CenSES

Centre for Sustainable Energy Studies

FME FORSKNINGS-SENTER FOR MILJØVENNLIG ENERGI

Striving for a Norwegian Low Emission Society post 2050

Three scenarios

Marius Korsnes & Knut H. Sørensen

Centre for Sustainable Energy Studies (CenSES) is a national Centre for Environment friendly Energy Research (FME) established by the Norwegian Research Council.

CenSES develops fact-based knowledge for strategic decisions, relevant both for government and industry. The focus is knowledge for a national energy policy, for national and international climate policy, and for strategies of innovation and commercialization.

CenSES research integrates the following disciplines: energy systems and markets, industrial ecology, economics, political science, sociology, innovation studies and science and technology studies.

The CenSES consortium includes research groups from Institute for Energy Technology (IFE), Institute for Research in Economics and Business Administration (SNF), Norwegian School of Economics (NHH), Norwegian University of Science and Technology (NTNU) , SINTEF, Sogn og Fjordane University College, Vestlandsforsking and University of Oslo (UiO).

CenSES collaborates with a number of international partners.

www.censes.no

Striving for a Norwegian Low Emission Society post 2050

Three scenarios

Marius Korsnes

Knut H. Sørensen

CenSES
Centre for Sustainable Energy Studies

NTNU

Acknowledgements

We wrote a first version of this report as a commission for the Norwegian energy government enterprise Enova. They issued a call for short projects to develop scenarios for a Norwegian low emission society in 2050. Enova has funded the main part of the work underlying the report, but also NTNU, Department of Interdisciplinary Studies of Culture and CenSES have contributed. We are grateful for valuable input from our colleagues at Department of Interdisciplinary Studies of Culture, in particular Professor Marianne Ryghaug.

Trondheim/Los Angeles June 2017

Marius Korsnes Knut H. Sørensen

Content

1. Introduction

> More needs to be done (…) to clarify why, at significant forks in the road, societies opt for particular directions of choice and change over others and why those choices gain stability or, at times, fail to do so. Jasanoff and Kim (2015: 14-15).

This report outlines scenarios of a Norwegian low emission society post 2050. 'Low emission' is defined to relate to both emissions of greenhouse gases and their forcing effects leading to global warming, as well as the use of finite resources on Earth through everyday life activities and the organisation of society.

In the following, we describe and discuss three scenarios that we have named 'The last oil' (in short: **last oil**), 'Green tax society' (in short: **green tax**) and 'Collective engagement society' (in short **collective engagement**). Integrated as a part of the discussion of the scenarios, we included the following three framework conditions underlying them: 1) the resource base of the Norwegian society towards 2050, 2) social factors that are considered important, and 3) technologies assumed to be developed and available. We describe each scenario with a focus on topics relating to the way the Norwegian society is organised in 2050, such as the role of the government, citizens' everyday life, presence of social conflicts, and the degree of public engagement in the process towards a low emission society. In addition, we provide outlines about the social processes we believe may be leading to each of the three imagined outcomes.

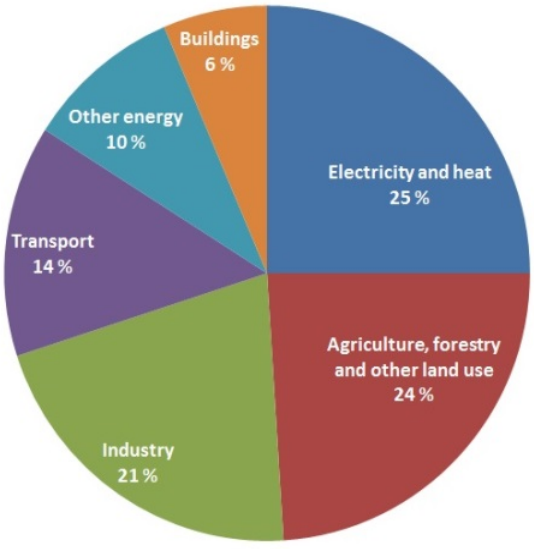

Figure 1: Human GHG emissions according to economic sectors 2010 (AR5, IPCC).

As a general framework, this report takes as its point of departure a recognition that there is a conflict between the drivers of global human expansion and the degree of stability of the climate system and other natural systems. We consider socioeconomic activity and population growth as primary drivers for energy demand, and regard the production of energy – for example in fossil fuel motors – as the main source of anthropogenic greenhouse gas (GHG) emissions. The fifth assessment report that the Intergovernmental Panel on Climate Change (IPCC) published in 2013 confirmed that Earth's climate is

warming and that human activities contribute substantially to this warming. When the IPPC looked at the total human greenhouse gas emissions in terms of main economic sectors in 2010, they found that electricity and heat production represented a 25 per cent share, agriculture, forestry and other land use 24 per cent, industry 21 per cent, transport 14 per cent, other energy 9.6 per cent and buildings 6.4 per cent (see Figure 1). The greenhouse gas emissions in these sectors occur due to human demand for products and services, and they cause global warming.

In Norway, the largest source of GHG emissions in 2015 was the oil and gas sector (Figure 2) (SSB, 2016). Together with industry and mining, this sector comprised 50 per cent of the emissions in 2015. Transport, including road and air traffic, water and motor equipment, constitutes 31 per cent of the total Norwegian greenhouse gas emissions. An important feature of Norway compared to most other countries is the rather sharp distinction between energy consumption and CO_2 emissions. This is due to the large share of hydropower in the country's production of electricity. For this reason, only six per cent of Norwegian greenhouse gas emissions result from onshore energy supply and heating, compared with 25 per cent internationally ('Energy supply' and 'Heating in other industries' in Figure 2).

In terms of carbon footprint, 61 per cent of Norway's carbon footprint is external to Norway. This means carbon that is embedded in products and services imported from abroad (Ivanova et al., 2015). These emissions are not addressed in the typical territorial emissions accounting of countries (i.e. emissions occurring within the territory of a county equivalent to emissions embodied in domestic consumption and exports), and are instead allocated to the countries in which production took place. However, taking full climate responsibility implies also realising that Norwegians' actions and activities have consequences in other places in the world.

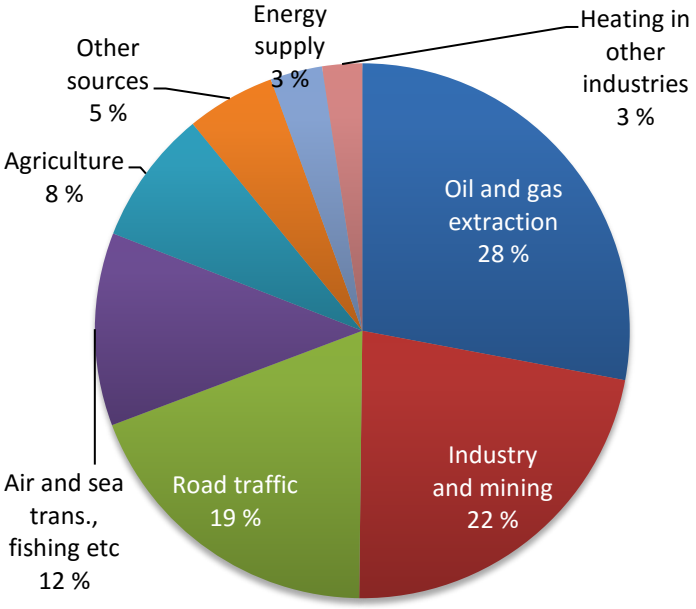

Figure 2: Norwegian greenhouse gas emissions by sector 2015, preliminary numbers (SSB, 2016).) (2016)

For Norway, 12 per cent of the emissions contributing to the household carbon footprint took place in China (Steen Olsen et al., 2016). Based on figures from 2007, the total Norwegian carbon footprint per capita was 17.8 tonnes (exiobase.eu 2016). If we only take into account emissions within Norway, the average emission per person was 10.3 tons of CO_2 equivalents in 2015 (SSB 2015). This implies that Norway is a net importer of carbon embodied in traded goods, which often is the case in economies where

consumers have a high level of purchasing power. About 53 per cent of the total carbon embodied in Norwegian consumption is associated directly with household purchases (Ivanova et al., 2015), where food, transport and housing were the consumption groups contributing the most to the total Norwegian household carbon footprint (Steen Olsen et al., 2016). In other words, these are sectors worth exploring further in this report in order to address the Norwegian emissions and measures needed to achieve a low emission society in Norway.

There have been some attempts to describe different paths to reach a Norwegian low emission future. One particularly relevant example is NOU 1998: 11, 'Energi- og kraftbalansen mot 2020' ('Energy and power balance towards 2020'). In this green paper, Norwegian politicians, industry actors, scientists, and labour union representatives developed four scenarios along two main axes: The character of the Norwegian economy (Knowledge and innovation driven or wealth and resource driven), and the character of international climate agreements (Weak or strong commitments). The four scenarios were called 'the long rise', 'green brain power', 'steady course' and 'the climate road', as shown in Table 1.

Table 1. Four scenarios for a low emission Norway (NOU 1998: 11, p. 28).

