CDM projects are required to be implemented timely so that CO-2 and air pollutants emissions are reduced effectively in long terms. The CDM projects affect on electricity mix substantially after the implementation owing to a technological lock in. Second, CDM projects should be evaluated in long term. While CO2 emissions increase by 43 CO2Tt once when the CDM projects are implemented, CO2 emissions decrease by 431 CO2Tt from the BAU after the implementation of the CDM projects. Third, this is proved by the estimation that co-benefits are invoked by the coal-fired generations CDM projects which are currently in registration and validation in India. SOx and NOx emissions also decrease by 1.27Tt and 0.35Tt at the end of time horizon from the BAU scenario. Developing countries seek to decrease air pollutants. Addressing co-benefits invoked by energy-related CDM projects raises motivations of host countries and attracts investors. Consequently, large CO2 emissions decrease will be attained through higher amount of CDM projects. Lastly, reduction benefits increase with an inclusion of reduction benefits of the air pollutants invoked by the CDM projects. This warrants 1.16 times higher Certified Emission Reductions (CERs) which attracts investors to offset markets. While the reduction benefits from the air pollutants accounts for 13% of total reduction benefits in the case of coal-fired generations CDM projects which are currently in registration and validation in India, this is due to the fact that the concept of the co-benefits is excluded in the CDM. Including the concept of the co-benefits in CDM leads to higher reduction of the air pollutants since projectors will consider the decrease of the air pollutants. Thus, this is identified that taking co-benefits into account benefits both of developed countries and developing countries.

SDWS2011.0347 Implementation and Evaluation of a Low Temperature Waste Heat Recovery Power Cycle Using Nh3 in a Organic Rankine Cycle.

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Abstract

With increasing cost for power generation the opportunities for small scale power generation from waste heat have increased. The awareness of untapped resources such as local waste heat streams as well as the available range of technology and products to harvest such streams is increasing steadily. For ORC power plant applications the number of open parameters is large though the reported field data is limited, particularly for low temperature waste heat recovery.

This paper presents field data and and a performance analysis of an ORC power generation plant operating with NH3 as media. The ORC unit operates on waste heat from a Swedish pulp mill at an available temperature level of 75 to 85degC. Performance at low waste heat temperatures and during capacity variation is reported as well as an analysis of the particular investment case.

The field data was generated by remote logging of control system information during a 15 day period.

The results show a thermal efficiency of 8 to 9% during a capacity range of 50 to 100% power generation. The results indicate a flat thermal efficiency kurve from 20 to 100% power generation.

The investment case is a supplier own-and-operate type of arrangement supplying the pulp mill with electric power at a predefined cost during a long period of time.

SDWS2011.0092 An Integrated Cost Benefit Analysis of a Photovoltaic Noise Barrier

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Abstract

In the light of global warming, renewables such as solar photovoltaics (PV) are important to decrease greenhouse gas emissions. An important issue regarding implementation of solar panels on large scale is the limited available area. Therefore, especially in residential areas, it can be interesting to look for alternative PV applications that do not require “additional” space. Complementary to roofs, also noise barriers located along a highway or railway can be an attractive option to serve as substructure for PV modules. This integrative concept is called a Photovoltaic Noise Barrier (PVNB). Studies

about the technical insights and the potential of PVNBs in Europe are already published, but information about the economic aspects is still missing.

In this paper, a case study of a PVNB in Belgium is conducted using a cost benefit analysis including a Monte Carlo sensitivity analysis. A distinction is made between the noise barrier and the PV array to evaluate them separately. Besides purely economic aspects, also ecological benefits are monetized. The results suggest that the separate PV investment is profitable even without including the ecological benefit of CO_2 reduction, which in this analysis is only of minor importance when expressed in monetary terms. Further, the noise barrier can be profitable when including the ecological noise reduction benefit, which is valuated using a Noise Sensitivity Depreciation Index (NSDI) applied to real estate prices. This means the initial investment cost of a sound barrier can be recovered via the benefit of reduced noise nuisance. Finally, also the PVNB as a whole is profitable in social terms.

When the government decides to place a noise barrier, additional PV panels are normally not foreseen. However, the construction of a sound barrier could in turn motivate the private sector to invest in solar panels that can be mounted on the barrier. This way, an extra amount of renewable energy can be produced without requiring additional space. Further, private investors could benefit from a profitable PV investment while surrounding residents suffer less from noise nuisance, which is reflected in an increase in real estate prices. In brief, this study shows that a PVNB could be a fruitful public – private partnership for the government, residents as well as private investors. Consequently, it would be beneficial to promote the technological development and the installation of PVNBs for example via implementation of flexible governmental legislation regarding investment conditions of PV sound barriers.

Buildings II

SDWS2011.0198 Applied Results of Enslic Methodology for LCA in Buildings

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Abstract

This paper demonstrates how to achieve energy saving in the construction and operation of buildings by promoting the use of life cycle assessment techniques in design for new buildings construction and refurbishment. The paper aims to draw on the apllication of a specific methodology for low energy consumption, integrated planning, environmental performance evaluation of buildings, design for sustainability and LCA techniques applied to buildings.

Through the ENSLIC tool for use in an integral planning process have been promoted to stakeholders who require a means to optimise environmental performance of buildings. The feedback of the stakeholders have facilitated the creation of some simplified LCA guidelines, a systematic approach guiding the user through the alternative options regarding choice of software – their strengths and weaknesses, databases available, usefulness of different indicators, aggregation, definition of limits, options for simplifying the process.

As a result, the paper presents the applied results of 3 case studies of pilot applications where this methodology is implemented serving as an energy saving evaluation tool for decision makers, end-users, professionals envolved in the different stages of construction, etc...

Finally, into the paper it is demonstrated how LCA can facilitate comparisons of different buildings, showing influence of all variables on a building's life cycle environmental impact. Removing market barriers to sustainable construction. is actually stricter and this is good news in order to promote higher energy efficiency in buildings. The potential for energy savings is demonstrated in the pilot cases described in this paper of new low-energy buildings that reduce their energy consumption with respect to conventional buildings.

SDWS2011.0589 Cost and Impact Analysis of Policy Measures to Reduce Nox Emissions of Buildings in Flanders.

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Abstract

The European NEC Directive (Directive 2001/81/EC on national emission ceilings) sets mandatory NO_x, SO_2, NMVOC and NH_3 emission reduction objectives for all Member States by 2010. The forthcoming revision of the NEC Directive is expected to set new objectives for 2020. In Belgium, the federal government has already implemented various measures to reduce emissions resulting from heating in residential and services sector. In this paper, we have analyzed for Flanders additional policy efforts, in the context of a NEC revision and the 202020 European Climate and Energy package. To this purpose, we evaluated stricter NO_x emission standards (up to 45% stricter) for natural gas and fuel oil boilers in federal policy using an impact and cost analysis. Based on a detailed assessment of the boiler stock and emission characteristics of each boiler type, we estimated the historical NO_x emissions in Flanders in 2001-2008. Secondly, we developed a reference NO_x emission scenario until 2030 against which we compared the impact and cost efficiency of two policy scenarios with stricter NO_x emission standards. The reference scenario comprises the 202020 EU targets and considers efforts on energy efficiency (e.g. roof insulation) and use of renewable energy (e.g. heat pumps). Moreover, the historically observed, high replacement rate of natural gas and fuel oil boilers does not change during the entire projection period. These assumptions, namely large energy savings and a quick replacement rate, result in high NO_x reductions in the reference scenario. The emissions decrease from 9,7 kton in 2010 to 4,3 kton in 2030. The two policy scenarios have a small additional impact on NO_x emissions. Even if the NO_x standards of natural gas and fuel oil boilers would be decreased up to 45% compared to the current legislation, our results show that only an additional reduction of 164 and 348 ton in 2030 would be achieved. Moreover, comparison of the social costs (investment and installation costs, maintenance and fuel costs, excl. VAT and subsidies) of the different scenarios, indicates very high marginal abatement costs for NO_x. The marginal abatement costs of the policy scenarios increases to 301 and 315 k€/ton NO_x compared to the reference scenario. In contrast, earlier work already showed that energy saving measures such as roof insulation and boiler replacement have a very short payback time. This study shows that energy savings in buildings and the rate of boiler replacement are important driving forces for achieving considerable NO_x reductions, without the need for tightening current NO_x standards for boilers.

SDWS2011.0780 Numerical Modeling of Thermal Response of a Concrete Wall with MCPS Micro-Encapsulated

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Abstract

The reduction of the energy consumption of telecommunication buildings is an international challenge for operators and internet actors. Electronics equipments are located in theses buildings witch induced very consequent heat generation. To compensate the energy balance, an air conditioning system must be used to transfer heat power at least equal to the total equipments power and to maintain ambient conditions (temperature and relative humidity of the air) in fixed ranges.

Studies in progress aim at defining rules of thermal design of buildings in order to reduce the consumption dedicated to the air conditioning. The idea is to use phase change materials (PCM) in the structure of the envelopes to increase thermal inertia and to ensure a cooling by forced ventilation during night period. The drawn lesson could be at the origin of an application to broader scale (large –sized building).

The first part of our communication concerns numerical modelling of thermal response of a concrete wall including PCMs micro-encapsulated. Modelling is carried out by an equivalent Heat Capacity Method discretized in an implicit way.

In order to validate this model, experimental tests are carried out on samples of parallelepiped form instrumented with flux meters and thermocouples.

The second part is dedicated to the studies done on two enclosures of interior volume of 1m3, equipped with a ventilation system. Walls of one enclosure contain PCM. A thermal model of this experimental setup is developed on TRNSYS 16. Sequences of measurements carried out are then exploited to study the relevance of the results of simulations got on TRNSYS. Temperature responses of the interior ambiances and of the walls under various conditions (dissipation of power internal, renewal of intermittent air) are studied

First results clearly prove the efficiency of the PCM to enhance the heat storage capacity of the whole building. Actually, by lowering significantly the internal temperature, it will reduce the energy consumption of air conditioning systems.

SDWS2011.0873 Ground Contact Heat Losses: Simplified Methodology for Residential Buildings

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Abstract

Heat loss trough building elements in contact with the ground plays an important role in a building's thermal behaviour, therefore its estimation and management is relevant when calculating buildings energy performance. To support the implementation of the Energy Performance of Buildings Directive (EPBD), the European Commission has asked to European Committee for Standardization (CEN) for the development of specific standards to support Member States for the national implementation of the EPBD. The European Standard EN ISO 13370 is one of those specific documents. It provides a method for calculating heat loss through the ground taking into account steady state heat loss as well as heat loss due to temperature variations throughout the year (on a monthly or seasonal basis) which is based on calculating thermal transmittance coefficients for floors and basement walls an differs greatly from the method established in the Portuguese building regulation codes. The EN ISO 13370 method requires a large input of data. In this paper an alternative simplified version of the method is presented, more suitable for general energy performance calculation procedures and concerning less calculation parameters and steps.

SDWS2011.0126 Methodological Aspects and Design Implications to Achieve Life Cycle Low Emission Buildings: a Case Study: LCA of a New University Building

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Abstract

Today, the construction sector is fully aware of a huge responsibility, being the highest energy consumer in the EU (about 40%) and main contributor to GHG emissions (about 36% of the EU's total CO2 emissions and about half of the CO2 emissions which are not covered by the Emission Trading System).

The energy certification processes for buildings that are being applied in European countries are a fundamental step towards improving buildings' energy efficiency. The

recast of this Directive proposes that all the new residential buildings, offices and services buildings that will be built into the EU from 2020 will be zero energy buildings, defined as buildings that generate in an annual basis the same amount of energy demanded. This will promote on-site generation from renewable sources and incorporation of energy efficient equipment in buildings, but it is not enough. A sustainable building should be characterized by a balance between the production of materials, their consumption for the construction or refurbishing of buildings and the use of the necessary natural resources.

The life cycle assessment of the buildings allows considering the impact in all the stages of their life cycle, including the production of the building materials and equipment, the transportation and construction, the use and maintenance, and the final disposal. At present, the current legislation is leading to the minimization of the direct consumption in the building use (which now accounts for 60-70% of the total impact, depending strongly on the type of building, constructive solutions and climatology), so that the impact of the indirect consumption (which now accounts for 30-40% of the total impact) will be increasing.

The aim of the paper is to present the life cycle assessment as an adequate methodology to design new "Life Cycle Low Emission Buildings". The methodology is applied to a new University building in Spain. This building aims to be a singular and exemplary building: a model of green building and sustainability and a reference of the last technological advances in eco-efficiency. Relevant methodological aspects are remarked, proposing good practice and identifying gaps in the knowledge and need for further investigation. Also some recommendations to reduce the emissions during the whole life cycle of the building are included. The results demonstrate the high impact of the urban mobility of the occupants and other indirect impacts, if they are included inside the system boundaries of the assessment.

The paper has been developed within the framework of the "LoRe-LCA" project co-financed by the European Commission-Intelligent Energy for Europe Program, and the "ACV-EDIF" and "ECOURBAN" projects, both financed by the Spanish Ministry of Science and Innovation.

SDWS2011.0584 Cost and E-Level Analysis of Different Dwelling Types and Different Heating Systems with Or Without Heat Exchanger

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Abstract

Energy efficiency in buildings has become a key goal of any energy policy. In this context, the Belgian government has created the 'Energy Performance and Interior Climate' or EPB standard. This standard is a transposition of the Energy Performance of

Buildings Directive (EPBD) and the revised EPBD issued by the European Union. In general, these directives aim to improve the energy performance of buildings in the European Union by promoting cost-effective solutions. In this context, the study will undertake a cost and E-level analysis of four different heating systems with or without heat exchanger taking into account the EPB standard. The analysis is performed for three representative Belgian types of dwellings: a terraced, semi-detached and detached dwelling.

The main results lead to the same overall conclusion for all dwelling types. They clearly indicate that the heating pump generates the best E-level but performs poorly in terms of costs. A condensing gas boiler is the cheapest heating system generating the lowest E-level, apart from the heating pump. Since a ventilation system with heat exchanger is always the best choice in terms of costs and energy use compared to a ventilation system without heat exchanger, the condensing gas boiler with heat exchanger turns out to be the best choice for all dwelling types.

Energy policy

SDWS2011.0096 Mapping the Road for Successful Implementation of Energy Efficiency Policy - Case: Croatia

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Abstract

The EU has adopted the Climate and Energy legislative package, in which it has agreed to cut primary energy consumption by 20% until 2020 by improving energy efficiency (EE). It is estimated that EE measures solely could deliver almost three fourths of desired EU's green house gases (GHG) emission reduction target. However, the results of policies in place are missing although EU has the most advanced EE policy in the world. With the current policy instruments in place, at the best a reduction of 11% will be achieved. There are number of reasons behind EU's EE policy failure and most of them are universal -applicable for non-EU countries, and originate from lack of policy implementation mechanisms and capacities. Governance that will mobilise and ensure cooperation between all stakeholders is the main prerequisite for successful EE policy implementation. The process of preparing the **Roadmap for Enhancing EE Policy Implementation** has just started in the Republic of Croatia and its results will be presented in this paper.

The starting point in preparation of the Roadmap is situation analysis. The situation analysis was based on semi-structured interviews with different stakeholder groups that are considered to be main pillars of implementing environment for EE policy: public institutions, civil society, media and business. Standardised questionnaires were prepared and adapted accordingly to each stakeholder group. No such analysis has been done up to date in Croatia - there are number of desktop studies performed by various external consultants, but none of these studies offered tailor-made solutions that respect all national circumstances. Field survey results were rounded with the thorough analysis of strategic, legislative and regulatory framework for EE in Croatia.

The situation analysis sets the baseline related to the implementation of EE policy in Croatia. Within every stakeholder group it analyses the capacities, competences and infrastructure at the disposal for implementation of EE policy. The scheme of existing as well as of targeted overall institutional set-up for implementation of EE policy was developed. Finally, the list of activities for removal of gaps/barriers within every stakeholder group and between them has been identified with assigned responsibilities and time frames for implementation. Special attention was given to the cooperation and coordination of activities between different stakeholder groups - their interactions and ways to enhance cooperation for the benefit of full EE policy uptake are analyzed.

Public institutions are the backbone of EE policy implementation, and their lead-by-example role should and could provoke EE activities in business sector as well. However, collective actions of all pillars of the society are needed to reach the EE goals and to fulfil the final aim - prevent the adverse effects of climate change.

SDWS2011.0202 Assessing the Effects of the Crisis on Economic Growth, Energy Consumption and the Environment – a Portuguse Case Study

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Abstract

The global financial crisis has brought severe impacts worldwide and particularly on the Portuguese economy. In this context, the Portuguese government has recently adopted some harsh measures that will have strong impacts on peoples' lives. This paper discusses the influence of these measures on economic growth, social well-being, energy consumption and corresponding impacts on the environment, through the use of a multi-objective linear programming (MOLP) model based on input–output analysis. Several uncertainty sources are captured by interval coefficients and interval programming techniques are used to deal with the mathematical model.

Input-output (I-O) analysis has been used for economic analysis, since it provides a consistent framework allowing to capture the contribution of related activities through inter/intra-industry linkages in the economy. Hence, I-O analysis is often applied to assess Economic-Energy-Environment (E3) interactions. An MOLP model based on I-O analysis has been developed, considering distinct coefficient sets to capture uncertainty modeled as intervals, to perform an integrated prospective study. The model time-span is 2020 and coefficients are consistent with recent governmental and international organization forecasts (e.g. EU, FMI and OECD).

An interactive methodological approach is used to obtain compromise solutions to the MOLP model based on I-O analysis with interval coefficients. Interval solutions are computed considering the optimistic and pessimistic versions of the objective functions and the feasible region. The exhaustiveness of the search process for "compromise" solutions is guided by a decision maker according to the information gathered about the solution structure and trade-offs that are at stake between the competing objectives.

SDWS2011.0213 Low Carbon Industrialization Technologies and Strategies in China: Integrated Assessment and Scenarios Analysis

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Abstract

Low carbon development strategy and targets in China have been unveiled in the Letter including autonomous domestic mitigation actions submitted by China to COP 15 and Copenhagen Accord (Appendix II), especially two numbers - lower carbon dioxide emissions per unit of GDP by 40-45% by 2020 compared to the 2005 level, increase the share of non-fossil fuels in primary energy consumption to around 15% by 2020. So how China's carbon intensity target in 2020 have effects on economy, industry, energy consumption and other crucial aspects? How to decompose the integrated carbon intensity target in 2020 to the 12th and 13th Five-Year Plan, to Regions, and to Industries? What's individual industry's potential, responsibility, contribution and cost to achieve such target? How China's economic policies, e.g. GDP growth, industries restructure, investments, consumption and international trades, have effects on industries' achievements of carbon intensity target? How can China fundamentally transit to low carbon industrialization and development? What's the role of technological change in such a transition? How to evaluate the efficiency and effectiveness of policies?

With above questions, the paper takes Low Carbon Industrialization Scenarios (LCIS) and optimization analysis based on Low Carbon Energy and Economy Model (LCEM), a Low carbon development integrated assessment model developed by Tsinghua IAMC team. The LCIS research further modify LCEM model, especially give more details to industrial sector, focus on the regional and sector decomposition research, and explored 4 groups of LCIS Scenarios, including Baseline Scenarios, Carbon Intensity Target Scenarios, Low Carbon Industrialization Technology Scenarios and Low Carbon Industrialization Policy Scenarios. The paper finally makes the integrated assessment of China's low carbon development technology roadmap and policy portfolio.

SDWS2011.0223 Making the Results of Bottom-Up Energy Savings Calculations Comparable

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Abstract

The Energy Service Directive (ESD) has pushed forward the issue of energy savings calculations without clarifying the methodological basis. Thus the Commission has prepared "Recommendations on Measurement and Verification Methods" in consequence of the ESD. Furthermore CEN prepares a preliminary standard on "Energy Efficiency and Savings Calculation" (prEN 16212). Both attempts for standardisation of energy savings calculations are confronted with considerable difficulties mainly with respect to bottom-up calculations as member states are interested to keep the ESD methodology under control. As a result, national methodologies have emerged. Although this fragmented approach is in line with the ESD it leads to unsatisfying results since bottom-up savings are calculated inside a "black box" leading to non-transparent, non-comparable results.

Against this background, the paper develops the idea of separating the issue of ESD verification strictly from the requirement of making results of bottom-up energy savings calculation comparable by introducing a parallel evaluation track. The idea is analogous to the calculation of unemployment rates, where - independently from national methodologies - exists a common European calculation routine which makes unemployment rates comparable across Europe.

Comparability is achieved by developing a standardised bottom-up calculation kernel for different energy efficiency improvement (EEI) measures. At the same time, the kernel makes different calculation options transparent in a structured way (e.g. different baseline options, different system levels, different ways of dealing with double counting, etc.). Due to the complexity and heterogeneity of bottom-up calculations the approach requires a central database where member states feed in input data on bottom-up measures according to a predefined structure (e.g. XLM standard), which are then processed with the standardised calculation kernel. The paper demonstrates the proposed approach for concrete examples of EEI measures.

SDWS2011.0230 Challenges of the New Slovenian Renewable Energy Action Plan – Path Toward Low-Carbon Economy

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Abstract

It is clear that the low-carbon energy consumption has become European Union top priority. Each member state should define its own strategy that will tackle this, new challenge in the most efficient manner, i.e. at the least costs to the society. These strategies need to be coordinated throughout the whole Europe. Supply side, in this respect, should be governed by the aim of achieving energy mix originating from secure and low-carbon energy sources.

In the frame of the European Union energy climate package Slovenia set ambitious target by 2020 to achieve 25% renewable energy in gross final energy demand. According to the new National Renewable Energy Action Plan Slovenia would play an active role in the development and promotion of the new technologies and solutions, which would enable wider usage of the renewable energy sources in industry, public, residential and transport sectors. During the development of the Action Plan model for predicting market transformation due to large scale usage of renewable energy sources has been developed.

With the imperative to keep this Action Plan alive, Slovenian Ministry of Economy will continuously monitor its implementation. Only by this adaptive approach during the action plan implementation the real-world aspects will be taken into account and will ensure the full applicability of the new renewable energy policy.

Within this paper evaluation of the most important challenges for the future development of the renewable energy sector in Slovenia is presented. Special attention is given to the full utilisation of the wind energy potential in Slovenia. Also, mechanisms to correct market imperfections and to stimulate wider usage of renewable energy sources are described and main recognised barriers for the Action Plan implementation are discussed.

SDWS2011.0309 Modeling Efficiency Improvement in Industry Through Implementation of Energy Management Systems

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Abstract

As a part of the international cooperation, the United Nations and the World Bank have declared the need of energy management commitment to reduce global energy intensity by 2.5 percent per year over the next twenty years either by increasing energy

efficiency or by shifting to low energy intensive activities with higher levels of output and gross domestic product (GDP). Separately, the European Union (EU) committed to reduce its primary energy consumption by 20 percent by 2020 detailed in the Green Paper published as a part of the strategy to ensure sustainable, competitive and secure energy. The industrial sector faces the challenge of moving from rhetoric to reality in sustainability with the implementation of energy management. The energy management potential in industrial sector will create many opportunities through improvements on three vital dimensions of sustainability; social, economic and environmental. This substantial opportunity assists not only the industry's strategic financial, operational and business objectives but also the environmental and social responsibility that have integrated into today's industry compliance programs. The following study presents a methodology for setting up energy management system in the industrial sector based on the guidance of the European standard EN 16001 through a systemic management approach. The implementation of the energy management by the Plan-Do-Check-Act framework is developed and performance analysis is performed by a process management simulation tool contributing to a certification based model of business processes supporting energy efficiency together with reduction of GHG emission. The proposed methodology in order to establish a systematic modeling and integration of energy management using the software provides an initial prediction of the process in industry. This simulation model offers a road map to all organizations to develop the best-practice method improving efficiency and enhancing quality of process.

Water treatment II

SDWS2011.0103 Retention of Mycoestrogens with Industrial Nanofiltration Modules

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Abstract

The effectiveness of organic micropollutants removal by nanofiltration is dependent on a number of factors and phenomena concomitant with membrane filtration. The most important mechanisms of micropollutant separation include: steric hindrance, hydrophobic-hydrophobic interactions which results in compound adsorption on a membrane and finally electrostatic effect. The three mechanisms mentioned above may be connected to both the physical and chemical properties of compounds and characteristics of a membrane used. The effectiveness of micropollutant removal also depends on the parameters of treated water and operating conditions. However, industrial membrane installations usually show a decrease in micropollutants removal compared to the results produced on a bench scale. This phenomenon and its causes are investigated in this paper.

The study assesses the effectiveness of selected mycoestrogens (zearalenone and α-zearalenol) removal by nanofiltration using a membrane installation equipped with a industrial spiral wound module NF270-2540 (active membrane area of 2.6 m^2) produced by Filmtec. The tests focused on the effect of permeate recovery at a 10-80% range on mycoestrgoens removal during the filtration of water containing various concentrations of organic and inorganic matter (deionized, tap and surface water). Nanofiltration was carried out at 20°C under a transmembrane pressure of 2.0 MPa (linear feed velocity – 3.4 m/s). The concentration of mycoestrogens in the treated water was 5 μg/dm^3.

The removal of mycoestrogens removal during nanofiltration depended on a compound being removed, feed composition and permeate recovery. Zearalenone and α-zearalenol removal fell within 57 – 75% and 70 – 100%, respectively. Lower mycoestrogen removal was observed for the filtration of surface water which showed the highest concentration of organic matter. An increase in permeate recovery also resulted in a deterioration in the results of micropollutants removal due to an increase in their concentration in the feed. Nanofiltration carried out under the conditions of high recovery of permeate (80%) decreased the removal of inorganic matter (determined by measuring water conductivity). On the other hand, the removal of organic matter determined by measuring total organic carbon (TOC) was high and exceeded 98%, irrespective of the extent of permeate recovery. The filtration conditions described herein produced the lowest effectiveness of the process. The extent of permeate recovery was accepted as the parameter affecting the separation of organic micropollutants in membrane installations operating on an industrial scale.

SDWS2011.0240 Evaluation of the Trophic Level of Kune and Vain Lagoons in Albania, Using Phytoplankton as a Bioindicator

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Abstract

Concentration of chlorophyll is a parameter that is considered adequate for assessing the trophic state of lagoon ecosystems. The content of chlorophyll a, b, c, carotenoids, phaeophyta, etc., is determined based on standardized spectrophotometric and fluorimetric methods.

Objectives of this study are: selection of a system of bioindicators to enable a good qualitative evaluation of the trophic state of the lagoons and their dynamics; evaluation of seasonal water quality variability and comparison between lagoons; design of respective measures of rehabilitation.

The trophic state of the lagoons is analyzed every month over the year. Water samples are retrieved at four different sites (exact GPS coordinates) each month, sites that are representative of different water circulation systems at each lagoon. Pigments are filtered, then extracted with aceton 90%. Determination of pigments is performed based on the trichromatic method, using equations based on the maximums of absorption for each component: chlorophyll a, b, c and carotenoids, in a spectrophotometer. Based on the content of photosynthetic pigments, ratios Chl a/Chl b, Chl a/Chl c, Chl b/Chl c and chlorophyll/carotenoids are calculated, in order to draw conclusions on the presence of types of microalgae present in lagoon waters and the state of their photosynthetic apparatus.

The trophic level in the respective lagoons is thus assessed through selection of an adequate system of bioindicators, processing and comparing samples of phytoplankton, in order to observe the oscillations of the amount of chlorophyll and therefore to determine the level of eutrophication (ultraoligotrophy, oligotrophy, mesotrophy, eutrophy and hypertrophy).

Based on the above parameters, the comparison of the trophic state in these two lagoons has shown that they have different trophic states.

SDWS2011.0090 Solar Distillation System Based on Multiple-Effect Diffusion Type Still

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Abstract

The multi-effect diffusion type still (MEDS) is a high-efficiency heat-driven distillation device, which was first published in 1967. But not many good application devices based on the principle of MEDS can be found. The present study intends to develop a high-performance solar desalination system (SDS) using MEDS and the vacuum tube solar collector (VTSC). The MEDS contains a series of vertical still cells, which are parallel and closely spaced. One face of a cell is the heating plate which is for heat absorption and vapor condensing. A slice of capillary material adhered on the other face to act as wick. The sewage water is supplied to the wick at the top. The heating plate absorbs the imported heat by the vaporized water vapor from the saturated wick of the adjacent still cell. The vapor diffuses and condenses at the next heating plate. The collectors under the heating plate collect the pure water drop. The latent heat relieves during the condensing process on the bare side of the heating plate, and evaporates the water on the other side of the heating plate attached with wick material. The process will repeat until to the last cell and finally discharge the residue heat to the environment.

The solar heat is absorbed by VTSC to produce high temperature vapor as the heat source of MEDS. The design of MEDS was studied. Simple analysis of MEDS was carried out to predict the performance. A MEDS prototype was designed and built for test with electric steam generator and vacuum tube solar collector. The preliminary test result shows that the measured result is very close to the estimation. The 10-eff MEDS will produce pure water at about 12.6 L/day/set (13.7 L/m^2/day) in Taiwan with solar irradiation 600W/m^2 and 18.1 L/day/set (19.7 L/m^2/day) in desert area with solar irradiation 800W/m^2. This value is much higher than the stills ever made before. The previous record is 1-3 L/m^2/day. For 20-effect MEDS, the daily pure water production rate (for 6 hr) is around 16.5 L/day/set (17.9 L/m^2/day) in Taiwan and 23.7 L/day/set (25.8 L/m^2/day) in desert area. For 20-effect still, the yield rate increase 32% compared to 10-effect still. All the above results will be improved if the heat recovery device was added.

SDWS2011.0878 An Experimental Study for Maximizing Nh3 And CO2 Removal Efficiency in Vacuum Membrane Distillation Process for Forward Osmosis Seawater Desalination System

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Abstract

In many parts of world, there is an increasing need for desalinated water in various purposes. A number of technologies such as MSF (Multi Stage Flash), MED (Multi Effect Distillation), RO (Reverse Osmosis) have been developed and continuously optimized to produce fresh water. The drawbacks of MSF and MED are the large thermal energy inputs for vaporization of water with the relatively low water recoveries. Since a key cost component of desalinated water is electrical requirements, an optimization of energy efficiency and life-cycle cost are the most important challenges for desalination plant. Hence, FO (Forward Osmosis) desalination process has been recently spotlighted as an alternative candidate to produce fresh water because the driving force of FO to separate water is natural osmotic pressure, not hydraulic pressure with high electricity consumption. In FO system, an aftertreatment process should be followed to produce fresh water from a diluted aqueous NH_4HCO_3 (Ammonium Bicarbonate) solution which is commonly used as draw solution in high concentration side. Therefore, simultaneous separation of NH_3 and CO_2 gasses from aqueous NH_4HCO_3 solution with low energy consumption is a key issue for the commercialization of FO desalination.

