

**Lao People Democratic  
Republic  
The First National  
Communication on Climate  
Change**

Submitted to  
The United Nations Framework Convention  
On Climate Change

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### Further information

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*Foreword*

The climate change issue is a challenge to the world community and all countries should address this issue collectively and seriously. The signature of the Lao People's Democratic Republic to the FCCC proof of the country's seriousness in cooperating with the world community in addressing the issue of climate change for the benefit of the Lao PDR as well as the world.

Awareness on issues of climate change issue is not widespread in the Lao PDR. One of the important steps therefore is to increase the awareness among government agencies and the general public at large on climate change issue and its implications. The preparation of the First *National Communication* to UN FCCC has increased the knowledge and understanding on climate change among those responsible for environmental management in the country. This enabling project has helped us understand the implications of climate change and is the first step towards wider public awareness on this issue. This has also increased the capacity of the Lao PDR to participate fully in the process of UN FCCC.

We believe that the first National Communication of the Lao PDR on climate change will inform the world community as well as the Laotians on the efforts of the Lao PDR government in addressing the climate change issue.

To the government policy on sustainable development, of which mitigating greenhouse gas emissions in the country is an integral part, we the Lao people will seriously cooperate and coordinate with the world community for the effective implementation of the measures in the present as well as in the future.

President

Science Technology and Environment Agency



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## ACRONYMS

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APICC	Accessible area of Possible Interest for Commercial Forestry Nature Conservation
ASEAN	Association of South-East Asian Nations
BOD	Biological Oxygen Demand
CEF	Carbon Emission Factor
CF	Conversion Factor
CFLs	compact fluorescent lamps
COP	Conference of the Parties
CH <sub>4</sub>	methane
CO	carbon monoxide
CO <sub>2</sub>	carbon dioxide
DOC	Degradable Organic Component
DOE	Department of Environment
FAO	Food and Agriculture Organisation
ECS	Electric Cook Stove
FAR	First Assessment Report
FDI	Foreign Direct investment
GDP	Gross Domestic Product
GEF	Global Environment Facility
GOL	Government of Lao PDR
Gg	gigagram
GHG	greenhouse gas
ICS	improved cooking stove
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
kha	kilohectare
ktC	kilotonne of Carbon
kt <sub>dm</sub>	kilotonne of dry matter
ktN	kilotonne of Nitrogen
kt	Kilotonne
LPG	Liquified Petroleum gas
Mha	million hectares

LPRP	Lao People's Revolutionary Party
NEM	new economic mechanism
NGIC	National greenhouse Gas Inventory Committee
NGO	Non-governmental Organisation
N <sub>2</sub> O	Nitrous Oxide
NO <sub>x</sub>	Oxides of nitrogen
NRS	National Reconnaissance Survey
ODA	official development assistance
PV	photovoltaic
PVP	Photovoltaic pumping
SHP	Small-scale hydropower potential
TC	Tonne of Carbon
TFAP	Tropical Forestry Action Plan
TJ	Terajoule
Tdm	Tonnes dry matter
TWG	Technical Working Group
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN FCCC	United Nations Framework Convention on Climate Change
MoF	Ministry of Finance
LECS	Lao Expenditure and Consumption Survey
MUB	Multi-nutrient Urea block
MAT	Multiple aeration technique
STEA	Science, Environment, Technology & Environment Agency



## Executive summary

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### 1 National Circumstances

The Lao People's Democratic Republic or Lao PDR is a landlocked country covering an area of 236800 square kilometres. The country stretches more than 1700 km from north to south and between 100 km and 400 km from east to west. The country shares its borders with the Socialist Republic of Vietnam, Kingdom of Thailand, Kingdom of Cambodia, People's Republic of China and Myanmar. The topography of the nation is mostly mountainous ranging from 200 to 28820 metres with mountains covering about two-thirds of the land area. The country is crisscrossed by a number of rivers, including a 1856km stretch of the Mekong (Nam Khong), which defines its border with Myanmar and a major part of its border with Thailand.

The Lao PDR has a tropical climate dominated by the south-west monsoon which brings high rainfall, high humidity, and high temperatures between mid-April and mid-October. The climate is characterized by high interannual variability of rainfall with relatively frequent occurrence of flooding and drought. The average temperatures range from 20°C in the mountainous areas and highland plateaus to 25–27°C in the plain. The intraannual temperature variations are large.

The Lao PDR is abundant in natural resources like water, forests and minerals. The country has abundant surface and groundwater resources. It has a per capita availability of 66000 cubic metres and, despite expected increase in future demand, there are no expected water problems in the foreseeable future. The mountainous terrain, combined with a large river network, provides a large hydroelectric power generation potential, which has barely been tapped.

Forest resources are an important source of income, construction material, fuel wood, and other non-timber products in the Lao PDR. They also contribute significantly to the foreign exchange earning of the country. The total forest area of the Lao PDR is 11.17 Mha (million hectares), covering 47% of the total land area. Over the last two decades forest areas have decreased due to shifting cultivation practices, poorly planned logging activities, and forest fires.

The Lao PDR has an abundance of mineral resources such as gold, copper, ferrum, limestone, gypsum, lead, and tin, which have so far been little exploited due to lack of resources for development and limited infrastructure to access the resources.

The Lao PDR is home to a small but ethnically diverse population. The population of the country, according to the 1995 census, is 4574848 mostly living in rural areas. The population can be categorized into three groups: the Lao Loum, the Lao Theung, and the Lao Soung. The average population growth rate is average of 2.5%.

The country is categorized as a least developed country. In 1995, per capita income in the Lao PDR was estimated at \$350. This reflects the minimal standards of living of the majority of people in the country. Poverty eradication and providing people with decent living conditions are the two important challenges for the Lao PDR. The economy has grown at an annual growth rate of 6.5% over the period 1990–1995. The government became a full member of ASEAN (Association of South East Asian Nations) in July 1997. The Lao PDR is one of the four riparian countries comprising the Mekong River Commission.

Agriculture remains the principal economic sector in the Lao PDR, accounting for 55% of the total value added in 1995. Since the NEM (new economic mechanism) was adopted in 1986, income from industry and tourism has increased rapidly. The economy is highly import-dependent and its major source of export earnings are hydroelectricity and timber.

The country is governed by an elected National Assembly, whose members are directly elected by the people for a term of five years. The government is headed by the prime minister and president is the highest level leader of the country. The Lao People's Revolutionary Party plays a dominant role in the country's political system. The country has a written constitution. The government is composed of heads of ministries and ministry-equivalent entities. The local government structure extends from provincial levels through district levels to village levels. A governor administers each province.

## **2 Greenhouse Gas Inventory (GHG Inventory)**

The emission inventory of GHG (greenhouse gas) was developed for four of the six sectors mentioned in the IPCC (Intergovernmental Panel on Climate Change) guidelines namely energy, land use change and forestry, agriculture and waste. The emissions are estimated for CO<sub>2</sub> (carbon dioxide), CH<sub>4</sub> (methane), CO (carbon monoxide), N<sub>2</sub>O (nitrous oxide), and NO<sub>x</sub> (oxides of nitrogen) for the year 1990. The inventory does not cover activities of the industrial sector because the sector made no contribution to the emission in the base year. The GHG emissions in the Lao PDR have been assessed based on the volume of activities and using IPCC default emission factors. The various data are available with the National Statistical Center and reports published by international agencies were used in estimating the inventory.

As is evident from Table 1.1, the Lao PDR is a net CO<sub>2</sub> sequester. The net annual CO<sub>2</sub> removal is of the order of 121641 Gg, which is much larger than the total fuel based

CO<sub>2</sub> emissions of 414.9 Gg (gigagram). The total CH<sub>4</sub> emissions in the economy is 312 Gg, of which agriculture accounts for 81% of emissions and forestry and waste sectors for the rest. The CO emissions are primarily from onsite burning of wood in forests. The N<sub>2</sub>O and NO<sub>x</sub> emissions in the economy are negligible.