		Character of international climate agreements	
Character of industrial development		Weak commitments	Strong commitments
	Knowledge economy, innovation driven	'The long rise'	'Green brainpower'
	Wealth and resource driven	'Steady course'	'The climate road'

'Steady course' implied that Norway's economy would follow the same path as before with its traditional industries as its backbone (oil, fish, wood and metal industries), while the government would lack incentives to implement effective environment and climate policies. 'The long rise' assumes that Norway and the world would have increased economic growth, but still weak climate agreements and few incentives to reduce emissions. This scenario is also described as the unfolding of a strong belief in liberalisation, efficiency and deregulation thinking. 'The long climate road' takes the point of departure that the Norwegian economy remains based on extractive and traditional industries while at same time stricter carbon taxes are introduced. This is linked to a high level of public expenditures through the Norwegian Pension Fund, and it is argued that with the assumptions underlying this scenario, several industrial sectors (e.g. steel, cement, oil refineries) will not survive in the long run. 'Green brain power' is clearly the preferred scenario. Here, Norway transforms into a knowledge and innovation oriented economy, and at the same time, the government implements effective climate mitigation policies. This scenario was focused on the growth of new industries such as

information and communication technologies as well as on substantial development of renewable energy sources.

The four scenarios were constructed from different, assumed outcomes with respect to industrial development and international climate agreements, arguably outside of Norwegian policy-makers' control. Thus, it was unclear what Norwegian policy-makers actually could do to influence the realisation of the preferred scenario. We consider this a weakness. Consequently, in this report, we use a different methodology that highlights political decision-making.

The report is structured as follows. Chapter 2 describes and discusses the applied scenario methodology and the underlying theoretical perspective on social change. Chapter 3 outlines the assumptions underlying each scenario, while Chapter 4 describes the three scenarios. In Chapter 5, we summarise and conclude.

2. Scenario methodology and the dynamics of low carbon transitions

Making stories about the future is an exercise that can be useful in dealing reflexively with uncertain processes of social change. Stories in the form of scenarios allow a systematic narrative simulation of possible futures, given a particular decision-making situation or major events external to the decision-making. A scenario is different from a vision or a foresight/prediction. A vision represents a wished-for future, while foresight efforts aim to identify a probable future. Scenarios describe futures that are possible but not necessarily attractive or probable (see, e.g., Lindgren and Bandhold, 2009). They invite the consideration of diverging developments and uncertainties related to decision-making.

In this sense, scenario narratives are tools of reflexion. Narratives about possible and plausible futures may help us to prepare and possibly act to avoid changes that we do not want. Furthermore, a diverse set of narratives suggesting alternative future worlds can be used as a point of departure for discussing the desirability or undesirability of future developments of society. Indeed, the interactive process of debating scenarios with a variety of stakeholders are probably more important than their eventual outcome (Swierstra, 2009). Thus, the main intention with this report is to invite discussion about how to achieve a low emission society.

2.1. Making scenarios

We have constructed the three scenarios described in this report from three different climate policy choices that could be made in Norway in the near future. The first – 'the last oil' – follows from a political decision mainly to continue focusing on the exploitation of oil and gas in combination with mitigating measures made possible by technological innovations like carbon capture and storage (CCS). The scenario explores possible consequences of this choice for Norwegian society and its ability to become a low emission society. The second – 'green tax society' – assumes that climate change is best mitigated through the introduction of a much stricter regime of green taxes (also applicable to the oil and gas industry), which provide a system of incentives to reduce climate gas emissions. The scenario presents possible consequences of this choice. The third – 'collective mobilisation' – is an investigation into the consequences of the Norwegian government and the Parliament's decision to pursue a climate mitigation policy that aims to engage and mobilise the public and to support stricter direct regulations with respect to activities that generate greenhouse gas emissions.

Furthermore, in this scenario, the government and the Parliament is concerned about climate justice. This means that policy-makers shape climate policy measures to avoid that some social strata and regions carry a relatively larger burden than others do.

We chose to focus on these three sets of policy decisions with the three ensuing scenarios because we see the focus on oil and gas, green taxes, and public engagement as suggesting three very different strategic avenues for a low emission Norway. In turn, when we compare them, we may highlight policy issues that are pertinent to present political discussions and invite reflexion regarding possible consequences of important decisions. We consider that 'The last oil' reflects the strong position that the oil and gas economy has in Norway, in politics as well as in industry. For several decades, the revenues from offshore production of oil and gas have been the backbone of economic progress in Norway. Many policy-makers and lobbyists articulate a strong pressure to continue the exploitation of Norwegian oil and gas resources because they believe that this is necessary to maintain a robust economic development.

The identification of 'The green tax society' emerges from the observation that the use of taxes to promote sustainability has a robust place in Norwegian policy-making. This reflects the strong position of economists concerned with what they call cost-efficient policy instruments, which make tax measures an attractive measure to help mitigate climate change. We arrived at 'The collective engagement' in a different way. This scenario resonates less well with the current political climate, even if public engagement is considered important. Instead, we drew from our research into public views of climate policies and frustrations regarding what many interviewees see as lack of political leadership. This research shows that it is a widespread sentiment that climate mitigation policy should be just and make people act collectively rather than offering a buy-out of commitments to those with high incomes (e.g., Aune et al., 2016). Consequently, we believe all three scenarios are possible, but not equally so. The political alliance pressuring for continued reliance on oil and gas is very strong. The idea of green taxes also have a lot of political support, while the making of a more engaging and mobilising climate policy seems to be less attractive to policy-makers.

In each scenario, we analyse probable consequences of political choices that define the main parameters of the scenario. The analysis is mainly intuitive but based on lessons from studies of science, technology and innovation as well as relevant research undertaken at our department (e.g., Ryghaug et a., 2011: Aune et al., 2016). This means that we cautiously avoid making assumptions about technical fixes or technology as a driver of social change, to avoid the lure of technological determinism.

We have constructed the three scenarios by focusing singularly on the respective mind-sets of policy-makers with dominant focus either on the economic benefits of oil, on green taxes as a cost-effective tool of transformation, or on engagement, mobilisation and climate justice. We have described them as a kind of Weberian ideal type, in each case cultivating the dominant political outlook and its potential effects on the development of Norwegian society with a particular concern for transformations towards a low emission Norway (or lack of this). Of course, we might provide predictions that are more

realistic by combining them. However, we believe that thinking from ideal types is more helpful to clarify the implications – positive and negative – of important political choices and to allow for further reflection regarding how Norway may be made into a low emission society.

When describing the three scenarios, we have made a selection of topics that we cover:

- Degree of public engagement
- Technological development
- Social conflicts and equality issues
- Everyday life
- Mobility
- Degree of urbanisation
- The role of the government.

In the rest of this chapter, we briefly discuss two important issues with respect to the construction of the scenarios. The first issue is how we may understand the concept of 'low emission'. The second issue is possible theoretical underpinnings of the thinking related to the transition to a low emission society.

2.2. Definitions of low emission

In order to make clear what we mean by low emission in this report, we provide a definition that explains our assumptions for the Norwegian low emission society post 2050. The IPCC (2013) stated in the 5th assessment report that in order to reach the 2° Celsius target, emissions per capita need to be reduced to a level of between 1.5 and 3.1 ton CO_2 equivalents by 2050 globally. In 2015, the average emission per person in Norway was 10.3 tons of CO_2 equivalents.

When we take as a point of departure that Norway, as a developed country highly fuelled by renewable energy technologies, should have higher ambitions than the world as a total, we end up with emissions of around 1 ton per capita. This is in line with the most ambitious assumptions made by the Norwegian Environmental Agency 2014 report: 'Kunnskapsgrunnlag for lavutslippsutvikling' (English: 'The knowledge base for low emission development'). In these assumptions, we do not include the effects of carbon uptake from Norwegian forests and landmass. Moreover, we assume a population of around 6.6 million people in 2050, which is SSB's (2012) medium projection.

Since consumption in Norway also has an effect on the use of resources and emissions in other places in the world we make use of a carbon footprint perspective. For Norwegian households, the three largest groups of emissions in 2012 were transport, food and housing, as can be seen from Figure 3 visualizing the difference between a product's contribution to emissions and its emission intensity. What it shows is that transport has higher emissions per NOK spent on it, compared to food and housing. In other words,

emissions from food and housing are high mainly because we spend a lot of money on them. Emissions from food increased by 33 per cent between 1999 and 2012. This was due to an increase in meat consumption and in the volume of food purchased per person. This has been interpreted to reflect an increase in households' food waste and/or obesity (Steen Olsen et al., 2016). The three scenarios will deal with this type of emissions in three different ways. 'The last oil' scenario largely ignores them, 'green tax' affects these through global carbon taxes, and 'collective engagement' directly address them by reducing material intensity and re-localising a large part of the production.