Few works have reported the separation efficiency of draw solution under various operating conditions even though it is a crucial issue in the early stages of FO desalination system design. The objective of the present study is to comprehend the thermal behaviors of aqueous NH_4HCO_3 solution, to improve a separation efficiency of NH_3 and CO_2 gases simultaneously. A number of experiments on NH_3 and CO_2 removal by means of a hydrophobic membrane contactor have been performed under various operating conditions in VMD (Vacuum Membrane Distillation) process. The effect of operating parameters to separate NH_3 and CO_2 gasses such as mass flow rate of feed water, initial feed water temperature and concentration of aqueous NH_4HCO_3 solution are predicted after feed water recirculation time of 120 min. The results of present lab-scale experiment show that the gas removal efficiencies are quite stable in the range of 95% to 99% with an initial feed water temperature of 50 and 60 ℃, initial feed water volume of 1ℓ and mass flow rate of 0.8ℓ/m. When the initial feed water temperature is 40 ℃, relatively low gas removal efficiency of 85% is achieved compared to the cases of 50 and 60 ℃. After the recovery of transmembrane vapor, the total water recovery of more than 85% was achieved in the all cases carried out in the present study while NH_3 and CO_2 removal efficiencies higher than 95% were achieved. The present results indicate that the optimum operating conditions of MD should be predicted in the early stages of the process design

to increase the possibility of commercialization of FO desalination system with high energy efficiency and low life-cycle cost.

Renewable energy resources I

SDWS2011.0032 Biomass from Agriculture and Municipalities for Energy

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Abstract

Energy from agriculture and municipalities has a form of biomass which contain chemical energy, and can be transformed into heat, electricity or mechanical for transport. On the market this energy is sell according to indicators of heat supply, electricity supply or petrol station with fuel for transportation. The biomass from agriculture has the form of solid, liquid or gas energy carriers. The biomass is the material originated from vegetation (wood, straw, lignin liquid waste as black liquor, waste paper), from animals (municipal sewage sludge, manure, dung), or substances after the processing of biomass producing biogas (from anaerobic digestion of manure, sewage sludge, or from organic solid waste on the sanitary landfills), bioethanol (from alcoholic fermentation of potatoes), or pyrolitic gas (produced from wood or sewage sludge). The resources of biomass of Poland are evaluated. The biomass is treated in two separate groups of resources: (1) primary energy resources, including wood, straw and sewage sludge (analogy of peat) and (2) second generation biomass as processed energy sources, upgraded into the form of biocarbon, biogas, bioethanol, biohydrogen and pyrolitic gas. Production of heat and power from biomass is very promising on the very good technical parameters of the boilers, very good economical results with relatively short pay-back period of investments if the residual biomass is used, and very positive ecological results with low level of the emission of the flue gases and low emission of the pollutants to the atmosphere. Biomass is much more environmental friendly than any fossil fuel.

SDWS2011.0087 Perspectives of CHP in the Wood Industry in Serbia

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Abstract

The paper presents result of techno-economic analysis of using woody biomass from wood processing industry for combined electricity and heat production (CHP). In previous years, in Serbia there were a number attempts to apply CHP, mainly in fossil fuel fired power and district heating plants. Woody biomass has become more interesting when the Government of Serbia at the end of 2009, introduced feed-in tariffs for promoting the production of electricity from renewable energy sources including biomass. Proposed tariffs depend on plant's power production capacity and the Law preferred smaller ones.

At present a number of companies in the field of wood processing are considering to invest in CHP. First reason is the expected economic benefits. Second is energy independence in critical situations and third is better reputation of the company itself and the timber industry as producers of energy from renewable and environmentally friendly energy sources. There are three main preconditions to be fulfilled in order to implement power generation in wood processing companies. The first one is surplus in quantities of wood residues. Second, is the existence of more or less constant demand for heat. Third precondition deals with economic justification and feasibility of this kind of production.

In the paper the possibilities of combined production of heat and electrical energy in sawmills and pellets factories is discussed. In the sawmill companies in Serbia hardwood is mostly processed, primarily beech. Sawmill production is with numerous low capacity plants (less than 10,000 m^3). The installation of CHP in so small production units is not economically justified. Main reasons are high investment per kW of power, and insufficient number of working hours per year (less then 6,000 as needed). Calculated price was about 0.20 €/kWh, which is more than offered rate (0.138 €/kWh). Our calculations show that the CHP installation will become profitable in sawmills which production is higher then 30,000 m^3 of logs per year. In Serbia there are 6 factories for wood pellet production with capacities ranging between 5,000 and 35,000 tons/annually, and their total capacity is about 100,000 tons/annually. Biggest on which capacity is about 35,000 tons/annually placed in Boljevac is taken in consideration. Calculations are based on data and experiences from Austria. The approximate production cost for the installation of about 3MW power output only slightly lower the offered purchase price of € 0.124/kWh.

SDWS2011.0102 Risks of Tropical Cyclones on Offshore Wind Farms in China

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Abstract

Frequent tropical cyclones pose great risks and obstacles to the development of offshore wind farms in the coastal regions of China and other areas in the Pacific, where development of wind energy is gaining momentum. This paper aims to identify and evaluate the risks of tropical cyclones on offshore wind farms within the Economic Exclusive Zone (EEZ) of China and help decision-making for planners and investors. The risks of tropical cyclone impact in this paper are defined by the statistical extreme wind climate and the expected economic losses of offshore wind farms. A probabilistic tropical cyclone event model is applied to evaluate 20-year, 30-year, 50-year and 100-year recurrence of extreme wind speeds by geographical location. Combining a damage model derived from empirical loss data and an investment cost model within a Geographical Information System (GIS), the expected annual losses of offshore wind farms from

tropical cyclones are evaluated and showed on a spatially continuous risk map. Results are given in terms of annual economic risks and the damage loss conditional on occurrence of an average recurrence interval event. Implications for identifying locations for offshore wind farms and setting design parameters of offshore wind turbines as well as risk-consistent insurance rates are then discussed. The impact of tropical cyclones on offshore wind farms likes a double-edged sword, which might be advantageous for some region (e.g. southeast coast of China) in terms of increasing full-loaded hours of turbines and therefore gaining cheap electricity generation costs, but also nightmares due to its destructive effects sometimes. However, specific design standards and insurance of turbines would effectively help reducing the risks and economic losses of offshore wind farms in tropical cyclone prone areas and expanding exploitable locations for future offshore wind farms.

SDWS2011.0151 A Methodology to Estimate the Photovoltaic Potential on Roofs in Regions and Islands: the Case of the Canary Islands

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Abstract

The Canary Islands (Spain) are highly dependent on external energy sources. For 2015, the Canarian Energy Plan establishes that 30% of the electricity demand will be covered by renewable energy sources, mainly wind and solar (the goal for solar photovoltaic –PV– is 160 MW). Another issue in the Canary Islands is the lack of available land. Considering both issues, land scarcity and energy goals, it is crucial to determine the PV potential on roofs for each island as a first step for the energy planning. Within this work, a new methodology for the calculation of the PV potential on roofs is proposed. As a first step, the roof surface usable for PV facilities per municipality is determined. For this purpose roof surfaces per municipality are classified as urban (residential, tourist or rural) or industrial types. For each of these four possible typologies, the percentage of usable roof for PV is determined as a function of the predominant architectural style. In a second step, the yearly full load-hours per municipality are determined. Finally the yearly PV production per municipality is calculated for three different scenarios: a) exclusive use of the usable roof surface for PV, b) solar use of the roof surface, including PV and solar thermal panels c) solar energy shares the roof surface with other non-energy uses. The results show the yearly potential PV production per municipality and islands, in comparison to the islands' electricity demand. An economical assessment is included as part of the results. The methodology proposed is also compared with other well-known methods. Ways of improving this methodology are then assessed, including potential improvements using GIS (Geographical Information Systems).

SDWS2011.0447 Renewable Energy in Mountainous Areas Under the Influence of the Economic Crisis

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Abstract

It is known that mountainous settlements have increased energy needs, due to harsh weather conditions in high altitudes. Metsovo, the case in question, a Greek traditional town found at an altitude of 1200m, has 53% greater thermal needs than Ioannina, a nearby town lying at 480m.

The scope of the paper is to present that a new momentum to the use of the renewable energy sources in mountainous areas is born, as a way to overcome the effects of the economic crisis, faced not only by Greece but other European countries as well.

The paper is based on a field survey in the town of Metsovo, which included two objects:

- Thermal behavior of the traditional buildings, making systematic use of thermal images
- Energy consumption, in relation to building characteristics
- It is proved that an amount more than 2.000.000€, annually, is required for heating purposes in this traditional settlement. The average energy consumption exceeds 100kWh/m^2. Thermal imaging showed that this low energy performance mainly comes from wooden window frames with bad insulation standards.

The heating expenses in Metsovo correspond to 11,4% of the households' annual income. A household is considered as energy poor, when more than 10% of its annual income is spent on covering energy needs. Things are going to get worse for mountainous areas in Greece due to the ongoing economic crisis. Because of tax increases, the prices of heating – oil will almost double in 2012.

In order to identify whether renewable energy sources can contribute to a socially and environmentally effective energy strategy in Metsovo, the locally available resources were estimated. Forest biomass exploitation was found to be an effective way of reducing oil consumption and energy expenses. Locally produced firewood can cover the energy needs of at least 1/3 of the households. The investment of replacing oil heaters with biomass ones was assessed and proved to be highly efficient. However, this solution should definitely be accompanied with measures that will improve buildings' thermal behavior. For example, by placing energy efficient window frames, the reduction of energy consumption in Metsovo was calculated to be at least 20%. This move is not as simple as it looks at first sight. First, the legislation about protecting vernacular

architecture (common in Greek mountain settlements), should change, in order to include energy efficiency standards. Moreover, the current energy saving policy ought to give special attention to settlements with higher energy demand than the average, such as mountainous ones.

To conclude, in contrary to the widespread aspect that the economic crisis is a factor that inhibits sustainability measures, it seems that in mountainous areas the most effective way to overcome energy poverty, a problem which is being intensified by the current crisis, is the wider use of renewable resources together with the application of basic energy saving measures.

SDWS2011.0171 Meteorological Challenges of Wind Energy Exploitation in Croatia

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Abstract

Within the most vital environmental issues today, a larger uptake of wind energy has become a top priority due to climate change threats and political insecurity of traditional energy supplies. Croatia has significant natural resources of wind energy, especially in mountain and coastal regions, in large part due to bora winds. However, the turbulent and extreme nature of bora – which can reach hurricane scale gusts – can decrease the envisaged energy production and therefore the feasibility of the wind energy exploitation.

The current state-of-the-science and the remaining meteorological challenges related to dynamical properties of bora winds and wind energy utilization in Croatia will be discussed and presented. The first topic covers wind speed climate and resource estimates as well as dynamical downscaling in complex terrain with a mesoscale and microscale numerical models, including the importance of bora turbulence and analysis of estimates of extreme bora wind speeds and loads. Furthermore, we present the status and development of wind forecasting and data assimilation with the use of ALADIN/HR model, and the related uncertainties. The statistical and scale selective verification of the accuracy of current methodologies will be presented and their limitations discussed. Finally, requirements and suggestions on how to advance the aforementioned methodologies will be proposed in order to improve the accuracy of results and therefore reduce the meteorological uncertainties related to wind energy exploitation in Croatia.

Renewable energy resources II

SDWS2011.0585 Evaluation of Res Projects for Electricity Generation

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Abstract

Renewable energy sources (RES) emerge as a necessary condition to achieve sustainable development. RES have a fundamental role in providing universal access to energy, creating new business opportunities, reducing the external energy dependency and, at the same time, contributing to reduction of greenhouse gas emissions. However, the investment costs often constitute a major barrier to their spread use. Moreover, the overall benefits of renewable energy technologies are often not well understood and consequently they are often evaluated to be not as cost effective as traditional technologies. Traditional evaluation models relying mainly on discounted cash-flows fail to assess the strategic dimension of the investments and do not allow for properly dealing with the risk and uncertainty of these particular projects.

From the moment that the energy sector started a deregulation process, with a high level of competitiveness and associated increased in market uncertainty, traditional project evaluation techniques alone became insufficient to properly deal with these additional risk and uncertainty factors. The diffusion of the renewable energy technologies are also affected by this features, so, the way investors evaluate their investments call for the use of more sophisticated evaluation techniques. Real options theory, gives the investor the ability to account for the value inherent in the flexibility to delay an irreversible investment into the future. In the RES projects field, this ability become particularly important, as these are often modular, normally require short construction times and exhibit learning curves with very steep slopes.

This paper presents a methodology to evaluate RES electricity generation investment projects using the real options theory. The proposed methodology is then applied to different projects based on different renewable energy sources for the particular case of the Portuguese electricity market conditions. The required input information is presented and the obtained results are analyzed. Special attention is given to the combination of learning curves and real options theory aiming to provide a new approach to the sustainable development and diffusion possibilities of renewable energy technologies. The developed methodology is expected to contribute to more informed investment decisions strengthening private investor interest for RES projects and by this promoting a sustainable energy system.

SDWS2011.0593 Technical Analysis of Ahybrid Wind-Photovoltaic Energy System

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Abstract

The technical analysis of a stand-alone hybrid wind-photovoltaic system with hydrogen gas storage was studied. The market for distributed power generation based on renewable energy is increasing, particularly for stand-alone mini-grid applications. Renewable energy combined with energy storage would provide a better system reliability making it suitable for remote stand-alone applications. This paper presents the dynamical simulation and analysis of energy system consists of a different wind turbines, photovoltaic array and an electrolyser with diesel engine generator sets (DEGS). The analysis is based on transient system simulation program TRNSYS 16. The purpose of the study is to design a realistic energy system that maximizes using the renewable energy and minimizes using the fossil fuels. Design of a hybrid energy system is site specific and depends on the resources available and load demand. The technical analysis has done for typical meteorological year (TMY) for region near Novi Sad, Belgrade and Niš cities.

SDWS2011.0945 Harvesting High Altitude Wind Energy for Energy Production: a Feasibility Study

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Abstract

High altitude winds are considered to be, together with solar energy, the most promising renewable energy source in the future. The idea of harvesting high altitude winds is almost 200 years old and today it can be used for either marine propulsion (kites) or for generation of electric energy (concepts based on e.g. kites or airfoils). In this paper the concept of transforming high winds into mechanical/propulsion and/or electrical energy by means of the Magnuss effect is presented, together with corresponding two-dimensional per-module aerodynamic analysis done with commercial CFD application. The concept is based on a rotating airborne cylinder connected to the ground station with a tether cable which is used for mechanical energy transfer. It was originally developed in Omnidea Lda, Portugal and is currenty under research in the European FP7-FET project under the acronym HAWE. Performed aerodynamic studies have shown good ratio

between lift and drag force of the airborne module, as well as positive correlation between the wind speed and mechanical energy which can be obtained on a cable. Finally, a brief economic feasibility study for electricity production is given, showing negative correlation between installed capacity and generating cost per kWh, similar to the case of conventional terestrial wind-turbines. The main conclusion of this work is that the concept presented can indeed be used in commercially feasible mechanical/electrical energy production.

SDWS2011.0133 The Scientific and Engineering Approach to the Sustainable Development of a Deep Waters and Geothermal Resources Environment Systems in Republic of Croatia

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Abstract

The **motivation for this paper** comes from the necessity to improve and disseminate knowledge on methods, policies and technologies used for increasing the sustainability of development of Croatian water and geothermal energy resources. These are important **objectives** not only because of the importance of renewable energy and energy efficiency use to enhance employment in agriculture, food processing and other branches of industry but also to trigger the development of sustainable tourism both in the continental and coastal parts of the country. Use of geothermal renewable energy in electricity generation systems as well as direct use for heating or cooling infrastructure is available together with the knowledge and techniques needed to define and manage it, and store both the heat and other fluids in the deep underground space. Not enough **was done** to meet the possible objectives, yet. However, a broad and well founded base is established, in applied cases, through exploration and production of deep fresh and geothermal waters. A revision of the macroeconomic analysis and financial ad regulatory mechanisms in view of the new cost-benefit ratios can change trends and predictions. The experience developed through long-term exploration and production of successful oil&gas and geothermal activities that exists in the country validates the objectives. Efforts are concentrated on promotion of geothermal energy potential in urbanism and regional planning, to ease the way through complicate and costly regulatory mechanisms, obligations and standards. **Major results** are expected as interest is raised in the private sector ad the local communities. A multidisciplinary and innovative approach, combining side funding, intrasectorial mobility and the industry-academia partnership, using experience and research is needed to achieve the objectives, while fighting with the high cost and complex nature of geothermal energy projects. In **conclusion**, with the approach of oil peaking, deep water and geothermal resources are vital for the local community development – the integration of renewable energy supply with classical as sustainable resilience of engineering systems to reach energy efficiency has a positive economical and

environmental impact in agriculture and industry. Activating geothermal energy and water resources in Croatia is an important goal in reaching sustainable development internally as well as across international borders.

SDWS2011.0278 Large Scale Analysis of GHG Reduction by Means of Biomass Co-Firing at Country Scale. Application to the Spanish Case.

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Abstract

In the very short term the evolution of the biomass power sector in Europe will be mostly based on combustion facilities. Medium to large biomass combustion power plants and biomass co-firing in coal power plants (CPP) are set to be the immediate available technologies candidate to contribute in the short term to the increment of the biomass power installed in Europe. As a matter of fact, those are the preferred technologies installed in the newly built biomass power generating plants of medium to large scale. Up to date several researches have worked out the potentials of biomass and co-firing at country and European scales. In parallel the research on sustainability of energy systems has been a source of results on the environmental impacts of biomass utilization. The combination of the biomass potentials of a country with the capacity of energy technologies to yield emission savings is a powerful tool to support decision taking in energy planning when sustainability is set as a priority. The present work starts from the methodologies previously developed by the authors on the assessment of biomass potentials and on the determination of the real actual greenhouse gases (GHG) reductions attainable when biomass is co-fired in coal power plants. The applied case is biomass co-firing in Spain. It has been found that agricultural and forestry biomass feedstock available in 100 km distance around the Spanish CPPs sum up to 72.5 PJ y^{-1}. Technical limitations constraint the utilization of biomass in diverse CPPs. Therefore the total amount of biomass resources assessed could not be introduced as fuel in CPPs. These restrictions halve the biomass resources that could be really utilized in CPPs. These available resources could be co-fired to generate 13 PJ_e of net electricity yearly. A Life Cycle Assessment (LCA) has been performed and applied to all the processes involved of the bioelectricity production in co-firing plants. The results indicate that CPPs replacing 10% of coal energy by biomass would cause a net GHG reduction of 7.02%. The adequate combination of the figures obtained from the resources assessment and from the LCA indicate that biomass co-firing could contribute in Spain in the short term to the mitigation of 3.8 $MtCO_{2\,eq}$ yearly. As regard of the results obtained, among the ready feasible means to produce bioelectricity in large scale, co-firing arises as one of the best environmental options in the Spanish case.

SDWS2011.0596 Assessment of Energy and Economic Effectiveness of Photovoltaic Systems Operating in a Dense Urban Contest.

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Abstract

Promoting renewable energy sources (RES) is a priority measure for achieving 20-20-20 energy targets of the European Union. For encouraging the installation of RES-based generation systems, many countries have wisely adopted different economic subsidiary measures. Moreover the rapid decrease in the cost of photovoltaic (PV) modules and the escalation in the price of the oil have encouraged the diffusion of PV systems.

Using electricity in the same place where it is produced it is very gainful for both the self-producing consumer, whose energy bills will lower, and the electrical manufacturers that will reduce the costs of energy dispatching. Unfortunately, the payback period for PV systems is still quite long and, for this reason, the energy performance of these systems must be assessed to accurately estimate the benefits of the economic investment.

To evaluate the effectiveness of Italian financial incentives for PV systems installed on roofs of big cities, the case-study of a 270.000 m^2 wide district of Palermo (Sicily-Italy) was investigated. The most part of the analysed buildings, which were built before Second World War, have few floors and slanted tiled roofs. Opposite to modern blocks of flats, this kind of buildings is very suitable for the installation of PV systems because the ratio of roof surface to the number of inhabitants is quite advantageous. Anyway many other significant physical and economic features must be accurately considered because they notably affect the performance and the economic effectiveness of PV systems.

To reach the most reliable results, all buildings of the district were classified and clustered considering the number of floors and the shape, tilt, orientation, and dimension of roofs in order to define the size of the PV system corresponding to the percentage of the roof that can be exploited by each co-owner. The yearly energy performance of the systems was estimated considering the loss of efficiency of the panels during the time, the effect of the shadowing obstructions and the mismatch between the produced and the consumed electricity.

The economic analysis, based on the calculation of the pay-back-period, the net present value and the internal rate return, has considered the costs for execution, maintenance, servicing, inflation and insurance against damage for 20 years; even the effects of cost trends of electricity and PV panels were considered. The economic benefits have been calculated considering the reduction in the cost of the energy bills, the financial incentive paid by the Italian Authority for Power Energy and the value of the surplus of electricity sold to the local Utility.

The long term effectiveness of the Italian support policy has been assessed with the sensitivity analysis of the parameters that are more unforeseeable and variable.

Advanced sustainable energy conversion systems

SDWS2011.0238 Plasma Technologies for Renewable Energy Systems

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Abstract

Renewable energy systems are becoming more and more important at present time bur their large scale commercialization is strongly restricted by high price and not to high efficiency and sometimes life time.

Plasma technologies and nanostructured materials produced by them permit to solve part if these important problems.

Such technologies as magnetron-ion sputtering, ion implantation, pulsed ion implantation and their modifications are intensively developed at our center. They are ecologically friendly and permit to provide surface modification of wide range of constructional materials of any shape without dimensional changes. Extremely high adhesion of the coatings is one of their significant advantages. Surface modification of gear wheels, bearings, turbine blades, photovoltaic and electrochemical system components carried out by these technologies permitted to increase the life-time of such components up to 3-5 times due to increase of mechanical strength and corrosion resistance with additional increase of efficiency.

But not only such rather known in principle possibilities make plasma technologies so attractive. In many devices of renewable energy systems such as converters, electrolyzers and fuel cells, accumulators and so on different types of catalysts are used. PEM electrolysers and PEM and alkaline fuel sells platinum metals are widely used which results in significant price problems. It is worth also to mention that traditional technologies (thermal decomposition, gas phase or liquid phase reducing synthesis) have some limitations for nanosized (3-10 nm) catalyst synthesis or are multistage processes and are rather expensive. We developed one stage magnetron-ion sputtering technology for electrocatalysts on carbon carries synthesis and are developing a liquid phase microwave discharge nanoparticle synthesis (including nanoparticles on different carriers).

By the first method were synthesized highly active metal catalysts based on Pt alloys with Ni, Co, Fe, Pd on different carbon materials (Vulcan XC-72, nanotubes, nanofibers). And use as a carrier of nanofibers, and particularly nanotubes leads to further increase the specific activity of catalytic nanoparticles (up to 20% in the case of platinum particles of size 4-8 nm). In this case, the formation of the spatial development of the structure of catalytic particles on the nanofibers and nanotubes in the catalyst layer of PEM electrolyzer or fuel cell provides to increase the life-time up to 20-30%, and the modification of carbon surface with oxide nanofilms (eg, SnO_2) increases the life of the oxygen catalyst compositions of up to 2 times. Additional application of ion implantation

(Ar, O, N – ions) permits to create semi-amorphous surface structure with increased electrochemical stability and electrochemical activity in some cases.

SDWS2011.0325 Perspectives on the Design and Use of Direct Alcohol Fuel Cells Fed by Alcohol Blends

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Abstract

The fast-growing power demand by portable electronic devices has promoted the increase of global production of portable PEM fuel cell, a quarter of them consist of direct methanol fuel cell (DMFC) units. These present the advantage of being fuelled directly with a liquid fuel, as well as direct ethanol fuel cells (DEFC) do.

Ethanol has much lower toxicity and from an ecological viewpoint ethanol is exceptional among all other types of fuel as it is the only chemical fuel in renewable supply, so direct ethanol fuel cells (DEFC) have also been investigated, despite their lower efficiency due to its poor oxidation kinetics. Ethanol also implies a lower incidence of "crossover" phenomenon. A direct alcohol fuel cell (DAFC) fed with a mixture of both alcohols will probably satisfy both interests: performance and low toxicity.

In this work a preliminary study of a DAFC fed with methanol-ethanol mixtures is presented. The objective of this study is to evaluate the fuel-fuel cell ensemble behaviour and find the main experimental problems that arise when using alcohol blends in different proportions to feed a direct alcohol fuel cell. Evident disadvantages come from the catalyst, whose optimization should be an important goal. Skipping it, a singular DMFC has been built, activated and then fed by a series of methanol-ethanol mixtures with different relative alcohol proportion. After being operated with alcohol mixtures, the cell has been repeatedly operated with methanol solutions in order to check the cell performance recovery.

To evaluate the contribution of the experimental variables, a simple model to obtain the polarization and power curves of an ideal "flexible fuel" direct alcohol fuel cell has been used. The contribution of each fuel to the fuel cell performance is weighted attending to their relative proportion. Methanol oxidation kinetics has been affected by the ethanol presence and the cleaning process reverts only partially this performance loss. A promising research field is open and attention to diverse aspects of direct alcohol fuel cells is required.

SDWS2011.0565 Homogeneous Deposition of Platinium Nanoparticles on Hollow Core/mesoporous Shell Carbon for Proton Exchange Membrane Fuel Cell

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Abstract

Proton exchange membrane fuel cell (PEMFC) has demonstrated great promise as a future energy source for various applications. Carbon black Vulcan XC-72 (VC) has been frequently used as a catalyst support in low temperature fuel cells. However, the VC contains large quantity of primary micropores of less than 1 nm in diameter, and many Pt nanoparticles trapped in the micropores were not involved in the electrochemical reactions on electrodes due to the absence of the triple-phase boundaries. In this study, hollow core/mesoporous shell carbon (HCMSC) has been fabricated through inverse replication of solid core-mesoporous shell silica templateand explored to support Pt cathode catalyst with high metal loading in PEMFCs. HCMSC existing as a discrete spherical particle has unique structural characteristics such as large specific surface area and mesoporous volume and well-developed 3-D interconnected multimodal porosity composed of a hollow macropore (~ 300 nm) in combination of mesopores (3.7 nm) in the shell, which make it an ideal candidate as a catalyst support for PEMFCs. In particular, in this work, urea was used as a precursor of precipitating agent in the preparation of HSCMS-supported Pt particles. The urea-assisted homogeneous deposition-precipitation (HD) method permits the in situ gradual and homogeneous generation of hydroxide ions through the urea hydrolysis, which allows slow and homogeneous deposition of active Pt phase onto an existing support. A polyol process using ethylene glycol (EG) as a precursor of the reducing agent was adapted to reduce Pt species deposited on the HCMSC. Interestingly, Pt NPs deposited on HCMSC by the HD-EG strategy show smaller Pt particle size with more uniform dispersion, enabling higher Pt utilization efficiency, and considerably improved fuel-cell polarization performance with 30-50 % higher power density compared with the Pt NPs prepared by conventional sodium borohydride reduction approach. Particularly important and significant is that this HD-EG method is very efficient for the synthesis of high Pt loading catalysts with tunable NP size and uniform particle dispersion.

SDWS2011.0506 Thermodynamic Basis of Thermo-Chemical Energy Systems and Fuel Cells

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Abstract

This research treats the power yield maximization for energy converters, such like thermal, solar and electrochemical engines (fuel cells). A common methodology is developed for the development of power limits in thermal systems and fuel cells. Thermodynamic analyses lead to converter's efficiency and limiting power. Steady and dynamic systems are investigated. Static optimization of steady systems applies the differential calculus or Lagrange multipliers, dynamic optimization of unsteady systems uses variational calculus and dynamic programming. The primary result of the first is the limiting value of power, whereas that of the second is a total generalized work potential. The generalizing quantity depends on thermal coordinates and a dissipation index, h, i.e. the Hamiltonian of the problem of minimum entropy production. The developed thermodynamics, of irreversible nature, implies stronger bounds on work delivered or supplied than the classical work of thermodynamics. It is shown how various analytical developments can efficiently be synthesized in order to evaluate quantitatively power limits in linear thermal systems and fuel cells.

SDWS2011.0217 Darrieus Water Turbine with Active Control of Blades – Prospective Renewable Power Generation Device for Slow Moving Water

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Abstract

Darrieus Water Turbine with Active Control of Blades –

Prospective Renewable Power Generation Device for Slow Moving Water

Dr. Prof. Stanislav O. Dovgy *, Dr. Volodymyr P. Kayan *, Oleksy G. Lebid **

The focus in sustainable energy is mainly on wind, solar, biomass, geothermal and energy of water, which covered 70% of our earth surface. As the main method of reception of energy from water is used osmotic energy of water pressure on barrages and dams. At the same time recycling of energy of slowly moving water, made by highly efficient water turbines, is a promising new source for renewable energy.

It is known, that blades active control of vertical axis wind turbine (Darries type) on a circular trajectory of blades movement allows to raise considerably an overall

performance of such turbine, especially at small velocity of incoming flow. Application of such turbines both with vertical and with a horizontal axis of rotation, especially in rivers with slowly moving water and in tidal currents can be rather effective.

Performance researches of vertical axis water turbine (VAWT) models in hydrotray at flow velocities V=0.4 – 0.7 m/sec were carried out. The model has 3 blade long 0.3m with chord 0.05m of symmetric airfoil NACA0015. Radius of blades rotation equal 0.0875m. The mechanism for control of blade pitch angle against a tangent to a trajectory of blade circular movement included the additional disk with a circular groove (mechanism " I ") or specially profiled groove (mechanism " II ") placed under the bottom disk crosspiece of VAWT model. In first case the control disk could move streamwise with respect to central axis of rotation of VAWT model, in second case - the control disk made angular movings against this axis.

The VAWT model operated at tip speed ratio $\lambda p = 1.1 – 1.6$ and we obtained the maximal values of power coefficients Cp = 0.24 (mech. " I ") and 0.28 (mech. " II ") at V=0.5 m/sec and Cp = 0.26 (mech. "I") and 0.34 (mech. "II") at V=0.7 m/sec against Cp = 0.15 – 0.17 for VAWT model with fixed (no controlled) blades. It is shown, that for each magnitude of flow velocity V and tip speed ratio of VAWT is the optimal magnitude of control disk shift when the maximal value Cp is reached (for mech. "I"). It is shown also, that at change of flow velocity the turn of the control disk with profiled groove round the central axis of VAWT model (for mech. " II ") on some angle concerning optimum position of profiled groove allows to support the maximal value of coefficient Cp.

Simplicity and adaptability to manufacture of a VAWT design with a turbine of such type allow to use them not only in tidal currents but also to place them in the rivers and water channels with slow moving water.

SDWS2011.0364 Efficient Utilisation of Coal by Integrating Various Industries

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Abstract

Natural gas, petroleum and coal are hydrocarbons with significantly different molecular weights and hydrogen to carbon ratios. Among the three conventional fossil fuels, coal is the most abundant and the cheapest, while petroleum is a most desirable fuel resource because it is easily processed into valuable petroleum products, especially gasoline and diesel. How to utilise coal resources, especially as a replacement of petroleum, is an important topic.