**Table 1.1** Summary of the GHG inventory (Gg)

<i>Sector</i>	<i>CO<sub>2</sub></i>	<i>CH<sub>4</sub></i>	<i>CO</i>	<i>N<sub>2</sub>O</i>	<i>NO<sub>x</sub></i>
Energy sector					
Fossil fuel consumption	414.9				
Traditional biomass burned for energy		22.75	157.92	0.12	4.18
Agriculture					
Enteric fermentation		97.92			
Manure management		14.38			
Rice cultivation		158.97			
Forestry					
Change in forest and woody biomass	-121,614				
Forest conversion: Aboveground CO <sub>2</sub> released from on-site burning	6752.67	29.5	257.8	0.2	7.3
Forest conversion: Aboveground CO <sub>2</sub> released from off-site burning	628.16				
Aboveground CO <sub>2</sub> release from decay	9247.84				
Waste					
Landfills		11.20			
Waste water		0.23			
Grand total	-104570	312	258	0	7

### **3 Policies, programmes and measures**

Awareness about climate change awareness has been growing in the Lao PDR since it participated in the Rio Earth Summit in 1992. However, the issue is still a new concept in the country and awareness is restricted to a few institutions and individuals exposed to the subject, primarily through the Lao National GHG Inventory Project. Even within this group, the understanding of the issues involved and the scientific and policy aspects is moderate. The NGIC (National Greenhouse Gas Inventory Committee) and the TWG (Technical Working Group) on climate change have been instituted within the STEA (Science Technology and Environment Agency). The NGIC and TWG has representatives of each ministry within the government.

The policy, programmes, and measures that are possible in the Lao economy are based on the analysis of mitigation options carried out under the Lao National GHG Inventory Project. Further, the policies and measures are suggested alternatives which will promote activities that reduce the GHG emission intensity of the economy. These measures do not constitute stated government policy but indicate the Lao PDR's national thought on issues relating to climate change.

The country initiated an economic reform process in 1986 to increase economy prosperity. Realizing the importance of natural resources to the economy and of the adverse implications of unmanaged growth process on the environment and natural resources, the government has a stated policy of strengthening the environment management of the economy to achieve sustainable economic development. The government's objective is to integrate environmental concerns into development planning in the long run, particularly the national socio-economic development planning process.

The development priorities of the country are to increase industrialization of the economy, modernize agriculture sector and provide basic amenities of living including electricity to the population. A number of opportunities exist within the long-term sustainable development framework of the country to integrate climate change mitigation measures. These possibilities are in line with the development priorities of the government.

The energy sector offers the maximum potential for mitigation. The possibilities include measures to conserve energy by utilizing better and efficient technologies, switching to more cleaner and less CO<sub>2</sub> intensive fuels, and shifting utilization of renewable sources of energy. One of the reasons for low emissions is that the main source of electricity is hydro power, a trend that is likely to persist into the future given the large hydro potential in the country. Further, the government encourages and promotes the use of renewable energy such as wind, solar, biogas, and geothermal. The major mitigation possibilities in the energy sector are outlined below.

- 1 Energy conservation and improvements in energy efficiency through upgradation of currently employed technologies.
- 2 Introduction of advanced technologies that are more efficient or based on renewable energy sources.
- 3 Structural change within the consumer sectors.
- 4 Promotion of the use of renewable energy such as small-scale hydropower development and electricity generation by wind, solar, biogas, thermal energy and biogas.
- 5 In the transportation sector, the options are governed by the objective of reducing congestion and local air pollution. The major options are use of 4-stroke engine to replace 2-stroke and expansion of public transportation service.

Forest is one of important resources in the country. To ensure proper ecological balance and forest resource management, one of the priorities is to increase the total forest area in the country from 40% to 70% of the country's land. Reforestation of degraded forest land, afforestation programme and delineation of national protected areas are the measures that can help to achieve this objective. Relevant legislation will be enacted to provide legal sanction to these efforts. These also will have a positive implication on carbon emissions from the economy.

The development goals in the agriculture sector are aimed at increasing productivity with minimal impact on the environment. One of stated policies of the government is to promote the use of organic fertilizer in the place of chemical fertilizer which increasingly being used. The options that are possible in the agriculture sector are

- 1 multiple aeration technique or MAT
- 2 strategic supplement to feed through MUB (multi-nutrient urea block)
- 3 Biogas digesters to capture CH<sub>4</sub> for energy use.

A GHG mitigation strategy was developed as part of the Lao National GHG Inventory Project to integrate the identified mitigation options into the economic planning and development process. The GHG mitigation strategy should be seen in the perspective of country's national circumstances and capacity of the economy to undertake these measures with minimal affect on economic growth. The country is at the very early stages of development. It is in the process of developing and strengthening institutions for implementing the policies and other measures effectively for economic development and environmental management. Environmental management institutions are being

strengthened. Increasing awareness of environmental issues including climate change and conservation among the wider public is one of the priorities.

A possible time frame presented here indicates the likelihood of the mitigation options being adopted is based on the following factors

- 1 Development goals of the country
- 2 Possibility of effectively implementing these options within the constraints of cost to the economy
- 3 Technical capability to implement the options and absorption capacity of the economy
- 4 Availability of donor funding to support these programs.

Reforms aimed at achieving market-oriented economy for increased competitiveness and higher rate of growth are likely to benefit energy and resource conservation measures. The process of strengthening institutions, especially natural resource and environmental management institutions, will help integrate the climate change concerns within the decision-making process. The foremost requirement in the short run is to develop technological capacity to increase the absorption of advanced and more environmentally friendly technologies.

Based on the development priorities and with the perspective of strengthening its institutions a list of projects concepts has been developed.

- 1 Reducing CO<sub>2</sub> emissions through use of CFL(compact fluorescent lamps) in the government and commercial sector.
- 2 ICS (improved cook stoves) demonstration project, promoting biogas use for GHG emission reduction.
- 3 Decentralized energy supply through solar home systems in rural households.
- 4 Assessing SHP (small scale hydropower potential) in the Lao PDR and demonstration project in combination with dissemination of ECS (electric cooking stove)
- 5 Removing barriers to adoption of 4 - stroke engine for two wheelers.
- 6 Reforestation and afforestation project

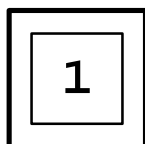
#### **4 Financial and Capacity Constraints**

The country is heavily reliant on the primary sector, and social and economic infrastructure is minimal. The government has been working on multiple fronts like developing institutions for governance, regulatory framework and implementation

structure, economic infrastructure, and social infrastructure in order to provide the people with basic needs of existence and a rule-based governance. To achieve these goals, adequate trained manpower for various activities, ranging from policy-making and research to implementation is required. The country lacks this capacity as also funds to facilitate action.

A number of drawbacks need to be overcome to strengthen capacity to effectively address the issue of climate change.

- 1 The STEA is not equipped to analyse the data needs for environmental aspects. This is true of the climate change activities too.
- 2 The current inventory was prepared using default technical parameters for emissions across all the sectors.
- 3 The climate change issue brings a shift in policy objectives and, hence, policy analysis.
- 4 There is a lack of information and expertise on projecting energy needs for the future and planning for energy needs in the economy. The information on energy demand is very important for management of climate change issues.
- 5 Awareness of the climate change issue is limited to policy makers. A wider dissemination of this information calls for inclusion of the climate change issue in the educational curricula.



# National circumstances

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## 1.1 Introduction

The Lao PDR signed the UN FCCC (United Nations Convention on Climate Change at the United Nations Conference) on Environment and Development in Rio de Janeiro in 1992. The convention was ratified by the Lao PDR on 5 January 1995. As per the FCCC the responsibility of the Lao PDR, being a non-Annex I country is to provide the Conference of the Parties through the Secretariat its national GHG inventory and steps to address the climate change concern within its developmental needs.

The Lao PDR has obtained financial assistance from the GEF (Global Environment Facility) through the UNDP (United Nations Development Programme) for capacity building within the government to achieve its obligation to FCCC, particularly the compliance of Article 4 and Article 12.

The Lao National GHG Inventory Project was initiated in 1997 to achieve the following objectives.