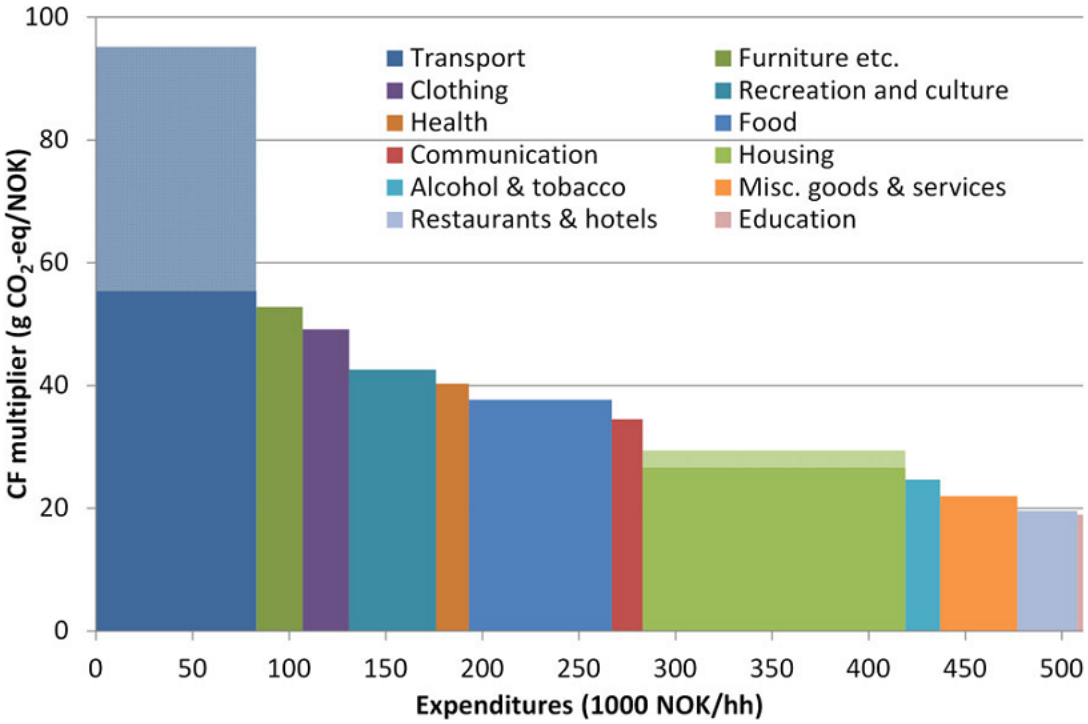

Figure 3: Norwegian household expenditures and the average carbon footprint intensities of each group (Steen-Olsen et al., 2016: 587).

By including the carbon embedded in the consumption of goods, we arrive at a much more ambitious – and internationally fair – target that Norway must reach in order to become a low emission society. Among our three scenarios, 'collective engagement' and 'green tax' consider this perspective, whilst 'the last oil' implies comparatively less emphasis on the idea of a Norwegian low emission society even if this remains a political goal. However, we have constructed all three scenarios from an assumption that efforts will be made to realise a low emission Norway in 2050. In doing so, we draw on some ideas about how social change to improve sustainability may happen.

2.3. Sustainability transitions and the understanding of social change

To become a low emission society, Norway needs to transform its current practices to reduce its carbon footprint. A fast-growing field of research investigates such transformations through the concept of sustainability transitions. The shifts from carbon-based to decarbonised practices are expected to be gradual. Moreover, sustainability transitions are intentional and involve coordination of several actors with a shared purpose (Markard et al., 2012).

There are many challenges involved in such orchestrated transitions. First, how to make sure that transitions are sustainable and when to consider what is the right time frame of evaluating such features? Second, setting shared goals is obviously not easy. Third, and related, there is the issue of climate justice: how to avoid that some social strata and regions carry an unfair share of the burdens related to climate mitigation. Fourth, who shall enact the transition and through what strategies? Sustainability transitions are often linked to technological change and innovation. This has produced a focus on how we may understand technology-related social change, and how improved sustainability may be achieved through new technology.

In the sustainability transition literature, change is at the outset believed to be difficult. This is highlighted though the widespread use of the concept of sociotechnical regimes. Regimes are not easy to undo. For example, the energy industry relies on large infrastructural constructions already in place. Moreover, its current practices are solidly embedded through education and culture. These may not cater for intermittent renewable energy technologies. Renewal of energy technologies happens especially slowly because capital expenses are large and investments are long-term, ranging from 30 to 40 years for an average coal power station (Jørgensen & Münster, 2010). Most countries' electric power systems run on fossil fuels and have developed over time, creating vested benefits for the continued use of fossil fuels. This development has been termed the 'carbon lock-in', and it is considered one of the prime difficulties facing new renewable energy technologies (Unruh, 2000).

Some scholars consider niche management as an effective strategy for changing regimes (e.g., Kemp, 1994; Kemp & Rotmans, 2005). The underlying idea is that new technologies should be nurtured and protected through the creation of niches. In this way, they may develop to outstrip old technologies and change the related regime. This may be done through so-called 'strategic niche management', which Kemp et al. (1998: 186) define as:

> the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation, with the aim of (1) learning about the desirability of the new technology and (2) enhancing the further development and the rate of application of the new technology.

Three elements characterise successful niche emergence and growth: visions and expectations, networks, and learning (Seyfang & Longhurst, 2013). Visions and expectations must be shared, networks must encompass several stakeholders, and learning 'should contribute not only to everyday knowledge and expertise, but also to "second-order learning" wherein people question the assumptions and constraints of mainstream systems altogether' (Seyfang & Longhurst, 2013: 882). The role of the government as a supporter, protector and nourisher of niches is implicitly taken for granted, as there are few other actors with the means, foresightedness and courage to take on such a role, as pointed out by Mazzucato (2013).

Niches are important localities of change also within the popular so-called multi-level perspective (Geels, 2002). However, this perspective also expect that changes may be due to alterations at what is called the landscape level. This may include globalisation effects like new technologies being implemented in other countries, changes of the natural environment, or transformations of political and cultural attitudes. Transition management is a process-oriented version of the MLP (Rotmans et al., 2001). It places itself between bottom-up approaches – such as strategic nice management – and top-down approaches that entail comprehensive planning and governance (Kemp et al., 2007). Overarching policy governance is identified as difficult due to challenges with distributed control (actors have different levels of authority, depending on the area), dissent (actors have diverging opinions about sustainability), and political myopia (politicians may be short-sighted, but transitions take time) (ibid.). By combining elements of long-term planning with incrementalism, the transition management approach sets out to:

> (C)reate a societal movement through new coalitions, partnerships and networks around arenas that allow for building up continuous pressure on the political and market arena to safeguard the long-term orientation and goals of the transition process (Loorbach & Rotmans, 2010: 239).

Transition management approaches also place significant emphasis on the role of guiding visions that can motivate and coordinate actors (Smith et al., 2005). Briefly put, the transition management approach is concerned with problems that relate to both short-term concerns and long-term imperatives, and it is explicitly pointed out that the 'government can and should assume a leading role in transition management' (Rotmans et al., 2001: 25). The role of governments should be to engage in reflexive and evolutionary management, with government actors taking on multiple roles, such as facilitators, stimulators, controllers, or directors, depending on the perceived stage of transition (Markard et al., 2012; Rotmans et al., 2001).

The transition management perspective may emerge from so-called reflexive governance (Voß and Bornemann, 2011). Reflexive governance means that governments understand themselves to be part of the dynamics that they govern. As pointed out by Voß and Kemp (2005: 4) reflexive governance incorporates feedback

> by opening problem-handling processes for diverse knowledge, values and resources of influence in order to learn about appropriate problem-definitions, targets and strategies of governance for sustainable

> development. As such, reflexive governance is about the organisation (modulation) of recursive feedback relations between distributed steering activities.

Hence, reflexive governance means to be open to learning and to changing policy according to what the (new) aim is and what proves to be effective policy measures. Indeed, reflexive governance appears to be a way of learning to be able to optimise policy according to current sustainability criteria. Therefore, experimentation and learning by doing are approaches that transition management scholars emphasise (Voß and Bornemann, 2011; Voß and Kemp, 2005).

With respect to the development of the three scenarios in this report, the sustainability transitions literature has at least two implications. First, technological factors do not have effects that are independent of the social circumstances under which technological development takes place. Thus, transitions will be socio-technical. When analysing sociotechnical change, we has to be careful to observe what actors do with new technologies. We also have to give international developments cautious attention.

Briefly, we have assumed that the sources of change to be considered when looking at the prospects for a Norwegian low emission society in 2050 are different in each of the scenarios. In 'the last oil', we see the main sources of change as external to Norway, like sustainability transitions happening in other countries leading to a reduced demand for oil. On the other hand, CCS is protected and nurtured to some extent, but the challenges of scaling-up seems to be underestimated.

In the 'green tax' scenario, the prevailing idea of change making is the use of market-based instruments. New technologies are supported through R&D investments but they are not protected and nurtured to be implemented on a larger scale. In the 'collective engagement' scenario, we assume change to be instigated in particular by a more active and mobilising government. Thus, change actions are distributed throughout society. Furthermore, there is not a singular focus on new technologies. The analysis also include effects of life-style changes, like new patterns of mobility and sustainable consumption.

The sustainability transition literature has given insufficient attention to the role of the public and the need for public engagement in the making of a low emission society. Ryghaug et al. (2011) and Aune et al. (2016) show that many Norwegians consider current climate policy as having low visibility and being given little attention by the government. This is interpreted as an indication that climate change is not such a grave problem after all. Furthermore, people ask for political guidance with respect to actions that may mitigate climate change, and they require climate justice; that climate policy is shaped to avoid social inequalities with respect to the effects of mitigation measures.

We emphasise such issues in each of the three scenarios, but in different ways. In 'the last oil' scenario, we assume that public engagement mainly will be neglected. Thus, there is little public activity aiming to mitigate climate change. In 'green tax society', the use of market-based instruments are supposed to make the public enact mitigation measures without particular engagement efforts. However, as clearly indicated by

Ryghaug et al. (2011) and Aune et al. (2016), the effects of tax instruments may be considered unfair. We believe this poses considerable risk of public protest, which may turn into voter support of parties promising to undo green taxes. This is different in 'the collective engagement' scenario, which is based on assumptions about the importance of political leadership to communicate with the public and to mobilise people to take an active part in the needed sustainability transitions.