Significant resources have been devoted in research and development of technology for production of petroleum substitute from coal. There are three technical routes to

convert coal into petroleum substitute: Fischer-Tropsch (FT) process, direct coal liquefaction by hydrogenation, and pyrolysis. Among them, pyrolysis is a simple process with mild reaction conditions and low capital investment, but is with the disadvantage of a relatively low yield of total gas and liquid, below 50%. The main problem for a large scale commercialisation of this technology is an efficient utilisation of the liquefaction residue, i.e. char.

Integration of various industries can provide an ideal solution for efficient utilisation of coal. This includes processing coal by pyrolysis with production of liquid and solid fuel products, which can be further processed into final products in petroleum refining/petrochemical industry. The solid char generated in coal pyrolysis can be used in metallurgical industry, especially for injection in blast furnace ironmaking process. Char can also be used as fuel for power industry by replacing coal.

Current blast furnaces and coal fired power generation plants use pulverised coal as fuel. Using pulverised char to replace pulverised coal will provide the following advantages to these processes: (1) saving energy of coal grinding and enhancing combustion efficiency; (2) increasing the safety of the pulverisation operation and pulverised char storage, and making the transport of the carbonaceous materials more reliable; (3) potentially, replacing pulverised coal injection by injecting char may make blast furnace operation more stable and more productive; (4) increasing the completeness of combustion of carbon.

Integration of various industries in coal utilisation provides a route for efficient utilisation of coal resources which does not need high investment in technology development and building up new plants, and will generate significant economic benefits to the industrial operators. This is especially important when the related industries are under the pressure of increasing their operation costs under the Carbon Trade Systems.

Waste to energy

SDWS2011.0112 Investigation on the Reburning Process Using Sewage Sludge-Derived Syngas for Nox and CO2 Emission Control

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Abstract

The traditional disposal methods of sewage sludge are land filling, cropland application and incineration; however, the drawbacks of these methods are environmental pollution (from heavy metals to pollutants emission). Owning the concerns about global warming, interests in the use of sewage sludge as an energy source has been investigated because the energy production from biomass is a carbon - neutral process. Gasification provides an attractive alternative for the treatment of sewage sludge in a more economical and more efficient way with the volume reduction and minimized environmental impact. Gasification of sewage sludge can provide clean and effective reburning fuel for combustion applications.

The motivation for this work was to define the reburning potential of sewage sludge gasification gas. The approach for this work included modeling to identify the main process parameters that affect the efficiency of NO_x reduction.

Two sewage sludge gasification gases were considered. Numerical simulation of co-combustion process of these gases in hard coal-fired boiler has been done. All the calculations were performed using the Sandia Chemkin Interpreter Package program Plug-Flow Reactor. The calculations were modelled using GRI-Mech 2.11 mechanism. This version is relevant to analysing reburning process. Flue gases were mixed with the reburning fuel. The molar flow rates ratio of reburning fuel is assumed to be 5%, 10% and 15% of the whole exhaust. The simulations were conducted for constant pressure equal to 1 atm, for temperatures range from 600 K to 1400 K and typical residence time 0.0-0.4 s. It was assumed that a flue gases which enters into the reburning zone contains 300 ppm of NO and that during combustion only NO is formed without other NO_x.

The highest NO conversions are obtained at the temperature about 1000-1200K. The highest reduction efficiency (about 90%) was achieved for the molar flow ratio of reburning fuel equal to 15%. The highest NO reduction occurs at 0.01-0.2 s and then it can be generally said that NO concentration remains almost constant. At the air excess ratio equal to 1, there is no influence on the NO reduction. The most intensive is observed for the range of air excess ratio equal to 1.1.

The combustion of hard coal with sewage sludge –derived syngas reduces CO_2, NO emissions and amount of coal needed to produce electricity and heat. Advanced reburning, which is a more complicated process gives efficiency of up to 80%. Calculations show that sewage sludge – derived syngas can provide better results.

SDWS2011.0285 Characterization and Environmental Analysis of Steel-Making Residues as Cement Manufacturing Feedstock

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Abstract

Steel-making process generates large quantities of non-uniform mix of compositional wastes during its different stages. The growing amount of these wastes justifies the efforts to find a technical and economically advantageous process to handle it all, reducing its environmental impact. The modern steel-making industry favors the use of Electric Arc Furnaces (EAF) above the traditional technique called Blast Steel Furnace (BSF), e.g. in Spain in 2009, 78% of steel was produced with the EAF process.

This paper is focused on the physicochemicalcharacterization of the main by-products or wastes of EAF process namely, steel-making slag, metallurgical ladle slag, milling scale and mud coming from the treatment of the water use in the refrigeration system, for their substitution as clinker or cement raw materials.

On the other hand, an evaluation of the environmental performance of cement production using these new materials, working with the life cycle assessment methodology, is presented. The inputs and outputs of each studied waste have been defined and the inventory emissions calculated by SIMAPRO v 7.2 have been classified into impact categories; non- energy sources, final solid waste as hazardous and non-hazardous, global warming and human toxicity. Two scenarios were compared: the first one corresponds to the existing cement production process and the second one represents the production using selected EAF process by-products.

Results show significant technical and environmental improvements in cement manufacturing taking into account the physicochemical characteristic of the studied steel-making by-products, who allow the substitution of raw materials achieving the same quality cement in a more sustainable way. In addition, life cycle assessment has allowed obtaining an important contribution achieving the minimization of the waste generated during the steel-making process allowing a “zero waste steelmaking industry”, and the reduction of energy consumption for cement manufacturing.

SDWS2011.0336 Application of ORC-process for Landfill Gas CHP-Efficiency Optimisation

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Abstract

Motivation:

Modern waste treatment is divided into several unit processes especially designed to reduce the adverse impact of the waste fraction in question. However unit processes like composting, anaerobic digestion, landfilling and waste water treatment are linked to each other with the fact that they are normally very energy intensive and therefore have to be connected into some kind of energy network. Mainly electricity and heat are required both in solid waste management and in waste water treatment processes. Simultaneously waste treatment produces valuable fuel gases either from statutory landfill gas (LFG) collection or from anaerobic biowaste digestion. Utilisation of these fuel gases in energy production instead of flaring can in some cases lead to total independency from bought energy. Being also CO2 neutral fuel LFG and other biogases are becoming even more interesting in renewable energy production. In Finland the State is issuing a bill on the production subsidy for electricity production based on biogas. This feed-in type tariff gives operators extra income if heat is being utilised to reach higher overall CHP efficiency

Since waste treatment facilities are often situated at the outskirts of towns and cities they are usually not connected into any district heating networks. Therefore electricity production (f.ex. in gas engines) instead of more energy efficient CHP production is often favored. This means that the valuable energy retained in the form of heat is often lost and have to be discharged. With rising energy prices and modern technical solutions it is becoming profitable to utilise this waste heat in different waste management unit processes. Low temperature waste heat from exhaust gases can be used for additional electricity production. Engine cooling waters can be used in landfill leachate and other waste water treatment processes. Remaining heat can be delivered into local district heating network for utilisation in space heating or biowaste treatment processes as process heat.

Task:

CHP efficiency of biogas collected from a MSW landfill is evaluated in a case study. Efficiency optimisation possibilities are studied in an existing 15 MWe LFG fired power plant application before and after introduction of waste heat recovery systems for both exhaust gases (ORC-process) and engine cooling waters (DH-system).

Objective:

Energy need of existing and planned unit processes within a waste treatment area are evaluated. Based on the latest technological possibilities a unit process selection is suggested where the optimum annual CHP efficiency can be achieved by utilisation of electricity and waste heat formed in LFG utilisation. Limit prices are determined where

waste heat utilisation becomes profitable f.ex. in on site waste water treatment, compared with treatment in municipal waste water treatment plant.

SDWS2011.0472 Cost-Effectiveness of Measures for GHG Emission Reduction and Energy Recovery in Waste Management in Croatia

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Abstract

By implementing the measures of greenhouse gas (GHG) emission reduction and energy recovery in the waste management in Croatia a number of energetic, environmental and economic benefits can be accomplished. By utilizing municipal solid waste (MSW) and landfill gas as fuel in industry and energy sector, a substantial reduction of GHG emissions could be achieved. The other benefit is the energy recovered from such waste that could be, at least in that part of MSW of organic origin, considered as a renewable energy source.

This paper investigates an economic side of the implementation of these measures in order to determine the priority between them. The cost of each emission reduction measure is expressed as the total annual cost of that measure, which is calculated by amortising the present value of the total cost stream. Respecting cost-effectiveness, marginal costs (expressed as EUR per ton of reduced or avoided CO_2eq) were then calculated. Marginal costs were calculated for the following measures: Utilization of landfill gas for electricity production, Utilization of refuse derived fuel (RDF) in cement industry, Landfill gas flaring, Thermal treatment (Incineration) of MSW, and Mechanical-biological treatment. Based on these costs a marginal cost-reduction potential curve is plotted. The potentials given in the curve are maximum achievable potentials of GHG emission reduction with defined measure implementation dynamics that follows national strategies and plans of waste management and climate change mitigation. It was calculated that around 1 million ton of CO_2 can be avoided in 2020, which is 2.1% of projected GHG emissions in Croatia while the energy that could be recovered from waste is 8.34 PJ in 2020, which is about 3% of the total final energy consumption in Croatia (in 2008).

The measures Utilization of RDF in cement industry and Utilization of landfill gas for electricity production showed a greatest economic benefit.

Since the marginal costs significantly depend on different parameters that could change, a sensitivity analysis that considers cost-effectiveness of measures was also done for some of the main influential parameters such as: gate fee in waste-to-energy plant

(Thermal treatment), a price of RDF for utilization in the cement industry, and the share of methane in the landfill gas in production of electricity in gas engines.

SDWS2011.0632 Modeling, Optimization and Scale-Up of Waste Tire Pyrolysis

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Abstract

The development and growth of vehicle industry represents a major environmental hazard worldwide. The problem of handling waste rubber and scrap tires, which is known from the beginning of the wide-spread industry, has increased to such an extent that it gave rise to new ideas for rubber and tire use. Until recently, the tires have been mainly deposited in landfills and used in the manufacture of asphalt, artificial reefs, river barriers, etc. In the last two decades the thermal decomposition or pyrolysis of waste tires was explored, because of their high calorific value. Increasing oil prices and increasingly stringent environmental regulations regarding the handling of waste tires have accelerated pyrolysis research and the development of various technologies for thermal degradation. Research has also extended to other materials with high calorific value such as waste biomass and fossil materials (bio- and alternative fuels). Our research was primarily focused on optimizing the pyrolysis process in a batch reactor. Therefore the kinetics (utilizing thermogravimetry (TG) and differential scanning calorimetry (DSC)) of waste rubber and tire pyrolysis, heat and mass transfer in a packed bed were studied. Experiments were carried out on a laboratory (1.6 L) and pilot scale. The process was carried out over the temperature range of 20–550 °C at different h eating rates, under the vacuum conditions of 200 mbar, and lasted for approximately 3 hours. Temperature, gas and liquid product flow and the mass loss of tire particle-packed bed were monitored and measured on-line. These measurements were necessary to determine in which manner these parameters affected the process of pyrolysis and which ones were the most important for setting-up the mathematical model of the process incorporating heat and mass transfer. Acknowledging literature, a basic model, which has been upgraded according to the mentioned parameters, was set-up. In the end a comparison between theoretical and experimental data was made based on laboratory and pilot scale in order to find out principal scale-up criteria for industrial plant.

SDWS2011.0398 Bio-Oil Production from Waste Furniture Saw Dust Via Fast Pyrolysis

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Abstract

The amount of waste forest generated in Turkey is around 18 million tons and the amount of waste wood is around 8 million tons in a year, which can be used for renewable energy or fuel feedstock production. Fast pyrolysis is an effective technology for conversion of the waste wood into mostly bio-oil. Quality of the bio-oil and its yield are highly dependent on reaction conditions. In this study, fast pyrolysis of waste furniture saw dust (pine sawdust) was investigated under various reaction conditions (reaction time, pyrolysis temperature, heating rate, and residence time) in a tubular reactor. The optimal reaction conditions for increased yields of bio-oil was found as reaction time of 5 min., pyrolysis temperature of 500^{o}C, heating rate of 300 ^{o}Cmin^{-1} under nitrogen flow rate of 400 cm^{3}min^{-1}. Pyrolysis oils were characterized by using instrumental analysis. According to the experimental and characterization results liquid products were found to be compatible with petroleum fractions.

Water resources II

SDWS2011.0450 **Water Pollution and Health Impact in Urban Tibet**

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Abstract

This interdisciplinary study of the political ecology of urban water use in Darchen, Tibet analyses the relation between water management, health issues, and urban design in the context of a fast-expanding and globalising tourism-based economy. The qualitative change in the water management regime in this locality induced by the combined forces of urbanisation and neoliberalisation is an instance of the Asia-wide process of water management 'modernisation' that this research programme addresses. Darchen is a small town situated at the foot of the holy mountain Kailash, which lies near the source of five of Monsoon Asia's most significant rivers. The town has been expanding steadily over the last decade through the growing influx of pilgrims and tourists, which is expected to increase exponentially in the next few years. Concomitant economic growth is causing significant lifestyle changes for the local population. However, the town, situated in a semi-arid region, is already facing serious environmental issues due to lack of water and sanitation infrastructure, and the way the society is utilizing limited water resources. Problems include inadequate supply of drinking water, water pollution, lack of waste water and solid waste management, and rubbish dumping in rivers. These are mapped using Geographic Information Systems. It is found that water resources used for drinking water are being polluted by lack of adequate sanitation infrastructure. Further, inhabitants face a number of health issues, which may be related to inadequacy and pollution of drinking water. In policy terms, the study seeks to suggest urban design solutions appropriate to tackling the water management problem, on the premise that analysis of health issues may visualize to decision makers the advantages of urban infrastructure investment enabling adequate and clean drinking water supply – a trigger with historical precedent. The research can inform Eco-town models for the development of other towns in the region as a visioning of alternative water futures.

SDWS2011.0579 Soil & Groundwater Contamination Issues in Malaysia

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Abstract

Soil and groundwater pollution in Malaysia in the past has not been identified as key environmental and sustainability issues in Malaysia. This is true since only a few cases of environmental and human health incidents have been reported. In addition, previously Malaysia does not have significantly huge industries that yield considerable amounts of hazardous waste that would have been the root of serious environmental disasters. Thus, currently there is no specific law to deal with soil and groundwater contamination. The same applies to soil or groundwater quality standards. In addition, Malaysia has yet to enter into any bilateral or multilateral international agreements or arrangements concerning groundwater resources, concerning quantity and quality of groundwater or otherwise.

However with increasing demand of groundwater for agricultural and drinking water use, there is a need to look on soil and groundwater contamination as an important environmental and human health issue. This emphasis is enhanced by massive urbanization, modernization and the ever increasing industrial activities. As such The Department of Environment (DOE), Ministry of Natural Resources and Environment have proposed to formulate soil and groundwater regulations in the 9th Malaysia Plan (a period between 2006 and 2010). In addition, one of soil and groundwater contamination's biggest contributor, i.e. landfills was also recently given prime attention by the setting up of Department of National Solid Waste Management and Solid Waste and Public Cleansing Corporation in the Ministry of Housing and Local Authorities.

This paper highlights and analyzed some main issues related to soil and groundwater contamination in Malaysia. This field is actually very far from maturing in Malaysia. Discussion will be based on technical and legislative aspects such as waste management systems and landfilling practice (including waste generation data), groundwater, site remediation and legislative issues. Thus, waste management systems and landfilling practices will also be discussed in detail. Both issues continue to play marked role in contributing to soil and groundwater pollution due to the recent increase in the amount of solid waste generated. Groundwater issues are incorporated to demonstrate that although its full potential is not currently tapped in Malaysia, it remained an important and strategic natural resource. Site remediation will be briefly mentioned followed by a case study on a landfill to show some problems near unengineered sites. Finally, the paper will further deal with some of the regulations currently available which is related to soil and groundwater contamination.

SDWS2011.0111 Estimation of In-Situ Groundwater Conditions Based Upon the Geochemical Equilibrium Simulation

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Abstract

In-situ groundwater conditions are essential for environmental assessment for radioactive waste disposal or CO_2 sequestration since they affect migration properties of metal or chemical species. The water condition data has been obtained by pumping up at an fixed section in a borehole, measuring physico-chemical parameters and sampling on the surface and analysing at the laboratory. A newly-developed in-situ measurement method has recently revealed that the existing method data has not represented in-situ pH and oxidation-redox potential (ORP) as important parameters for species migration analysis. On the contrary the former requires much more cost and time compared to the latter.

This paper presents a method by which the in-situ groundwater conditions would be estimated in use of data obtained with the existing method. It estimates groundwater pH and ORP under in-situ temperature and pressure by means of geochemical equilibrium calculation on the basis of the existing data as an input including physico-chemical parameters of groundwater pumped up, ion contents, gas/water ratios and gas contents. A code of PHREEQC, which was developed by USGS, was applied for the equilibrium simulation. The equilibrium calculation was iterated by dividing temperature and pressure from the surface condition to the in-situ.

This estimation method was applied to a pumping test with an approximately 600 m deep test interval in a 1000 m deep borehole which was performed as one of borehole investigations in the course of Horonobe Underground Research Laboratory Project in Japan,. The result is that measures and estimates of in-situ pH and ORP were 6.20, 6.20 and – 166 mV, -174. Since the estimates are in good accordance with the measures, the method was concluded to estimate the in-situ pH and ORP.

This method was also applied to other existing pumping tests at the same site to estimate distributions of the in-situ pH and ORP. The in-situ pH estimates show a tendency for acidification with depth, which is coincident with a result that deeper groundwater contained more free CO_2 gas. The in-situ ORP estimates are stable, approximately -200 mV under some hundreds meters depth, which is the general tendency that chemical atmospheres are reductive in the underground. It represents that this method could estimate the distrbution of the in-situ groundwater physico-chemical parameters.

This method was applied to approximately 70 points selected in the groundwater database of Japan and dominant redox reactions were analised. The in-situ estimates of pH and ORP were plotted on an equilibrium curve of FeS_2 and sulfate, which implies that some of the groundwaters in Japan would be governed by a redox couple of FeS_2 and

sulfate. It suggests that this method could help estimate the in-situ redox reaction governing the water conditions.

SDWS2011.0245 The Comparison Between Water Quality Monitoring by Normal and Extreme Runoff Conditions

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Abstract

The aim of the study was to describe and compare the water quality parameters´ values (nitrate, ammoniac, phosphate and suspended solids) and runoff data during normal water level conditions and extreme rainfall-runoff events. The study explains the interactions between the concentration changes in surface waters and discharge dynamics during extreme rainfall-runoff events and during normal hydrologic conditions.

The study was carried out in two catchments in different conditions of the Czech Republic. These two localities differ in the land use type – the first one is typical arable land and the second one is used as pasture.

There will be presented results proving that extreme rainfall-runoff conditions are great contributor to the total amount of nutrients and sediment loss during the year. Also there will be mentioned the impact of land use type in particular localities, where the research was done. We also tried to compare the relationship between ammoniac and nitrate ions concentrations during normal and high water level conditions. The main result indicates the very strong contribution of the extreme rainfall-runoff events through the year to the total amount of nutrient and suspended solids loss. Also it is possible to state that the theoretical calculated loss of the suspended solids is 20x lower than the real one.

As the conclusion it is possible to claim that just the monitoring of nutrient and sediment loss by normal water level conditions is insufficient and to have the truthfully results about the soil particles loss and about the loss of other components as fertilizers, it is necessary to supplement this type of monitoring by the monitoring during the extreme conditions.

This article is based on results of grant of Ministry of Agriculture of Czech Republic QI91C200 Evaluation of complex land consolidation realization efficiency.

SDWS2011.0966 Utilization of Standardised Precipitation Index(Spi),palmer Drought Severity Index(Pdsi) and Reconnaissance Drought Index (Rdi) as Drought Indicators in South Bulgaria

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Abstract

During the last decades an increase of the number of extreme natural events has been observed all over the world. Drought in Bulgaria has been in details studied by many researchers, but being a problem of vital importance, is continuously considered with enhanced attention. Drought in South-eastern Europe is among the extreme events, which might have significant negative impacts on the socio-economic sectors. 50-years time series of precipitation, collected from 20 weather stations located at the Maritsa and Tundja river basins (South Bulgaria) are used for Standardised Precipitation Index, Palmer Drought Severity Index and Reconnaissance Drought Index calculation with the purpose to detect drought periods and intensity. Some trends in drought frequency are analyzed. A comparison between Standardised Precipitation Index (SPI), Palmer Drought Severity Index (PDSI) and Reconnaissance Drought Index (RDI) is also done in order to assess applicability of these indices for the regional climatic conditions. This study is implemented under the activities dedicated to the Drought Management Centre for Southeastern Europe.

SDWS2011.0055 Seasonal Changes of Free Surface Water Quality in Northern Zone of Persian Gulf

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Abstract

Persian Gulf as an important biological aquatic basin which is located in Middle East and joints via Hormuz Strait to the Oman Sea and Indian Ocean, has been utilized for not only fishery and shipping; but also, commercial and tourism purposes, extensively. Meanwhile, tide, wind, precipitation, solar radiation, and evaporation are main phenomena regarding the oscillation trend of water quality variation in mentioned basin. Moreover, the flow entrance from Arvand River to the Persian Gulf influences aforesaid phenomenon, thoroughly. This research bases on Mt. Mitchell statistics collected in NOAA research vessel investigation through the Persian Gulf, Strait of Hormuz, and Gulf

of Oman. In addition, investigating the variation of shallow water conditions in aforesaid aquatic basin; we analyzed the regional observations and measurements in comparison with the outputs of a numerical model which has been developed based on Navier Stokes partial differential equations. The results show that baroclinicity and stratification of fluid column are two important events occur and change in Persian Gulf, seasonally. Based on our obtained results, creation of turbulence; and consequently, diffusion of internal waves originate from both occurrence of thermocline through the water environment and variation of this event in space and time. Just the same, this study focuses on effective parameters and elements in creation of thermocline and the related influences of flow entrance from Arvand River. According to the results, we are convinced about creation and existence of more baroclinicity and turbulence in northern coasts of this aquatic basin in comparison with deeper parts; and this event originates from effects of internal flow from Arvand River, related bed stresses and situation and direction of wind sources.

Energy systems II

SDWS2011.0692 The Influence of Gaseous Fuel Composition on Characteristics of the Components of Integrated Gasification Combined Cycle

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Abstract

Exacerbation of the environmental standards within the European Union favours the development of the electricity market based on the use of clean technologies. In Poland, the primary energy fuel is coal, and therefore among the most interesting technologies for investments are enumerated mainly: supercritical coal power plants, IGCC systems and power plants that uses oxy-combustion technology. The paper presents the results of the studies on the use of synthesis gases rich in hydrogen in the gas turbine installation. The motivation for the direction of research is future-oriented character of the IGCC system integrated with carbon dioxide capture before combustion. In these systems, additionally, there is a need for a shift reactor to convert carbon monoxide into carbon dioxide. Different composition of synthesis gas in relation to the commonly used natural gas influences the nature of the conversion process within the gas turbine and the heat exchange in the heat recovery steam generator. Relationships describing changes in relation to nominal values for the most important variables determining the performance characteristics of the gas turbine and of the heat recovery steam generator are presented. The paper presents the results of the calculations made for the assumed structures of the combined gas-steam cycle. Gas turbine with capacity of around 200 MW, double-pressure heat recovery steam generator and extraction-condensing steam turbine were used in the system. The model built in the GateCycleTM software was used to generate the thermodynamic characteristics. Within the framework of the work sensitivity analysis of the basic thermodynamic parameters on the change of the synthesis gas composition were performed.

SDWS2011.0710 Modelling the Impacts of Electric Vehicle Charging in the Single Electricity Market

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Abstract

European Union (EU) Directive 2009/28/EC mandates each Member State to ensure that 10% of transport energy (excluding aviation and marine transport) comes from

renewable sources by 2020. In addition, Ireland's target under EU Decision 2009/406/EC on effort sharing with regard to reduce greenhouse gas emissions (GHG) from sectors not included in the EU Emission Trading System is to achieve a 20% reduction in GHG emissions by 2020 relative to 2005. Energy use in transport accounted for 43% of Ireland's total final energy demand and 36% of energy-related carbon dioxide emissions in 2007. Therefore the challenge is considerable but the Irish Government intends to achieve some of these targets with a number of policies including an increase in the use of biofuels in transport by 3% by 2010 and ensuring that 10% of all vehicles in the transport fleet are powered by electricity by 2020. In this paper the impacts of 10% Electric Vehicle charging on the single wholesale electricity market (SEM) for the Republic of Ireland and Northern Ireland is examined. The energy consumed and the total carbon dioxide emissions generated in the SEM is quantified using the wholesale electricity market model called PLEXOS.

SDWS2011.0744 Carbon and Environmental Footprinting of Low Carbon Uk Electricity Transition Pathways to 2050

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Abstract

Electricity generation contributes a large proportion of the total greenhouse gas emissions in the UK, due to the predominant use of fossil fuel (coal and natural gas) combustion for this purpose. Carbon and environmental footprint analysis has been employed to estimate the environmental impacts associated with UK power generation based on historic data and alternative energy scenarios out to 2050. The British Government has set a legally binding target of reducing the nation's CO_2 emissions by 80% over this timescale in comparison to a 1990 baseline. Historical electricity consumption data was available from national statistics for different fuel types over the period from 1950. In order to determine future trends in the power sector footprints, a range of future energy scenarios were adopted that had previously been developed for the UK SUPERGEN Consortium on 'Highly Distributed Power Systems' (HDPS) by Jardine and Ault [Proc. Instn Mech. Engrs Part A: Journal of Power and Energy, 2008, **222** (7): 643-655]. The original aim of these scenarios was to study the potential for extensive penetration of micro-generators into the British electricity network. They were characterised as 'Business As Usual' (BAU), 'Low Carbon' (LC) and 'Deep Green' (DG) futures, and yielded possible future electricity demands to 2050.

Methodologies were established for the present study to calculate the environmental and carbon footprints of the UK electricity industry on both a historic timescale and in accordance with the HDPS scenarios. These were consistent with that developed by the

Global Footprint Network and related bodies. The environmental footprint was broken down respectively into carbon (effectively cf), embodied energy, transport, built land, water, and waste components. ef was then calculated on an annual basis from 1950-2050. Uncertainties related to both footprints were estimated using an established procedure for uncertainty analysis (formally adopted by the ASME Journal of Fluids Engineering). It was found that the current environmental footprint as a result of UK electricity supply and demand is 41 million gha, with an estimated uncertainty of ±4%. If future trends follow the HDPS BAU scenario this footprint in 2050 is predicted to fall to about 25 million gha (±3%), whereas both the LC and DG scenarios lead to footprints of less than 4 million gha (±5%). The latter two scenarios were found to give rise to quite similar pathways out to 2050. It is argued that the latter two scenarios are likely to be the most effective transition pathway in terms of meeting the 2050 CO_2 reduction targets for electricity generation, with the 'Deep Green' scenario proving the preferred choice if total decarbonisation of UK power generation were deemed desirable.

SDWS2011.0807 Balancing Wind Energy and Participating in Electricity Markets with a Fuel Cell Population

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Abstract

Motivation and research objective

In addition to reducing CO_2 emissions and fossil fuel consumption, the increase of fluctuating renewable electricity also involves the challenge of providing economically feasible electricity in times of low feed-in. For this purpose, rapidly controllable power plants (e.g. natural gas) can be used. However, a more intelligent interconnection of decentralised consumers and suppliers is also a possibility which, moreover, can also harvest household cogeneration potentials.

The presented research aims at analysing the potential of using a large number of fuel cells for even out the stochastic feed-in of wind power plants. In a second step, additional revenue possibilities by the participation of a virtual fuel cell power plant in electricity markets are analysed.

Methods

For the purpose of analysing potential flexibilities in an energy system with a larger share of decentralised cogeneration, an integrated simulation model of household energy consumption (heat and electricity) with fuel cell heat and electricity production is used. The model is based on test series performed with existing commercial fuel cells (2 CHP fuel cells, 5 kW_{el}, manufacturer: Air Liquide, Electro Power Systems) and artificially produced household load profiles. In a subsequent step, the model is linked with the energy market, i.e. with data about wind feed-in and electricity prices.

Results

Because of the underlying dynamic restrictions of fuel cells, they are not able to cover the household's entire demand for electricity. Within an arrangement of one fuel cell and one household, a yearly residual in a range up to 21.6% will be left over. For arrangements exceeding 11 fuel cells, residuals drop to less than 1%. In assessing the reaction possibility to secondary demand in addition to the households demands, larger populations of fuel cells were considered. Here the results show that the annual load duration curve in one German control area could be flattened for 235 days (5'640 h) on the median wind power level of 29 MW and with a market share of 11%. With the aggregated fuel cell capacity for secondary demand, a yearly amount of coverage in the range of 145 to 200 EUR per fuel cell can be yielded. Participation on the operating reserve market involves yearly amounts of coverage that are 2 to 3.5 times higher than on the spot market.

Conclusions

A population of intelligently operated fuel cells can contribute significantly to reduce volatility of wind energy in-feed to the electric grid. However, the large positive deviations of wind energy in-feed can't be absorbed even if a large market share of fuel cells is assumed. When analysed in monetary terms, the presented results suggest that there is a large demand for system services, especially operating reserve (balancing service), delivered by flexible decentralised generation.

SDWS2011.0643 Changes in Greenhouse Gas Balance and Resource Demand of German Biogas Plants Over a Period of Three Years

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Abstract

Introduction Replacing scarce fossil fuels and reducing greenhouse gas emissions from energy production are the main drivers for producing energy from biogas. However, a closer examination reveals, that greenhouse gas emissions and resource demand of different biogas concepts can vary considerably.

Aim Greenhouse gas emissions and consumption of fossil resources of six modern farm-scale biogas plants were analyzed in detail. Based on a weak point analysis, strategies for reducing the environmental impacts and for optimizing the efficiency of combined heat-and-power production from biogas were derived.

Methods Unlike many other similar research projects that use scenarios, the calculations presented here are based on data from real biogas plants in agriculture. On six biogas installations, material and energy flows were recorded during a yearlong monitoring. Additional data were retrieved from literature only where necessary. The six

biogas plants with diverse design and a mixture of livestock manure and energy crops as input material reflect some of the diversity of biogas installations as it is typical for Southern Germany.

Using the material flow analysis software UMBERTO[â], a detailed material and energy flow network was constructed for each of the biogas plants. All fossil energy resources consumed for construction and operation of the biogas plant were summed up and rated according to their primary energy demand. For calculating a greenhouse gas balance, all relevant emissions were converted to carbon dioxide equivalents.

Results Differences in resource demand between the individual biogas plants originate mainly from different requirements for mineral fertilizer and the source of electric energy for operating the plant. Compared to the energy consumption during the utilization phase, the consumption of resources for biogas plant construction is almost negligible.