- 1 Inventory of sources and sinks of GHG emissions in the Lao PDR
- 2 Assessment of mitigation options in the Lao economy
- 3 Formulating National Action Plan and Strategy on GHG Emission Mitigation

The National Communication presents the information generated from the above study and summarizes the national circumstances. As there are currently no studies on climatic vulnerability of Lao PDR, the document does not report the country's vulnerability to climate change. This is a priority activity for future and the government will approach the GEF to support a study to assess the vulnerability of Lao PDR to climate change.



## **1.2 Physical features and natural resources**

### *1.2.1 Geography, topography, and climate*

Lao PDR is a landlocked country with a land area of 236,800 square kilometres. The country stretches more than 1,700 km from north to south and between 100 km and 400 km from east to west. It has an eastern border of 1,957 km with the Socialist Republic of Vietnam, a western border of 1,730 km with the Kingdom of Thailand, a southern border of 492 km with the Kingdom of Cambodia, a northern border of 416 km with the People's Republic of China, and a north-west border of 230 km with Myanmar (Figure 1.1). It therefore provides a strategic land link among these countries for closer subregional cooperation in the Greater Mekong area.

The topography of the nation is mostly mountainous. About two-thirds of the country is covered with mountains, with the height ranging from 200 to 2,820 m. The northern part of the country is mountainous and the central and southern parts form the plains. The highest mountain in the country, Phou Bia, is situated in the northern part of the country and has an altitude of 2,820 m. Although the country has no direct access to the sea, it has an abundance of rivers, including a 1,856 km stretch of the Mekong (Nam Khong), defining its border with Myanmar and a major part of its border with Thailand. Within the Mekong Basin, the rivers most important for meeting the government's development objectives are Nam Tha, Nam Beng, Nam Ou, Nam Suang, Nam Khane, Nam Houng, Nam Ngum, Nam Ngiap, Nam San, Nam Theun, Hinboun, Se Bang Fai, Se Bang Hieng, Se Bang Nouane, Sedone, and Sekong.

The mountains pose difficulties for transportation and communication, but together with the rivers they produce vast potential for irrigation and other infrastructure development projects. The rivers north of Vientiane Province are located in the deep and narrow valleys with very limited possibilities for irrigation and relatively low potential for hydropower development. A significant part of the potential for hydropower and irrigation schemes is in the central and southern provinces and on the Mekong River, making this region very important for national development. Major stretches of the Mekong river and its tributaries are navigable and provide alluvial deposits for some of the fertile plains.

Figure 1.1



Lao PDR is a tropical country lying between 13°54' to 22°3' north latitude and 100°05' to 107°38' east longitude. The climate is tropical and dominated by the southwest monsoon, which brings high rainfall, high humidity, and high temperatures between mid-April and mid-October. While over 70% of the rainfall falls during the wet season, the climate is characterized by high interannual variability with relatively frequent occurrence of floods and drought. Annual average temperatures range from 20 °C in the mountainous areas and highland plateaus to 25 °C-27 °C in the plains. In Vientiane, the capital of the country, the average temperature ranges from a minimum of 16 °C in January to a maximum of 38 °C in April. The country is divided agro-climatically into three zones.

- 1 The mountainous north with elevations over 1000 m and steep slopes is dominated by moist to dry subtropical climate with annual rainfall between 1500 and 2500 mm. The area experiences a cooler dry season and hence higher intra annual temperature variations than the rest of the country. Soils in the north tend to be heavily leached and acidic. They have low water retention capacity and generally low fertility. The combination of a rugged terrain and relatively poor soils leaves little room for intensive agricultural production.
- 2 The mountainous parts of the centre and the south have elevations between 500 and 1000 m (and some peaks over 2000 m) but generally moderate slopes is dominated by a tropical monsoon climate with annual rainfall from 2500-3500 mm on the Bolovens plateau. Soils are similar to that in the north with the exception of the Bolovens Plateau, which possesses deep, well structured, less acidic soils with relatively good water retention and drainage capacity.
3. The river plains along the Mekong and its tributaries include the Vientiane plain, the narrow plain in Bolikhamsay and Khammouane, and the larger plains in the southern provinces of Champassak, Saravane, and Attapeu. These areas are inhabited by more than 50% of the population and are dominated by a moist to dry tropical climate with annual rainfall varying from 1500 to 2000 mm. The flood plains and immediate adjacent levies are generally characterized by recent alluvial deposits which are acidic and shallow, with low organic matter and low fertility. The younger alluvial soils of the flood plains are more fertile than the older terrace soils, but they are often subject to wet season flooding.

The Lao PDR is highly prone to natural disasters, with the northern parts prone to drought and central and southern parts prone to floods.

## *1.2.2 Natural Resources*

### *1.2.2.1 Water Resources*

Lao PDR has abundant surface - and ground water-resources. With 66000 cubic metres per capita, the country has the highest per capita availability of renewable fresh water resources in Asia (20 times more than the Asian average). Current use amounts to only 228 cubic metres per person per year. The main users of water are agricultural sector (82%), industrial sector (10%), and domestic sector (8%). Although the hydrological pattern is strongly influenced by the marked dry and wet seasons, acute water shortages and competition for water resources are not a major issue. Because of significant inter annual fluctuations in rainfall, flooding and droughts often affect significant areas of agricultural land.

Although demand for water is expected to increase significantly over the next decade (urban domestic consumption of water is projected to increase by over 150% by the year 2000, while potential for irrigation is more than twice the currently developed area), serious competition for water resources is not expected to be a problem in the foreseeable future.

The country's hydro electric power generation potential is estimated to be about 12300 MW excluding the Mekong stream, but it has barely been tapped. The generating capacity developed amounts to about 582 MW of which hydropower accounts for 565 MW. Hydropower is a major source of export earnings, accounting for 25% of total exports.

#### 1.2.2.2 Forest Resources

Forest resources are an important source of income, construction material, fuel wood, and other non-timber products in Lao PDR. The total forest area of the Lao is 11.17 Mha, covering 47% of the total land area. High-density<sup>a</sup> forest covers 19% of the land area. While 58% of the area in southern province is under forest the corresponding figure for the northern region is 36%. The forest cover in the region is indicated in table 1.1 Figure 1.2 shows Lao PDR's forest cover.  
Figure 1.2

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*a The National Reconnaissance Survey defines the following main forest categories.*

- *cucurrent forest crown density > 20%.*
    - *Highdensity forest –Crown density > 40% and diameter of dominant trees > 30cm.*
- potential commercial forest –crown density > 40%, Slopes < 30% Elevation < 1500 m.*

**Table 1.1** Forest cover distribution('000 ha) by region(1989)

	Total	North	Center	South
Total area	23680	9821	7229	6630
	11168(11			
Current Forest 1/ High Density forest	7)	3563(36)	3739(52)	3866(58)
2/	4,527	801(8)	2178(30)	1548(23)

Note. Figures in parantheses show percentage of area

Source. **Department of Forestry, National Reconnaissance Survey, 1992**

Forests comprise a wide variety of commercial tree species suitable for production of sawn timber, plywood, parquet, and furniture. The commercial forest area is estimated at 1.3 Mha whereas the potential commercial forest area is estimated at 2.5 Mha. Data on land resource availability and use in the country are shown in Table 1.2. This data provide a preliminary indication of the current use of land resources in the country and aggregate changes since 1982, but is dominated by a forestry perspective.