3. Reaching 2050: Assumptions underlying the three scenarios

In order to make each scenario plausible and relevant, this chapter further describes and argues the underlying assumptions of how each scenario reaches the year 2050. Detailing our underlying assumptions is important in order to make clear the outcomes of specific political choices. A general conjecture is that we have mirrored the international and the national situation in each case, in order to highlight the consequences of similar political choices made nationally and internationally. We argue this assumption from several instances of anecdotal evidence'. For instance, policies (e.g., Germany's renewable energy policies, see e.g. Lewis and Wiser, 2007) and social/political trends (e.g. the European rise of populism, see e.g. Kriesi and Pappas, 2015) appear to spread in many countries and across continents. We believe such insights are important when we consider the effects of the policy choices made in each scenario. Although the international and national situation mirror each other, the effects on emissions of the situation described in each of the scenarios may end be different in Norway compared to the rest of the world. This is so because the impact of a policy that is effective globally may vary according to the economic and social dynamics at the country level. In this report, we only describe the Norwegian situation in the three scenarios.

Another assumption is that social development happens at a similarly relatively peaceful pace that the world has seen after the Second World War, especially as experienced in Norway and Northern Europe. Therefore, we do not consider the possibility of a large, global 'landscape' disruption from wars, revolutions, or other large-scale forces or severe incidents that would radically influence the scenarios. This is because we do not see such events as very probable and introducing them in the scenarios will reduce the attention to the importance of political decisions. Lastly, all scenarios reflect that Norway is more dependent on the international community than vice versa. International events will affect Norway more than the other way around. In other words, global industrial development will shape Norwegian consumption patterns while the effect of changes of Norwegian industry on global consumption will be small or negligible.

3.1. The last oil

Global assumptions

In terms of emissions, this scenario follows closely the 'New Policies Scenario' scenario of the Word Energy Outlook 2015 (IEA, 2015a). These new policies had been implemented by 2015, in addition to policies that were pledged implemented as part of the COP21 in Paris 2015, the so-called intended nationally determined contributions (INDCs). In the New Policies Scenario, energy-related CO_2 emissions increase until 2040, reaching 36.7 Gt that year, 16 per cent higher than 2013, while global primary energy demand increases by nearly one third over the same period (see Figure 4) (ibid.). This scenario is well short of the 2-degree goal globally, which would require much lower annual CO_2 emissions in 2040 (18.8 Gt) (ibid). The historical backdrop supporting the likelihood of this scenario is abundant. For instance, between 1988 and 2015 the total amount of global CO_2 emissions in the energy sector matched the total level of all previous years (IEA 2015b), indicating that CO_2 levels are bound to increase.

At the same time, we assume that renewable energy technologies – in particular solar technologies – continue to make progress. This means that solar energy is becoming cheaper than all kinds of fossil fuels, and it is implemented at an accelerating scale. Battery technologies have also improved as has fuel cells. Increasingly, electric and hydrogen cars dominate. The result is a dramatic drop in the demand for oil and gas and prices falling below the level of profitable extraction from Norwegian fields.

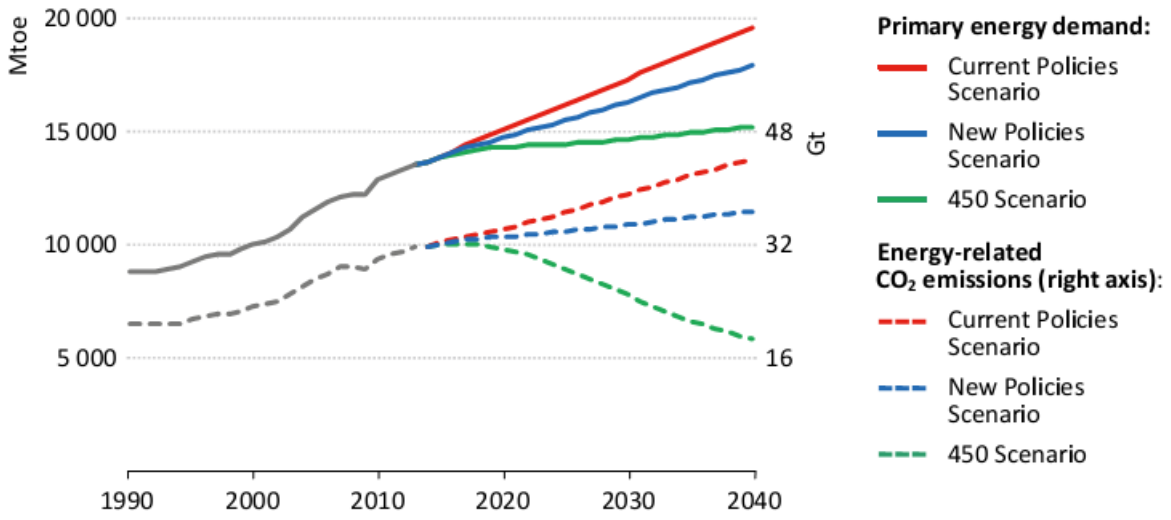

Figure 4: World primary energy demand by fuel and scenario, IEA (2015a: 57).

Current assumptions among policy-makers and oil and gas companies, internationally as well as in Norway, are based on a belief in a continued need for fossil fuels for a long time. 'The last oil' scenario challenges this belief. It is in agreement with Helm (2017) that proposes that an energy revolution is under way to pave the way for the endgame of fossil fuels. The scenario shares with Helm a worry that a lack of early

recognition of this development may lead to social unrest and problems, due to wide-ranging changes in the economy and the labour market.

Norwegian assumptions

As illustrated in Figure 5 below, in the 'last oil' scenario, Norway continues to specialise in oil and gas (O&G) extraction as its main industry before 2030. Lobbyists from the oil and gas industry persuaded the majority of politicians to support the industry and to open up new fields of exploitation. They argued that this was required to uphold the wealth of the country. However, critical voices increasingly noted that the profits from oil and gas were dropping. The low prices in 2016-2017 remained, contrary to widespread assumptions. This was due to accelerating investments in renewable energy and increasingly strict regulations to curb the climate gas emissions. After Donald Trump was wiped out of office in the 2020 election, also the US increased radically its efforts to replace fossil energy.

Still, Norway's oil and gas extraction continued at a high level until 2030, when the global oil market becomes increasingly shaky and OPEC is dissolved. This leads to an accelerating decrease in Norwegian extraction and export. After 2030, offshore oil and gas extraction in Norway becomes unprofitable. Some fields are closed down, and plans for further development are shelved. The Norwegian escalation of oil and gas extractions before 2030 is rooted in strong beliefs in the benefits of carbon capture and storage (CCS) and in the benefits of replacing coal with gas. In addition, politicians see the oil and gas related industry as an economic pillar. The continued reliance on oil and gas extraction happens with the least polluting technologies available. Moreover, continued use and extraction of fossil fuels is understood as the only feasible way to reach a future zero-emission society without considerable economic setback. The majority of politicians assume that oil and gas is necessary in a transition phase towards a low emission society that enables sustainable growth.

After 2030, Norway struggles to find and to develop new industries to support its economy, since policy-makers' neglect of the possibility of this turn of event leaves Norway unprepared. While many people have raised concerns regarding the need to develop other industries for many years, this did not happen. The economy after 2030 is characterised by negative feedback-loops that lead to historically high unemployment rates and a depletion of the Norwegian Pension fund to try to keep unemployment at bay. Developments with respect to information and communication technologies are leading to massive redundancies in banks, insurance companies, etc. The Norwegian welfare state experiences pressure before 2050 and is on the verge of collapse in 2050. This is mainly due to the effects of the 'Dutch disease', which occurs when a country has become too dependent on only one sector and with accompanying high levels of unemployment.

Most sectors in Norway continue to increase their carbon impact until 2030 when the global oil sector collapses. Due to impacts from a Norwegian economic downturn, the emissions decrease between 2030 and 2050, but the Norwegian society is still not a low emission society in 2050 even if it is coming closer. However, international development

regarding sustainable transport technology has helped Norway to curb CO_2 emissions from the transportation sector.

CCS has become an 'off the shelf' technology, but with limited use in Norway, due to high costs. The lack of national implementation of full-scale CCS plants in Norway has also contributed to a failure for Norwegian actors to be able to export CCS knowledge.

'The last oil' is a top-down scenario without little 'low emission society' engagement of the public. This slows down the transitions to low carbon lifestyles. Growing unemployment rates and economic problems after 2030 produces social unrest and controversies with respect to the need for climate change mitigation.