If based on energy crops, the main sources of greenhouse gas emissions from biogas production are the combustion of fossil fuels (carbon dioxide) and the production of mineral fertilizers (carbon dioxide and nitrous oxide). Biogas production based on treatment of animal manure receives a credit for avoiding methane emissions during conventional manure storage. Due to their high global warming potentials, relatively small emissions of methane and nitrous oxide have a major influence on overall greenhouse gas emissions of energy supply from biogas. The energy and greenhouse gas balances of biogas systems can be substantially improved by providing as much heat energy to external consumers as possible. Our results contribute to a better evaluation and effective reduction of the environmental impacts of energy supply from the renewable resource biogas.

SDWS2011.0428 Evaluation of Some Characteristics of the Crude Oil Light Products Originating from the Main Oils Wells in Albania

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Abstract

For the evaluation of some characteristics of the light oil products originating from the main oils wells in Albania, two samples of each technological oil plant were employed. The evaluation of the above mentioned oil samples is based on the physico-chemical characteristics of the crude oils, on their respective by products as well as the potential of light products content and other burning compounds, in compliance to the Albanian State Standards (SSH 34:1986 – SSH 44:1986). All the analysed crude oil

samples were acquired from the technological decanting plants prepared for marketing. Due to the high water content of these samples (higher than the max allowed limit), the thermo-chemical decanting was performed at 120-140°C under pressures up to 10 atm, utilizing hermetical retorts. In dependence of the oil-water emulsion strength, small amounts of de-emulators were employed to separate the water content from the crude oil samples up to 0.5-0.6%. The later, was suitable for the investigation under the primary distilling apparatus TBP. All the considered samples from each crude oil well were submitted for the determination of the qualitative physical-chemical characteristics such as: the density, the water content, the mechanical residues content, sulphur and vanadium content as well as the potential content of light products. The fraction with the boiling temperature 200°C (petrol) was obtained under atmospheric pressure, while the distillation of the fraction with the boiling temperature 200 - 350°C (gasoil) is carried out under vacuum, at approx. 10 mm Hg. The light fractions content of crude oil originating from the existing oil wells, which make the focus of our research, is done according to some variants referring the nature of the aimed final product (the bitumen production; heavy fuel oil production; coke production from bitumen or heavy fuel oil). The evaluation of the actually obtained characteristics revealed a decrease of the potential light fraction content in comparison to the years 1980 – 1990. This difference was up to 2 – 4%.

Carbon capture and storage/sequestration

SDWS2011.0187 The Effect of Retrofitting Portuguese Fossil Fuel Power Plants with Ccs

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Abstract

The resource mix in Portuguese energy sector reflects the country´s heavy dependence on fossil fuels, mainly for electricity generation. In 2010 47.5 % (23.7 TWh) of electricity in continental Portugal was generated by fossil fuel power plants (23.9 % coal-fired, 23 % natural gas-fired and 0.6 % fuel-oil-based). The objective of present work is to investigate the possibilities of CO_2 reduction in the electricity sector in Portugal by implementation of the carbon capture and storage (CCS) technology. The study considers CO_2 capture on both, coal and natural gas power plants. The IECM (Integrated Environmental Control Model) is used to analyze these Portuguese fossil fuel power plants and to provide a systematic techno-economical analysis indicating the cost of emission control equipment, reduction in greenhouse gas emissions and other key parameters which may change when a CO_2 capture unit is implemented into a fossil fuel power plant. Among the existing technologies, this work employs a monoethanolamine-based (MEA) system for post-combustion CO_2 capture, since it is a commercially established technology. Recently the IECM has been expanded for evaluation of the pipeline transportation for CO_2 and costs for potential storage possibilities. In Portugal there are suitable geological formations that can be used as CO_2 storage sites. Our cost analyzed system includes geological storage of high-pressure liquefied CO_2 in the deep saline aquifers. The length of the pipeline to the basin has been defined by crossing large point CO_2 sources and potential geological storage locations in a created map of continental Portugal in ArcGIS programme. Here presented assessment shows the effect of CCS at each power plant by comparing the performance and cost with and without CCS. The addition of CCS increase the cost of electricity, compared to a plant without CO_2 capture, however CCS can be economically viable if CO_2 taxes are high enough. The study demonstrates the breakeven price for each power plant and specifies power plant configuration and its capability to assess the performance and cost of carbon constraints like CCS and CO_2 price.

SDWS2011.0218 Regional Capacity Estimates for Geological Storage of CO2 in Deep Saline Aquifers – Upper Miocene Sandstones in the Sw Part of the Pannonian Basin

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Abstract

Deep saline aquifers –formations of porous and permeable rocks deeper than 800m, are regarded as the most promising objects for CO_2 geological storage, mostly because of their large storage capacities and extensive spatial distribution in most sedimentary basins. The only but important drawback is that these formations have not been as extensively explored compared to the oil and gas fields. That is why present capacity estimations are burdened with the greatest level of uncertainty.

The first estimations of storage capacities in deep saline aquifers within the Croatian part of Pannonian basin were made in FP6 projects Castor and EU GeoCapacity. Methodology was simplified, based on a volumetric approach and with the single average value of thickness, temperature, pressure and porosity used for each of the objects. Therefore, the obtained capacities were only theoretical, with no attempt to delineate the most prospective areas within aquifers and to really define the distribution of the cap rock and reservoir rock properties.

Significant step from regional towards local capacity estimation is redefinition of regional storage capacities applying modified methodology for integrated studies of hydrocarbon reservoirs. The most important aspects of this novel procedure were investigated by detailed mapping of the West Sava aquifer. First, the caprock was chosen based on its depth, thickness and lateral continuity. The target reservoir was chosen in the second phase – the Upper Miocene Poljana sandstone layers underlying the regional caprock. Their depth and effective thickness, as well the subsurface pressure, temperature and resulting density of CO_2 were mapped based on the well data. The aquifer body was then divided into prisms and the storage capacity was calculated for each of these elements. Due to the lack of data concerning the spatial distribution of porosity, the average porosity value from the neighbouring oil fields was used. The resulting map of specific storage capacity shows the areas of greater potential for geological storage, namely parts of the deep saline aquifer that should be further investigated for detailed definition of the potential storage objects.

SDWS2011.0256 Secuestration of CO2 in Supercritical State by Mercury Oxide

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Abstract

Inspired from the physico-chemical properties of supercritical CO_2 and its extended use as an attractive continuous phase for different applications, we employed in our study supercritical CO2 as a reaction medium for a variety of reactions between inorganic species including fairly nonpolar molecular compounds as well as polar, ionic crystalline compounds or merely solid elements. In this course of investigation aiming to obtain mixed valence compounds of mercury from the system Hg_2Cl_2-HgO in supercritical CO_2 using a self made lab-scale system at 200°C, 200 bar for one week, instead of the desired product, $HgCO_3$*2HgO (mercury carbonate oxide) was obtained, as mixture of educts and partly non reacted HgO. The same result was confirmed by a later reaction between pure HgO and supercritical CO_2, although our objective was the formation of mercury carbonate. This revealed the possibility of the synthesis of $HgCO_3$*2HgO even without the presence of water as reported by Bilinski et al. and Schlyapnikov et al. in similar syntheses under atmospheric and higher CO_2 pressures. The presence of small amounts of water in the system Hg_2Cl_2-HgO-supercritical CO_2, under 200°C and 200 bar, yielded the mineral terlinguaite ($Hg_4O_2Cl_2$) and neither mercury carbonate nor mercury carbonate oxide was formed. Repeating the process under the same conditions but in absence of CO_2, brought to the synthesis of same terlinguaite, showing no influence of the of supercritical CO_2 presence in the yield of terlinguaite. The techniques used for the identification of the compounds in solid state were X-Ray diffraction, Raman spectroscopy and IR spectroscopy.

The modern strategy to decrease the CO_2 emissions is based on the injections of CO_2, generally in supercritical state directly into underground geological formations in form of deposits. These underground deposits might get in contact with earth formations containing the above mentioned systems, leading therefore, to the permanent fixation of CO_2 (geo-sequestration) in form of carbonate-oxides due to processes which occur naturally over many years at lower temperatures, or to no CO_2 capturing at all if water is present, due to the higher thermodynamic stability of terlinguaite.

SDWS2011.0265 System Approach to the Energy Analysis of an Integrated Oxy-Fuel Combustion Power Plant

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Abstract

A power plant operating in compliance with the oxy-fuel combustion technology is an integrated system consisting of basic and auxiliary modules. The basic modules comprise: pulverized-fuel or fluidized-bed boilers, water-steam cycle, air separation unit (ASU) and carbon dioxide purification and compression unit (CPU). To the auxiliary modules belong: fuel conditioning, water treatment, air pollution control (APC), module of solid wastes management, cooling water system and conditioning of flue gases (cooling and condensation).

The simulating and optimizing energy analysis may be considered on two levels, viz. the upper level of coordination concerning integrated oxy-fuel combustion power plant and the lower level of technological modules. This permits to apply the decomposition method both in the case of simulation and optimization analysis.

In order to characterize the integrated oxy-fuel combustion power plant the matrix of its structure is to be considered, as well as the vectors of connections with the environment. To be distinguished are: input and output vectors. The elements of the input vector are, among others, fuels, raw and tap water, limestone. To the output vector belong among others, electricity, useful heat, nitrogen, gypsum, solid wastes.

The survey of the hitherto existing conceptions of integrated oxy-fuel combustion power plants have been presented. This is the basic of the proposal all-purpose input-output balance model of energy. The modular structure of the mathematical model permits automatically generating variants of integrated oxy-fuel combustion power plant. In addition the two-levels structure gives a possibility of applying the decomposition procedure. Particular attention in devoted to the possibility of integrated ASU and CPU with thermal cycle concerning both waste heat recovery and electrical connections.

SDWS2011.0355 Ccs Potential in Norway – Exploring the Role of Flagship Projects: the Mongstad and Kårstø Case Studies

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Abstract

For the last 25 years Norway has lead the way for CCS projects globally, conducting top-level research and initiating various pilot projects for CO_2 storage. Recent decisions for a “carbon-free” Norway by 2050 have raised the expectations, also forcing the need

for full-scale plants construction. Following the spirit of those decisions Mongstad and Kårstø flagship projects were initiated.

These two ambitious efforts were halted recently, causing much skepticism on the Norwegian implementation plan on CCS. In this study, an effort for unveiling the reasons for that postponement was made based on the analytical framework provided by the functions of innovation systems approach for technological systems in a regional level. Landscape influences and regime dynamics were also explored in order to understand the current state of the niche region and to interpret to severity of the possible barriers and obstacles.

According to the analysis, the conditions for CCS deployment today are less favorable than in the past. Apart from obvious reasons, like financial burdens due to the global economic crisis, some less clear barriers were identified: "over-optimism" followed by under-estimation of mitigation costs, first-mover disadvantages and a change in the major actor's priorities for investments also influenced the government's decision. What is clear for CCS in Norway is that certain measurements need to be taken if the situation is to change in the future. The steps for market internationalization, combined with an increase in R&D funding related to capture, along with strong policies about CO_2 taxations can provide the starting point for rebuilding a common-trust relationship between the Norwegian state and the public, thus providing CCS "space shuttle" with the necessary propulsion power for its space travel.

SDWS2011.0828 Numerical Study of Accuracy Prediction on Performance of CO2 Absorber Column by Using Various Reaction Rate Coefficients

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Abstract

Carbon dioxide (CO2) is regarded as a major greenhouse gas contributing to global warming. With growing concerns about the environmental impact of greenhouse gas, effective CO2 emission abatement strategies such as carbon capture and storage (CCS) are essentially required to reduce the CO2 emission from a large CO2 source such as a power or cement plant. In post-combustion, CO2 absorption using aqueous solution of monoethanolamine (MEA) has been mainly used for the removal of CO2 from gas stream. Several mathematical models have been proposed to simulate the CO2 absorption processes in the literature. Lawal et al. compared the rate-based approach with the equilibrium-based approach in modeling of the absorber and showed that the rate-based model has a better prediction of the chemical absorption process than the equilibrium-based model.

In the present study, a one-dimensional rate-based dynamic model was used for predicting the performance of CO2 absorber column using MEA solution. The mass-and heat-transfer model based on the two film theory was used to consider the mass transfer flux of each species and the heat transfer between bulk vapor and liquid phase. Henry's law was applied for modeling the vapor phase equilibrium of CO2. The various chemical reactions, such as the main reaction of MEA and CO2, the hydrolysis of CO2 with H2O, the formation of bicarbonate, etc., were considered to understand the thermal behaviors and physicochemical phenomena occurring inside CO2 absorption column. The equilibrium constants proposed by Liu et al. were used. To determine the concentration of each species and temperature distribution along the column height, mass- and heat-balance equations of vapor and liquid phase were coupled with chemical equilibrium and chemical kinetics. The mathematical and reaction kinetics models used in the modeling were validated in the comparison of the simulation and experimental results produced in the present study. Then a parametric

study for the performance of CO2 absorber column using MEA solution was conducted under the various operating conditions, such as CO2 partial pressure in vapor phase, vapor flow rate, liquid flow rate, MEA concentration, CO2 loading of MEA solution, etc. The result showed that an increase of CO2 partial pressure in gas phase raised the amount of CO2 transferred from gas phase to liquid phase. When the flue gas flow

rate was increased at the constant liquid flow rate, the CO2 removal efficiency of absorber column decreased due to the reduced gas-liquid contact time. Meanwhile, an increase in liquid flow rate at constant gas flow rate enhanced the CO2 absorption efficiency in absorber column. As the concentration of MEA in liquid phase was increased, the active concentration of MEA used to react with CO2 was increased. conversely, an increase in CO2 loading yielded the deterioration of CO2 absorption efficiency because of the decrease of the amount of the active MEA in liquid phase.

Biofuels - Algae

SDWS2011.0052 **Production of Biodiesel from Microalgae**

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Abstract

In recent years, biofuels have the prospects of providing alternative substitute to ever increasing demand of conventional fuels. Therefore, there are vigorous research initiatives aimed at developing alternative renewable and potentially carbon neutral solid, liquid and gaseous biofuels as alternative energy resources. However the food grain based ethanol production is constrained due to increased food demand which calls for concentrated R& D efforts to convert lingo cellulosic biomass feedstocks to alcohol. Second generation biofuels derived from lignocellulosic agriculture and forest residues and from nonfood crop feedstocks address some of the above problems; however there is concern over competing land use or required land use changes. Presently biodiesel production using non- edible seed oil crops like Jatropha, pongamia, mahua etc is being given top priority to produce substitute to diesel fuel.

Based on current knowledge and technology projections, third generation biofuels specifically derived from microalgae are considered to be a technically viable alternative energy resource that is devoid of the major drawbacks associated with first and second generation biofuels. Microalgae are photosynthetic microorganisms with simple growing requirements (light, sugars, CO2, N, P, and K) that can produce lipids, proteins and carbohydrates in large amounts over short periods of time. These products can be processed into both biofuels and valuable co-products.

Micro- algae is getting renewed interest for its production with regards to its oil extraction and biodiesel production and it is expected to provide enormous possibility to be used as feedstocks for biodiesel production on massive scale in near future because it does not complete with existing food production issue.

The present paper attempts are made to review the different species of algae having potential of high oil production and technologies used for growing, harvesting and extraction of oil. The work done so far nationally and internationally on biodiesel production issuing algae is reviewed and presented in the paper.

SDWS2011.0136 Green Crude Oil Directly Extracted from High-Moisture Microalgae Without Drying, Cell Disruption, and Heating Extractant

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Abstract

The sustainable supply of renewable biofuel is a global talking point. In particular, microalgae have attracted significant interest as a new generation biofuel resource since corn, soybean, and other crops have many problems in biofuel mass-production, e.g. the influence of weather, slow growth, and competition between food and biofuel production. Microalgae have a high capacity for absorbing carbon dioxide, and consume less water in their life cycle and food chain. However, since microalgae are aquatic plants, a huge amount of water remains, even after agglomeration and mechanical dewatering processes. The algae fuel production process include species selection, microalgae cultivation, recovery of algae fuel (green crude oil), and biofuel refining. The second and third steps are highly cost intensive and environmentally damaging. In microalgae cultivation, recycling of water is required to protect water resources, especially in drought-stricken regions. When recovering algae fuel, significant energy is required for the multiple solid-liquid separation steps which involve drying, cell disruption, extraction by toxic organic solvents such as hexane, chloroform, and methanol, and evaporation of these solvents.

Recently, we proposed a simpler and more energy efficient method which can directly extract green crude oil from high-moisture microalgae. Compared with conventional methods, this method omits drying, cell disruption, and heating of the solvent. In this method, the extractant is liquefied dimethyl ether (DME). This method is conceptualized from our previously proposed energy efficient dewatering method (H. Kanda and H. Shirai, 2002, Patent number – JP 4,291,772 B2; H. Kanda and Y. Urakawa, 2006, Patent number – US 7,803,253 B2) and deoiling method (H. Kanda, 2006, Patent number – JP 4,542,517 B2), based on the following DME characteristics, namely (i) high affinity with oil and partially miscible in water (ii) lower boiling point and moderate pressure at normal temperature (iii) harmless and naturally decomposable. Green crude oil was successfully directly extracted from a mixed-species (mainly Microcystis) natural high-moisture microalgae with high extraction yield by this method. GC-MS analysis shows that a lipid substance was predominant in the extracted green crude oil. The calorific value was 45,790 J/g (H. Kanda and P. Li, 2011, Fuel). Subsequently, this method was tested on several species of natural microalgae, and high extraction yields were achieved, approximately equivalent to the widely-used Bligh-Dyer's method. In addition to green crude oil extraction, this method also showed great dewatering ability for all of these tested spices (H. Kanda and P. Li, 2011, Proc. of World Renewable Energy Congress 2011). Beside these advantages, this method also has the ability to reuse the extracted water for algae cultivation with water resource protection in mind.

SDWS2011.0181 Photochem: Enhanced Micro-Algal Cultivation for High-Value Product Formation

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Abstract

Various micro-algal strains constitute powerful cell factories with high potential for removal of pollutants and even eco-toxins like components of industrial effluent gases and waste water of different origins. Especially their enormous capacity for CO_2 fixation indicates their high potential for diminishing current ecological problems like global warming. Together with these positive environmental impacts, algae provide numerous high-value products, ranging from bio-fuels to pharmaceuticals, nutritional additives and feed.

Low cell densities and low growth rates obtained in classical algal cultivation processes are identified as the major draw-back in cost-efficient industrial-scale production of micro-algal products. For a commercially viable production of algal biomass and products, high cell densities are required to obtain reasonable volumetric productivities. For some algal strains, heterotrophic cultivation, i.e. provision of organic materials as C-source instead of CO_2 (autotrophic cultivation) features a viable strategy to obtain high concentrations of biomass. Here, numerous waste materials can be applied as substrate. In a second step, the biomass undergoes the formation of desired products via CO_2 fixation that can stem from industrial effluent gases. Hence, combining of heterotrophic and autotrophic cultivation features a powerful strategy to produce high concentrations of active biomass using cheap substrates in the first step and subsequently to switch to the production of valuable compounds like pigments or certain lipids via photosynthetic CO_2 fixation. After product isolation, the value-creating utilization of residual biomass constitutes another challenging item.

The article at hand presents novel insights into the promising prospective of micro-algae for industrial development. It focuses on the work currently done in improving the cultivation strategy, enhanced product formation, downstream processing and utilization of residual biomass within the project PHOTOCHEM in Graz, Austria.

SDWS2011.0363 Cost Reduction Potential of Biofuel Production from Microalgae

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Abstract

Energy is a key element for our society and also a key input for economic development. Biomass and bio-fuels have attracted growing interest as sustainable and renewable energy. Biomass feedstock such as crops, trees, and food waste can be converted into more convenient energy carriers such as solid fuels (e.g., wood chips, pellets, briquettes), liquid fuels (e.g., methanol, ethanol, bio-diesel, bio-oil), or gaseous fuels (synthesis gas, biogas, hydrogen). Liquid bio-fuels such as bio-ethanol and bio-diesel are suitable for transportation purposes and they have therefore received substantial attention not only from academia but also in the business scene.

Although there are a variety of feedstocks, microalgae are expected as a promising one because of their high production efficiency, high land use efficiency, water efficiency, and energy conversion efficiency. However, the current production cost of liquid fuels is not comparable with gasoline and the other energy source or is not feasible in practical use because of the economic reason. The aim of this paper is to investigate the cost structure of biofuel production form microalgae and to identify the cost reduction potential. We conducted a detailed analysis based of process modeling of unit processes from cultivation in raceway pond and photo bioreactor, dehydration by filtration and centrifuge, oil extraction and liquefaction. We used the cost data of materials, equipment, utilities, and labor cost. We surveyed existing literatures of each process, structured data, and integrated them to model the production process.

Our analysis showed that total production cost of 4 $/l. According to our analysis most of cost is attributed to both cultivation process whose cost is 2.64 $/l and dehydration process of 1.27 $/l. These processes are influenced by land price, labor cost, and climate conditions. And therefore, we must take regional factors into consideration. Research and development in cultivation and dehydration are the key factors for future dissemination of biofules from microalgae.

SDWS2011.0553 Policies and Challenges for Advanced Biofuel Technologies: a Look into Microalgae

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Abstract

Sustainability is a fundamental principle in the natural resources management. Therefore, it is increasingly clearer to society that the continued use of fossil fuels for energetic purposes is unsustainable. Innovative technologies must be developed to replace fossil fuels and contribute to the reductions of emissions of greenhouse gases associated with their use. Biofuels are particularly important to decarbonise means of transportation that lack of other fuel options (especially trucks, ships and aircrafts). However, alternative sources of biofuel derived from terrestrial crops such as sugarcane, soybeans, maize, rapeseed, among others, inflict a lot of pressure on the global food markets, contribute to water scarcity and precipitate the destruction of forests. Furthermore, the use of biofuels will depend on the development of viable, sustainable, second-generation technologies that don't appear to be yet commercially viable.

In this context, algal biofuels are generating considerable interest around the world. In the United States, they may represent a sustainable pathway for helping to meet the biofuel production targets set by the Energy Independence and Security Act of 2007. Similarly, in the European Union, they can contribute to the achievement of goals established in the recent Renewables Directive. It is thus necessary to contribute with a study that incorporates biomass feedstock availability assessment, production, management and harvesting in support of the up-scaling of microalgae-to-biofuel technologies. Hence it is needed to foster commercial maturity in order to develop large-scale, sustainable production of advanced biofuels and highly efficient combined heat and power from biomass.

The overall purpose of this study is to provide an integrated assessment of the potential of microalgae in the context of a source to produce biofuels, while confronting it with competing emerging biofuel technologies. This article also presents a discussion of the ongoing development of policies to optimize the production and encourage emerging technologies in the European Union. Biofuel production needs to be set in place and an efficient distribution system needs to be organized to bring biofuels to the market. At the end, to create a credible market, steady and with a growing demand, it needs to be stimulated. In this way, with adequate policy support and incentives, the algal biofuel industry is prone to develop and assuming that this technology follows renewable energy cost trends, costs will decrease to eventual economic viability. In order to provide insightful arguments, this paper builds upon the Strategic Energy Technology Plan (SET Plan), the European Directive 2009/28/EC and scenarios made available by the International Energy Agency regarding Energy Technologies Perspectives 2010. A meta-analysis among scientific state-of-the art literature is performed.

Waste treatment

SDWS2011.0373 Pyrolysis Kinetics of Plastic Wastes in Thermogravimetric Analyzer

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Abstract

Effective treatment of municipal solid wastes, especially plastics, constitutes one of the most significant challenges in the protection of the environment and natural resources. In today's world, recycling processes for upgrading plastics wastes are getting attract attention by converting them into valuable and reusable chemicals. Among the thermochemical conversion processes, pyrolysis technique is still the most common technology. Therefore in this study, the most encountered plastics wastes, high density polyethylene (HDPE), low density polyethylene (LDPE), polystyrene (PS) and polypropylene (PP) were selected as raw materials and pyrolysed in thermogravimetric analyzer (TGA) in order to investigate their thermal and kinetic behaviors. The experiments were conducted under N_2 atmosphere with a heating rate of 10K/min. from room temperature to 1075 K. After pyrolysis process, kinetic parameters were derived and thermal decomposition ranges were determined through the TGA results for each plastic. Experimental results showed that plastic wastes can be decomposed easily at high temperature regions and converted into valuable chemicals as an alternative way to green energy.

SDWS2011.0532 Pollution Prevention in the Pharmaceutical Industry

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Abstract

The pharmaceutical industry traditionally utilizes a vast array of complex batch-type processes and technologies in the manufacture of medicines. Only recently has the production of specific medicines by continuous processes been envisaged.

Due to the diversity of these processes, it is impractical to define a general set of waste prevention guidelines that would apply to all drug manufacturing. The most applicable methods of prevention can however be delineated for each of the 5 steps in the pharmaceutical manufacturing, i.e. (i) research and development, (ii) chemical synthesis, (iii) natural product extraction, (iv) fermentation, and (v) product formulation. The paper

will review the essential procedures of each of these steps, prior to concentrating upon the specific prevention strategies.

Waste streams generally arise from cleaning and sterilizing equipment, chemical spills, rejected by-products and the processes themselves. Wastes and their composition will be classified according to the process origin.

Prevention will then be dealt with according to different categories of actions being waste reduction by materials substitution, process modification/optimization, waste stream segregation, recovery and recycling and solvent waste recycling. Each of these categories will be assessed in detail and will lead to guidelines for waste minimization methods according to the waste streams under scrutiny, i.e. containers, air emissions, equipment cleaning wastes, spills and floor wash-down, off-spec products, solvents, and production equipment.

SDWS2011.0539 Activated Carbon by Co-Pyrolysis and Steam Activation from Particle Board and Melamine Formaldehyde Resin: Production, Adsorption Properties and Techno Economic Evaluation

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Abstract

The disposal and environmental problems associated with waste resin produced during the production of melamine (urea) formaldehyde and wood waste containing these aminoplasts requires a processing technique which results in products of considerable added value and which meets both ecological and economical needs. Several published results demonstrate that nitrogen incorporation in active carbon can play a significant role as a key parameter for the adsorptive properties, as well as for the catalytical activity and the dispersion of carbon supported catalysts. The production of high value nitrogenised activated carbon after thermal treatment in an oxygen deficient environment and activation, is considered as a possible opportunity. In this study the feasibility of a process design for the production of this high added value nitrogenised activated carbon by pyrolysing a mix of particle board waste and melamine (urea) formaldehyde waste is investigated. The process design is developed based on various literature sources, for different mixing ratios of the two waste products. The economical feasibility has been investigated, by calculating the net present value and the internal rate of return of the cash flows incurred by an investment based on the process design. Also the most crucial variables that influence the profitability of the investment have been determined with a Monte Carlo sensitivity analysis. Even though the current assumptions rather start from a

pessimistic scenario: e.g. a zero gate fee for the melamine (urea) formaldehyde waste, a first plant cost,..., encouraging results for a profitable production of active carbon are obtained. Moreover, the ability to reuse two waste streams and possible production of a specialty carbon enhances the value or usefulness of the active carbon manufacturing facility.

SDWS2011.0040 Mathematical Approach for Improving the Reliability of Parameter Calibration in Modelling of Anaerobic Digestion Processes

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Abstract

Anaerobic digestion is a complex biological process requiring the involvement of a variety of microorganisms. Therefore, mathematical models can be useful for understanding the numerous processes or microorganisms involved. After successful calibration, a mathematical model is able to predict reactor behavior. The IWA Anaerobic Digestion Model No. 1 (ADM1) has mainly been used for simulation of the fermentation of different substrates. Anyway, calibration of kinetic parameters to both substrate and conditions is required. Although the quality of model results strongly depends on calibration of kinetic parameters, their estimation is usually done manually by visual comparison to experimental results. This procedure however is quite subjective and requires experience.

In the field of hydrology, the so called Nash-Sutcliffe model efficiency coefficient is widely used in order to assess the quality of simulations compared to observed data. By qualifying the sum of differences to the average of measurements, it is not only possible to find parameter sets with best fit, but also quantitatively describe the accuracy of model outputs independent from their units. The applied methodology to adapt ADM1 followed a two-step procedure. First, all kinetic parameters were set to default ADM1 values. Second, simulations were run by varying kinetic parameters around default value. An efficiency of 1 corresponds to a perfect match of modeled parameters to observed data, where an efficiency of 0 indicates that the model prediction is as accurate as the mean of the observed data. Values below 0 evaluate the simulation worse than the simple average of measurements.

By indicating a parameter set with the best fit, possible equifinality of models has to be kept in mind. Equifinality means that there is not simply one optimal parameter set that represents a system, but rather several combinations of parameter values for a chosen model structure may fit the data equally well. Thus, not the parameter value itself is

important, but rather the combination. The result of several combinations leads to a kind of map, consisting of global and local highs and lows.

Applying the Nash-Sutcliffe coefficient enables parameters sensitivity analysis and parameter estimation as well. A quality assessment procedure based on the NSC implemented in the model facilitates the software to search for the tupel with the best fit automatically.

Thereby

- extensive manual analysis of model output is avoided,
- percental quantification of degree of agreement is enabled,
- comparison of different goodness of fit independent of their units is possible,
- a new approach for parameter sensitivity analysis is presented and
- finally the reliability of model calibration is seriously improved.

SDWS2011.0400 Developing and Evaluating New Policy Instruments for Sustainable Waste Management

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Abstract

Swedish waste policy is governed by a number of policy documents, including the European Union waste directive, Swedish environmental quality objectives, and policies in other sectors, including energy. Swedish policy instruments affecting waste management include a ban on landfilling of organic materials, a landfill tax, an extended producer responsibility of some product groups, and energy and carbon dioxide taxes on fossil fuels used for heating. Waste related policy instruments are likely to develop further in the future. One reason is the European waste directive, which requires that the waste hierarchy should be used although exemptions can be made based on life-cycle thinking. In that context, it can be noted that most currently used policy instruments are moving waste away from landfilling. There are currently few general policy instruments for supporting waste minimization and increased recycling, thus supporting the waste hierarchy. Also, the national goal of stabilizing the amount of waste generated is difficult to reach, suggesting that there is a need for new instruments. The threat of climate change will also call for further changes in all sectors, including waste management and the energy systems. “Towards a sustainable waste management” is an ongoing research program in Sweden involving nine research institutes. The aim of the program is to suggest and evaluate new policy instruments for a more sustainable waste management. This paper will describe a subproject with the aim to make a survey of waste related

policy instruments and to suggest a number of interesting instruments that can be further evaluated in other subprojects. The focus is on the higher levels of the waste hierarchy. Suggestions for policy instruments were gathered through a number of workshops with stakeholders and literature studies. The further prioritization was based on a number of criteria including economic, environmental and social aspects. Another workshop with stakeholders was also organized where participants voted for and against different instruments. The result was a list of policy instruments that will be further evaluated in the research program. These are:

- Information to citizens and companies;
- Tax on raw materials;
- Weight based waste collection fee;
- Environmentally differentiated waste collection fee;
- Waste minimization in enterprises
- "Advertising brochures –Yes, please!";
- Recycling certificates;
- Developed collection systems;
- Tax on incineration of waste from fossil fuels;
- Tax on incineration of waste;
- Including waste in green certificates for electricity production;
- Tax on hazardous substances;
- Labeling of products and goods with hazardous substances;
- Improved control by authorities;
- Differentiated VAT; and
- Ban on incineration of recyclable materials.
- Preliminary results from the evaluation will also be presented.