**Table 1.2** Land use statistics

Land use group / vegetation type	land use and Area (%)	( '1000 ha)
Current forest	47.162	11167.9
Dry dipterocarp	5.095	1206.5
Lower dry evergreen	0.361	85.5
Upper dry evergreen	4.480	1061.0
Lower mixed deciduous	3.657	866
Upper mixed deciduous	31.457	7448.9
Gallery forest	0.369	87.5
Coniferous	0.559	132.3
Mixed coniferous Broad-leaved	1.184	280.5
Potential Forest	37.791	8949.0
Bamboo	6.469	1531.9
Unstocked	28.680	6791.4
Ray	2.642	625.6
Other wooded areas	6.099	1444.4
Savannah/open woodland	3.854	912.5
Heath. Scrub forest	2.245	531.7
Permanent agriculture land	3.587	849.5
Rice paddy	3.334	789.4
Agriculture plantation	0.075	17.8
Other agriculture land	0.179	42.3
Other non forest land	5.361	1269.5
Barren lands/rock	0.49	116.1

Land use group / vegetation type	land use and Area (%)	( '1000 ha)
Grassland	3.474	822.8
Urban areas	0.356	84.2
Swamps	0.149	35.4
Water	0.891	210.9
Total	100	23680.0

Forest resource degradation is a major issue of concern in the country and expansion of permanent agriculture land and shifting agriculture are the main causative factors. Fuel wood extraction in some areas is also a cause of degradation. Expansion of agricultural land into forest land not only contributes to the deforestation, but unless agricultural production systems are well adapted to the soil conditions of the former forest land, cultivation can result in serious land resource degradation and further downstream effects such as siltation and decreased streamflow. Close to 80% of domestic energy consumption is based on fuel wood, and an estimated 300000 ha of forests are lost annually largely due to shifting cultivation and logging activities. In the effort to conserve forest resources, protective measures are being implemented against shifting farming practices.

### 1.2.2.3 Mineral Resources

The country has good mineral potential, which is so far underused. Commercial mining activities have consisted of relatively small quantities of tin, gypsum, coal, and gems. New minerals with high potential include precious metals, gems (mainly sapphires), lead and zinc, chrome, and industrial minerals. Tin is the economically most significant mineral and has traditionally been mined for export in Khammouane Province. Reserves of the lateritic alluvial deposit are estimated at 10 million tonnes of ore with a grade of 0.24% tin. Gypsum is mined near Savannakhet Province and exported to Vietnam. Defined reserves<sup>a</sup> for gypsum are 150 [C1]million tonnes and total possible reserves could be 5000 million tonnes. Anthracite coal production has been carried out intermittently in Vientiane Province since the early 1970s. Five million tonnes of reserves have been identified in irregular, steeply dipping seams. Relatively little is known about the quality and extent of reserves of the other mineral resources. New minerals with low potential are bauxite, potash, and other evaporite minerals, iron ore and copper minerals. To date, exploration and exploitation of mineral resources has been modest compared to neighbouring countries mainly due to lack of resources for development and limited access to mining areas. Mining currently accounts for about one per cent of GDP.

<sup>a</sup> Explain defined reserves

## 1.3 National development situation

### 1.3.1 Population

Lao PDR has a population of 4574848 as per the 1995 population census. The male-female population ratio is 1000:1023. Urban population constitutes 17 % of the total population in the country. The population of the country is very young with 53% of the total population falling below the age of 19. The percentage of female population below the age of 19. 53% of female population and 55.3% of male population. The Lao population lives in 752102 households, with an average size of 6.1 members, in 11935 small villages (ban) located in 133 districts (muong).

Population density remains one of the lowest in the region, at 19.4 persons per square kilometre. The population density in the country ranges from 8 persons per square kilometre Xaysomboun Special Zone Province to 142 in the Vientiane municipality which has a population of about 528109. The other population centres are Savannakhet (671581) and Champassak (500994) in the south and Luang Prabang (365333) in the north.

The Lao population is ethnically diverse - Up to 47 ethnic groups have been identified. They can be roughly categorized into the Lao Loum, who occupy the lowland plains and the Mekong river valley and constitute some two-thirds of the total population the Lao Theung, who occupy the mountain slopes comprising about 22 of the population and are thought to have been the first inhabitants of Lao PDR the Lao Soung, who occupy the high mountain tops over 1000 meters constituting about 10 % of the total population and follow indigenous linguistic traditions in the remote and highly mobile settlements.

Particular emphasis is being placed on finding ways to more fully integrate the ethnic groups into the economic and social life of the country.

The 1985 census recorded a population of 3584803, implying an annual average intercensal growth rate of 2.5%. The average birth rate for the country is 4% and the average death rate is 1.5 per cent. At the present growth rate, the Lao population will reach 5.2 million by the year 2000 and will double in next 29 years.

### 1.3.2 Human Development

The per capita income in the country is estimated at \$ 350 for year 1995. This reflects the minimal standards of living for the majority of people in the country. The Lao Expenditure and Consumption Survey estimated that over 2.1 million people (almost 50% of total population) live in poverty. About 1.9 million of them are in the rural areas where poverty incidence (53% percent) is more than double compared with that in the urban areas (23.9%). Among the three regions of the country, the south exhibited the

highest poverty incidence at 59.8% percent. In the rural south, 66.2% of the population or 2 out of 3 people live in poverty.

The income disparity in the country is high with a gini-coefficient of 0.32. The LECS revealed considerable inequity in income distribution. It uses consumption data as a proxy for income. The survey shows that the poorest 10% of the population accounted for only 4.2% of total consumption while the richest 10% consumed 26% of the total.

Based on the survey of five urban centers (Vientiane, Luang Prabang, Savannakhet, Pakse, and Thakek) in 1994, it was reported that 5.6% of the labour force, i.e. the economically active population, was unemployed.

Despite respectable economic growth since the NEM was adopted in 1986, Lao PDR still lags behind other countries in the region in terms of social well being of its population. The human development index developed by the UNDP for year 1998 gave Lao PDR a value of 0.465 placing it in the "low human development" category. It is ranked 136 among the 175 countries for which the index is developed. Key social indicators for which data are available for the year 1995 are presented in Table 1.3 and give a picture of the development status of the country.

Table 1.3 Main indicators for human development indicators

Life expectancy at birth:	517 years
Infant mortality rate:	113 /1000
Under - 5 mortality rate (1994)	142/1000
Maternal mortality rate	656/100000
Fertility rate	66 children
DPT 3	54 %
Measles	68%
Access to safe drinking water	51%
Access to sanitation	32%
Under - 5 severe malnutrition	10%
Adult literacy rate	58%
Primary school:	
Net enrolment rate (1994)	72%
Completion rate (1994)	41%

Source:



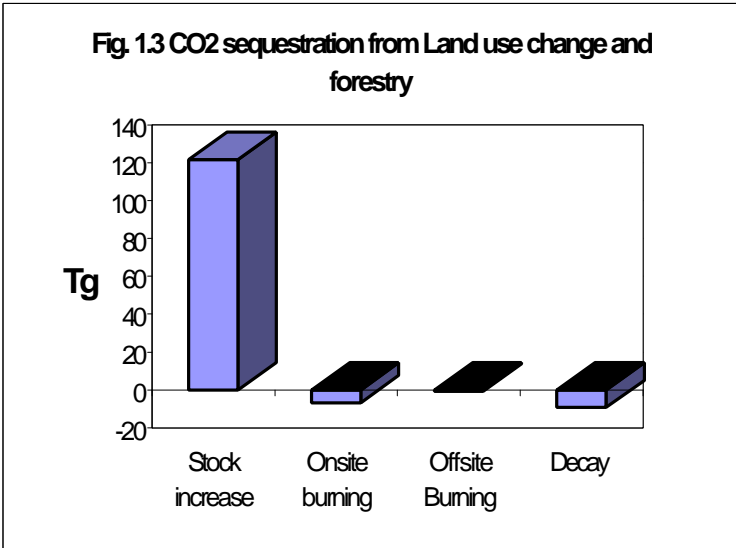
The adult literacy rate in the country, though high for its level of development, is not reflective of the true picture. An Estimated 4000 villages continue to be without access to primary schools. In 1994, despite expansion in educational facilities, one in four children between the ages of 6 and 10 years did not attend school. Less than half the children entering school completed primary education. An estimated 62% of the rural schools have textbooks. Though there has been a considerable expansion in educational facilities, a lot more has to be done in the field of education.