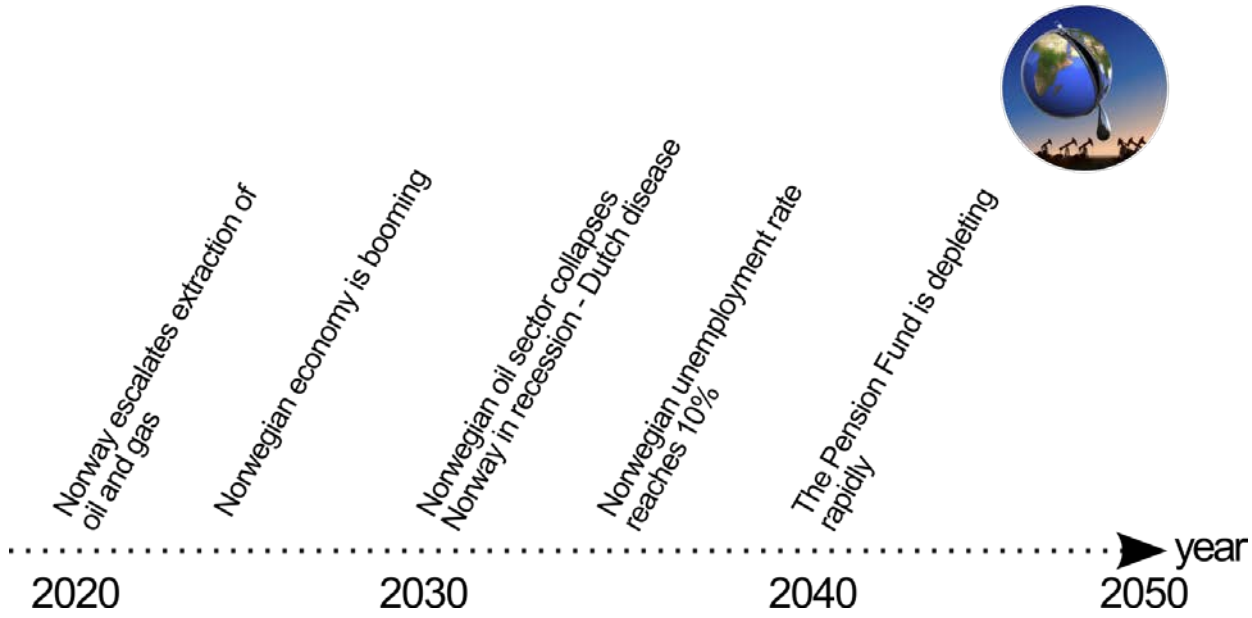

Figure 5: Timeline of the 'last oil' scenario

3.2. Green tax society

Global assumptions

We build this scenario on the assumption that several of the proposed polices in the World Energy Outlook 2015 are implemented, specifically the policies regarding carbon pricing, (bio-energy with) carbon capture and storage (BECCS), and increasing energy efficiency. In other words, this is mainstream economists' preferred scenario. 'Green tax' is guided by a strong belief in 'green growth': continued economic growth but lower pressure on Earth's resources through so-called ecological modernisation. The policies used to reduce emissions are mainly supply-side instruments directed at producers. There is only indirect focus on demand-control or demand-reduction among consumers, although green taxes are supposed also to reduce consumption of goods with a carbon footprint, due to higher prices. Green taxes, including a carbon price, are central

since they are expected to reduce demand of carbon-intensive products and the use of oil and gas.

This scenario requires considerations regarding the consequences of policy instruments that are supposed to be cost efficient and of optimisation approaches; principles known from mainstream economics. Usually, so-called cost efficient policy instruments are market based and require less direct intervention. However, an emphasis on cost efficiency may lead to less concern regarding governance effectiveness. A particularly important aspect of this is the preference for so-called 'technology neutral policies'. It is assumed that the government should not engage in the development of particular technologies but let the market select the most feasible and profitable technological options.

Reasoning from the sustainability transitions literature discussed in the previous chapter, the use of technology neutral policy instruments means that government abstains from using niche strategies. In the green tax scenario, we have assumed that this seriously hampers the development of innovations needed for a low emission society. We have also taken for granted that increasingly strict EU regulations and goals modify Norwegian policies to become less strictly based on cost efficiency considerations.

Norwegian assumptions

For Norway, cost efficiency considerations mean that hydropower and hydrogen (electricity intense) energy sources are interesting areas to exploit. Norway also has a natural abundance of wind off the Norwegian coast. However, since there is no mechanism ensuring a nurturing and shielded space for innovations, Norway never develops experience with offshore wind farms, and generally, Norwegian companies lack necessary learning opportunities to become internationally competitive with respect to exporting renewable energy services and technologies. Instead, the companies that exploit Norwegian natural resources come from other countries where the comparative advantages of technological learning were greater. In other words, wind turbines installed in the North Sea are manufactured elsewhere, and the projects are developed and operated by foreign energy companies. Overall, Norwegian actors in such initiatives would be at the bottom of the value chain: providers of resources, but not owners of intellectual property. In the green tax scenario, this means that Norway loses out with respect to wealth from technological development and risks de-industrialisation.

As detailed in Figure 6 below, Norway introduces carbon capture and storage (CCS) full scale in the 2020s because a global carbon price is introduced. Norway has abundant renewable energy resources, which Norway increasingly uses to become a 'battery' for the European continent during the 2030s. However, this turns out to be less lucrative than energy sector actors assumed.

In 'green tax', emissions in most Norwegian sectors decrease until 2050. Some sectors do not see much reduction, such as energy provision, since emissions from distribution and production of electricity already are low. We expect 'green tax' to become a highly electrified society. Most agricultural and industrial products are

imported, leading to lower emissions from these sectors in Norway in 2050. Emissions from oil and gas extraction are not much affected by implementation of CCS, since this technology is not considered cost effective to mitigate greenhouse gas emissions in the Norwegian context. Thus, Norway gains little from its considerable investments in CCS R&D.

As soon as the cost of renewable energy outstripped fossil fuels, the Norwegian economic advantage from oil and gas decreased and nearly disappeared. In the 2020s, Norwegian universities were reorganised around centres of excellence to make Norwegian scientists more prominent internationally. This effort of taking seriously the advice of the 2015 Productivity Commission produced universities with increasingly less relevance for Norwegian society and with a dropping educational quality. This contributes to Norway's lack of success with respect to green innovations. Another reason is the disregard of economists of the need for direct measures to achieve such success. After 2030, research has been less popular among policy-makers due to the lack of success of previous investment, and there are continuous cuts in the budgets of universities and research institutes. This hampers the transition to a low emission society.

The green tax scenario describes a transition to a low emission society that is top-down. Parliament decides the level of green taxes, which the central administration designs and implements. Industry and the public are supposed to comply by enacting economic rationality; the public is not really asked to engage in the making of a Norwegian low emission society. Thus, we expect populist reactions, since in this scenario, the public is left on its own to adapt everyday life to the increasing pressure from taxes, and experiences a lack of climate justice through increased social inequalities regarding consumption of goods and services rendered expensive through the green taxes.

Thus, Parliament has found it politically difficult to raise the level of green taxes to make them sufficiently effective. The green tax scenario illustrates the problems occurring with a top-down set of policies without public engagement initiatives. The use of market-based instruments to mitigate climate change proves insufficient to provide for a low emission society in Norway in 2050, even if progress in the mitigation of greenhouse gas emissions is achieved.

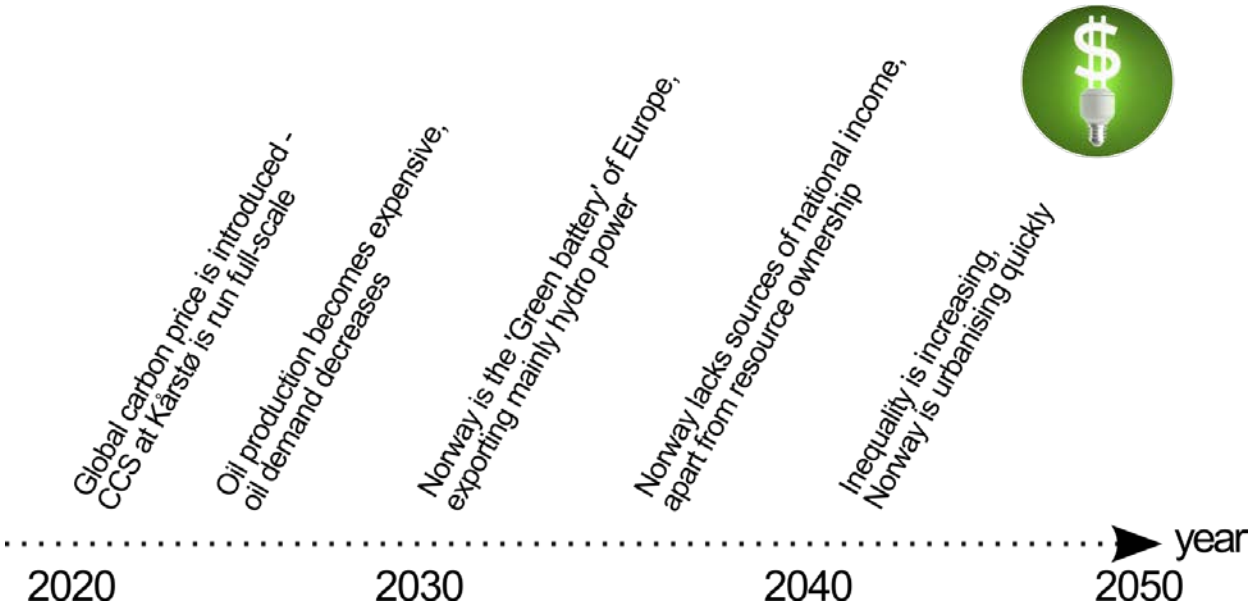

Figure 6: Timeline of the 'green tax' society scenario

3.3. Collective engagement society

Global assumptions

This scenario ends up with a concentration of greenhouse gases of around 450 ppm in 2100 because it is the result of a different set of approaches to reach this target than the two other scenarios. The methodology underlying the scenario is similar to a type of *back-casting* approach used in IEA's 450-scenario. Here, a desirable future is defined, and then analysed backwards to identify changes that could be instigated in order to achieve this future. However, our starting point is that changes are made according to other metrics than those featuring in the green tax scenario. Rather than cost efficiency, the starting point is energy sufficiency and reduction (Wilhite and Norgard 2004) and governance effectiveness. The focus is on reduced material intensity and maintained personal and social wellbeing. The scenario comes about due to several global and national occurrences. For instance, the EU Emissions Trading System collapses in 2022, one year after entering the 4th trading period (2021 – 2028) during which auctioning of emission allowances is supposed to phase out free allowances. This leads quickly to changes in the understanding of how emissions can be reduced.