SDWS2011.0370 Adsorption of Heavy Metal Ions from Aqueous Solutions by Bio-Char, a By-Product of Pyrolysis

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Abstract

The disposal of solid wastes such as biomass, industrial and municipal wastes by incineration is an important environmental problem. In fact biomass is a renewable energy resource and has a growing interest as a chemical feedstock source. There are several thermochemical processes for conversion of biomass into valuable products which are combustion, gasification, liquefaction and pyrolysis. Among them pyrolysis is one of the primary thermochemical technology to obtain bio-char, bio-oil and light molecular weight gases. A great number of applications have been considered for liquid product (bio-oil),

but the char hasn't been received much attention. Evaluation of bio-char as low-cost adsorbent for wastewater treatment should be taken into account. Therefore in this study, bio-char, obtained as a by-product of almond shell pyrolysis, was used as an alternative adsorbent precursor for the removal of heavy metal ions from aqueous solutions by adsorption. Pyrolysis experiments were performed in a fixed bed reactor at 600°C with a heating rate of 10°C /min in the inertatmosphere. The adsorption potential of almond shell bio-char for Ni (II) and Co (II) removal was investigated. Adsorption experiments were carried out by varying pH, adsorbent dosage, initial metal ion concentrations, contact time and temperature to determine the optimum conditions. The results showed that bio-char derived from pyrolysis of almond shell can be used as a low-cost and effective adsorbent for removal of heavy metal ions from aqueous solutions.

Sustainable transport and vehicles

SDWS2011.0160 A Control-Oriented Simulation Model of a Power-Split Hybrid Electric Vehicle

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Abstract

A Hybrid Electric Vehicle (HEV) contains two or more power sources in order to improve the fuel efficiency and reduce air pollution. Thus, the complexity of a HEV energy management control system is significantly increased compared to that of a conventional vehicle. The control system design is typically based on extensive computer-aided optimization and simulation studies, which require an accurate and computationally efficient power train model. From the standpoint of energy management optimization, the model should accurately describe losses in different power train components. At the same time, it should include the most dominant dynamic modes including the inner control loops. This paper presents a detailed simulation model of one of the most common and effective power split HEV known as a two-mode hybrid system. The system consists of internal combustion engine, two electrical machines, a pair of planetary gears interconnected through two clutches, and an electrochemical battery. The system is modeled in three basic steps. Firstly, the bond graph method is used to derive a HEV transmission model with a minimum realization and a computationally efficient clutch friction stick-slip description. Secondly, the model is reduced for each of the two operating modes, where the clutches are either open or locked. The reduced model forms are used for the design of inner loop controller of electrical machine, which are then incorporated in the full model. Thirdly, the model is extended with static maps which describe the energy losses in engine, electrical machines, transmission, and battery. The battery model includes the effect of hysteresis in voltage vs. state of charge static curve. Finally, the model includes the aerodynamic and road grade resistance, and a simple supervisory control logic. The simulation model implementation aspects are discussed, as well, and characteristic simulation results during long vehicle launch and stopping periods are presented.

SDWS2011.0201 Intelligent Thermal Management for Full Electric Vehicles

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Abstract

A technological survey is conducted to identify the current limitations imposed by thermal loads on power electronics and electrical machines (PEEM) in full electric vehicles, as well as two-phase cooling technologies currently proposed to perform thermal management, which play a crucial role in PEEM performance. From all available thermal management options, direct spray cooling on the power electronics context appear to be the one which is able to achieve heat fluxes slightly above 250W/cm2 demonstrating the feasibility of the concept. Moreover, if a comparison is made relatively to the order of magnitude of the convection heat transfer coefficient associated with direct liquid cooling, Mudawar et al. (2008) have observed that it is 10 times that of liquid force convection, 10^2 of liquid natural convection and 10^3 that of air forced convection. Also Turek et al. (2008) have used an evaporative spray cooling nozzle array applied to an IGBT-based inverter, capable of removing up to 140W/cm2 while its operating temperature is kept slightly under 125ºC. However, none of the works reported so far take into account an active control of the cooling process required for an intelligent thermal management during periods of transient heat loads. The active control of heat transfer can be interpreted as a spatial control over droplet density, as suggested by Pavlova et al. (2008), or as a temporal control over the flow rate using an intermittent spray by proper matching the frequency and duration of injection. The later approach allows a cooling system capable of responding to transient heat dissipation with liquid savings up to 90%, for the same efficiencies reported for continuous spray cooling (Panão & Moreira, 2009, Panão et al., 2010). Within the context of the work presented here, intermittent spray cooling is compared with current proposals for thermal management in electric vehicles. The paper also includes the development of a parameter to quantify the benefit a thermal management strategy achieves in phase-change cooling. Finally, some of the results reported in the literature for spray cooling are compared in terms of the benefit retrieved from phas-change, and some considerations are made relatively to the cooling technological approach needed for developing an intelligent thermal management of power electronics in full electric vehicles.

SDWS2011.0317 The Potential of Natural Gas as a Bridging Technology in Low-Emission Road Transportation in Germany

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Abstract

To mitigate climate change, Germany aims at the reduction of greenhouse gas (GHG) emissions. Although there are tax-incentives and regulations aiming at the reduction of the specific emissions of vehicles, road transportation is still largely based on high carbon petroleum fuels and accounts for nearly one fifth of GHG emissions in Germany. Though new technologies like electric and fuel cell vehicles get a lot of publicity as well as research and development subsidies, they are still far away from being market-ready.

This paper explores the potential of natural gas as a bridging technology in low-emission road transportation in a case study for Germany. Natural gas is available in large quantities; its technology is marketable and already applied on a large scale in several countries; GHG emissions from natural gas-based road transportation are significantly lower than those of petroleum-based mobility.

By means of a scenario analysis, the paper focuses on the quantification of the emission reduction potential of an intensified use of natural gas in road transportation and determines the requirements for as well as the consequences of such a transformation.

Our scenario analysis is based on extensive datasets of transport behaviour and vehicle fleets. It shows that if technology adoption is incentivized and the existing practical and economical obstacles are removed, natural gas-based road transportation in Germany can accumulate up to 464 million tonnes of CO2-equivalent emission reductions until 2030 depending on the speed of the diffusion process. If similar policies were adopted EU-wide, the emission reduction potential could reach a maximum of about 2.5 billion tonnes of CO2-equivalent.

As a fossil fuel, the potential of natural gas to reduce emissions is limited. Nevertheless, it may be an interesting option for lowering emissions in road transportation during the next years until new, lower-emission technologies are ready for the market.

SDWS2011.0846 Comparing Battery Electric and Fuel Cell Vehicles - Performance, Environmental Impact and Infrastructure Requirements

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Abstract

During the last two decades fuel cell vehicles have received much attention and funding. Nevertheless, they still await market introduction. On the other hand, battery electric vehicles were the first to set the world records for automobiles in the early 20th century. After a short renaissance in the 1990ies they have now been extremely pushed and market introduction programmes are being performed in many countries.

Does this mean that fuel cell vehicles are now obsolete?

Firstly, both battery electric and fuel cell vehicles are electric vehicles that are based on very similar vehicle architectures. Secondly, both satisfy customer needs that are hardly overlapping but rather complementary - batteries serving the very short, inner city range, fuel cells rather the mid to long distance travel. Thirdly, both suffer from underdeveloped infrastructure - even though this is not sufficiently recognised. Finally, the environmental footprint of both fuel types very much depends on the origin of the primary energy that is used to produce the fuel (electricity or hydrogen).

The small company H2O e-mobile has been converting light passenger cars to electric drive and battery and fuel cell energy supply. A small fleet of 15 vehicles is currently being employed in a demonstration scheme in the NorthWest of Germany.

The paper will summarise the infrastructure analysis with regard to investment, performance and operational cost and the environmental impact of the complete system of vehicles and infrastructure.

H2O favours a concept of fuel cell hybrid vehicles with a dedicated role for both battery and fuel cell in achieving market acceptance, cost effectiveness and customer satisfaction. The background and results of this concept with respect to supplying low-cost, environmentally friendly vehicles at an otherwise early market introduction stage will be presented.

SDWS2011.0093 European Transport Policy Information System- Development and Implementation of Data Collection Methodology for Eu Transport Modelling

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Abstract

European Committee has an ongoing requirement for good quality input data to support transport models, evaluation methodologies and indicator frameworks. Without information integration, DG-TREN lacks a consistent data source, and encounters problems of data interpretation arising from the heterogeneous methodologies associated with the available data sources. This has led to the concept of a common database to be used by modellers and policy makers, as first implemented through the framework project ETIS in 2005. ETISplus 7th framework project fulfil the role of updating the inputs of ETIS project. The new tasks have various objectives as follows:

- To develop a framework for the collection and dissemination of data and network information related to transport including the use of new data collection methods, the use of efficient, cost-effective methods in cases where gaps in data collection currently exist, the use of a dedicated IPR free dissemination and retrieval tool.
- To provide a central repository to be used by transport support policy tools at EU level.
- To implement and validate a database , updating and extending the ETIS database both geographically and by adding additional variables, adding new reference years 2005 and 2008 and including the newest member states and neighbouring countries in more detail.
- To establish a communication between all stakeholders.
- To prepare guidelines and structures for future updates and management.
- Since the start of the project some results have already been achieved and most activities have started up and are ongoing, the paper includes description of main achievements and project results during the first half of project duration.

Life cycle assessment

SDWS2011.0159 Comparison Between Electric and H2 Vehicles by Life Cycle Analysis

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Abstract

Sustainable mobility in urban area plays an important role in reducing greenhouse gas emissions in transport sector, and is particularly focused on alternatives to fossil fuel-fed vehicles, such as electric or hydrogen fed-vehicles [Briguglio, 2010]. While electric vehicles are already seen as a possible reliable alternative, H2-mobility can be pulled by the increase of smart grid market shares [Rifkin, 2008].

Commercial traffic is considered to be a priority target for urban emission displacement, and this work focuses on electric and H2-fleets of city delivery vans running within the urban area of a medium-sized town.

Life Cycle Analysis (LCA) provides the comparison of these two alternatives with a comprehensive and scientifically supported environmental impact assessment.

The system boundaries of LCA include the whole fuel production chain, the vehicle production, use and end-of-life.

In particular, two fleet scenarios are considered, running either on electricity produced by local renewable resources or on hydrogen, which production chains are modelled on realistic assumptions regarding potentially available sources within the region Tuscany (Italy). These were investigated within the regional project "Progetto Idrogeno" (Hydrogen Chain), and the following were described [Biagini E. 2010]:

- Windpower + electrolysis
- Biomass gasification + electrolysis
- Biomass gasification + separation
- Geothermal steam + separation

As for the utilization phase, a standard glider, common to both the typology of vehicles, is analysed based on literature data [Notter 2010] and data relative to the typical components are obtained from literature when foreground data are not available. In particular, battery and electric train are analyzed for the electric vehicle, while FC or ICE powertrains are analyzed for the hydrogen vehicle, depending on the purity of used hydrogen.

The calculated environmental impacts are referred to a standard yearly average distance covered by the vehicle for goods delivery in the urban area.

The impact assessment is calculated according to CML2002, with 8 main categories: abiotic depletion, acidification, eutrophication, global warming, ozone layer depletion, human toxicity, aquatic ecotoxicity and photochemical oxidation. Use of resources,

energy and water, are also evaluated so as to comprehensively assess the environmental hot spots of electrical and hydrogen vehicles.

SDWS2011.0165 Model of Material-Economic Analysis of Power Technology Life Cycle

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Abstract

The continuous increase in demand for electricity, as well as irreversible changes in the surrounding environment, particularly "greenhouse effect", caused in recent years greater interest in low carbon power technologies. The result of this interest is the energy policy of the European Union, as well as the Polish energy policy.

Energy security policy of both the European Union, as well as Polish focuses on comparative analysis of power sources, including the costs of production and properties of various power technologies. To carry out such comparative analysis should take into account all phases of the life cycle of an power technology: construction, operation and scrapping.

The paper will be presented the mathematical model used in the developed material and economic life cycle analysis of power technologies based on ISO 14040, the methodology presented in paper and the economic model presented in and also the material model presented in.

Presented in the paper model will take into account such factors as:

- material inputs in the different phases (construction, operation and scrapping) of power technology (PT) life cycle;
- environmental loads in different phases of the life cycle of PT;
- construction costs of PT;
- fuel costs in the various phases of the life cycle of PT;
- maintenance costs;
- direct and indirect environmental costs;
- revenue from sale.
- Moreover in the paper will be calculated internal rate of return (IRR) and net present value (NPV) and break-even point (BEP), as well as the equivalent unit cost of electricity production (COE) and the equivalent unit cost of heat production (COH).

The simulation results will be presented for two power technologies: nuclear power plant and gas-steam power plant.

SDWS2011.0284 Environmental Performance of the End-Of-Life-Tyres Recycling

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Abstract

End-of-life tyres disposal is a considerable environmental problem around the world due to the great amount of them generated every year. The most commonly used rubber matrix is the co-polymer styrene-butadiene (SBR), or a blend of natural rubber and SBR with carbon black, extender oil, zinc oxide, stearic acid and sulphur as main components aggregated which allow recycling the End-of-life tyre completely.

In the European Union, the environmental performance of products and services through their life cycles have achieved the introduction of several policy instruments based on the responsibility of producer for managing their products when they reach their end of life cycle.

This research has been conducted with the aim to quantify the environmental impact produced by the recycling operations and transport of End-of-life tyres from different recollection points to the recycling plant in order to obtain the net emission benefit. To this end, Life cycle assessment has been used to determine the most environmentally friendly option of End-of-life tyres disposal for Aragon/Spain. The inputs and outputs of each management stage have been defined, and the inventory emissions calculated by SIMAPRO v 7.2 have been classified into impact categories; non- energy sources, final solid waste as hazardous and non-hazardous, global warming and human toxicity. On the other hand, fundamental discussions focused on the system boundaries limit established, which cover services that require the consumption of traditional resources, is presented.

Additionally, the LCA also compares different plant capacities and location of them in order to find the optimum option. The LCA found that for the range of inputs and scenarios considered there are important considerations to establish the optimum option taking into account size of the plant and the distance between the recollection points and the aforementioned plant, in terms of GHG emissions. Results have been analysed and recommendations are showed to improve current End-of-life tyres Waste Management System.

SDWS2011.0576 Development and LCA of an Advanced Solid Bio-Fuel, and Comparison with Similar Traditional Products

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Abstract

The purpose of this contribution is to describe and to discuss the results obtained in developing an advanced solid bio-fuel along with a suitable process for its production at industrial scale. This new product, similar in the shape to the well known woody pellets, can be obtained not only by wood or woody material but also by non contaminated agro-industrial vegetable wastes. In addition, it is characterized by high density, low mixture content, and good calorific value. All these desirable properties were obtained by compressing and heating the raw materials, previously chopped and mixed, at temperature significantly higher than that used for drying but smaller than that used for the pyrolysis of woody materials. Similarly to other solid woody bio-fuels, this new energetic product is characterized by a CO_2 balance which is practically zero. The advanced technology proposed here will provide solidified biomass which can be used as an alternative fossil coke and, at the same time, it represents an efficient way of disposal/valorization of a variety of agro-industrial vegetable solid wastes like pruning, pomace oil, marc, sawdast, wood bark, twigs, and others. The compression and the heating conditions of biomass is set within the range that heat decomposition or thermal hardening of hemicelluloses of the biomass is induced. Unlike the pyrolysis, in this case there isn't any production of liquid or gaseous energetic stream. Stem is the only stream produced in addition to the solid product; it can be usefully condensed for heat recovering and decontamination in typical waste water treatment plant. In order to quantify the net renewable energetic value and the environmental impact of the whole production process an LCA analysis was made for this new product and similar solid bio-fuels already marketed like woody pellets and briquettes, and chips. The results show that the new product is significantly better for both net renewable energy content and environmental impact.

SDWS2011.0266 Dish-Stirling Technology for Power Generation. Environmental Evaluation

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Abstract

Dish-Stirling systems have been in development during the last three decades. One reason for this development is the fossil fuel energy sources depletion. This fact, together with environmental degradation caused by the use of fossil fuels, has given rise to renewable energy technologies. The use of renewable energy has meant the development of a variety of technologies, optimizing durability and cost issues, in such a way that some of them have achieved an acceptable level in comparison with conventional fossil fuel technologies However, the environmental evaluation is being more and more considered when taking decissions about technologies selection for power generation. This evaluation must be taken into account when comparing the dish-Stirling technology with the current alternatives for sun energy exploitation. The literature review shows several studies concerning photovoltaic technologies, but there is very few information regarding dish-Stirling technology. The aim of this paper is to provide a comparative environmental assessment of dish-Stirling technology and a similar photovoltaic facility. The procedure used has been Life Cycle Assessment, and it has been demonstrated that the level of environmental impact is similar for both technologies. Thus, it is concluded that development of dish-Stirling technology should be optimized in order to get further reductions of the environmental impact to be really competitive regarding environmental evaluation. This conclusion helps to determine the future works about this technology, such as hybridization, preferably with other renewable sources, and application of thermal storage.

SDWS2011.0959 Sustainable Production of Food Crops Via Eco-Efficiency

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Abstract

Food security has become one of the main concerns these days. This is not only because the world population is increasing but also the agricultural land is being decreased, due to economic reason. Environmental interest has also been spread all over the world. Crop production consumes resources and releases emissions to the environment. This could deteriorate the sustainability of the next generation. Moreover, crops are the upstream of food industries. The environmental performance of crops would influence the competitiveness of the downstream industries. Consequently, the sustainable production and consumption relied on both economic and environment factors.

In this work, these two factors were combined and expressed as "eco-efficiency", which derived from the selling price at farm divided by environmental impact of crop production. This parameter was used to determine which crop was promising for sustainability. Fourteen crops were studied, including baby corn, onion, potato, shallot, strawberry, tomato, as well as four organic and conventional crops, i.e. bush bean, arabica coffee, garlic and oolong tea. The environmental impacts of crop productions were determined using life cycle assessment, via ReCiPe Midpoint (H) method. The concerned impact categories were Fossil depletion, Climate change, Terrestrial acidification, Particulate matter formation, Metal depletion, Agricultural land occupation, Eutrophication and Human toxicity.

The results show that, coffee demonstrated the highest impact of Fossil depletion, where fertilizer usage contributed more than 90% of the impact. The large fertilizer consumption of coffee resulted in distinguished impacts of Climate change, Terrestrial acidification, Particulate matter formation, and Eutrophication. Tea also showed high Fossil depletion, where 75% of the impact was attributed to electricity used in the field. This was also the reason for tea showing the highest impacts of Metal and Water depletions. LPG usage in both conventional and organic tea caused high Human toxicity.

The organic crops showed the highest eco-efficiencies in all impact categories, as a result of their relatively high prices and low environmental impacts. In the category of Fossil depletion, the eco-efficiencies of organic and conventional coffee were about 38,000 and 46 Bt/kg oil eq, respectively. This means that, the use of 1 kg oil eq could produce organic coffee of 38,000 Bt, which was 800 times more valuable than the conventional. In the case of Metal depletion and Climate change, the eco-efficiency ratios of organic and conventional coffee were about 100 and 80, respectively.

It could be concluded that organic crop productions were promising for sustainability. The crops showing the lowest eco-efficiencies were coffee, tea, potato and

baby corn. The reductions of fossil fuel, electricity and synthetic fertiliser consumptions in these crop productions should be paid attention

Poster session I

SDWS2011.0220 A Simple Dynamic Model of a Solar Tower Plant with Heat Storage in Steam Tank

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Abstract

Concentrating solar tower plants are one of the most promising technologies for large scale solar power generation. In these plants the use of a heat storage tank supports, in combination with an auxiliary boiler, the generation of steam during transient periods due to hazy operating conditions. Additionally, this back-up system allows obtaining additional power during the shut-down process at the end of the day, increasing the operating range of the power plant to a certain amount of time after sunset.

In this work the use of a heat storage tank in a solar tower plant working with saturated steam is analyzed. For this purpose, a stationary model of a CSP tower plant has been developed and validated against public information of existing solar tower plants. The unknown data, for instance the pressure of some steam bleeds from the turbine, have been derived by applying optimization techniques orientated at obtaining the maximum efficiency under stationary operation. Departing from the stationary model and taking into account the different time constants of the major elements of the plants, a dynamic model has been developed using the time-dependent mass and energy equations applied to the heat storage tanks. PI controllers have been included to control the steam flow to and from the tank as a function of the steam pressure at the generator and of the turbine condensing pressure.

This model has been used to analyze the effect of different heat storage tank settings on the performance of the power plant: minimum pressure, volume and discharge set-point for different patterns of clouds. Additionally, an economic analysis is included for the optimum tank volume and the number of independent tanks for that volume. Finally, for the selected tank settings, the performance of the power plant is analyzed for a number of irradiating conditions.

SDWS2011.0867 Long Term Energy Demand Projection and Potential for Energy Savings of Tourist-Catering Trade Sector: Case Study Croatia

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Abstract

Today, tourism represents one of the backbones of Croatian economy and one of the main factors of its growth. Having that in mind we can expect significant investments in Croatian tourism in the future, both in expanding and improving existing capacities as well as building new ones. Combined with catering trade sector, tourism represents a significant energy consumer that has the tendencies of future growth. Since services sector, which tourism-catering trade sector is a part of, is not jet well covered regarding future energy balances it would be very interesting to see how would possible future growth in tourism influence energy balance of the services sector in Croatia. Through this paper long terms energy demand projections of tourism-catering trade sector were studied with special emphasis on future growth of tourism in Croatia as well as future financial, legal and technological mechanisms that might lead to certain energy savings. TEDM (Tourism-catering trade energy demand model) was developed in order to quantify previously mentioned mechanisms that would lead to changes in energy consumption and to model the base year energy demand. Model is based upon bottom-up methodology which combines a lot of input data, roughly divided into heating/cooling section and all other consumption that would cover all other areas of tourism-catering trade sector. The Model shows certain possibilities of energy savings based on different mechanisms that are expected in the future as well as certain discrepancies from Croatian national Energy Strategy that are result of bottom-up approach in calculating future energy demand.

SDWS2011.0885 A 100% Renewable Energy System in the Year 2050: the Case of South East Europe Energy Community

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Abstract

This paper presents methodology and results for 100% Renewable Energy System of South East Europe energy community. The energy community of South East Europe (SEE) include eleven countries – AL, BA, BG, HR, GR, ME, MK, RO, RS, SI and XK. The SEE energy system has been modelled in an EneregyPLAN model in order to

investigate how energy system may be designed to achieve high penetration of the intermittent renewable energy sources. The reference model of SEE energy system was developed for the year 2008, which was then used for the analysis in the year 2030 and year 2050. Analysis in the year 2030 was made for 50% renewable energy system, which represent first important step toward 100% renewable energy system in the year 2050. Also, analysis for the maximum wind penetration in the referent SEE energy system from a technical and economic perspective has been made. Results show that 100% renewable energy system can be achieved but to achieve this goal optimal energy resource mixes alongside with storage is needed.

SDWS2011.0955 Lessons Learned from Project Smart

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Abstract

In the project SMART (**S**trategies to pro**M**ote small sc**A**le hydro elect**R**icity produc**T**ion in Europe) from the programme IEE (Intelligent Energy Europe) 7 institutions from 5 European states participate: Province of Cremona – Italy; CESI RICERCA SPA – Italy; Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb – Croatia; Karlovac County – Croatia; Norwegian University of Science and Technology – Norway; Regional Secretariat of Attica - Greece and Energieagentur Waldviertel – Austria. The SMART proposal address to important barriers for the expansion of small-scale hydro electricity production in Europe: the lack of suitable support methodologies and tools able to create a clear view of the mini-hydro potential in the territory, the complexity of the legal/administrative processes to obtain concessions, the economical/financial attraction of private investors. Main objective of project is to give clear contributions to pull down these non-technological barriers, as helpful tools for European, national, regional and local authority decision-makers for increasing the implementation of small-scale hydro electricity plants (SHP). Policies, methodologies and tools to improve water resources management, to better communicate, disseminate opportunities to investors, and to increase the interest of stakeholders to invest in small scale electric plant are defined. 5 representative regions in the partner countries serve as learning areas about strategic actions. In previous papers, the results of investigations performed with aim to detection and pull down the non-technological legal/administrative barriers in partner states are presented. Now, lessons (strategic action) learned from pilot regions, which contribute to wider implementation and technical viability of SHP will be presented: hydrological data review and modelling is one of the most important parameters in determining the feasibility of a site; topographic and

geological data review; the hydropower assessment must include selection and optimisation of the operating range of the turbine and the capacity factor of the scheme; social and environmental impact assessment must be made, including consideration of land acquisition; preliminary design and scheme arrangements need to be made; costing should be assessed with necessary accuracy and contingency; appropriate technology – ensure that the technology is appropriate to the location; selection criteria developed should consider the technical feasibility, etc. Previously will be elaborated and illustrated on the locations for SHP in pilot region Karlovac County (Croatia) using the original software developed by the project partners.

SDWS2011.0437 Possibilities of Exergy-Based Parameters in the Search of Meaningful Indicators to Water

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Abstract

Social, environmental and physical indicators are becoming fundamental in our society. They are demanded by policy makers as summaries of the changing reality. Their deep analysis to assure their completeness, are part of our days. Water world is not an exception and more and more ratios and parameters are being introduced in the field as a way to synthesize varied information.

In this sense, indicators are called to play a relevant role in the water bodies characterization, as well as in the specification of river basin management plans designed as fulfilment of different international water-related legislations and general requirements. Those regulations and guidelines, however, are generally quite ambiguous and without much additional precision, and they claim about appropriate indicators.

In addition to the information provided by the currently used indicators, such as water footprint, water stress, virtual water, water use per capita, water consumption in the different economic sectors, fresh water depletion rates or the total water demand and supply, for instance, additional and physically-based indices are demanded from a sustainable perspective.

Within this context, exergy and, in particular, the exergy costs, are proposed in this paper as a comprehensive tool to assess the environmental water cost in particular and to study water issues in general. The exergy analysis of water comprises the quantity and the quality of the water flow and, in addition to that, it evolves in the space, as well as in the time. Main advantage of this index is that it evaluates the phsyco-chemical conditions of a water mass, and therefore as physical processes are not ideal, higher energy will be required to restore the former quality and quantity. Even though if restoration were not finally carried out, a number of the energy (and its associated monetary and environmental costs) required maintaining water as it flows is obtained.

Thus, the particular characteristics of exergy as working tool to define water indicators are explained in this work. Specifically, the exergy cost is proposed as a physical indicator to calculate the environmental water cost of water and to compare water supply and water treatment alternatives in a given area. Finally, the different exergy components and the exergy cost of water within the watershed are calculated for a case study, the Ebro river. It is one of the most representative basins in Spain and, therefore, numerous studies and references can be found and compared to the results presented in this paper.

SDWS2011.0248 Evaluation of Water Quality in Two Albanian Lagoons of the Adriatic Coast (Kune and Vain), Using Dissolved Oxygen as an Indicator

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Abstract

Dissolved oxygen and Biological Oxygen Demand are used to periodically assess the water quality in Kune and Vain lagoons. Oxygen is essential to water life and decomposition of organic matter. The amount of oxygen is dependent on environmental factors, such as time of day, season, turbulence and salinity.

In this study, comparative assessment of Dissolved Oxygen and Biological Oxygen Demand in the two lagoons is performed, over a one year period, using samples collected periodically at the exact same sites.

The variability of Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) is also studied in connection to a physical factor, such as the temperature of the water. DO varies according to temperature, as well as other physical parameters, such as atmospheric pressure and salinity. DO is higher in cold waters compared to warmer waters. The pH of water samples is also measured on site and used in the processing of data as a comparison detail, in order to provide a more holistic view on the water quality.

The Dissolved Oxygen (DO) and the Biological Oxygen Demand (BOD) tests are performed periodically in water samples collected at the assigned points in each lagoon, Kune and Vain separately (exact coordinates).

Oxygen content in water is measured using the Winkler test, which consists in adding equal quantities of manganese and Iodine ions in an alkaline solution to a sample of the water. This is then titrated with a sodium thiosulfate solution with a starch indicator. The amount of dissolved oxygen is directly proportional to the titration of iodine.

DO tests are performed on site, while BOD_5 tests are performed in lab conditions, after a five day period of being deposited in a dark and cool place. After the five period,

BOD_5 is assessed using the same method as per the DO. Biological Oxygen Demand (BOD) is then calculated as a difference between DO and BOD_5.

As a result, these two lagoons are compared based on the oxygen content, which is an indicator of water quality. The two lagoons result in having different oxygen content, which is also reflected in the different trophic states.

SDWS2011.0592 Removal of Chemical and Biological Contaminants by Ldh

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Abstract

All over the world there is a problem of piling up and utilization of waste. One of the places for piling up the waste in Mariupol is the area on the left bank of the river Kalmius, 100 m far from the river. So, the dump is dangerous to the river, as well as to the Sea.

The dump negatively influences the underground water objects in great degree. High concentration of phenols and iron are discovered in the flows of the dump and that is not typical for traditional dumps. As a result of drainage and jointly with the rainshower flows toxical chemical conjunctions, the microorganisms, ova of helmints get into the water of the river Kalmius or into subsoil waters and later on into the basin of the Azov Sea. There are different ways and methods of making the flows free from helmints, microorganisms, viruses harmless as well of removal of iron and phenols.

As far as at this industrial object the concentration of different contaminating substances changes in great degree, it is necessary to choose the method of nonselective removal of great variety of substances. So, it is the most advisable to use layer double hydroxides for disinfection of dump flows from chemical and biological pollutants.

The kinetics of ionic-exchange sorption of phenol for LDH of different composition has been investigated. Capacities of adsorbents in reaction with phenol has been studied. The constants of sorption rates of phenol for sorbents with different mole ratio Mg/Mg+Al have been calculated: (k = 0,52-0,83; 0,72-1,23; 0,81-1,67; 0,86-1,70)

The kinetic investigations of sorption processes of iron (Fe^{3+}) from the mass of sorbent: have been carried out (k=0,52-5,0; 0,72-5,4; 0,81-1,9; 0,86-3,0). Rate dependence of sorption of cathions Fe^{3+} on temperature has been examined for the sorbent Mg/Mg+Al = 0,72 mol/l. E = 11,5 kJ/mol, diffusion process.

After solutions passing through the LDH it has been found out the removal of microorganisms, including the coliforms. Such complete removal can be explained by the fact that the dimensions of investigated microorganisms are of 0,4-3,0 micron. It is comparable with the dimensions of the particles LDH of 10-50 micron. Apparently, mechanical removal of abovementioned objects during solutions passing through the layers of LDH takes place.

As far as the dimensions of the particles of LDH are much bigger than the dimensions of viruses (10-20 nm), so the absorption of virus is possible only on the surface.