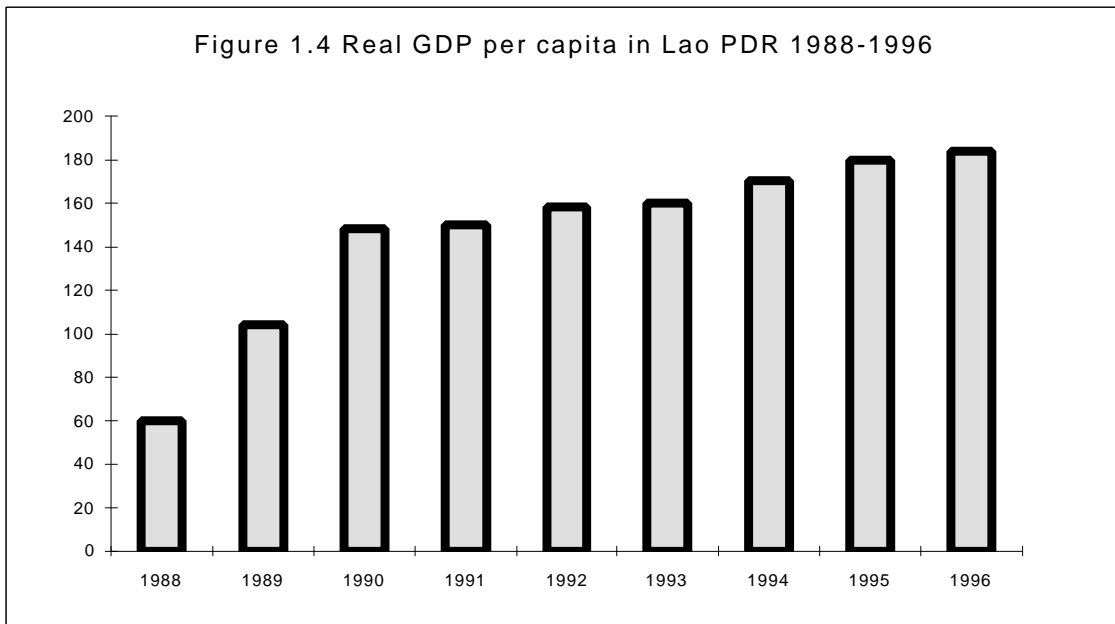
The high mortality rate and low life expectancy reflect low level of health status in the country. Malaria is the most serious public health problem with an estimated 1.4 million cases per year resulting in 14 000 deaths. Acute respiratory illness and diarrhoea remain major causes of child mortality after malaria. The poor health conditions reflect the inadequacies of the health system and people's lack of access to quality health care. The expanded immunization programme was launched in 1982 to cover all the villages, and 61.5% children have been vaccinated against measles. The number of children not immunized fully from diphtheria, pertusis and tetanus fell from 32% in 1994 to 11% in 1995. The other major health concern in the country is malnutrition. Approximately 41% of the children under five are reported to be malnourished, and another 12% are severely malnourished. Only 23% of the villages in rural areas have access to hospitals. Of the 117 district hospitals, only 20 are reported to be fully operational.

Access to basic amenities and services needed for a decent living is very low. Only 49% of the rural population have access to safe water, and 20% to proper sanitation facilities. Only 28 of the population use electricity for lighting, the rest use either kerosene or candles. Only 8% of the households have a water faucet in the house: 37% rely on rivers, dams, and lakes. 32% of the households have latrines, of which only 20 % have flush toilets, the rest use pit latrines. Inadequate access to safe drinking and appropriate sanitation exacerbates the lack of access to adequate health care. The challenge for the Lao PDR is to urgently address these problems of human poverty by investing in improving people's health, education, and living conditions.

### 1.3.3 Economic development

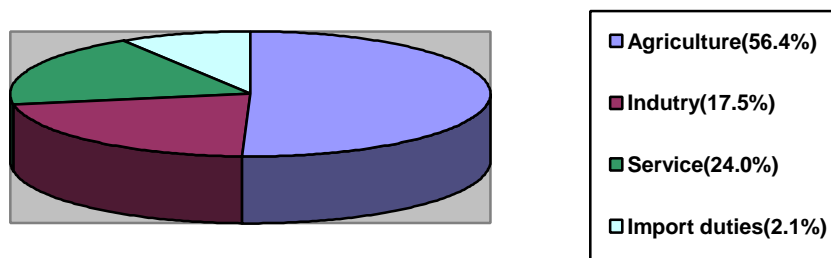
With an estimated per capita income of \$350 in 1995, Lao PDR is considered one of the least developed countries. The per capita income has grown from \$ 200 in 1990 to present level as a result of the New Economic Policy that the country has pursued since 1986(Figure 1.3). Between 1989 and 1995, the country's GDP (gross domestic product) grew at an average of 6.5% per year.





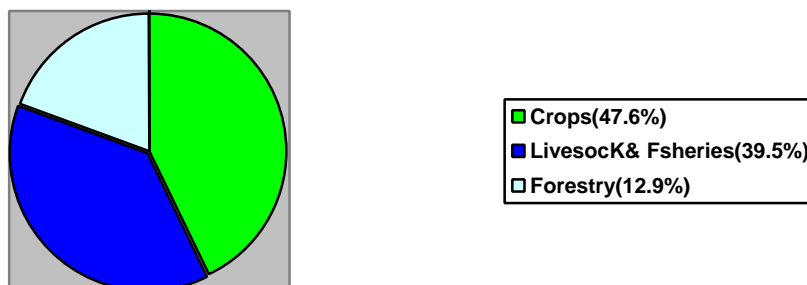
The country's economy is heavily reliant on the primary sector, though the development over the last decade has changed the economic structure in favour of the secondary sector. The share of agriculture has decreased from 61.4% in 1988 to 56.4% in 1995. The service sector shrank from 25.8% of total area to 24.0% during the same period, while the contribution of industry sector to the economy increased from 11.2% to 17.5%. Figure 1.5 gives the composition of economy for year 1995.

**Figure 1.5** gross domestic product composition for 1995



Agriculture accounted for 56.5% percent of the total value added in 1995, covering a wide range of activities from subsistence production to agriculture-related industries. According to the 1995 census, 83% of the population lives in the rural areas and is engaged in agricultural activities, broadly defined to include livestock, fisheries, and forestry. Figure 1.6 gives the breakdown of agriculture sector GDP.

**Figure 1.6** Agriculture value added composition, 1995



Approximately 737000 ha or 3% of the total land area under cultivation of this 600000 hectares or 81% is devoted to rice cultivation. Only 11000 ha or 1.8% of total area under rice cultivation are irrigated, contributing to low agricultural productivity. Sixty five per cent of the country's rice is grown in the lowlands, and the rest in the upland. Other crops, including coffee, maize, starchy roots, soybeans, mung beans, peanuts, tobacco, cotton, sugar cane, and tea, are planted on the remaining 19% cultivated land area. Cultivation of cash crops has been encouraged in recent years. In 1995, measures to allow tariff-free exports of coffee and cotton were announced to encourage cash crops. Farmers cultivating these crops were exempt from paying duty on imported farm equipment.

Agriculture production is heavily dependent on the climatic factors. Families dependent on upland rice production are particularly vulnerable to the vagaries of the weather.

Livestock holdings include buffalo and cattle, as well as pigs, sheep, goats, and poultry. The total population of livestock in the country in 1995 was 1145900 cattle, 1191400 buffalo, 1723,600 pigs, and 11338400 of poultry stock. Goat and sheep are also reared in the country, but their population is negligible. The growth rate of cattle is 6.2%, buffalo 2% and pigs 4.8 %. Since the mid-1980s, there has been a drive to develop fish farming.