Governments in Europe and the world increasingly recognise that a strong interdependence through international free trade also has important negative effects. Thus, increasingly, governments try to increase local production of many goods. This effort is facilitated by technologies like 3D printers and robots, which make mass production comparatively less competitive. Moreover, a large amount of government resources and time is focused on developing and implementing new renewable energy

technologies. The global demand for oil and gas is substantially reduced, as becomes clear around 2020 with new forecasts of a steep increase in energy coming from renewable sources.

Norwegian assumptions

In the collective engagement scenario, we have assumed a gradual change in the criteria of progress in which competition and economic growth give way to welfare and community. Using a mixture of top-down and bottom-up measures, new problem areas are defined and solutions provided (i.e., reflexive governance as introduced in section 2.3). This implies combining diverse sources of knowledge, values and influence in order to learn about appropriate problem-definitions, targets and strategies. Pluralism is considered necessary to avoid eco-fascism and fossil populism. In this scenario, policy-makers realise diversity is important and has to be catered for. This includes economic activities.

As a result of this, government – nationally as well as locally – increasingly has become a supporter, protector and nourisher of technological niches, where sustainability is explored and experienced. An economy based on sharing has been emerging and is becoming widespread, with a much stronger focus also on maintenance and repair. Collective experiments with alternative ways of social organisation are extensive, such as increased participation in local agriculture, new forms of mobility, new housing models, off the grid production of sustainable energy, 6-hour workdays, and voluntary, non-monetary based exchange of services and goods. This is sketched out in the timeline in Figure 7 below.

In 'collective engagement', emissions from the oil and gas sector are reduced considerably until 2030. This is due to a decision to electrify as many activities as possible, but also to reduce radically the investments in offshore oil and gas and to decommission oil and gas extraction rigs. Emissions from industry and mining are also slowly reduced; not only because of more energy efficient and/or less fossil-based technologies, but also because the production is geared more towards less carbon-intense goods. Emissions from agriculture decrease the least in this scenario because more people work with food production in their homes and in close-by farms. Emissions from road traffic has reduced considerably due to a change in people's mobility practices away from individual cars to collective transport for long-distance travel and bicycling/walking for shorter distances. Above all, electric bikes are widely used. In addition, largely, transport has been made low emission through continued efforts to make people choose electric and hydrogen-based vehicles. Electric vehicles (bikes, trucks and buses) become dominant around 2030 due to global technological developments with respect to batteries and fuel cells. Car collectives are widespread due to new business models and government initiatives, and individual car ownership is substantially reduced.

The transition towards a low emission society has happened through considerable public engagement. Policy-makers have spent much time in explaining the need for such a transition and initiated broad debates about how Norway can build a low emission society with emphasis on climate justice. While there have been controversies, the

seriousness of human-made global warming and the need for concerted mitigation action is widely accepted. This motivates the public to participate in experiments with alternative ways of living and with new modes of production. Furthermore, a positive circulation of experiences has been established, which continues to make people interested in experimenting with new ways of living.

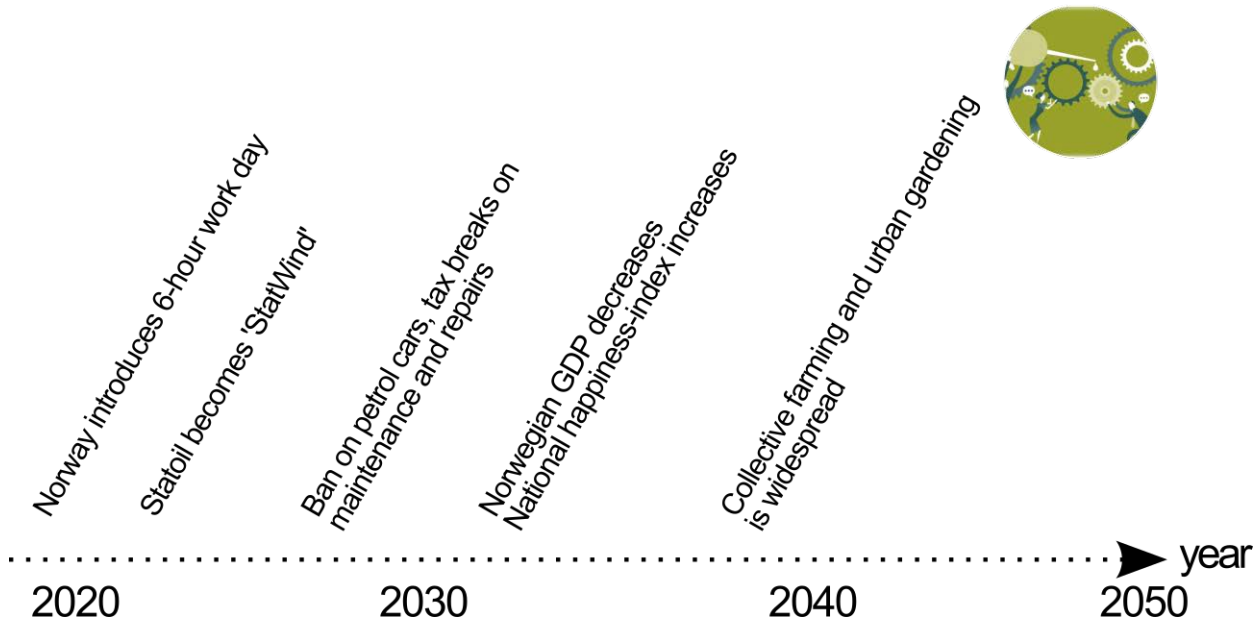

Figure 7: Timeline of the collective engagement scenario.

4. Images of the Norwegian Low Emission Society post 2050

We have described the journey to 2050 in the previous section. In this section, we focus on some topics that was addressed in the previous chapter but that we will discuss in somewhat more detail. We do this separately for each of the three scenarios. The topics are: the degree of public engagement, technological development, social conflicts and equality issues, everyday life, mobility, the degree of urbanisation, and the role of the government.

4.1. The last oil scenario

The assumptions described in the previous chapter allow us to draw a rather general picture of Norwegian society post 2050. 'The last oil' represents a failure to reach a low-emission society by 2050, as Norway was taken by surprise by the fast changes in the world economy after 2030 that rendered oil and gas obsolete for many purposes. Since politicians did not act at an earlier stage, Norway is left unprepared to deal with pressing issues such as economic and industrial readjustment, high unemployment, increased level of inequality, low level of satisfaction of citizens, and a lack of trust between government and civil society. The degree of public engagement is low in this scenario since the government made decisions without properly including the public early in the process. This leads to low participation in elections, with growing tensions between a political elite and the public.

'The last oil' Norway is a society with increased levels of social inequality. Rich people have manifested their wealth and position, while people who used to work within the oil and gas sector find it difficult to get new jobs. Increasingly, unemployed Norwegians are pre-occupied with making ends meet. This situation has become more precarious since welfare state support is diminished due to the economic crisis. Norway struggles economically because the country failed to find new and more suitable economic opportunities and technological resources to replace the demise of the oil and gas industry. After 2050, the situation is gradually improving but unemployment was high after 2030 and it remains high in 2050. Investments in CCS have proved to be a failure, and electrification to reduce CO_2 emission happens slowly because Norway has failed to develop sustainable energy to meet the increased demand, resulting in high prices of electricity. In panic, the Parliament decided to develop most of the few remaining possibilities for large-scale hydropower. This led to a lot of protest and costly delays in the construction projects.

Everyday life is characterised by a struggle to get by for most Norwegians apart from the wealthy few. Norway also experiences occasional waves of climate refugees, and combined with an aging and unemployed population, the Pension fund is depleted in 2050. As this happens, frustration increases in the segment of the population that is already struggling. This leads to increased support of right-wing populist politicians. Norway is experiencing a split between a relatively well-off urban population located around the Oslo-area, Bergen and Trondheim, and a poorer population elsewhere.

Transportation did only slowly become low emission until 2030, when international technological developments made electric and hydrogen cars cheaper to run than fossil fuel vehicles. In 2050, car ownership is reduced due to economic hardship, but collective transport does not work properly because of lack of funding from the government. Thus, mobility is markedly reduced, since it is very expensive. Most people can no longer afford to take vacations outside Scandinavia.

4.2. Green tax society

In 'green tax', increasingly, Norway is de-industrialised and the service sector is the primary national source of income. After 2050, there is a relatively low degree of public engagement. Policy-makers consider such activities as unnecessary, since green taxes are supposed to provide strong economic incentives to changing ways of living. However, consequently, the public is expressing feelings of estrangement from national and local government and distrust in the green tax system, which is considered unfair because it results in relatively greater burdens on low-income groups. Citizens are also wary of the competition and efficiency rhetoric voiced by the authorities pursuing the green tax solution to climate mitigation. The estrangement is reinforced by the perceived lack of transparency and clarity concerning climate change accountability among elected politicians and the national and multinational business elite. This elite uses a language of financial accounting that obfuscates more than it illuminates the roles of and meaning of the new climate policies implemented.