The efficiency of this process is determined by the rate in the inner space and, so, it depends on the time of presence. At the time of presence of about 10 minutes the efficiency of viruses removal is higher of 90 %, and if the time of presence is less than 1 minute, no removal is observed.

SDWS2011.0425 The Low Carbon Transportation Model: an Integrated Approach to Assess Technologies and Policies Towards Sustainable Transportation

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Abstract

Transportation has been the fast growing sector in terms of worldwide energy demand, especially in developing countries like China. Various top-down and bottom-up modeling approaches are used for exploring the potential for energy demand and mitigation in the transportation sector. However, there are still lacks of integrated assessing tools at the national scale for China, with bottom-up, sectoral detailed simulation of the effect of integrated demand and supply-side policy strategies to reduce emissions.

This study reviewed a series of typically and famous transport energy systems throughout the world, and both the advantages and limitations of their methodologies are discussed in general.

According to the specific conditions of developing country, we use some modeling experiences from OECD countries and build up a Low Carbon Transportation Model (LCTM) based on the platform of Tsinghua IAMC model.

The LCTM model is a newly developed long-term strategic transport, energy, emissions and environmental assessment model, covering a wide range of transport-energy-environment issues from socio-economic and policy influences on energy demand reduction to lifecycle carbon emissions and external costs. Taking the transport sector of China as the main research object, international maritime is also involved in to describe a global transportation framework.

This model illustrated the heterogeneity growth for the demand of urban, inter-city and rural area which is especially important for developing country as china, the evolution of the transport structure and the alternate process of the new traffic technologies from 2000 to 2100.

Several technology and policy scenarios are presented in the paper to explore the full range of technical, fiscal, regulatory and management policy interventions towards the sustainable transportation future of china.

SDWS2011.0392 Material-Energy Model of Motor Vehicle Life Cycle

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Abstract

Nowadays one of the most important elements of economic and social lives is motorization. Its development is most of all accompanied by increasing use means of transport, especially motor vehicles. Such a significant increase of amount of produced vehicles can be the result of the global use of productive materials and energy carriers, which is higher and higher each year. Operating more and more number of vehicles causes increasing environment pollution , not only by deleterious substance emission, being the effect of fuel combustion, but also by growing amount of exchanged parts and sub-assemblies and, mostly, by rapid growth of vehicles that were withdrawn from traffic and subjected to the car-breaking.

The article presents a material-energy model of a motor car life cycle that can be helpful in determining the type and size of expenditure of material and energy as well as emission loading in particular phases and the whole life cycle of a vehicle.

Results obtained within the research allowed to present the following aspects of material-energy modeling of the vehicle life cycle:

- material decomposition of a vehicle and inventory control of mass flux, energy flux and connected with them emission loadings as well as formation the tables of interaction between the particular fluxes;
- examples of equations mapping the particular mass fluxes as basis of mass balance, in a mathematical way;
- examples of equations mapping the particular energy fluxes as basis of energy balance, in a mathematical way;
- examples of equations mapping the particular fluxes of deleterious substances (CO_2, CO, NO_x, $SO_{2)}$ as basis of emission balance, in a mathematical way;
- examples of defined, total and single estimate factors related to, inter alia, the level of material and energy absorption, the level of emission loading and also the level of secondary waste utilization.

SDWS2011.0997 Wastewater Minimization in Batch Process Industries

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Abstract

Water is probably the most widely used natural resource for either raw material or utility in the processing industries, typical industries in this category include (petrol) chemical, pharmaceutical, food and beverages, pulp and paper and many other industries. It has a role in nearly every plant operation. Usage of water for running various applications in the industries changes the quality due to the introduction of contaminants and it discharge back into the environment as effluent. Due to increase in the cost of freshwater use by the industries, there is a need to reduce the amount of effluent water generation in the batch process industries. To this end, a mathematical model was developed to address the problem of wastewater generation describing the wastewater minimization, where there is no presence of storage vessel but wastewater recycle and reuse. Differential evolution (DE) as a simple, robust and high speed evolutionary algorithm is applied to the minimization of wastewater in the food processing operations. The objective function of this work is to minimize the wastewater generation and to reduce contaminants level of the effluent. The constraints included in the mathematical model are mass balance constraints without reusable water storage, constraints associated with water recycle, contaminant concentration.

SDWS2011.0397 Preparation of Activated Carbon from Sesame Stalk by Chemical Activation for Heavy Metal Adsorption

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Abstract

Adsorption is one of the most efficient and economic method for removal of heavy metal pollutants at low concentrations. Due to their large surface area and high adsorption capacity activated carbons have a widespread usage for the removal of heavy metal pollutants. In recent years, there is a great interest in the production of activated carbons from agricultural wastes due to their large availability and low cost prices. Being an agricultural country, sesame is one of the most important agricultural crop in Turkey. The stalk of this crop is not used for any other beneficial aim. Therefore in this study sesame stalk was utilized as precursor for the preparation of activated carbon by chemical activation using $ZnCl_2$. The impregnated sample was carbonized at 973 K under nitrogen flow of 100 ml/min with a heating rate of 10 K/min in a stainless steel fixed bed reactor.

The obtained activated carbon was evaluated as adsorbent in order to remove heavy metals from aqueous solutions. According to experimental results sesame stalk seems to be an effective and low cost adsorbent for removal of heavy metals from aqueous solutions.

SDWS2011.0369 Removal of Phenol from Aqueous Solutions Onto Activated Carbon Derived from Bean Crop Waste by Chemical Activation

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Abstract

Due to their high toxicity, poor biodegradability and potential harmful effects to living organisms, it is obligatory to remove phenolic compounds and their derivatives from wastewaters. Several methods for the binding of phenolic wastewater such as filtration, oxidation, ion-change, precipitation and adsorption have been employed. Among them, adsorption on activated carbon is the most effective and frequently used method, because of the large surface area, high adsorption capacity, high purity and easy availability of sorbent material. Activated carbon can be produced from various raw materials such as coal, lignite, wood and agricultural wastes. Activated carbon prepared from agricultural wastes has been much pointed out due to high production cost of fossil fuel activated carbons.

In the present work bean crop waste was evaluated as precursor for the production of activated carbon by chemical activation using KOH as chemical activating agent. The impregnated bean crop waste was carbonized in a stainless steel fixed bed reactor at 550^0C under nitrogen flow rate of 100 ml/min with a heating rate of 10^0C/min. Obtained activated carbons were evaluated as adsorbent precursor for removing phenolic compounds and their derivatives from aqueous solutions. Experimental parameters affecting the adsorption such as pH, adsorbent dosage, initial phenol concentration, contact time, and operation temperature were optimized. Consequently, experimental results showed that activated carbon prepared from bean crop waste can be used effectively as a potential adsorbent precursor in order to remove phenolic compounds in wastewater from the view point of economic and environmental aspects.

SDWS2011.0783 Energetic Evaluation on Auxiliary Systems of an Hydrogen Hybrid Minibus

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Abstract

The transport is currently shifting towards an electric hybridization of the powertrain and the primary target is to decrease the pollutant emissions, to enhance efficiency and contemporary maintain the current vehicle performances. In particular the range is crucial for the electric powertrain and it could be sensitively affected by the Auxiliary Power Unit (APU) consumption. In fact it represents a considerable load and its consumption could reach 25 percent of total energy in a vehicle. The work presented in this paper has dealt with the auxiliary system analysis of mini-buses powered by hydrogen, consisting of air suspension compressor, cooling fans, water pump, servomotor, windscreen wiper, doors motion, breaks, lights, defrosting device, electronic management system.

The APU incidence has been evaluated on the global efficiency of the minibus monitoring the energy use of every component by developing an efficient data acquisition system. The bus has been analyzed in different significant cases study varying the number of bus stops, of the switch on-off, of the passengers and the weather conditions.

Once set up different representative working parameters, the acquired data have been exploited to simulate the APU energy incidence on the actual range of the bus in real use.

In addition, the study has brought to evaluate the possibility to substitute some components to decrease the energy consumption in order to enhance the mini-bus overall efficiency.

The conclusion is that improving the APU efficiency, the bus can significantly increase the autonomy.

Poster session II

SDWS2011.0426 The Role of Renewable Energy Sources on Electricity Prices in Spain. a Maximum Entropy Econometric Model

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Abstract

This paper explores the impact of renewable energies and electricity market regulation on household electricity prices in Spain by using a Maximum Entropy Econometric approach.

The liberalization of generating and retailing electricity activities could increase competition thus reducing electricity prices. However there is a controversial debate about the effects of electricity generation from renewable energy (RES-E) on household electricity prices.

The majority of renewable energy technologies increase generation costs as compared with conventional generation, thus increasing electricity prices.

Moreover, the development of Spanish RES-E is mainly driven by a feed-in tariff support scheme. This promotion system has costs to the final consumer that finally has to pay the required expenditures through a retail electricity price increased.

Besides, it is necessary to consider that a higher use of renewable energies could reduce even the electricity final prices because its promotion stimulates the generation of renewable energy which is characterized by variable costs lower than fossil conventional technologies.

In the described context this paper explores the impact of several economic variables on household electricity prices in Spain. However, information available about Spanish electricity liberalization market is scarce so it limits the sample date to the period 2002–2007. Therefore, when trying to estimate the price electricity model through regression procedures a dimensionality problem arises. As an alternative to estimate the model, we propose a Maximum Entropy Econometric approach.

Our results suggest electricity prices increase with the deployment of electricity generated from wind and also with electricity generated from hard coal. Energy dependence has also an important effect on electricity prices in Spain.

Regarding to the liberalization in electricity retail activities it has a positive effect on electricity prices. This result suggests that electricity market liberalization does not necessarily imply competitive price as it depends on the number of enterprises and the tendency of consumer to switch.

SDWS2011.0670 Impact Alcohol Addition Strategy on Enzymatic Transesterification of Jatropha Oil for Biodiesel Processing

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Abstract

Jatropha (Jatropha curcas), belonged to the family Euphorbiaceae, is globally distributed in subtropical and tropical regions. Its seed oil is currently receiving a lot of attentions for biodiesel production. Currently, non-edible oils have been more favourable to serve as biodiesel feedstocks to avoid competitions with food sources under increasing population pressures. The utilization of seed oil from tree sources can have synergistic benefits with afforestation, like carbon sequestration and climate mitigation. In addition, the wide adaptability of jatropha tree makes it a prime candidate as the pioneer tree for landslide sites and derelict farmlands.

Lipase transesterification of triglycerides is an eco-friendly alternative to chemical process due to a lower process temperature and an improved selectivity. However, the intoxication of lipases by methanol hampers further applicability of enzymatic transesterification. Although many operational advantages of using immobilized lipase were reported, few enzymatic catalytic transesterification of jatropha oil were reported.

In order to characterize the enzymatic transesterification for jatropha oil, methanol and ethanol were employed. Immobilized lipase (Novozyme 435) was used at 10 % w/v vs. oil. The reactions were conducted at 40^{o}C to 60^{o}C with oil/alcohol at a molar ratio of 1:3 for 24 hours. The alcohols were added in two ways: stepwise (three equal portions at the first three 30-minute intervals) and gradients. The results were compared. For stepwise addition, the conversions by methanols were from 33 to 41 %. For gradient addition, the conversions by methanols were from 38 to 49 %. But interestingly, the ranges of conversion for ethanol stepwise and gradient addition were similar at 15-28 % and 18-29 %. The above finding is consistent to the fact that the ethanol was hardly toxic to lipase. Triglycerides (TG) and its intermediate products (diglycerides (DG) and monoglycerides (MG)) were also monitored to examine the details of the three-step reactions. Finally, the overall potential of biodiesel production from Jatropha plantation in Taiwan was also estimated. This study may assist to find an optimized strategy of alcohol addition during enzymatic transesterification.

SDWS2011.0269 Greenhouse Gases Inventory from Public District Heating Plants of Republic Serbia

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Abstract

The global climate change has led to significant changes of Serbia climate characteristics. Each of the scenarios of climate change in the Republic of Serbia showed that some of economic sectors will be highly affected by the projected climate changes. It is of eminent importance to continually work on greenhouse gases (GHG) emissions reduction. Republic of Serbia, a non-Annex I member States of the Framework Convention on Climate Change (UNFCCC), seeks to contribute in achieving the basic objectives of the Convention, in accordance with their capabilities and the principles of sustainable development. Preparation of national communications and related documents is one of the most important obligation of non-Annex I countries. In order to carry out these activities, it is necessary to draw up a detailed inventory of GHG emissions from the relevant sectors. This paper presents the fuel/energy consumption data and results of GHG emissions calculation from thermal energy production in Public District Heating Plants (PDHP) for 1990, 1998 and 2008. The GHG inventory was prepared according to the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. The internationally recommendation for net calorific values and emission factors for all fossil fuels (solid, liquid and gaseous) were used (Tier 1 Method), except for the low calorific open pit mined lignite. Open pit mined lignite emission factor of lignite with low calorific value was experimentally determined. Two scenarios of GHG emissions projections for 2015 are presented. The basic scenario involves an expected increase in GHG emissions, remaining the share of fossil fuel type unchanged. An alternative scenario envisages GHG emissions in the case of coal and heavy oil substitution with natural gas. The results provide a quantitative measure of possible GHG emission reduction effect by switching from one to another fossil fuel type.

SDWS2011.0411 Traffic Intensity Influence on the City of Niš Air Quality

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Abstract

Air quality in urban areas is being influenced by many factors, mostly anthropogenic. Proper estimation of pollutant distribution is very important for making decisions for air quality improvement.

If we consider pollution a problem, application of CFD techniques is not a solution for the problem, but an estimation tool, which gives the data needed to the environment protection experts. Application of CFD techniques is giving the most detailed information about pollutant dispersion.

In this paper, measured traffic intensity is used for defining initial and boundary conditions in the CFD model. For this usage, COPERT software package was chosen. As being well known that wind characteristics have the largest influence on pollutant dispersion, they were carefully treated. There are two main wind directions on the City of Niš area, so two groups of simulations were done, for each main wind direction separately. For pollutant dispersion estimation PHOENICS software package was used.

For each wind direction, two simulations were done, considering the traffic intensity distribution, one for the morning traffic minimum, and other for the afternoon traffic maximum, considering measured wind data at the same time. The results of the numerical simulation shows good agreement with the measured wind data and CO_2 concentrations.

SDWS2011.1015 Exergoeconomic Analysis of the Energetic Processes in Rubber Industry

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Abstract

Essentially, energy efficiency is directly associated to positive economic effects that are result of the implementation of energy efficiency measures. The main reason for initiation of energy efficiency projects, as well as the main motivation for adoption of these measures by consumers is just the energy savings that directly result with financial benefits. When we need to provide necessary amount of energy to meet demand, we usually focus on the optimization of activities on the energy supply side. However, using

principles and tools of exergoeconomy might lead to recognizing significant improvements potential on the demand side.

The aim of this paper is to show the potential for cost reduction on the demand side, using the exergoeconomic method on the example of a real industrial plant for rubber production. Industrial plant was monitored over a longer period of time and data related to energy consumption were collected on an hourly, monthly and annual basis. Initial investments and maintenance and operation costs data are also collected. Real data were used to perform error analysis and verify the results. This paper presents a model of an industrial plant with units for which the energy, exergy and exergoeconomic analysis are carried using the theory of exergy costs. The paper is based on the data of an industrial enterprise collected during one business year, on the usage of saturated steam (16,291.00 t) and electricity (4,476.14 MWh) and production level (2,127.67 t), as well as the data on the investment, running and maintenance costs. The results of scientific analysis show that the energy management system is developed in this factory and that many improvements are already implemented, but there is still potential for energy savings at demand side up to 7%. The exergoeconomic techniques provide effective approach for identifying, evaluating and reducing the thermodynamic inefficiencies and the costs in an energy system.

SDWS2011.0316 Sustainability Evaluation and Reporting by Pharmaceutical Companies

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Abstract

Currently no standardized methods exist for integrating, measuring, or communicating sustainability by pharmaceutical companies. Schneider et al. analyzed the evolution of sustainability reporting in the pharmaceutical sector, concluding that it has increased in breadth and depth, but have now shifted more towards corporate social responsibility, which reflect the companies' needs to satisfy public opinion. Blum-Kusterer and Hussain analyzed the main drivers for sustainability improvements in the pharmaceuticals industry, concluding that regulation followed by the implementation of new technologies are the major drivers for process change. Greiber et al. concluded that due to the intangible and qualitative nature of the social dimension of sustainability there is a lack of consensus about what are the relevant criteria for companies to account for it, in order to be able to compare different companies and benchmarking them.

One form of evaluating the sustainability of pharmaceutical processes is by using sustainability metrics or indicators. Several indicators and metrics have been proposed by researchers over the years. The problem with some of these metric systems is that they

only cover certain dimensions of sustainability and not all the three dimensions: environmental, societal and economic.

This study aims to present the recent advances in this area by summarizing the key metric systems that have been proposed by researchers in the pharmaceutical or fine chemicals field. Also, it describes how to perform a sustainability evaluation of pharmaceutical products through its supply chain. A framework for selecting sustainability indicators that take into account all three sustainability dimensions is presented. Special attention is given to a useful definition of the system boundary and to the identification of the relevant impacts associated with pharmaceutical products. A set of sustainability indicators is proposed for quantitative sustainability assessment, based on the impacts seemed to be relevant at each stage of the supply chain. Some qualitative arguments are also presented to support the indicators selection and calculation.

SDWS2011.0528 Environmental Externalities and Their Effect on the Cost of Consumer Products

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Abstract

Various economic activities, such as energy conversion, generate pollution, which causes damages to the society and the environment. Using thermodynamic principles combined with empirical techniques, it is possible to estimate the quantities of emitted pollutants from energy conversion systems. The objective of this work is to assess the cost of pollution using different methods. For this purpose the EcoSenseWeb and GAINS software are used. EcoSenseWeb is based on the results of the ExternE project, whereas GAINS is developed at the International Institute for Applied Systems Analysis and takes into account air pollution policies. It is shown that the dispersion of pollutants has an influence on the external environmental costs (externalities), which are assessed for different countries. In addition, the neighboring countries that are strongly affected by the pollution in each particular country are identified. The procedure for estimating the cost of externalities is described in detail. Furthermore, the sensitivity of the externalities and of the unit cost of electricity on certain important parameters is investigated.

SDWS2011.0529 Environmental Externalities and its Influence on the Thermo-Ecological Cost

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Abstract

In the situation of even minimal probability of depletion of non-renewable natural resources, their rational management will become more and more important. In addition, energy conversion systems based on non-renewable resources generate pollution which causes damages to human health, building materials, crops, land etc. The human impact on the depletion of natural resources can be measured using the thermo-ecological cost, which is defined as the cumulative exergy consumption of non-renewable resources that affect every stage of manufacturing process. This cost takes into account the additional consumption of non-renewable resources arising from the need to compensate for adverse effects on the environment caused by the harmful waste substances. For this purpose the external environmental cost of pollution is calculated. This is done based on the results of EcosSenseWeb and GAINS software. In this paper the sensitivity analysis of thermo-ecological cost based on the cost of externalities is presented.

SDWS2011.0386 Optimal Design and Operation of a Biogas Fuelled MCFC System Integrated with an Anaerobic Digester

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Abstract

In the north west part of Italy there are various experiences of anaerobic digestion both for municipal solid wastes and for waste sludge from sewage treatment. Biogas produced in these installations is usually used for electricity generation or cogeneration in internal combustion engines (ICEs). High temperature fuel cell systems may be used instead of ICEs to achieve larger electrical efficiencies.

In this paper, a hybrid system, obtained by integrating a molten carbonate fuel cell with a micro-turbine is considered. The size of the plant is selected on the basis of the maximum biogas production registered by monitoring annual operation of one of the two anaerobic digestion plants in Pinerolo. The hybrid system produces electricity and supplies heat to the digester. Heat is necessary to keep correct operating temperature of bacteria (48°C-53°C), thus this is a strict constraint for the plant.

A model of the system components is built and the plant optimization is performed. Design parameters are the fuel cell temperature, pressure ratio, inlet turbine temperature, reforming temperature, recirculation percentage, size of the two subsystems. Two competing objective functions are considered: the energy efficiency and the unit cost of

electricity. The Pareto front shows that efficiencies close to 50% are obtained, with unit costs comparable with market prices of electricity.

The optimal system is then considered in off-design conditions caused by variations in biogas production and thermal request of the digester. Experimental data from the digester are used in order to investigate such variations depending on the amount of waste supplied to the digester. The optimal operation, obtained by varying the microturbine load as well as acting on some bypass valve are selected depending on the daily heat request and biogas production. Possible economic and energy benefits that can be achieved by adding natural gas are also investigated.

SDWS2011.0876 An Artificial Neural Network Modeling of Energy Use Prediction in Sunflower Production

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Abstract

Artificial neural networks (ANNs) are massively parallel-distributed information processors that have certain performance characteristics resembling biological neural networks of human brain. This study focused on the capability of artificial neural network as an alternative tool to the conventional regression model to forecast sunflower production based on eight inputs including human labour, machinery, diesel fuel, biocides, fertilizers, electricity, irrigation water and seed energies. Both the models were developed and evaluated and their performances were compared using the quality parameters. The results revealed that the ANN model consisting of one input layer with eight input variables, single hidden layer with three neurons and one output layer with one output variable has the highest coefficient of determination (0.976) and the lowest values of RMSE (61.57 kg ha^{-1}) and MAE (50.94 kg ha^{-1}). A comparative study on the results obtained from both the models indicated that the selected ANN model with a higher coefficient of determination and lower value of error tended to have more accurate predictions of sunflower production than that of multiple regression models. The ANN model with 8-3-1 structure was the best model for predicting the sunflower yield and ANN model had a superior performance compared to traditional multiple regression technique. From the results of this study it is proposed that the artificial neural network models are useful tools in helping to predict the crop yields with respect to energy inputs.

SDWS2011.0470 Bio-Hydrogen Production from the Digestion of Starch Using Mixed Cultures

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Abstract

The production of hydrogen is attracting a growing interest due to the recognised environmental and economic advantages, mostly related to its potential energy-application, but also with respect to being an important feedstock for e.g. chemical, pharmaceutical and food industries. Its utilisation is expected to grow significantly over the coming years, and the development of new production methods to complement or substitute the traditional steam reforming, gasification or electrolysis, will further enhance the growth.

The microbial conversion of biomass is considered as the route with the highest immediate potential for its significant hydrogen-yield and low energy input.

The research reported in the present paper investigates this potential, using starch as raw material for the digestion and by selecting appropriate micro-organisms. Comparative tests were conducted in a 1 litre digester, using different starch concentrations. It was however demonstrated that a starch concentration of about 1 wt% produced the best results, and this concentration as thereafter investigated as reference.

Digestion using single micro-organism strains are shown to be of limited efficiency only for H_2 production, with a biogas H_2-content between 17 and 39 vol% as function of the pure strain used, with a low yield of 0.15 to 0.2 mole of H_2/mole of starch. The combination of an amylase producing strain and acidogenic bacteria significantly enhanced the bio-hydrogen production yield. Under the same test conditions, a maximum production of 900 ml of biogas was achieved after 40 to 50 hrs of digestion.

The starch conversion reached a maximum of 80.4 %. The hydrogen production of 0.52 mol/mol starch was present at 62-63 vol% in the biogas (the remaining vol% being CO_2).

The paper will detail the experimental conditions and provide complete results towards bio-hydrogen production, while also discussing the evolution of pH and COD during the experiments.

Results for the optimum starch concentration of 1 wt% will moreover be modelled in order to define the kinetic parameters of the digestion, needed for design and scale-up purposes.

SDWS2011.0623 Influence of the Composition of Natural Gas Blended with Hydrogen (Hcng) on the Design and Performance of a Spark Ignition Engine

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Abstract

The growing concern for the care of the environment in all of the fields of knowledge also affects the reciprocating engine manufacturing industry. In order to be more respectful with the environment, decreasing the emissions of greenhouse gases to the atmosphere is required and different alternatives to fossil fuels are continuously being studied. Hydrogen is postulated as the long-term alternative, as it is abundant in the nature and the combustion products are practically harmless. However, nowadays the major part of the hydrogen is obtained via fossil fuels, so the dependency on these fuels is not solved. In addition, hydrogen storage is also a critical issue due to it is very explosive, and the size and weight of the deposits are high, and the reciprocating engine performance is reduced with respect to the fossil fuels. An alternative solution as transition to hydrogen technology is natural gas blended with hydrogen, known as HCNG.

Natural gas has excellent anti-knock properties, so the compression ratio can be higher improving efficiency and power. However the flame propagation rate is low and the auto ignition temperature is high. Hydrogen has a high flame propagation rate and is easier to ignite. A combination of the two fuels could solve the limitations of both pure natural gas and hydrogen.

In the present work an indicated cycle model of a spark ignition engine fuelled with pure natural gas, pure hydrogen and different blends of hydrogen and natural gas (HCNG) has been developed in order to analyze the influence of the hydrogen fraction on the engine performance and CO_2 emissions. A combustion model based on thermodynamic equations is used considering separated zones for the burned and unburned gases.

In order to validate the model, experimental data from other investigators are used to compare the results of the model. The model fits the experimental data with an error lower than 3% in the evolution of the pressure.

The results show that the maximum cylinder pressure increases as the fraction of hydrogen in the blend increases. The presence of hydrogen in the blend leads to a decrease in the CO_2 emissions and to an increase of NO_x emissions. Because of the properties of hydrogen, leaner fuel-air mixtures can be used and with the appropriate ignition timing, the engine improves its emissions without a worsening in performance.

SDWS2011.0501 The Future of Biomass Pyrolysis in the Production of Value-Added Products

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Abstract

Pyrolysis is widely used in the chemical industry to produce e.g. carbon black from HFO and coke from coal, to convert post-consumer plastic waste into chemicals, and to transform heavier hydrocarbons into lighter ones. Whereas a lot of work has been presented on the production of bio-oil from biomass through pyrolysis, the objectives of added-value feedstock production are now a major focus when using biomass as input for the pyrolysis reactor: the highly oxygenated nature of the bio-oils requiring an extensive and costly upgrading towards fuel-applications. The biomass pyrolysis is now recognised as a valuable route of chemical synthesis.

Whereas fast pyrolysis targets mostly bio-oil yields (up to 60 or 70 wt%), with about equal amounts of biogas and char being produced, slow pyrolysis targets mostly char yields (up to 50 wt%), together with 30-35 wt% of bio-chemicals and the balance as gas.

Bio-oil from slow pyrolysis contains mostly polar compounds (more than 50 wt%), less than 5 wt% water, 35 wt% aliphatics and 10 wt% aromatics. Bio-oil from fast pyrolysis contains 16-20 wt% water and is composed very differently, containing all the components cited above, with polar compounds still representing 30 wt%.

The paper will present results from fast and slow pyrolysis of biomass species, with a full analysis of the products being formed in both cases, with a potential market perspective for these chemicals, and with the possible upgrading into products of immediate commercial potential (e.g. steam activation of char into activated carbon, separation of polar compounds, etc.).

Finally, the recommended operation mode for slow, intermediate and fast pyrolysis will be dealt with, together with a selection of the available technologies: fluidized bed, fixed bed, rotating cone, spouted bed, rotary furnace, etc.

SDWS2011.0935 Implementation of Biofuels in Malaysian Transportation Sector Towards Sustainable Development: a Case Study of International Cooperation Between Malaysia and Japan

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Abstract

Modern transportation nowadays has evolved into an important economic activity for human civilization. Even though various alternative energy solutions have been put forward to reduce the dependency on fossil fuels, biofuels remain one of the few options which are capable of replacing the roles of fossil fuels in transportation sector without suffering from major economic losses. Malaysia with a huge supply of palm oil for biofuels production is intended to implement mandatory biodiesel blends in its transportation sector in 2011 in order to achieve its carbon reduction commitment towards a more sustainable development. This implementation was originally targeted to start in 2009 but had to be postponed due to several obstacles such as expensive cost, lack of sufficient infrastructure and low public demand. On the other hand, Japan is also trying to fulfil its carbon reduction obligation as outlined under Kyoto Protocol with the usage of biofuels to replace fossil fuels in the transportation sector. However, it lacks of sufficient biofuels supply to support its high transportation energy demand. In this case study, the mutual cooperation between Malaysia and Japan in the implementation of biofuels in transportation sector will be studied and analysed in order to overcome the challenges presented in both countries. It is hope to ascertain potential cooperation opportunities among those two countries to promote biofuels energy as Malaysia is rich in natural resources while Japan has the relevant expertise and technology. It is believed that the strengths from one country can help to cover for the weaknesses from the other and vice versa via closer bilateral partnership which will be extremely crucial when dealing with global energy issues. Ultimately, it is hope that this case study will enable both Malaysian and Japanese government to achieve their renewable energy target in domestic transportation sector.

SDWS2011.0333 **Grate-Firing Thermal Conversion System Development Applied to Novel Energy Crops Combustion**

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Abstract

Growing interest in local energy crops production as new biomass sources for heating purposes demands gaining knowledge related to the most suitable conversion technology. In order to develop a very high reliability level facility, able to increase biomass share even when difficult fuels are considered, previous knowledge and current state of technology based on combustion of stemwood based assortments have to be assessed. However, due to the fact that ash chemical characteristics and physical properties differ among stemwood based assortments and novel fuels such as agricultural residues and energy crops, theoretical and experimental studies with this new kind of biofuels are also demanded. In Spain, different kind of Mediterranean energy crops have been studied as part of the "PSE On Cultivos" I+D+i national project. This project involves all the production chain steps from fuel production to its transformation in the energy conversion system. In order to evaluate Mediterranean energy crops applicability for heating purposes, a biomass grate-firing boiler has been developed and conversion technology adapted to the specific combustion properties and ash chemical characteristics of the pelletized fuels. The main objective of this paper was to highlight important considerations that should be taken into account when these new generation biofuels are combusted for heating purposes. Main characteristics of the thermal conversion system developed in the "PSE On Cultivos" framework were also compared with those ones corresponding to traditional facilities implemented for stemwood based assortments. Two of the most promising fuel alternatives that are currently being assessed in this project, an herbaceous one, i.e. Brassica carinata, and a woody one, i.e. Populus ssp., have been used to perform the combustion experiments of this work in the novel medium scale grate biomass pellet boiler (250 kW_{th}) according to EN-303-5 requirements. Based on the experimental results achieved by this research and considering current state of technology and available information from literature review, factors of significant influence on the best combustion performance during grate-firing thermal conversion of these potential future biofuels have been identified and discussed. So, the results that have been obtained would help to increase the sustainable development of the worldwide energy crops market by means of multi-fuel thermal conversion systems.

SDWS2011.0410 Experimental Investigation of Flammable Properties of Municipal Sewage Sludge

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Abstract

Ignition temeprature is one of the most important features of fuels. This parameter can affects the stability of the combustion process and the safety of fuel operation. Municipal sewage sludge is generated in municipal sewage-treatment plants in the process of sewage treatment. Sewage sludge may be an alternative to non –renewable fossil fuels. The main problems of majority of EU countries are the high percentage of stored sewage sludge and a lack of installations for its thermal utilization. Thermal processes can be used for the conversion of large quantities of sewage sludge (e.g., in large urban areas) into useful energy. Those methods have to be developed. One of the aspects is knowledge of the sewage sludge ignition temperature.