**Table 1.4** Change in livestock holdings between 1990 and 1995 ('000)

Year	Buffalo	Cattle	Pig	Sheep	Poultry
1990	1072	1041	1349	139.4	7884.5

1991	1099.5	899.1	1468.6	116.8	8028.7
1992	1130.3	993.0	1560.5	104.1	8906.0
1993	1134.2	1019.8	1624.8	125.7	10091.1
1994	1168.2	1081.1	1673.5	141.8	10696.5
1995	1191.4	1145.9	1723.6	152.9	11338.4

The forestry sector is an important source of export earnings and it also supplies construction material, fuelwood and other non-timber forest products. The sector contributed around 4.5% to GDP in 1995 and is a leading export earner. Forestry products include wood, rattan, bamboo, cardamom resins, and furniture. The principal challenge facing the authorities finding a way to manage this resource in a sustainable manner. Illegal logging and slash-and-burn cultivation have been responsible for a rapid reduction in forest cover. Forests still cover around 47% of the country (although only half of this is commercially accessible), but this is a significant drop the 55% in 1991. The government has issued numerous regulations limiting the amount of living timber that can be felled each year and banning the export of unprocessed logs, but they have proved difficult to enforce. Most of the logging is undertaken by three state-owned enterprises under the control of the Ministry of Defence.

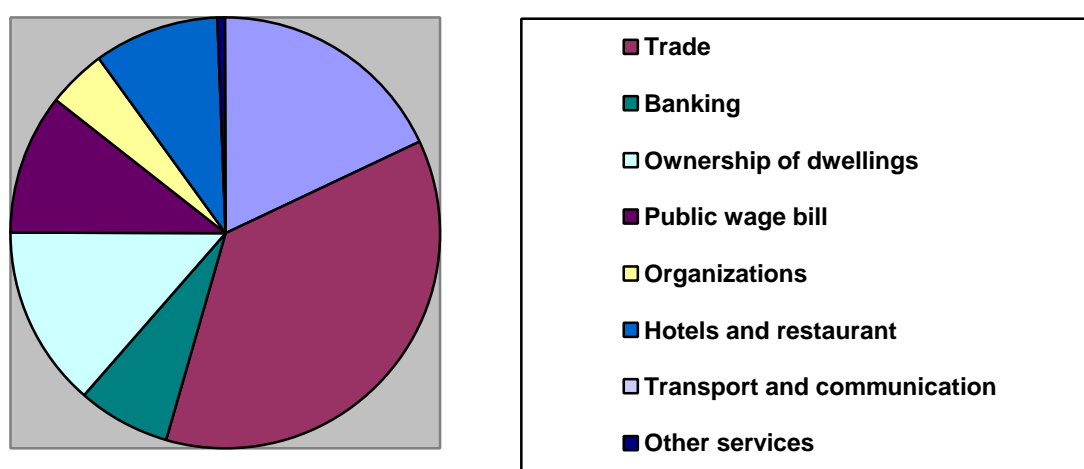
Since the NEM was adopted in 1986, there has been considerable expansion in the output of the industrial sector, leading to a gradual change in the economic structure during the last five years in favour of that sector and the service sector as well. In 1995, the industrial and service sectors accounted for 17.5% and 24.0%, respectively of GDP. Within these two sectors, Construction and tourism-related activities have expanded rapidly and increasingly provide off-farm employment opportunities.



**Figure 1.7** Industry value added composition, 1995

**Figure 1.8** Services Value Added Composition, 1995

The Lao PDR is endowed with a wide range of minerals. Despite the governments commitment to develop the mining sector there has been little investment in this sector. The majority of domestic mining companies are state-owned. Difficult terrain and poorly developed infrastructure are the major constraints on growth of mining activity. The mining sector was opened to foreign investment in the early 1990s. A number of companies have signed exploration agreements, including in the oil and gas sector, but few have reported commercially viable finds. A number of Thai companies have undertaken exploration for coal and limestone and South Korean and Chinese



companies were given permission in 1999 to explore for gold and precious stones. The manufacturing sector is characterized by small-scale processing and assembly plants, predominantly concentrated in and around Vientiane. Heavy industry is virtually non-existent in the country. Industry's share of GDP has risen due to the increase in the number of small enterprises. The number of handicraft companies almost doubled in the space of one year, from 5947 in 1994 to 10826 in 1995. Apart from handicrafts, the main growth areas are garments, agri-business, and wood products. However, as recently as 1993, 50% of manufacturing output was generated by rice milling and a further 25% by production of beer and soft drinks. Reforms in the state-owned enterprise sector have also played a part in increasing productivity in this sector. Competition from imports in the border regions, cautious private sector investment, and high transport costs are the major constraint to the growth in industrial activity.

Agro-processing has been identified as a highly promising sector for future development. Increasing output of construction material like cement to reduce import dependence is another priority area. A number of foreign companies have been licensed

to produce cement, including the Lao Cement Company, which is a Chinese-Lao joint venture, approved in May 1998.

The construction sector's contribution to GDP (three per cent) though small, has increased since the late 1980s. Expansion has been largely concentrated in and around Vientiane. Prior to the Asian crisis, demand for hotels and housing benefited the expansion of this sector. Construction growth dropped sharply in 1998, chiefly because the East-Asian crisis led to a decline in investment in the sector and will probably remain sluggish in the near future. Both state-owned and private sector firms are active in the construction sector, although the state's share of output has fallen from 70% in the late 1980s to around 40% currently. The sector has also benefited from the development of light industry and hydroelectric power.

Exports represent only about 50% of imports. The major exports are either natural resource-based (hydropower and forest products) or re-exports with very little value added (garments and motorcycle assembly). Hydropower is expected to be the main source of foreign exchange earnings in the future. Annual foreign exchange inflow from Nam Theune 2 alone is projected at around \$ 2.5 Million dollars, which is equivalent to the total annual external assistance inflow into the country.

Consumer goods constitute almost 50% of imports. Local production of basic consumer goods is constrained mainly by the limited size of the domestic market and would be financially viable only if produced for export as well. The Balance of payments deficit is financed largely by external assistance inflows.

#### BOX1.1 DEVELOPMENT POTENTIALS

- Large potential for Hydropower
- Large irrigation potential which, once developed will increase food production capacity and allow for further crop diversification
- Potential for sustained development of high-value timber, provided forest resource management and reforestation programmes are improved
- Significant export potential for non-wood forest products (such as cardamom, benison, sticklike and other resins)
- Significant growth potential in the service sector, particularly tourism-related services
- Considerable scope for increasing the quantity of minerals exported
- Proximity to large external markets, which implies a potentially strategic position for entropy trade, although until now most economic activity tends to be concentrated along the Mekong River and the Border with Thailand.

**BOX 1.2 Development Constraints**

- Limited size of the domestic market.
- Lack of skilled manpower and insufficient institutional capacities required to support a flexible, growing economy.
- Fragmentation due to geographical isolation of communities within the country
- Prevalence of subsistence farming and barter exchange among the vast majority of the population
- Insufficient physical infrastructure (such as transportation networks and communications systems)
- Insufficient access to markets, technologies and investment opportunities
- Low level of domestic savings, causing dependence on external assistance to finance a large part of the government's investment programme and the balance of payments current account deficit.
- High transportation costs, particularly for exports, because of the country's land locked state.

## **1.4 Political and administrative organisation**

The country is governed by a written Constitution, which was adopted in 1991. Under the constitution, the Lao People's Revolutionary Party is responsible for setting broad policy guidelines. The government is responsible for executing these policy guidelines and day-to-day administration.

The party organization extends downward to the district and village levels, parallel to the government administrative structure. In line with the NEM reform programme, the administrative reforms include further delineation of the responsibilities of the party from those of the state and restructuring of the civil service to correspond with the implementation requirements of the NEM reforms.

The Constitution provides for the separation of legislative, executive, and judicial powers. The National Assembly, whose members are directly elected by the people for a



five-year term, exercises the legislative function. Among the key functions of the National Assembly is the approval of the annual state budget, the medium-term national development plan and public investment programmes. Among important laws it has passed vital to the functioning of a market economy are revised foreign investment law, domestic investment law, budget law and the law on government. Other legislation critical for creating a political and economic environment characterized by the rule of law have been prioritized by the Ministry of Justice in consultation with the line ministries and the Prime Minister's Office for future consideration of the National Assembly.

Under the Constitution, the president is the head of and the main organ of the government is the Prime Minister's Office headed by the prime minister. The government is composed of heads of ministries and ministry-equivalent entities such as the Bank of the Lao PDR, and the State Planning Committee. Ministries and equivalent entities to serve as staff to the government in the macro management on their respective sectors throughout the country.