This arrogance towards the inclusion and participation of normal citizens has led to dissatisfaction and disillusionment by many people, and populist politicians that require lower taxes and preach climate denial are gaining support. Norway is now experiencing a political development similar to what many countries went through in the mid-2010s. Consequently, the level of green taxes is moderated after 2030, and the transition to a low emission society appears to be postponed. Moreover, there has been a de-politicisation of social domains that in the past were issues of public discussion, such as healthcare, education, telecom, and retail banking. This is due to increased privatisation, which has led to further alienation of citizens from the political arena and fuelled support for populist parties.

The effects of the dominance of market-based instruments in climate change policy-making have been positive to the extent that CO_2 emissions are reduced, even if the reductions are less than needed. However, as already indicated, the social impacts

have been considerable. Inequality has grown, social services and other public goods have increasingly become privatised with consequent lowering of wages and quality, several industries have become outsourced or have ceased existing, and Norway has become more centralised. Large industrial farms, giant chains and shopping malls that are emitting less CO_2 due to their scale advantages and higher relative efficiency have replaced smaller farmers and businesses. Healthcare services have become privatised but fail to deliver in terms of outcome measures; although cost efficient, there is an almost constant cost crisis due to expectations of returns on investments and low ability to pay. In other words, those who can afford proper insurance can also afford proper health care. Due to the equalising effect of the Norwegian pension fund, social inequality remains more modest in Norway in 2050 compared with other European countries.

There is a growing split between those living in cities and those living on the countryside. 'Green tax' Norway has become highly urbanised, with the three major cities Oslo, Bergen and Trondheim having the main share of the total population. Between these three cities, highly competitive Chinese firms have constructed and run medium high-speed electric trains with a low level of comfort. The high degree of urbanisation has happened because of a prevailing idea that living in large cities is the most sustainable way of living, since more public facilities become shared this way. The green tax system reinforces this development.

The role of the government in 'green tax' is reduced, apart from its central role in deciding and implementing green taxes and related climate regulations. Innovation with respect to renewable energy is low, due to the emphasis on providing technology-neutral support only and the focus on making Norwegian universities scoring higher on research excellence measures. Thus, the energy industry struggles to grow, and there is little export of new energy technology. The continued reliance on neo-liberal policies has open the production of electricity to foreign ownership, which now dominates Norwegian production of electricity. Energy intensive industry is mostly closed down, since the energy industry believes that export of electric power is more profitable.

Some lifestyle changes have happened. Since mobility has become considerably more expensive, people travel less. People have smart and automated technologies in their homes, which regulate their everyday lives considerably. Urbanisation and increased prices of houses has led to a clear reduction in the average size of homes. However, due to continued cheap imports, consumption remains on a high level and with a large carbon footprint.

4.3. Collective engagement society

'The road to the free market was opened and kept open by an enormous increase in continuous, centrally organized and controlled interventionism' (Polanyi 1957: 146).

In 'collective engagement', the Norwegian economy has become more grounded (or 'foundational', see Bowman et al., 2014), meaning that it centres on the production of mundane and sometimes taken-for-granted goods and services that ensure the welfare

of all citizens. Examples of such goods and services are pipe and cable utilities, transport, retail banking, food retailing, health, education and social care. Consumption is less material and carbon intensive, and the activities and lifestyles of Norwegians have shifted from long work hours and fast food, to shorter work hours and 'slow' food. Emission reductions are not the result of carbon capture and storage, even if CCS has been implemented in some biofuel and heat-producing plants. Rather, reductions result from reduced, more energy efficient and climate neutral production, in addition to changed demand and greater impact of circular ways of organizing the economy. This change and reduction of demand has also had repercussions globally, leading to a lower carbon footprint for Norwegians in 2050.

Above all, Norway is a relatively important actor within renewable energy technologies, providing world-leading knowledge and technology within fields such as hydropower, offshore wind technologies, biogas, and hydrogen. Norway is also more thoroughly electrified (including the use of hydrogen) in this scenario, but electricity is increasingly produced on an off-grid basis, where villages and neighbourhoods have their own local production of electricity with neighbourhood storage. A government that is increasingly active in its support of new innovations and their implementation has driven these developments. Some investments have been failures, causing critique from neo-liberalist parties, but this critique has silenced in the light of the overall success of this active innovation policy.

According to Polanyi (1957: 46), people value material goods when they serve a social and not an individual end. In 'collective engagement', such ideas has become increasingly popular. This is reflected in the growing emphasis on social and collective interests and needs. Public engagement initiatives help citizens and the government to identify current matters of concern and to initiate debates about how to deal with the emerging issues. Diverse sets of policies are introduced at an early stage, to be tried out. Examples of such policies are support of collective housing projects and the establishment of repair centres where people may borrow tools and get instructions about repairing small household and leisure equipment.

The government has introduced a new standard for calculating the value of natural resources and biodiversity and the cost of pollution. This has changed the calculation of economic wealth and provided changes in what efforts that are seen as socially profitable. There is also increased focus on the use of indicators that estimates quality of life. This has shifted the attention from economic growth towards improving the possibilities for people to have meaningful and gratifying lives. Consequently, economists have lost their dominant position as policy advisors.

'Collective engagement' is characterised by an emphasis on climate justice, on improving social equality. This, together with changed lifestyles and lower inequality, leads to improved physical and mental health and increased life expectancy. Everyday life for Norwegians is characterised by less time pressure due to the introduction of the 6 hours day. This allows for more time spent on physical exercise and other pastime activities, and the making and growing of food.

In ‘collective engagement’, we see further development and implementation of technologies and patterns of use that allows for high quality virtual contact across distance, ubiquitous access to information, instruction and entertainment, and support for everyday life activities. Personal consumption has shifted towards from physical products to services provided; e.g., like continuing education, nature guiding, concerts, theatre, craft services and services addressing personal wellbeing.

International long distance mobility has been reduced, but it has also changed with increased use of ships and trains. Local transport is basically electric (including fuel cells). Car ownership and use in the cities has been reduced, while electric bicycles have surged in popularity. Collective transport plays a major role, and most city centres have very strict limitations on the use of cars. In rural areas, cars remains important. Second homes and ‘mountain cottages’ have remained a challenge to reduce car ownership and embedded emissions, but an improved infrastructure of car rentals has provided for some reduction.

Urbanisation in the ‘collective engagement’ society has been another challenge, but improved technological options for local production of goods has provided more employment to rural areas. The rhetoric of ‘smart cities’ was radically revised in the early 2020s, to emphasise an economy based more on sharing, with initiatives such as ecovillages, community-shared agriculture, urban gardening and other types of shared facilities. ‘Smart’ has increasingly been interpreted in social terms, emphasising community rather than calculation and control.

In general, the government takes an active role as facilitator in this scenario, constantly aiming at refining and redefining policies that aim at increasing welfare and reduce material and carbon intensity of Norwegian lifestyles. This implies supporting and encouraging experimental and situated approaches and forms of organisation, testing out several new types of policy initiatives (experimental) to see what works best where (situated). The government emphasises diversity in ends and means. This has given local authorities new tasks and made them prioritise to be in touch with and engage the public, to learn what governmental measures are needed and what may be left to citizens.

5. Summary and conclusions

In this report, we have outlined briefly three scenarios describing three paths with distinctively different dynamics regarding the development of a low emission society post 2050. The outlines are brief and rough, since our project of constructing the scenarios had modest resources. However, we have tried to highlight some consequences of three options we believe are present at the crossroads that Norway and the Norwegian government and Parliament face: (1) to continue to pursue oil and gas as the dominant economic activity ('the last oil' scenario), (2) to pursue a green shift towards low emission society through so-called cost effective measures like green taxes ('green tax' scenario), or (3) to go for more radical change including active and engaging forms of governance ('collective engagement' scenario). In this manner, we cultivate particular mind-sets to explore what they may come to mean with respect to a Norwegian transition towards a low emission society. This is summarised in Table 1.

In reality, the future will probably see a mix of all three scenarios since it is possible to combine several of their features. Judging from present-day policy-making, the most likely development would be some kind of mix of 'last oil' and 'green taxation' – a top-down transition that is more robust, but nevertheless, failing to engage the public and thus facing problems of lack of popular support for climate mitigation measures. The long time horizon of the scenarios raises particular challenges. For example, in a (functioning) democracy it is not likely that a government would continue with the same type of policy if citizens discover that the chosen policy-direction is not working. However, the exercise that these three scenarios provide is useful since it invites a discussion about the direction that Norwegian society ought to take.

Put in a different way, the 'last oil' scenario is a business as usual scenario, where Norway tries to get as much out of the oil and gas resources as possible. This scenario reflects the strong belief that oil and gas is of such great economic importance to Norway that this industry will remain important at least to 2050, even if it may be considered as a detour to a low emission society. The risk of increasing inflexibilities in the Norwegian economy is disregarded, and the risk of a fossil fuel endgame is overlooked. The 'green tax' scenario follows from mainstream economics that argues that the use of cost-effective, market-based instruments (green taxes) will make people and companies reduce their carbon footprint due to the unavoidable enactment of economic rationality. We highlight as a main challenge that effective green taxes may cause protest and the election of politicians that reduce these taxes, due to lack of climate policy leadership and public engagement. Cost efficiency is prioritised over governance effectiveness, which is not wise.

Table 1: The main features of the three scenarios.