In the paper the ignition temperature of four types of Polish (Iława, Pisaeczno, Włocławek, Kozigłowy) sewage sludge was defined. Kreulen method was used. The test focused on the effect of the fuel fragmentation on the ignition temperature. Additionally, the proximate analysys of sewage sludges was done. The indications were done based on the Polish Standards.

The lowest ignition temperature (195^{o}C) was obtained for Iława's sewage sludge with a stream of oxidizer equal to 10 dm^3/h and for heating factor equal to 4. Simultanously, these sewage sludges are characterized by the highest content of volatile matter and the lowest moisture content. On the other hand, the highest ignition temperature (221^{o}C) was obtained for Koziegłowy's sewage sludge for the same process parameters. With the increasing of the fuel fragmentation the increment of autoignition temperature was observed.

Thermal utilization of sewage sludge is an important element in the wider problem of sludge disposal. There are many technologies that use gasification or pyrolysis (or a combination of these two). Polish conditions appear to present a good opportunity to utilize this group of waste-disposal technologies but it requires carrying out basic research in terms of combustible properties of sewage sludge.

SDWS2011.0186 The Study of Biodegradation of Halogenoacetic Acids in Bioreactor with Polyacrylonitryle Ultrafiltration Enzymatic Membrane

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Abstract

Haloacetic acids (HAA) are known disinfection by-products of the chlorine treatment of water. The category of haloacetic acids includes the following nine compounds: monochloroacetic acid (MCAA), dichloroacetic acid (DCAA), trichloroacetic acid (TCAA), monobromoacetic acid (MBAA), dibromoacetic acid (DBAA), tribromoacetic acid (TBAA), bromochloroacetic acid (BCAA), dichlorobromoacetic acid (DCBA) and dibromochloroacetic acid (DBCAA).

The study were focused on the possibility of biodegradation of halogenoacetic acids in bioreactor equipped with ultrafiltration enzymatic polyacrylonitryle membranes. Flat sheed membranes chemically modified with hydrazine hydrate and glutaraldehyde were used as a base for active membranes (with immobilized enzymes on their surface). The feed introduced to biodegradation process was an aqueous solution of 5 HAA of concentration 1 mg/dm^3 each. After 6 h operation under optimal process conditions determined experimentally the total removal of acids was obtained.

SDWS2011.0488 Problems and Remedies During the Fluidized Bed Combustion of Biomass

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Abstract

Biomass is a renewable fuel and considered CO_2-neutral. Cheap biomass is available as waste by-products. Biomass can be combusted directly to produce heat and power. The fluidized bed (FB) offers very good temperature control, good scale-up potential and simple operation. The diversity of biomass however makes it a complex fuel. High percentages of alkali and chlorine, together with high ash content are major sources of concern towards corrosion, erosion, agglomeration and fouling. The presence of N and S in biomass leads to significant levels of NO_x and SO_2 in the combustion gas. Incomplete combustion gives rise to emissions of CO and organics (even of polycyclic nature), while the presence of trace metals also requires consideration.

The paper will identify problems with underlying reasons, and will detail in-bed or post-combustion solutions: adequate measures are a sum of optimum operating

conditions, the use of in-bed additives and the application of different post-combustion pollution abatement technologies.

SDWS2011.0887 Comparative Characterization of Cork Concrete Masonry Blocks

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Abstract

The construction industry and the subsequent maintenance of the buildings created consume considerable amounts of energy, with consequent high levels of greenhouse gases (GHS) emissions. Energy consumption during use is largely determined by the building envelope. Its thermal performance depends on the materials used in its construction, and the production of these materials implies certain energy requirements and environmental impacts. In sustainable development, construction materials may incorporate renewable and/or recycled ingredients instead of traditional ones.

This paper will investigate the influence of concrete containing cork, a natural and renewable material, when used on the production of concrete masonry blocks. This paper will present a physical, mechanical and hygrothermal comparison between this innovative product and a traditional expanded clay lightweight concrete block with a specific geometry. Parameters such as the weight, compressive strength, water absorption and bulk density of the block will be considered. Acoustic and thermal behaviour of walls composed by those concrete blocks will be also achieved.

SDWS2011.0940 Improvement of CO2 Secuestration by Carbon/nitrogen Ratio Using Chlorella Vulgaris Utex 1803.

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Abstract

Among many attempts to reduce the quantity of CO_2 in the atmosphere, biotechnology using microalgae in a photo-bioreactor has extensively been studied. CO_2 sequestering by Microalgae could become a profitable industry that would help to mitigate global warming (GLW) and probably, enable environmentally neutral utilization of fossil fuels until their full replacement by alternative energy sources.

The aim of our study was to find the influence of microalgae growth under two different CO2 flows. The algal strain used in this work was Chlorella vulgaris UTEX 1803. C. vulgaris was cultured using Bold Basal Medium in accordance with using artificial freshwater formulation (Culture Collection of Algae and Protozoa, Oban, UK). The microalga was grown in photobioreactors (PBR) with 2000 ml of culture at 23±1°C under 12/12 hours light/dark cycles with constant CO_2 flow. Illumination was provided by four fluorescent lights combined to give the desired light intensity.

The growth response of Chlorella vulgaris was studied under varying concentrations of carbon dioxide (2,3%; 3,8%) and sodium nitrate as nitrogen source (NO_3) (0,59mM; 1,18mM; 1,77mM; 2,35mM). Later, an additional experiment was carried out between the best productivity conditions. The highest Productivity (0,51 g L^{-1} d^{-1}), and chlorophyll concentration (69,4mg L^{-1}) were recorded at 3,8% CO2 level and 1,18mM N.

This work mades part of the "Bioprospecting Colombian Microalgae for biodiesel production" code 2008D32006-6710 funded by the Ministry of Agriculture and Rural Development, with the participation of the Universidad Industrial de Santander, the Colombian Petroleum Institute ICP-ECOPETROL and Morrosquillo Institute Corporation.

SDWS2011.0939 Comparision of Environmental Performance of Biodiesel Production from Palm and Castor Oil Using Life Cycle Assessment

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Abstract

In this work, Life cycle assessment for two biodiesel processes was evaluated using SIMAPRO 7.1 software, with the aim to compare these different scenarios. The scenarios evaluated depend on the geographical location of cultivation area, raw materials applied, method of oil extraction and biodiesel production. The Colombian geography selected for this study was the eastern savannas and Magdalena River's midland valley. Two different raw materials were evaluated; the plantations considered as a source of oil were palm for Magdalena River´s midland valley, and castor for the eastern savannas; with respect to the extraction, the option of whether or not to use solvent was considered; and finally, for the biodiesel production, it was taken into account the usage of ethanol such as reactive and different types of catalysts (basic catalytic homogeneous reaction). All those industrial processes were simulated using Aspen Hysys 2006.5. Life cycle inventories were divided in four stages: crops, oil extraction, biodiesel production and combustion. The LCA was applied within all the steps as specified in ISO 14040 and 14044 (2006). For each case, the categories of impact studied in the LCA were: climate change (CCI), acidification (AI), eutrophication (EI), photochemical smog formation (POI), respiratory effects (REI),

non-renewable energy (NRE) and others; this way it was possible to obtain the environmental profile of the systems studied. With the quantification of the input and output flows in the different phases of the life cycle made possible to determine the most relevant emissions as well as the consumption energy associated in each one of the stages. According to the environmental profiles obtained, the stage of distribution and use of the B10 blend has the greatest influence in the output impact categories and the input impact category. As a result the LCA proposed in this work gives a powerful tool for sustainability analysis of biodiesel production. This study was supported by the Colombian State Department of Science, Technology & Innovation (COLCIENCIAS), Projects CT 475-2007 and CT 272-2008; and the Ibero-American Program on Science and Technology for Development (CYTED), Project 306RTO279 UNESCO codes: 330303, 332205, 530603, 330999.

SDWS2011.0915 Energy Use of Residual Marine Macroalgae: Biodiesel and Pellets

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Abstract

Galicia (north eastern Spain) is a region with an abundance and wide diversity of marine species and has a deeply rooted seafaring tradition. Algae in Galicia have been traditionally used for agricultural uses. Coastal residents have always collected upon arrival at the coast after storms, to use such as fertilizer, correcting the soil pH, and even as food for livestock. There are a great number of different marine algae but only some species are being used as a food product. The other species are collected in the beaches and they are treated as a waste. Galician macroalgae from the Atlantic Ocean can be used for biodiesel production, fuel similar to that obtained from terrestrial plants or seeds. The use of this raw material can give a solution from an environmental and economic point of view.

Biodiesel refers to any diesel-equivalent biofuel made from renewable biological materials such as vegetable oils or animal fats by chemical reaction with a short-chain alcohol, such as methanol, ethanol, or buthanol and a catalyst, called transesterification.

Pellets are a type of biomass fuel, generally made from compacted sawdust. They are usually produced as a byproduct of sawmilling and other wood transformation activities but can be obtained from many types of raw material. The pellets are extremely dense and can be produced with a low humidity content (below 10%) that allows them to be burned with a very high combustion efficiency.

In this paper we have studied the use of residual macroalgae for energy use. The first step is to synthetize biodiesel by basic catalyzed direct transesterification reaction of

macroalgae with sodium methoxide. Residual transesterification biomass can be used to produce highly energetic pellets, which can be used on any device.

SDWS2011.0544 Feasibility, Economy and Implementation of Waste Heat Recovering from the Exhausted Flue Gas with Low-Pressure Economizer for a 600MW Power Plant

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Abstract

It is known that large amounts of heat are contained in the exhausted flue gas of a fossil fuel firing power plant before the gas goes into the desulfurizer to be cleaned. Lots of water will then be evaporated from desulfurizer by this amount of heat. It is believed that reasonably utilization of the wasted heat is beneficial to increase the economy of the unit, decrease the emission of CO_2 and other pollutants and reduce the water needed in the process of flue gas desulfurization. The wasted heat entering the desulfurizer could be recovered with the installation of low-pressure economizer (LPE) before desulfurizer to heat the condensated water and squeeze out the steam bleeding to do extra work. The effects of conservation of energy and water and reduction of pollutant emissions are analyzed for the LPE installation on the aspects of feasibility and economy. A detailed case study of a 600MW coal-fired power unit with wet stack is presented for the feasibility of the addition of LPE and the expected economy. The serpentine pipes with rectangularly finned extensions are used for the LPE heat exchanger with the overall coefficient of heat transfer of 37W/m^2·K and the static pressure loss of 781Pa. Analysis for this unit shows that it is feasible to install LPEs in the exhausted flue gas system between pressurized fan and desulfurizer, and there is no negative impacts on the unit with the introduction of LPE. Results also show that, under full load, the saving of standard coal equivalent is 2~4g/kWh and the saving of water is 25~35t/h.

SDWS2011.0801 Influence of Technical Development and Declining Ore Grades on the Availability of Gold Resources

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Abstract

There are two counteracting trends which influence the future availability of mineral resources. First, the decline in ore grades, which rises energy consumption per ton of metal extracted, and second technological improvements, which may hamper this trend. This paper analyses these opposite issues through the survey of data set on historic gold

mining in Australia so as to establish relationships among resource extraction and energy use. The outcomes are used to validate the theory of learning curves. The latter enables to compare technical changes in regard to resource use; therefore it allows being aware if actual mining processes are leading gold mining sector towards sustainability. With learning-by-doing, increases in material and energy efficiency heighten with cumulative production. Nevertheless, technical efficiency cannot improve indefinitely and it can never overcome thermodynamic bounds. Otherwise, in the mining industry, energy consumption trend is strongly influenced by the decline in ore grades. Hence, this study is done under the following assumptions: that resource quality decreases with increased cumulative extraction and as ore grades decline energy requirements increase. Accordingly, special attention is given to technological constrains on each mine considering the prevailing ore grade. Results suggest that if no significant changes in mining process occur in the gold mining industry the energy consumptions will continue to increase threatening the capability to fulfill the prospective demand.

SDWS2011.0857 Simulation and Analysis of Indirect Coal-To-Liquid Technology with Ccs

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Abstract

China, an oil scarcity country, is coal dependent, and this situation will remain for a long time. The liquid fuel market in China is growing very quickly compared to the rate of increase in liquid fuel production capacity. The possibly efficient and environmental friendly way of producing chemicals from coal instead of oil becomes an attractive technology. As there are several processes that have not been industrialized, it is necessary to do relative simulation, especially on coal gasification and following processes like FT fuel, MeOH, and DME, as replacers of traditional liquid fuel. The production of FT fuel from coal is chosen to be studied in this article. Besides, for any fossil energy utilization including coal and oil, much more attention is paid to CO2 as it is one important reason for global warming. CCS (carbon capture and storage) technology is being considered to be an important solution way facing this problem. Systems with or without CCS are simulated by Aspen Plus. The system are divided into several units first, namely the air separation unit (ASU), coal gasification, water gas shift (WGS), syngas cleaning, FT synthesis & distillation, flue gas cleaning and power generation. Then these units are differently combined to construct six different systems. Through simulation and calculation by Aspen Plus, systems are compared from two aspects, energy analysis and environmental analysis. In energy analysis, thermal efficiencies are calculated. The thermal efficiency of FT once-though synthesis & power generation from off gas without

CCS (FT-OT) is the highest which is 59.8%, and that of FT recycled synthesis with CCS before and after synthesis (FT-RE-CCS-all) is the lowest which is 42.9%. Results show that FT once-though synthesis & power generation from off gas could achieve better energy unitization and the influence for introducing CCS to the system on thermal efficiency is 3%~7% negative. In environmental analysis, the CO2 emission of FT once-though synthesis & power generation from off gas with CCS before and after synthesis (FT-OT-CCS-all) is the lowest, and that of FT recycled synthesis without CCS (FT-RE) is the highest. Results show that the introduction of CCS could significantly reduce CO2 emission. And it is suggested that it is necessary to use CCS before and after synthesis in FT once-though synthesis & power generation from off gas system, while only use CCS before synthesis in FT recycled synthesis system. Based on the above research, it is concluded that although CCS could cause some thermal loss, the thermal efficiency of FT synthesis system with CCS considering CO2 emission is also competitive. In order to guarantee development of coal-to-oil industry as well as low energy consumption and low CO2 emission, it is important and necessary to introduce CCS technology progressively.
Keywords: Coal; FT; CCS; Aspen Plus; Simulation; Analysis

SDWS2011.0802 The Quality of Public Space in Networks and in Infrastructural Urban and Regional Nodes

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Abstract

This work aims to define the conditions necessary to achieve sustainable mobility as a complex system that affects the quality of urban life, regeneration areas, services and renewable energy. The motivations are dictated by the need to reverse the current trend of allocating urban spaces (streets, squares, gardens) to increase private profits, by multiplying the places of "consumption" and consequent positive externalities for the individuals concerned and negative to the community in terms of congestion and pollution. Furthermore, the externalities, historically determined by the predominance of exchange value on land use and by the creation of land rent in urban and regional areas, are the original matrixes of all the existing forms of incomes that afflict the economies and politics. The objectives are the recovery of public space of the roadways and sidewalks of roads with greater charge of mobility to realize bus lanes, cycling paths, park and ride to promote accessibility to public service. A second goal is the necessary integration between urban and territorial planning, transport and energy. In western Sicily we want to consider four examples in three cities of different size and role in the region: the metropolitan area of Palermo and its campus, Casteldaccia, a small town of Palermo hinterland and Alcamo a medium-sized town in the province of Trapani. In Palermo we

want study the issue of territorial planning of a urban park with integrated services for private residential use with a sustainable internal and external mobility and interchange nodes. It will also be introduced the feasibility of the implementation of urban equalization of lands and a scheme of urban parks that can be realized. In Casteldaccia we will study the implementation of a sustainable mobility system inside the urban area and the feasibility of a link with Palermo by rail or hybrid bus. For Alcamo the proposal is the creation of a public transport with electric bus shuttle and an urban system of cycling paths, even to link the near Alcamo marina and interchange areas where photovoltaic panels and small wind turbines for renewable energy could be realized. The conclusions will demonstrate that the benefits on the quality of urban life, the polycentrism and cohesion social can be significant, in accordance with costs compatible with the use of existing resources, trough a policy of subsidises and public-private participation integrated by specific taxation.

Poster session III

SDWS2011.0808 Sustainability of a School Water and Sanitation and Hygiene Education Programme in a Forgotten Crisis, Field Experience in the Western Sahara Refugees Camps.

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Abstract

Forgotten crisis are particular humanitarian situations that differ from classical emergencies because they don't reach the long term phase of recovery and settlement. They are also different from development situations due to the total dependence on the external humanitarian aid that makes self-sufficiency unattainable. In these particular contexts, sanitation facilities should be gradually installed for the health and well-being of the victims. International guidelines studied for emergencies have to be specifically adapted to forgotten crisis in order to pursue sustainability.

The paper analyses the five interrelated sustainability dimensions of a water and sanitation programme in a forgotten crises: technical, financial, institutional, social and environmental. It pretends to apply and investigate these key aspects in a school sanitation and hygiene education programme realized in the Western Sahara refugee's camps in Algeria, which have been set in 1975 and considered a forgotten crisis by ECHO.

The school sanitation and hygiene education programme carried out in the 31 primary schools of the Western Sahara refugee camps (attended by 25.536 students and 1.063 school staff) attempted to provide a balance between the hardware (technical, environmental and financial aspects) and software (social and institutional aspects). The sustainability was analyzed transversally in each of these components of the program, adapting the bibliographic reference to the particular context of forgotten crisis. Data were collected through focus group discussions, in-depth interviews, participant observation, mapping and photography.

The paper shows which type of methodology has to be used to identify the appropriate sanitation technology taking in consideration the social and cultural aspects, the local material and capacities available. An all-in-one grey water recycling system, experimented by CIRPS, SES and BRAC, could be an appropriate technical solution due to the limited water supply and environmental characteristics. The financial sustainability in this context is unachievable, but institutional strengthening is a key to keep systems operational, accessible and widely used.

Although forgotten crisis lack of the recovery phase and the promotion of self-sufficiency is complicated, the sustainability must be taken in consideration. In a sanitation programme the five dimensions of sustainability have to be analysed with a special attention to the institutional strengthening.

SDWS2011.0281 The Potential of Social Business in Water Supply and Sanitation Services. on Site Production of Sodium Hypochlorite (Osec) by PV Solar Source.

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Abstract

This study aims to evaluate the impact of an On Site Electro Chlorination (OSEC), asystem of sodium hypochlorite production from renewable energy sources, on the improvement of health and hygienic standards in Chiapas and Pacific Region (Costa Rica), as well as in Africa focusing on Western Sahara and Tanzania.

In each country has been studied the threats of infectious diseases which have high impact on the vulnerable population.

In this framework the production of low cost Sodium Hypochlorite through a stand alone system powered by PV solar source could be a good starting point in improving sanitation conditions, assure a disinfection of water, improve food safety and the disinfection of surfaces and clothes.

The cost analysis shows that to produce Sodium Hypochlorite with a OSEC solar system could lead to a economic saving of about 10/15 times in respect to the market price, even more in developing countries.

The paper aims, as well, to describe the possible employees of the Sodium Hypoclorite in the African and Latin America context and the potential to develop a series of Social Business and microenterprises for the production of products for hygiene and sanitation lead by local people, selling products at social prices and using a network of local sellers to reach the poorest villages.

SDWS2011.0095 Offshore Wind Energy in Denmark: Scale Economies and Institutional Choice

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Abstract

Offshore wind energy has developed in terms of turbine and project size, and currently undergoes a significant up-scaling to turbines and parks at greater distance to shore and deeper waters. Expectations to the positive effect of economies of scale on power production costs, however, have not materialized as yet. On the contrary, anticipated electricity generation costs have been on the increase for each increment of technology scale. Moreover, the cost reductions anticipated for progressing along a technological learning curve have are not apparent, and it seems that not all the additional

costs can be explained by deeper water, higher distance to shore, bottlenecks in supply or higher raw material costs. This paper will attempt to explain the paradox of increasing costs of offshore wind energy despite larger scales and technological development by looking at other factors: The limited availability of locations, driven by accelerating requirements of environmental concern, park size and public acceptance, is one important driver. Mounting risk of mega-projects and the infinite demand for renewable energy is another likely cause.

The present paper addresses the scale of offshore wind parks for Denmark and invites to reconsider the technological and institutional choices made. Based on a continuous resource-economic model operating in a geographical information systems (GIS) environment, which describes resources, costs and area constraints in a spatially explicit way, the relation between project size, location, ownership and costs is analysed. A scenario is proposed, which aims at locally owned smaller parks that may have several economic advantages but require a greater deal of tolerance and acceptance because of higher visual impact. Higher specific costs in some areas are outweighed by lower costs in other, by reduced expectations to profit and by the distribution of risk.

SDWS2011.0156 Sustainable Development and the Inequality Aversion of Society - Measuring Energy and Income Distribution in Germany with the Atkinson Index

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Abstract

Our analysis shows that the Atkinson index provides a powerful new tool not only for measuring the German distribution of income but also for estimating the distributional dimensions of energy consumption in Germany. Our analysis shows that a distribution analysis based on the Atkinson index can make an important contribution to the social debate about the distributional justice of income and consumption. With the epsilon parameter, the Atkinson index explicitly reveals the inequality aversion of society, and it enables us to define how sensitively the Atkinson index should react to inequalities. The epsilon represents the social trade-off between social equality and economic efficiency. With the Atkinson parameter, a normative dimension is therefore incorporated into the inequality analysis, which allows a degree of social aversion to be introduced into the inequality analysis.

The epsilon parameter of the Atkinson index reveals both the values of society for distributional justice and the willingness of society to accept transfer costs to achieve distributional justice. The epsilon parameter represents a connection between the universal equal political rights of the citizens and the efficiency criterion of the economy, and it defines fairness from the perspective of society. Epsilon indicates how high the

welfare difference can be between the lower and higher income groups from society's viewpoint.

Epsilon can be extended to consider sustainable development in such a way that the greater the epsilon value is, the higher the need for financing sustainable development projects is in the view of society. A low epsilon value means that society has a low aversion to inequality both in an intragenerational and an intergenerational sense. The inequality aversion increases with a rising epsilon, and society takes more intra- and intergenerational questions into consideration. Epsilon can therefore be interpreted as an intergenerational and intragenerational justice factor in the sense of sustainable development. The trade-off between equality and efficiency is thereby extended to the area of intergenerational equality. Hence epsilon can be interpreted as a sustainable parameter and the enlarged Atkinson index has the advantage that the index is quantitatively determinable so that the sustainability goals of a sustainability strategy can be determined.

For our analysis, we used disaggregated consumption and income data from the German Household Expenditure Survey conducted by the German Federal Statistical Office. The results of applying the Atkinson index could make a significant contribution to science and policy debates on income and energy equity in the context of sustainable development.

SDWS2011.0204 Renewable Electricity Production Costs – a Framework to Assist Policy-Makers' Decisions on Price Support

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Abstract

Despite recent progress, the production costs for renewable electricity remain above those for conventional power. Expectations of continuous reductions in production costs, typically underpin governments' policies for financial support. They often draw on the technology-focused versions of the Experience/Learning Curve model. This paper discusses how national-contextual factors also have a strong influence on production costs, such as geographic, infrastructural, institutional, and resource factors. As technologies mature, and as they reach significant levels of diffusion nationally, sustained increases in production costs might be recorded, due to these nationally-contextual factors, poorly accounted for in policy-making decisions for price support. The paper suggests an analytical framework for a more comprehensive understanding of production costs. Based on this, it recommends that the evolution of specific cost levels and factors be monitored to locate 'sources of changes'. A specific set of monitoring indicators is also proposed. Further, the paper suggests policy instruments that governments may use to

facilitate cost decreases, whenever possible. The application of the framework is illustrated for the diffusion of wind power in Spain during the past three decades.

SDWS2011.0571 Implementation of Sustainable Energy Management in Companies – Gap Analysis Technique

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Abstract

Implementation of the entire process of sustainable energy management can be conducted using appropriate techniques that are applicable regardless of whether the management process will be applied to a particular company, region or specific country. Applying these management methods is not recommended on a wider level than national, since the process requires the analysis of the environment and the control includes measurements that are performed to the level of each state, so that the accuracy to this level is acceptable. A particularly unclear situation would be obtained in the process of environmental analysis that is very complicated on the territory that is wider than the borders of the country, as in Mesa countries there are significant differences in social, political, economic and environmental situations.

The main role of the mentioned models lies in the fact of implementing the pre-selected strategy. Sustainable Development Strategy has been selected as the only acceptable strategy for energy management and its implementation can be carried out by selecting one of the proposed models. Namely, all the mentioned models are designed to enable the segmentation of the subject on which management is performed. The company, region or country is characterized by its specific features; they are determined by numerous parameters and in the given time they are in various stages of development.

The traditional way of approach to management took on segmentation and defined parts of the portfolio based solely on their economic viability. Modern science of sustainable management imposes the need to review the portfolio in terms of energy efficiency, energy consumption and emissions that result from it. Economic viability ceases to be the only factor that influences decision-making about the direction and the decision making. The environmental component, with energy sustainability in its framework, becomes an important factor which, to some extent, changes the traditional concepts of management and absolutely disturbs the traditional primacy of economic viability. The intent of sustainable energy management does not consist in the fact that environmental, and therefore the energy aspects of development, is placed in the foreground and becomes the deciding factor. The purpose of the new analysis of management techniques serves to find a method which will harmonize economic growth and environmental-energy responsible business, without substantial harm to the development of a country or company as a whole.

SDWS2011.0166 Comparative Assessment of Solar and Wind Energy Pilot Projects in Rural Areas

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Abstract

The paper investigates the prospects for better utilization of solar and wind energy in Macedonian agricultural sector by analyzing the technical aspects, economic and environmental effectiveness and social benefits of five pilot projects: (1) Solar water heater on a farm, (2) Photovoltaic (PV) system for sheepfold, (3) PV system for water pumping, (4) Wind power system for sheepfold and (5) Wind power system for water pumping.

The analysis has shown that incentives are needed to improve the overall financial viability of these types of projects. On the other hand, the forthcoming market driven fuel and electricity costs in parallel with the raising awareness for the socio-economic and environmental benefits would increase the interest of farmers for investments

The solar system for hot water production, on the grounds of its economic viability, environmental effectiveness and social benefits, but also as a result of simplicity and flexibility of the technical solutions, appeared to be a “champion technology” that can pilot the mass utilization of solar energy in rural areas. The other solar practices could also be promoted as good examples of overriding environmental and social concerns, since, under current circumstances, their economic viability is not an issue.

Wind turbine is not very suitable for mass utilization in rural areas in Macedonia.The selection of adequate location is very difficult due to high sensitivity to wind speed and the lack of long-term measurements. However, wind turbines should be promoted in combination with solar PV, or other complementary energy sources. These hybrid systems should serve as good examples of most effective utilization of various energy sources at the selected site.

SDWS2011.0179 Artificial Neural Networks for the Generation of Geothermal Maps of Ground Temperature at Various Depths by Considering Land Configuration

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Abstract

A neural network is used for the generation of geothermal maps of the temperature at three depths (20, 50 and 100m) in Cyprus. Archived data of temperature recorded at 41 boreholes are used for training a suitable artificial neural network. For eight of the boreholes the temperature was recorded over a period of one year whereas for the rest, data from a study carried out in the seventies were used. Various architectures and learning rates were tested, aiming at establishing a network which can yield an acceptably accurate estimation of temperature at any arbitrary location on the island which can subsequently be used for drawing the geothermal maps.

The parameters used for the training of the network are; the lithology class at the area of each borehole; the borehole elevation; the mean, min. and max. ambient air temperature at the location of the borehole; rainfall at the location of the borehole; the x and y coordinates for each borehole, measured from some reference point; the depth at which temperature is recorded; and the temperature at the particular depth. A total of 90 patterns were available (for some holes there were no data for all depths). From these 81 patterns were used for the training of the network and 9 for its validation. The correlation coefficient obtained between the predicted and training data set is 0.9889. The validation of the network was performed by using the unknown data for 9 cases. The correlation coefficient for the unknown cases was 0.9253. The prediction error for the mean annual rainfall was confined to less than 1.74°C, which is considered quite adequate.

In order to broaden the database, the nine patterns used for the validation of the technique were embedded into the training data set and a new training of the network was performed. The architecture and the other parameters of the network were kept the same as for the validation phase. The correlation coefficient value for this case was equal to 0.9818.

A 10x10 km grid is then drawn over a detailed topographic map of Cyprus and the lithology class; elevation; mean, min. and max. ambient air temperature; rainfall and the x and y coordinates for each borehole, measured from the same reference point were recorded. This information was then supplied to the trained network and by doing so the temperature at the same depths as above were predicted at each grid-point. The x and y coordinates and the estimated temperatures at the three depths for both the original boreholes and the grid-points, were then used as input to a specialized contour drawing software in order to draw the geothermal maps.

It is believed that the proposed method of explicitly involving the lithology class, elevation, ambient temperatures and rainfall in drawing geothermal maps realistically

produced valid maps of temperatures at the three depths. These maps will be a helpful tool for engineers wanting to apply geothermal heat in Cyprus.

SDWS2011.0507 Smart Grid Implementation in Developing Countries: Analysis Focussing Consumer Behaviour, Markets and Regulation

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Abstract

We are living an historic moment into the energy provisioning market. Mainly in so-called emerging countries, where Brazil is included, there is a clear opportunity to manage the transition the process and (re) organize the business to find out emerging needs and commitments to the future. Smart grid could be the path if its complexity and intrinsic knowledge are unveiled.

A level of commitment to an energy efficient and sustainable model will depend on a number of arrangements, such as the adequacy structure of generation and delivery, customers needs understanding and also, socio-cultural measurements built to motivate the conscious use. These needs should be backed by vigorous and modern designed regulation and legislation, enabling profitable business but generating mechanisms for monitor and evolutes the electric grid, and hence, qualify, quantify the use of the electric energy while organizing efficiency awareness.

The objectives of this research were the organization of future scenarios for the electric power sector considering smart grid in Brazil. This will shed light on the regional diversity of consumer behaviour, including considerations about of the current Brazilian electricity market arrangement as well as the energy matrix, the climate and local resources conditions. Issues concerning the transmission and distribution grids, and the role of customer participation in the process (as a conscious consumer and also a co-generator). Also, the paper presents initial regulatory actions that are being discussed in the country concerning the measurement and quality of electric power monitoring.

Additionally, some models are proposed as a market segmentation to involve Brazilian consumers, based on their current consumption and as future decision makers. We summarize the actions and decisions expected from the standpoint of regulatory and legislative, as well as business, and the electricity supply industry.

SDWS2011.0564 New Nanostructured Carbon with Hollow Core-Mesoporous Shell Structure as an Efficient Anode Material in Li Ion Battery

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Abstract

New energy technologies are critical for the energy future that seeks the goal of sustainable energy development. Rechargeable lithium ion batteries are becoming a key-enabling technology and have potential applications in electric and hybrid vehicles due to their high energy density, high voltage, and long lifespan. However, their rate capability which is dominated by the diffusion rate of lithium ions and the electron transport in electrode materials, needs to be improved greatly. Recently, much attention has been paid to high surface area porous carbons with various nanostructures due to the expected reduced diffusion length of lithium ions and rapid charge transfer.