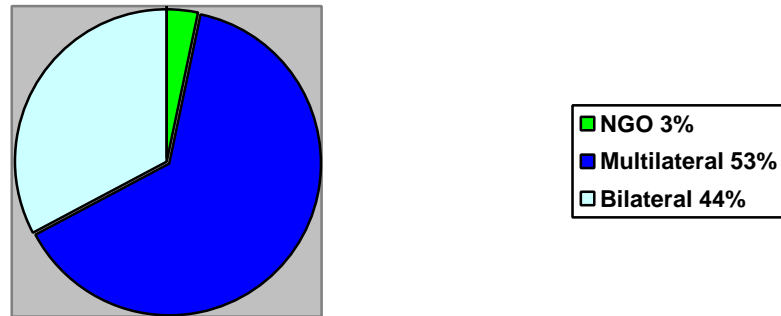
The local government structure extends from provincial level through district level to village level. A governor administers each province. Division of responsibilities within the provincial and district administration is similar to those at the central level, covering the same fields as the central ministries, except in the areas of national defence, foreign affairs, and police. The fiscal collection and budgetary allocation is centralized and is under the purview of each ministry.

## **1.5 Economic and Development Management System**

The Lao PDR has made much progress in its transition to an open market economy since 1986 when the NEM was adopted. An economic system anchored on market principles is now guaranteed by the Lao PDR Constitution. A market economy is now functioning where market forces, with few exceptions, determine product and factor prices. Efforts at building a legal and policy framework for economic transactions continue to enable, encourage, and, where necessary and appropriate, regulate private sector participation in economic activities. Laws have been passed to attract private sector investment from both domestic and foreign sources.

The government became a full member of ASEAN in July 1997, thereby making it an integral part of a dynamic sub regional grouping where free trade among its members is envisaged by year 2000. The Lao PDR is one of the four riparian countries comprising the Mekong River Commission.

Development management is carried out through a system of indicative macroeconomic planning, medium-term public investment programming, and annual budgeting of public revenues and expenditures. The MoF is responsible for fiscal management, including collection and custody of tax revenues, receipt and custody of non-tax revenues, e.g. proceeds from privatization and from external grants and loans, annual budgeting of revenues, and expenditure accounting, reporting and control of public expenditures, and cash and debt management. The MoF is also responsible for



implementing the privatization programme in the country. The State Planning Committee is responsible for planning, public investment programming, and statistical coordination. It is headed by officials with ministerial rank as is the Economic Research Institute. The Committee for Investment and Cooperation, under the deputy minister of the Primer Miister's Office, is responsible for foreign assistance coordination and foreign investment promotion.

## 1.6 Aid management system

Official development assistance or ODA is derived from multilateral, bilateral, and NGO (non government organization) sourcea. The principal bilateral donors in 1997 were Japan, Germany, Sweden, Australia, France, and the United States. The principal ASEAN ODA partner is Thailand. Among the multilateral organizations, the Asian Development Bank and the World Bank (WB) are the largest loan providers, while the UN (United Nations) system is the largest multilateral grant provider. Within the UN system, the UNDP is the largest financial contributor. In 1997, the World Food Programme (WFP) also delivered significant food aid for disaster relief. World Vision Lao and Care International are the largest NGOs in terms of programme disbursement.

**Figure 1.9** Total official development assistance by type of donor

Since Lao PDR adopted the NEM in 1986, ODA inflow has generally risen. Total disbursements of 167.3 million dollars in 1992, nearly tripled to \$ 416.5 million dollars by 1996. Traditionally, ODA and FDI (foreign direct investment) have buttressed chronic government budget deficits. The drop in FDI from \$ 1.29 billion dollars in 1996 to 0.11 billion dollars in 1997 further increased the importance of ODA in the Lao PDR. In 1997, total ODA also fell to 388.5 million dollars, a seven percent drop from 1996. This reduction is largely due to the absence of IMF (International Monetary Fund) assistance in for 1997 and reduction in ODA from key bilateral partners. Initial indications for 1998 show continued reduction in ODA, principally relating to decline in support from the Asian Development Bank and World Bank.

## 1.7 National policy structure on climate change

Lao PDR is in the process of creating legislative and institutional structures for the management of natural resources and environment. The government objective is to incorporate environmental concerns with development planning. Thus, different aspects of environmental policy and management are the responsibilities of different agencies in the Lao government. The overall coordination and management of environment, including climate change, is vested in the STEA. Table 2.5 outlines the environmental responsibilities of line ministries, departments, and agencies.

Table 1.5 Institutions and their environmental responsibilities: climate change activities

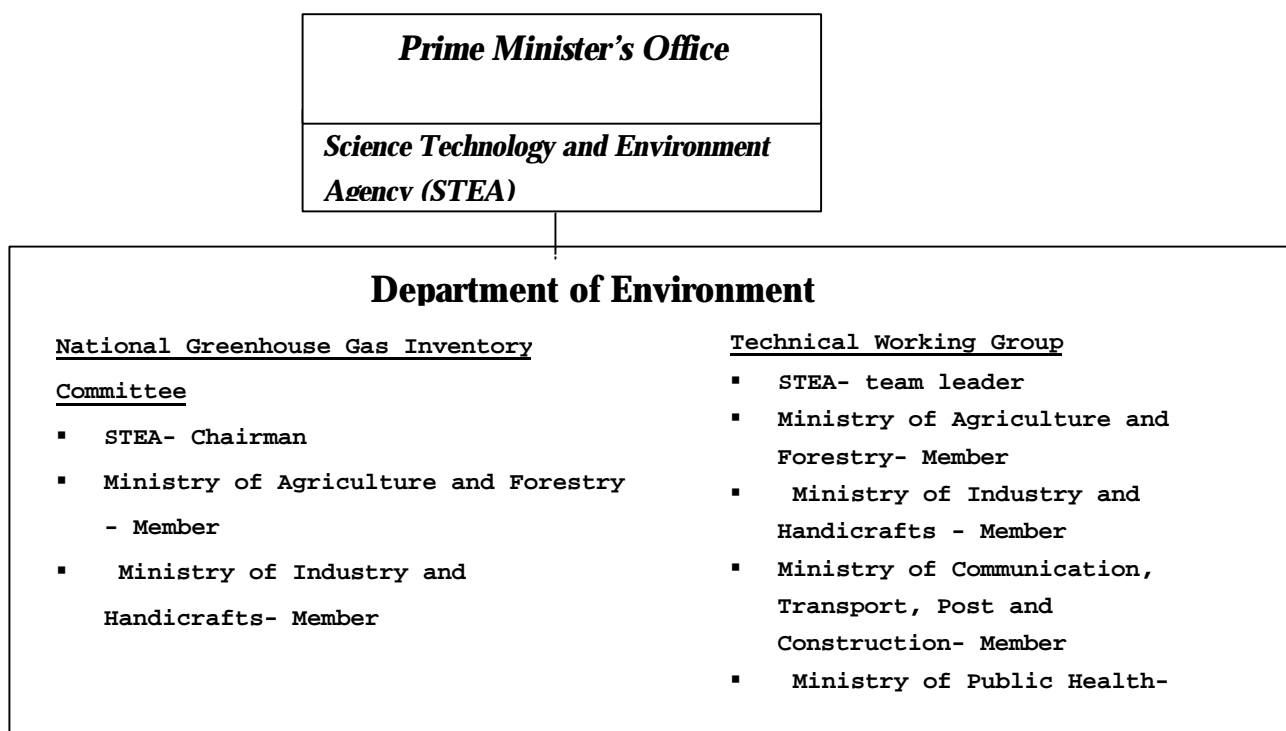
Institution	Department(s)/division(s)	Area of responsibility
Science Technology and Environment Agency	Department of Environment Environmental Research Institute	Overall Responsibility and coordinating role for environment
Ministry of Agriculture and Forestry	Department of Forestry Department of Agriculture Extension Department of Meteorology and Hydrology	Forestry, agriculture, shifting cultivation, biodiversity, watershed, management of Protected Area, etc. Hydrological data, Climatological data
Ministry of Industry and Handicrafts	Department of Industry (Division of Environment) Department of Geology	Industrial pollution, air pollution Mining and environment Hydropower development