	'Last oil'	'Green tax'	'Collective engagement'
Low emission society in 2050?	No. Slow development hampered by economic problems	Partly but the transition has been slowed down by populist politicians reducing the level of the green taxes and a failure to address the carbon footprint	Yes
Economic situation	Difficult, due to a downturn in the oil and gas industry around 2030 and lack of timely preparation	Moderate because of passive government relying too much on market based measures	Fairly good, due to active government, but economic growth intentionally reduced to reduce carbon footprint
Technological development	Slow due to the previously singular focus on oil and gas	Slow due to lack of active support of innovations	Fairly successful due to active support of innovations and social experiments
Role of government	Crisis management	Passive, the market is supposed to make decisions	Active and engaging, facilitating new forms of socioeconomic organisation
Public engagement	Few initiatives from the government	Few initiatives from the government	Government very inviting
Urbanisation	Has stopped since the economic crisis makes rural life more attractive	Strong and continuing since densification is assumed to reduce the need for energy	Moderate, due to slower lifestyles and a growing interest in the production of one's own food
Social conflicts and equality issues	Social inequality has grown a lot during the crisis, which also generates dissatisfaction and social conflicts	Social inequality has grown, in terms of climate injustice. A high income allows continued consumption of carbon-based goods and services. Conflicts over the level of taxes and the importance of global warming	Level of inequality reduced due to a focus on sharing of burdens. Low level of conflict
Everyday life	Lower carbon intensity due to the economic crisis and the high level of unemployment	Lower carbon intensity but people are struggling to find ways to live low emission lives since challenges are supposed to be managed individually, or with smart and automated technologies.	Slower life due to reduced working hours, more focus on sharing and repairing. Social debates and experiments develop low carbon everyday life routines
Mobility	Reduced because of economic crisis – lack of investment in public transport	Reduced because of increased cost of cars and air travel, which creates distrust because those who can afford it retain a high level of mobility.	Reduced because the need for mobility is reduced, in addition to development of better public transport, sharing arrangements, and a shift toward walking and bicycling

From Table 1 and the preceding presentation, it is clear that, based on the methodology we have used, a low emission society may not be in place in 2050. In terms of reduced greenhouse gas emissions, the 'last oil' fails because of a longstanding optimism on behalf of the oil and gas industry. In this scenario, Norway fails to prepare for a situation where the demand for oil and gas drops dramatically, resulting in an economic and social crisis that hampers the necessary changes towards low emission practices. The 'green tax' scenario describes Norway as closer to the low emission goal, but failing because the lack of climate change focused political leadership paves the way for a kind of tax populism and resistance towards the level of taxation needed to achieve the goals.

Thus, the 'last oil' Norway will continue to struggle in its realisation of low emission society goals also after 2050. Also 'green tax' Norway still has a job to do after 2050, but EU regulations that set more concrete targets for emission reducing measures may kick in. This could undermine the scenario by forcing government to play a more active role in supporting innovations, technologies and practices needed to satisfy EU requirements and emission goals. In our outline, only the 'collective engagement' scenario will have succeeded in meeting low carbon society goals. This happens above all because government and the public, in this scenario, are aligned in the effort of curbing climate change.

6. Literature

Aune, M., Godbolt, Å. L., Sørensen, K. H., Ryghaug, M., Karlstrøm, H., & Næss, R. (2016). Concerned consumption. Global warming changing household domestication of energy. *Energy Policy*, *98*, 290-297.

Bowman, A., Froud, J., Johal, S., & Law, J. (2014). *The end of the experiment? From competition to the foundational economy*. Oxford University Press.

exiobase (2016). The Global Resource Footprint of Nations. Online: http://exiobase.eu/index.php/publications/creea-booklet/73-creea-booklet-web-resolution/file

Geels, F.W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy*, 31(8–9), pp.1257–1274.

Helm, D. (2016). *Burn out. The endgame for fossil fuels*. London: Yale University Press

IEA (2015a). *World Energy Outlook 2015*, International Energy Agency (IEA)

IEA (2015b). *Energy and Climate Change*, World Energy Outlook Special Report, International Energy Agency (IEA)

Ivanova, D., Stadler, K., Steen-Olsen, K., Wood, R., Vita, G., Tukker, A., & Hertwich, E. G. (2015). Environmental impact assessment of household consumption. *Journal of Industrial Ecology*.

IPCC (2013), *Climate Change 2013: The Physical Science Basis* , Online [URL]: http://www.ipcc.ch/report/ar5/wg1/ (accessed 13.06.2017)

Jasanoff, S., & Kim, S. H. (Eds.) (2015). *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power,* University of Chicago Press. Kindle Edition.

Jørgensen, B.H. & Münster, M., (2010). *Nye energiteknologier. Forskning, udvikling og demonstration*, Danmarks Tekniske Universitet (DTU), Risø Nationallaboratoriet for Bæredygtig Energi. Available at: http://www.bibliotek.dtu.dk/Inst/MAN/Service/Telefonbog.aspx?lg=showcommon&id=270534.

Kemp, R., (1994). Technology and the transition to environmental sustainability: The problem of technological regime shifts. *Futures*, 26(10), pp.1023–1046.

Kemp, R., Loorbach, D. & Rotmans, J. (2007). Transition management as a model for managing processes of co-evolution towards sustainable development.

International Journal of Sustainable Development & World Ecology, 14(1), pp.78–91.

Kemp, R. & Rotmans, J. (2005). The Management of the Co-Evolution of Technical, Environmental and Social Systems. In M. Weber & J. Hemmelskamp, eds. *Towards Environmental Innovation Systems*. Springer Berlin Heidelberg, pp. 33–55.

Kemp, R., Schot, J. & Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management. *Technology Analysis & Strategic Management*, 10(2), pp.175–195.

Kriesi, H., & Pappas, T. S. (Eds.). (2015). *European populism in the shadow of the great recession*. Ecpr Press.

Lewis, J. I., & Wiser, R. H. (2007). Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms. *Energy policy*, *35*(3), 1844-1857.

Lindgren, M., & Bandhold, H. (2009). *Scenario Planning. The link between future and strategy*. 2nd edition. Houndmills, Basingstoke: Palgrave Macmillan.

Loorbach, D. & Rotmans, J. (2010). The practice of transition management: Examples and lessons from four distinct cases. *Futures*, 42(3), pp.237–246.

Markard, J., Raven, R., Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy* 41, 955–967.

Mazzucato, M., (2013). *The Entrepreneurial State: Debunking Public vs. Private Myths in Risk and Innovation*, London, New York, Delhi: Kindle Edition

Polanyi, K. (1957). *The Great Transformation: the Political and Economic Origin of Our Time*. Boston: Beacon Press.

Rotmans, J., Kemp, R. & Van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *foresight*, 3(1), pp.15–31.

Ryghaug, M., Sørensen, K. H., & Næss, R. (2011). Making sense of global warming: Norwegians appropriating knowledge of anthropogenic climate change. *Public Understanding of Science*, 20(6), 778-795.

Seyfang, G. & Longhurst, N. (2013). Desperately seeking niches: Grassroots innovations and niche development in the community currency field. *Global Environmental Change*, 23(5), pp.881–891. http://dx.doi.org/10.1016/j.gloenvcha.2013.02.007.

Smith, A., Stirling, A. & Berkhout, F. (2005). The governance of sustainable socio-technical transitions. *Research Policy*, 34(10), pp.1491–1510.

SSB (2012). Rask utvikling mot 6 millioner innbyggere. Online: https://ssb.no/befolkning/statistikker/folkfram/aar/2012-06-20

SSB (2016). Utslipp av klimagasser, 2015, foreløpige tall. Statistisk Sentralbyrå (SSB) https://www.ssb.no/natur-og-miljo/statistikker/klimagassn/aar-forelopige/2016-05-20

Steen-Olsen, K., Wood, R. & Hertwich, E. G. (2016). The Carbon Footprint of Norwegian Household Consumption 1999–2012. *Journal of Industrial Ecology*, 20: 582–592. doi:10.1111/jiec.12405

Swierstra, T., Stemerding, D., & Boenink, M. (2009). Exploring techno-moral change: the case of the obesity pill. In Sollie, P., & Düwell, M. (Eds.). (2009). *Evaluating New Technologies: Methodological Problems for the Ethical Assessment of Technology Developments* (Vol. 3). Springer Science & Business Media.

Unruh, G.C., (2000). Understanding Carbon Lock-in. *Energy Policy*, 28(12), pp.817–830.

Voß, J.P. & Bornemann, B. (2011). The politics of reflexive governance: Challenges for designing adaptive management and transition management. *Ecology and Society*, 16(2)

Voß, J.-P. & Kemp, R. (2005). Reflexive Governance for Sustainable Development – Incorporating feedback in social problem solving. Paper for European Society for Ecological Economics (ESEE) Conference, special session on Transition Management, June 14-17, Lisbon. Available at: http://kemp.unu-merit.nl/pdf/Voss-Kemp%20Reflexive%20Governance%20for%20ESEE%202005.pdf

Wilhite, H. & Norgard, J. (2004). Equating Efficiency With Reduction: A Self-Deception in Energy Policy. Energy & Environment 15(6): 991–1009.

CenSES — Centre for Sustainable Energy Studies
Faculty of Humanities
Norwegian University of Science and Technology (NTNU)
7491 Trondheim
Norway

www.censes.no
censes@ntnu.no

Order a copy of the report: censes@ntnu.no

ISBN 978-82-93198-22-2