Nanostructured porous carbon materials have been attracting much interest due to their potential use in various applications as sorbents, separation and filtration, photonic crystals, catalyst supports for low temperature fuel cells, sensors, electrode materials for electrochemical capacitors, lithium ion batteries, solar cells, hydrogen storage systems, and in other emerging nanotechnologies. Novel synthesis methods have been developed to prepare porous carbon materials with designed morphology, porosities and architectures, especially carbon frameworks with hierarchical porosity, namely, macropores in combination with meso-micropores.

Hollow core-mesoporous shell carbon (HCMSC) with hierarchical nanostructure was prepared and explored as anode in Li ion battery in this work. Compared with commercial graphite and ordered mesoporous carbon (CMK-3), the HCMSC not only demonstrates higher Li storage capacity, but also better cycling performance and rate capability. The HCMSC possesses unique structural characteristics such as large surface area and mesopore volume, and particularly the multimodal porositiy composed of hollow macropore core and well-developed 3D interconnected mesopores embedded in the mesopore shells, facilitating fast mass transport and charge transfer. The enhancement in anode performance especially in the cycling performance and rate capability is mainly attributable to the superb structural characteristics of the HCMSC, particularly the macropore core encapulated in well-developed 3D interconnected mesoporous shell, which act as efficient Li storage and buffer reservoirs to reduce volume change during the charge–discharge cycling especially at high rates.

SDWS2011.0625 Creating Consciousness About the Opportunities to Integrate Sustainable Energy on Islands

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Abstract

Many islands face problems in regard to sustainable development, both environmentally and economically. Due to geographical isolation, resources like food, goods and energy are imported from the outside. Focusing on local energy use may help islands to identify sustainable strategies and solutions. Islands in transition towards using more renewable energy sources are part of the project "Cradle to Cradle Islands", funded by the EU Interreg IVB North Sea Region Programme.

Energy systems on islands are diverse and linked to each specific location. Opportunities for the development of sustainable energy solutions are often inhibited by institutional, organisational or habitual problems. It is therefore essential to examine islands individually in their context; both in regard to energy use and available resources. This can be used to assess possible energy savings and unused renewable energy sources, and visualise their interaction, the consequences for the environment, as well as the effect on insular economy. Even though islands face different problems, experiences from other islands can be used as inspiration for others.

In this paper a straightforward tool for examining insular energy systems is presented. The tool is currently being applied to five different islands in the North Sea Region. The application of the model to identify the possibilities for each island can be used to improve the regional development in these areas.

SDWS2011.0743 Prediction of Wind Power Plants Energy Production by Use of the Publicly Available Wind Measurement Data

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Abstract

Current Croatian power system is characterized by large hydro power plants HPP (2000 MW in HPP of which 1600 MW is storage, 286 MW reversible or pumped storage and rest is run-of river) and thermal power plants of which 500 MW operate as CHP.

Although feed-in tariff system for promotion of renewable energy sources has been introduced in 2007, the large development of new sources has not emerged as in other EU countries. To speed up process of power system development, in 2009 Croatian Parliament accepted new energy strategy with a goal to satisfy 20% of electricity consumption in 2020 by energy from wind power plants or to have totally installed 1200 MW. With installed 70 MW of wind in 2010 there is a lot of job to be done in the next ten years by various stakeholders if goals set by the strategy will be fulfilled. Nevertheless, in the Croatian registry of RES projects investors applied over 5400 MW of new installation of which 4500 MW are located in the Southern Croatian region Dalmatia which has very favourable wind conditions.

The main problem that is in front of power system operators, investors in wind power, banks and energy planers is how to determine and predict, with the acceptable uncertainty or error, yearly, monthly, hourly and instantaneously power production of wind power plants from the field measurements in the Southern Croatia. The power system operators are interested in impacts of wind power on reliability and efficiency of the power system, while investors and owners in wind power plants and banks are more interested on production at certain location or site. Interest of Energy planers will be somewhere in between as usually they need to take care of planning from local to regional and global levels.

Paper presents results for vertical wind shear determined by multiple regression and related power production from certain types of wind turbines. Moreover, presented are correlations of hourly wind production inside a country which can describe local and regional level impact.

SDWS2011.0642 Wind Technology: a Solution to Reducing the Carbon Footprint

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Abstract

Renewable energies such as solar and wind are now widely accepted as possible future energy sources to enhance the energy demands and support the intense desire to reduce the worldwide carbon footprint. Unfortunately there are no renewable energy sources that can currently account for zero carbon footprints due to the fact that the carbon footprint is divided into direct and indirect elements.

The direct or primary carbon footprint is related to the CO_2 emitted when burning fossil fuels in such areas as transportation (flights, public and private modes of transport) and domestic energy consumption (home electricity, home gas/oil/coal).

As well as this direct carbon footprint which is universally accepted there is also an indirect or secondary carbon footprint. This footprint is not often highlighted but in fact

encompasses above half of a normal person's carbon footprint and is related to the indirect emission of CO_2 emanating from the purchases of today's society. This indirect footprint is associated with the manufacture and eventual breakdown of the products we buy and can be summarized such as public and financial services, recreation and leisure, home buildings and furnishings, car manufacturing and delivery together with clothes and personal effects although this list is not exhaustive.

While all forms of renewable energy do not have any direct CO_2 emissions they are not carbon neutral as they, like every other product produced, have an indirect carbon footprint. However, when compared with traditional energy sources the carbon footprint for non-traditional energy forms is still significantly limited.

This paper will discuss carbon footprint and its effect on our current society but more importantly it will focus on wind technology and how they can be integrated as an emerging energy technology to minimize the carbon footprint worldwide.

SDWS2011.0913 Integrated Simulation Platform for Urban Transition Modelling

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Abstract

The critical challenge for contemporary urbanism is understanding how to develop the knowledge, capacity and capability for public agencies, the private sector and multiple users in city-regions to systemically re-engineer existing built environment and urban infrastructure in response to climate change and resource constraints. In the UK and elsewhere cities are increasingly confronted with, or have voluntarily adopted, challenging targets for increasing renewable and decentralised energy, carbon emissions reduction, water saving, and waste reduction and management. In this paper, an integrated simulation platform is presented to enable stakeholders to envisage urban transitions scenarios towards sustainability at a city-regional scale. Based on this platform, users can envisage a systemic transition in our existing built environment, not just to zero carbon, but across the entire ecological footprint of our cities and the regions within which they are embedded whilst simultaneously promoting economic security, social health and resilience.

SDWS2011.1002 The Potential of Res for GHG Emissions Reduction

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Abstract

As European Union (EU) candidate country, Macedonia is in the process of adoption of the EU strategic energy policies, harmonization of the national legislation with the EU legislation and defining the respective national goals. In this regard, the government has recently adopted a National Strategy for Utilisation of Renewable Energy Sources (RES), prepared by ICEIM-MANU.

The main goal of this paper is to assess the potential for greenhouse gases (GHG) emissions reduction by implementation of 21%-RES-scenarios from the Strategy. The corresponding emissions reduction is calculated against the baseline (reference) scenario developed within the Second National Communication on Climate Change. Furthermore, all potential RES technologies are analyzed from economic aspect and combined in a form of emissions reduction cost curve, displaying the total marginal cost of the GHG emissions reduction by RES.

Finally, on the bases of the environmental and economic effectiveness of the considered RES technologies, as well as taking into account the country specific barriers, the priority actions for GHG emissions reduction are identified.

SDWS2011.0741 Theoretical and New Scientific Approach to Market-Based Mechanism for the Promotion of Energy Efficiency Starting from Italian Market Experience

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Abstract

The last years has been characterized by an increase of energy peak demand in several European Countries, which caused two consequences: the raise of energy prices and greenhouse gas emissions. The energy demand management actions seem to be the right way to reduce this continuous increase and to boost the end use energy efficiency. According to the most important energy sector experts, market-based mechanisms are considered one of the best solution to promote energy efficiency because they are strictly connected with the new energy policies adopted by Europe referring to an increase of competitiveness between Member States through the liberalization and an high level of concurrency of internal markets.

The paper describes the research concerning the analysis of the potentialities of Italian White Certificates mechanism, also evaluating the results coming from all the market sessions which show a strength participation of actors involved in the Italian energy efficiency system.

Furthermore, the analysis has underlined the peculiarity of Italian system in terms of flexibility and opening to the new energy saving technologies and saving evaluation methodologies. That gives to the Italian market-based mechanisms an enormous potentiality of development of the targets from both qualitative and quantitative points of view.

Starting from the above mentioned applications, an energy auditing methodology has been implemented in order to optimize the White Certificates approach.The methodology has been also tested in the large-scale retail trade sector, that is very significant in the energy consumption analysis.The results of theoretical and experimental analysis show that the performance of energy saving application can be enhanced by exploiting the White Certificates.As mentioned, the outputs achieved have been validated by considering some practical applications in the field of energy efficiency. The energy saving level result to be very encouraging.The analysis has been applied also to an important large-scale retail trade firm, and the result have been substantially confirmed.

Moreover, through a detailed analysis of relations and collaborations between suppliers, public administrations and law authorities involved in system, it has been possible to evaluate the next-years scenarios of energy efficiency boosting in Italian liberalized energy markets.

Until today, the development of an effective policy of the energy efficiency in Europe has been slowed down by the very low economical sustainability of the energy saving interventions. Also the reduction of the cost coming from the technological development, has been not enough to collect investments from the stakeholders.

Italian experience demonstrates, on the contrary, the high sustainability of the market-based mechanisms, as tools for the energy efficiency promotion. This research offers scientific starting points for the future application at the European market of the Italian mechanism.

SDWS2011.0319 Analysis and Identification of Organic Compounds Contained in the Waste Waters Produced Form the Steam Distillation Industry in Albania

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Abstract

Thousands of liters of waste waters are discharged in the nature every year in Albania from the industrial essential oil distillation plants. It is well known that these waters contain organics dissolved in them, and environmental risk assessment and environmental impact studies basically are not carried out. Industrialists in Albania are becoming more aware of environmental impact and are seeking ways of recycling these waters.

In collaboration with Filipi Company, we were interested in investigating the chemical profile of waters produced during the distillation of Thymus Vulgaris. Depending on that content suggestion for alternative uses of these waters will be made.

There are two types of waters that we have collected and analyzed: the hydrolates that distill with essential oils and the under vessel waters. For that purpose samples of 25 liters of waters were taken from the industrial plant. The hydrolates were extracted with ether and then analyzed with GC. In some cases the waters were saturated with salt prior to extraction, but this did not give any sensitive improvement of the yield. Each organic compound found on this aqueous phases was characterized by GC-MS. The analyses showed that it contains up to 0.2% organics. The under vessel waters contain more polar organics and they have been analyzed by HPLC after extraction with $CHCl_3$.

Because of their aroma, natural products contain and of these distilled waters, the use of hydrolates in shampoos and liquid detergents is suggested and formulation trials are under way.

SDWS2011.1005 Modelling and Simulation of Isolated Dc Microgrids Supplied by Renewable Energy Resources

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Abstract

This paper presents a detailed development of models of typical components that form a hybrid power system. Hybrid system consists of a small wind turbine, a photovoltaic string, a battery string and a load. The battery string is the most important element of the system, being the only component able to process a two way power flow. It is connected directly to the DC bus bar, as well as the load supplied, and its function is double; securing uninterruptible power supply and maintaining system voltage in set boundaries. The battery's voltage is a nonlinear function depending on its state of charge, current and environmental conditions. Accurate state of batteries voltage is critical for modelling production of all other components in the hybrid system, since their production is directly depended on this value. All of the modelled components are connected to a direct current (DC) busbar. Presented model is based on real measurement results and creates an environment for simulation of electrical supply in isolated microgrids.

Panel: Water sustainability

Out of 6.9 billion people in 2010, 884 million people (1 of each 7.8) lack safe drinking water, 2.5 billion (1 of 3.6) have inadequate access to water for sanitation and waste disposal, and rapid ground water depletion harms agriculture. The world is increasingly facing a water crisis which is considered to be to be even more dangerous than the energy and associated global warming ones. It is obvious that immediate and strong action must be taken to develop and use water sustainability, founded on quantitative environmental, economic and social principles.

Five water experts will speak briefly about different aspects of water sustainability, followed by questions, answers and discussion with the audience.

SDWS2011.1021 Water Problems and Management of the Mexico City Metropolitan Area

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Abstract

Mexico City's Metropolitan Area (MCMA) is the second largest urban center in the world after Tokyo's Metropolitan Area. Its nearly 20 million inhabitants represent around 18 per cent of the country's population and the region produces 35 per cent of the national GDP. As a result of such an urbanized area, water use and sanitation is a major problem.

Water use in Mexico City Metropolitan Area is estimated at 63 m^3 per second of which 1.5 m^3/s come from surface systems within the basin, 42 m^3/s are extracted from the basin aquifers, and the rest come from external sources to the basin, of which 6.0 m^3/s are from ground water in the near Lerma basin and 13.5 m^3/s come from surface water in the Cutzamala basin (volume of water has to be pumped through a distance of more than 160 km, and 1,100 m high). The aquifers in and out of the basin are overexploited and some of them have pollution problems. Most of the water used in the MCMA is not treated but it irrigates about 85 thousand ha for agricultural porpoises. Leaks of the water system are calculated in nearly 30% and a considerable part of the city suffers from chronic water shortages during the dry season. On the other hand, rain and sanitation water are mix in the same drainage system and in spite of the large historic investment in bringing this water out of the basin during the rainy season, many parts of the MCMA still suffer from floods.

The government of the MCMA, as well as the water management and administration relies on the federal government, the Mexico City government, the State of Mexico government and 43 municipalities. Although the huge water problems of the MCMA, there are technical and management solutions. However, they need public investment, coordination of the different governmental agencies involved in its management and community involvement.

SDWS2011.1022 Will We Have Enough Water?

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Abstract

In contrast to fossil resources water is a renewable resource. But will there be enough water for a world of 9 billion people by 2050? I will briefly review water supply and demand estimates at global and regional scales. (This will give me the opportunity to acknowledge the outstanding work of Igor Shiklomanov who died last year. He was responsible for much of our knowledge in this area.) I will conclude that there will not be a global water shortage but regional issues may be severe. This will be the case, in particular, in large arid river basins that share these characteristics:

- water supply is dominated by precipitation at high elevations;
- climate change is likely to alter quantity and seasonality of precipitation;
- downstream water supply will be diminished by increased evapotranspiration and reservoir sedimentation;
- water demand is growing as a result of population rise and need for more food.
- To meet future water demand improved basin management is needed. Even if successful, ecosystem support will suffer.

SDWS2011.1020 Groundwater Resources Management in the Mediterranean Basin with Special Reference to the Intrusion of Seawater in Coastal Aquifers.

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Abstract

Groundwater is a valuable natural resource for Mediterranean countries as it plays a vital role to the national economies of these countries. The fact that almost 87% of the total amounts of annually exploited water is used for agricultural purposes, proves the necessity for the “smart mining” of groundwater resources in the Mediterannean basin. This extensive overexploitation of groundwater resources, especially in coastal aquifers , has resulted also in the qualitative degradation of groundwaters, in cases where the aquifer system is hydraulically connected to the sea , and therefore seawater encroached towards the mainland. This has been considered as being an always increasing environmental problem, with global (e.g. population dynamics) and climate (e.g. droughts) changes putting an extra stress on groundwater resources. Currently new techniques, policies and

technologies are developed, aiming to the minimization or even the prevention of seawater intrusion and hence the sustainability of the freshwater coastal aquifer systems. This study analyses the phenomenon of seawater intrusion in the Mediterranean basin (origin and present state), the current scientific and engineering techniques followed for its identification as well as the managerial practices that are developed and applied for its prevention.

SDWS2011.1018 Abstract: Tariff-Setting – Creating a Sustainable Economic Basis

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Abstract

The economic basis of any investment and financing decision in water and wastewater investment projects is the future expected revenue stream. A stable revenue stream, sufficient to cover the operating and maintenance costs, depreciation, investments, and debt service including coverage ratios, is the key requirement for external financiers (IFIs or commercial banks) in providing finance. The well-known main problem in the water sector is that the level of tariffs is in many cases insufficient even to cover operating and maintenance costs. This clearly creates an unstable and financial unsustainable situation and prevents new investment or rehabilitation of already depreciated facilities. In addition tariff-setting is in many cases strongly politically influenced and no adequate methodology following the principle of full cost-recovery is used. The fact that the level of tariff can usually not be directly influenced at the local utility level thus poses a major risk to the financial sustainability of all water utilities.

A common result of the aforementioned situation is the so-called "vicious circle" that often plagues the water and wastewater sector and poses major institutional, financial and technical obstacles to development. In brief, the vicious circle involves low tariffs (that are insufficient to support capital investment or rehabilitation costs), which lead to low efficiency and high operating costs, as well as inadequate resources. This in turn leads to low service quality followed by loss of customer support (unwillingness to pay higher tariffs to improve services).

From the point of view of a financial manager of a water utility the challenge is to find ways to finance needed investments in modernisation and rehabilitation investments against a tariff level over which his/her influence may be limited. Nevertheless, there are several factors which can be controlled by utility managers and have a direct influence on the financial standing of the utility. The two main strategies are to increase the collection rate and to increase operational efficiency. Both measures directly lead to increased revenues and a decrease in operational costs. While those two measures lead to direct and immediate financial effects, other – equally important measures - have indirect and longer-term effects. Such measures are for example the introduction of long-term strategic

planning, enhancing the skills in financial analysis and financial planning/forecasting and management, and an increased capacity to prepare, procure and implement (investment) projects. In parallel public participation as well as awareness-raising activities regarding the value of the public services are crucial to improve the willingness to pay at the client side.

SDWS2011.1023 Physical Hydronomics_A_Valero Et Al_Sdewes_2011

A. Valero[*1], J. Uche[1], A. Martínez[2], B. Carrasquer Álvarez[3]
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Abstract

The connexion between the exergy analysis and economic analysis in a natural environment like a river basin is developed in this presentation. The exergy analysis is able to contain the energy quality and its quantity of the water flow. Water uses provoke a loss in its quality due to the anthropic (point and non-point) pollution, but natural degradation of the river also occurs when the river swept away different materials in its path. Sometimes, it is not so easy to recognise the polluter. If a sustainable water policy is going to be fulfilled, this identification is needed for allocating the corresponding restoration costs.

The methodology here presented is called Physical Hydronomics (PH), (see references in previous SDEWES Conferences and other papers). It allows expressing the flows involved in the hydrologic cycle in terms of exergy values. The exergy of a water body along the river varies due to natural and anthropogenic reasons. Also for keeping the water basin in good conditions, water technologies are required. And, these technologies will consume more or less energy depending on its efficiency. Thus, the energy, operation and maintenance and, investment costs for restoring the status of water bodies need to be allocated, even prior to human pressure.

For achieving the good ecological status of water bodies by 2015, the European Water Framework Directive (WFD) has defined a very clear target: The full cost recovery principle, that is, the polluter has to assume the cost of its pollution. The PH methodology connects well with the international concern about fresh water resources, and the preservation of aquatic ecosystems. As any alteration of the river changes its chemical and/or physical properties including its mass, all these properties can be converted into exergy variations. Therefore a careful and comprehensive analysis of the chemical and physical variation of the river allows identifying the polluting origin and, its magnitude be quantified in terms of exergy. Thus PH can allocate the costs of recovering the water bodies, according to its exergy degradation.

Indeed, the results obtained do not satisfy each and every economic interest. One key example can be seen in the paper presented in this Conference for the most paradigmatic

River in Spain, the Ebro river, very representative of the Mediterranean Area (Carrasquer et al., "Taking the exergy to allocate the environmental cost of the WFD among users: the case of the Ebro River Basin"). Anyway, it is a very interesting methodology to involve water authorities in the link of water and energy, and using the Second Law of Thermodynamics to help promote a more objective human Law.

Panel: Sustainable development and jobs

Unemployment is obviously creating serious difficulties for the unemployed and usually for regional and national economies. This clearly became emphatic during the recent economy downturns, which raised, and are continuing to raise, unemployed significantly in most of the world. The vitally needed and ongoing transition to sustainable development, founded on the environmental, economic and social pillars will have an important impact on future employment prospects, and employment is inextricably related to the stability and strength of all sustainability pillars. It is obviously best if increased employment also generates commensurately useful results beside the benefits of providing income to the previously unemployed.

Five sustainable development experts will speak briefly about different aspects of the critical interaction between sustainable development and employment, followed by questions, answers and discussion with the audience

SDWS2011.1028 Sustainability and Jobs

P. Rae[*1]

[1]International Renewable Energy Alliance, Australia;

Abstract

The presentation will explore the job creation potential of various forms of renewable energy development in the context of the very rapid deployment of new generation in both the developed and the developing world.

I propose to concentrate on the jobs in sustainable development of energy sustainability for general electricity supply by renewable technologies and transport through electric motor vehicles and biofuels.

This involves the continuation and expansion of the very rapid recent growth in investment in renewable energy capacity, eg last year investment increased by one third from $US150 billion pa to $US207 billion pa, as well as the related rapid growth in training of employees in a wide cross section of job skills from manufacture through to construction, site evaluation and planning, deployment, operation and maintenance.

I will identify jobs growth using specific examples while also providing the estimates published by REN21 and others showing the rate of growth in direct and indirect employment in the world.

The presentation will identify methods of increasing the job creation benefits by methods of renewable energy growth such as community power (CP) which has developed extensively in various parts of the world following and expanding on the Danish model of the past 30 years.

Beyond doubt is the acceptance of the importance of capacity building in the developing world.

This brings with it an employment multiplier of impressive proportions.

The World Summit on Sustainable Development in 2002 agreed that the priorities, in order were water, energy, health, agriculture and biodiversity (WEHAB) and that through the development of these capacities the developing world will achieve sustainability.

Each of them, as they develop, creates employment opportunities as they also create and distribute wealth through their local communities.

Electricity for lighting changes lifestyle and creates opportunities for learning. Learning creates capacity for training and training enables skills development to carry through to everything from water management, improved agricultural method, production and processing and thereby sustainability in food production and supply with better health.

The distributed (ie local) generation, even on a small scale, of electricity can "light the light" to show the path towards sustainability. Every step along the path involves new jobs.

Comparisons will be provided to show numbers employed for different forms of electricity generation from coal and nuclear on the one hand and the renewable technologies on the other. This will help support the conclusion that sustainability and job creation are collaboratively co existent.

Other panellists will be invited to provide emphasis on aspects of sustainability and jobs separate from renewable energy development.

SDWS2011.1026 Assessing the Conflicting Interactions of Employment with Sustainable Development

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Abstract

The need for new approaches to decision-making for supporting sustainable development policies has been well recognized within ecological economics**.** Sustainability models are effective tools for the appraisal of distinct policies. Those models assist political decision makers in their choice of suitable instruments and measures, by taking into account and quantifying conflicting aims between the different dimensions of sustainable development within a consistent framework. A sustainability model offers the framework for differentiated analyses, which go beyond economic factors and include environmental and social effects of different policy measures. These models enable gaining knowledge about possible impacts of different policy measures on economic, social and environmental aspects. In particular, multiple objective linear programming (MOLP) models based on the linear inter/intra industrial linkages of production (that is input-output analysis) can be used to study the interactions between the four main pillars of sustainable development: economy, energy, social and environmental concerns. These models allow assessing the environmental and social impacts resulting

from changes in the level of the economic activities associated with distinct policies, through the explicit consideration of distinct axes of evaluation of the merits of different policies that are modeled as objective functions: Maximization of Gross Domestic Product (GDP) as proxy for assessing the economic growth, maximization of the level of employment as a measure of social well-being, minimization of the energy imports as a way of minimizing the energy dependency of the country, and minimization of GHG emissions in order to account for the environmental impacts of the economic activities. In this context, the input-output framework provides a tool for determining the number of jobs created, but as the body of literature concerning sustainability and employment grows it has become increasingly obvious that there is no consensus on how best to measure job creation, especially for particular technologies.

SDWS2011.1025 Employment Impact of Sustainable Development Policies: the Case of Clean Technology Sector

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Abstract

The employment impact of sustainable development policies with particular regard to clean technology sector is studied and discussed.

Although a positive effect between these two issues is generally expected, maintaining and increasing employment coming from sustainable policies may depend on several factors such as long term planning. Furthermore, particular attention has to be paid to policy design and implementation.

With regard to clean technology sector, since 90's, environmental concerns and sustainable development issue have led to a new phase in developing clean technologies, with the growth of investments, research effort and employment.

According to a study provided by the European Commission, European renewable energy industry has employed 1.5 million people so far, and in order to fulfil 2020 targets a further 3 million is expected. These values show as a long term planning, such as the European Union 'Climate Package', can both provide stability to the market and support the industry sector.

Among industries, Small Medium Enterprises (SMEs), which characterize the European territories, can particularly take opportunities coming from energy savings and renewable exploitation, due to their decentralized nature, with a positive effect on local occupation.

The clean tech sector requires medium-high skills, generally university and technical school degree with a positive young people job creation; furthermore, the highly regulated energy sector requires staff with regulatory experience.

The need of Research & Development department, which is not generally developed in SMEs since they cannot afford high investments, can encouraged the birth of start-up

companies in the innovation field, such as academic spin-off, with the aim of transferring results of research to industries or even directly to market.

Over the last twenty years in Italy, such as in other European countries, like France and Denmark, both academic and public authorities have been paying increasing attention to the commercialisation of technical results developed in universities and research centres. The number of these new companies has dramatically arisen, thus creating new job opportunities for students involved in the research area and also increasing the competitiveness of industries in the energy market.

SDWS2011.1029 Sustainable Energy Development as a Driver for Jobs Creation

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Abstract

The region of South-eastern Europe is in the process of being integrated in European Union and with the process it will be implementing European energy and climate strategy. Very ambitious goals for renewable energy will change the energy planning in the region. While the regional energy community will help create regional energy markets, it will also help to absorb increased share of intermittent renewables. If understood as opportunity and well implemented, the renewable energy may become a significant driver of economic growth, regional development and employment generator. While the renewable energy project development may sometimes be best implemented on the national level, increasing the local added value by industrial production of components and equipment, it will have much better chances of succeeding if coordinated with regional energy planning and research policy.

SDWS2011.1027 The Tragedy of the Credit Crisis:full Speed….. in Reverse?

K. Mulder[*1]

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Abstract

The economy depends on cyclic processes that are easily disturbed. Jobs result from consumption and investment. The credit crisis had a devastating effect on investments, gradually leading to lesser production and consumption, unemployment.

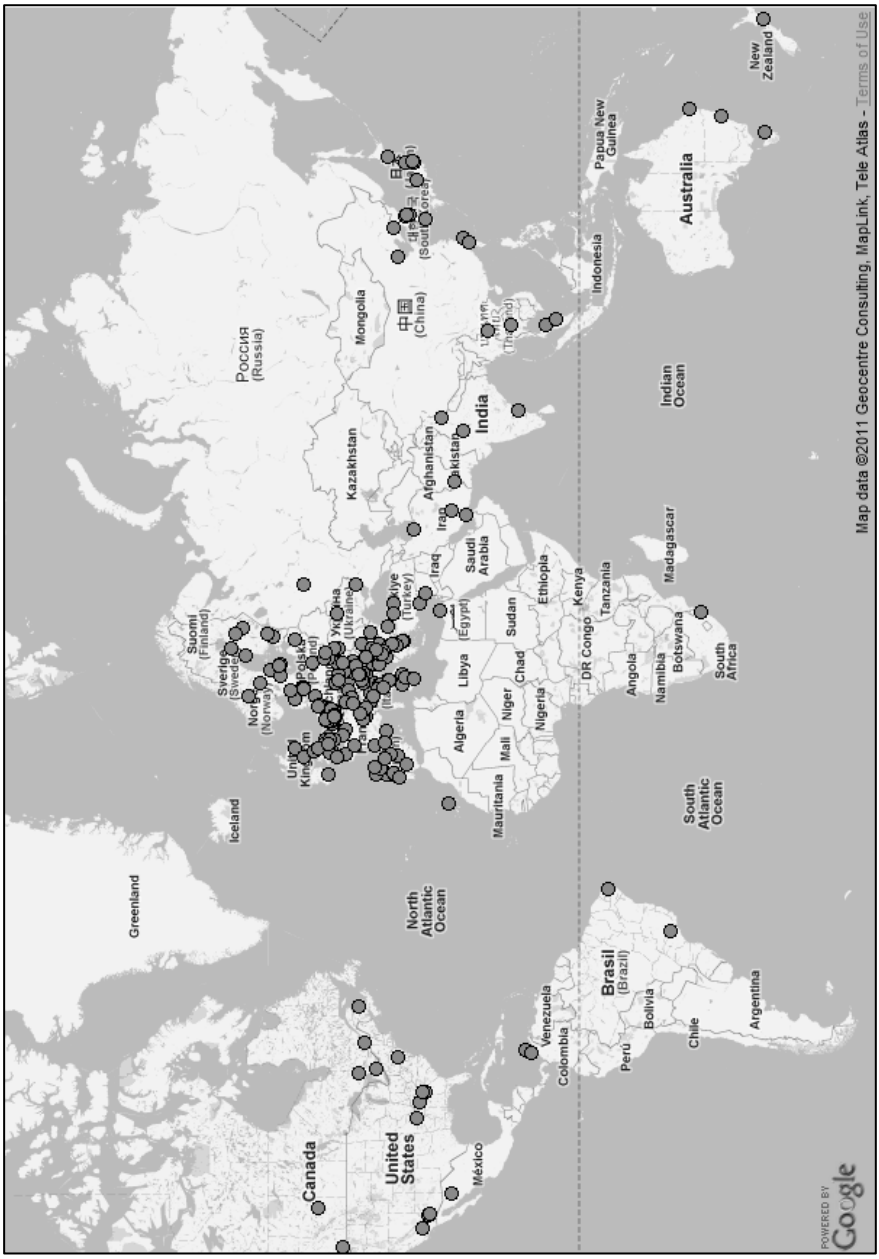
There is a second crisis: Our production and consumption system are not in balance with the recovery capacity of natural systems and their capacity to replenish resources. Policies should therefore be focused on solving the ecological crisis by investments in cleaner technology, which could then produce the upswing for the economic cycle.

Instead, many countries forget about the ecological crisis, as ecology is seen as something that cannot afforded. The normal production/consumption cycle is reinforced which makes the ecological crisis worse. The main problem is a lack of understanding of the Challenge of SD: it is not a choice, it is a necessity for which we have to prepare.

The backdrop of renewable energy is shown for the Netherlands, and figures will be presented to illustrate the large number of jobs that are already produced by a rather insignificant renewable energy sector.

Investing in Sustainable Development brings jobs, and eases tensions that are produced by a globalized economy.

AUTHORS' INDEX



SDEWES participants from 6 continents, 54 countries, 226 cities and over 300 universities, institutes and companies.