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	and Mines		
	Department	of	
	Electricity		
Ministry of Communication, Transport, Post and Construction	Department of Transport Planning	Vehicle	emissions, household and municipal
	Department of Housing and Urban Planing	waste burning,	methane emissions
Ministry of Public Health	Department of Hygiene Department of Preventive and Curative Medicine and Rehabilitation	Hospital occupational standards	waste, health
State Planning Committee	National Statistic Centre	National	socio-economic data, national
	Department of Strategic Planing	development,	public
	Department of Public Investment	investment programming	

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Lao PDR ratified the FCCC on 5 January 1995. STEA has the central responsibility of coordinating the activities related to climate change. The NG and TWG have been established to address the climate change issue and incorporate related aspects into the planning process within the STEA. The NGIC is chaired by the STEA chairman and has the responsibility of provide overall guidance to the climate change policy. The TWG, which has representatives of each of the ministries, has the responsibility of preparing GHG inventory and analysing actions to address the issue. Figure 2.10 gives the structure and constituents of the NGIC and the TWG.



**Figure 1.10** Organizational structure of the National GHG Inventory Project

A number of laws which are either directly or indirectly associated with atmospheric pollution and natural resource management have been promulgated by the government. These have indirect benefits for the mitigation of GHG emissions and listed in Table 2.6 below.

**Table 1.6** Legal instruments relating to environmental and national resource management

Sector/Instrument	Status	Description
National Constitution	Adopted 14 August 1991	Article 17 - All citizens must protect the environment and natural resources: land, subterranean, forests, fauna, water sources and atmosphere
Prime Ministerial Decree No. 169 Management and Use of Forests and Forest Land	Adopted 3 November 1993	Major reform instrument that provided framework for forest management zoning and forest land use, community management of forestry resources Protected areas Penal codes Supersedes Decree 117
Prime Ministerial - Land Decree No. 99	Promulgated December	Supersedes Decree 117 and provides first comprehensive land use/ownership coverage

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	1992	
Decree No. 66 Prime Minister's Decision on the approval of the Tropical Forestry Action Plan of Lao PDR	Promulgated 7 September 1991	Defines the medium -term priorities of the forestry sector
Council of Ministers Decree No. 67 Cessation of Wood Exploitation	Promulgated 26 August 1991	Concerns the operations of a national logging ban and the accompanying inventory and audit activities
Council of Ministers Decree No. 52	Promulgated 7 September 1990	Establishes the Forestry Police
Council of Ministers Decree No. 14 Order of the Council of Ministers Concerning Wood and Forest Business	Promulgated 26 September 1990	Defines the annual quota logging for 1991 at <b>400000</b> cubic metres.
Law on water and water resources	Promulgated in 1996	Sets the principles, regulations, and measures necessary for the management, exploitation, use, and development of water and water sources in the Lao PDR with the aim of preserving them sustainable and ensuring their volume and quality, meet the people's requirements, promote agriculture, forestry, industry, national economic development, avoiding any environmental impact
Forest law	Promulgated in 1996	Sets the fundamental principles, regulations, and measures for the management, preservation, and use of forest resources and forest land, promotion of the revival afforestation and development of forest resources in the Lao PDR with a view to ensuring the balance of nature, of forests and forest land as the people's sources of livelihood and sustainable use, preserving water sources, preventing land erosion, preserving seeds, trees, aquatic animals, wild life, and the environment in contribution to the national social-economic development.
Land law	Promulgated in 1997	Defines types of land and government agencies responsibility for development and environmental protection, and compensation for loss

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Mining law	Promulgated in 1997	Provides a system of management for the conservation, exploration, mining and processing of minerals, for both local consumption and for export, and for the use of mineral resources in industry and its processes and to improve the quality of life for the people of the Lao PDR.
Environmental Protection Law(EPL)	Promulgated in 1999	Sets fundamental principles and makes provisions for regulations for the protection, mitigation, and restoration of the environment including the management and inspection of the environment and for the effective and sustainable utilization of natural resources for securing public health in order to contribute to the national socio-economic development

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## Greenhouse gas inventory

### 2.1 Scope of the study and methodology

Lao PDR has developed its first national GHG (greenhouse gas) inventory for the year 1990 using the IPCC guidelines. The inventory was developed for four of the six sectors mentioned in the guideline, namely energy, land use change and forestry, agriculture and waste. The GHGs covered in the inventory include CO<sub>2</sub>, CH<sub>4</sub>, CO, N<sub>2</sub>O and NO<sub>x</sub>. Industrial processes were not covered because as the only operative industrial activity that falls in this category is a cement plant, and this plant was not operational in 1990. The inventory for solvents was not estimated, as there is no data on use of solvents and other chemicals covered under this category. The revised IPCC guidelines (1996) methodology were used to develop the GHG inventory.

Emissions were estimated from the volume of the activities. The volume data for each activity was collected from the National Statistics Centre and various reports published by international agencies in cases where data was not available from the national sources. The present data collection system is geared to the needs of development planning and thus, does not cover certain areas that are necessary for estimation of GHG inventory. The Lao PDR is still in the process of building a system of collecting data on various aspects of economy and social indicators. This implies that a number of assumptions had to be made in preparing the inventory in absence of adequate data availability.

The accuracy of estimating the emission and removal of the GHGs from the atmosphere largely depends on the availability and accuracy of the activity data and emission factors. The emission factors used in developing the inventory are IPCC default values. Currently there is a complete absence of Lao specific emission factors for the various emission related activities and also a lack of capacity and resources to generate information on emission factors specific to the Lao PDR. The agriculture data for crop areas is reliable but the emission factors used are IPCC default values. The livestock data doesn't reflect the variations in breed; age structure of livestock and information on animal feed is not available. The data for forestry sector is based on a recent exercise on developing an inventory of forest areas. The data for growth rates in forest areas is still not available, and default plantation values from IPCC manual has been used to estimate the growing stock. The information of waste is based on a sample survey of five urban areas and the emission norms and decay rates are assumptions. Information on the



generation of waste water in different sectors is not available. The estimates are of wastewater generation are therefore based on IPCC defaults and assumptions.

## 2.2 Time periods.

According to the resolution, second session of the Conference of the Parties, 1990 was assigned as the basic year for the inventory, and hence the estimates are for the same year. The GHG inventory was prepared on a calendar year basis. However, as recommended in the IPCC guidelines, a three year average of activity for forestry and agriculture sectors was used to estimate emissions. The time periods have been furnished in Table 2.1.

**Table 2.1** Time periods for GHG emission computations.

GHG sources and sinks	Period
Energy	
Fuel combustion	1990
Fugitive emissions	1990
Agriculture	
Enteric fermentation	1988 –90 average
Manure management	1988–90 average
Rice cultivation	1988–90 average
Land use change/forestry	
Changes in forest and other woody biomass stocks	1988–90 average
Forest and grassland biomass conversion	1988–90 average
Waste	
Solid waste disposal on land	1990
Waste water treatment	1990

## 2.3 Energy

Fossil fuel consumption in the Lao PDR includes gasoline, jet kerosene and other kerosene, diesel, and coal. All hydrocarbons are imported and are used mainly in the transportation sector. There is no consumption of natural gas. Coal mining began as late as 1990 in this country. Breakup of data for hydrocarbons by end use activity is not available and therefore, the aggregate emissions alone are reported. The percentage shares of energy consumption in the Lao PDR from a total energy consumption of 945.73 ktoe (kilo tonnes of oil equivalent) consumed in 1990 were, fuelwood 77.59%, oil 14.32%, charcoal 3.03%, hydro power 4.93%, and coal about 0.13%

Following assumptions were made in estimating emissions from energy use.

- IPCC default values are used for the energy content of fuels and carbon emission factors.
- 20% of the total consumption of jet kerosene is used for international bunkers.
- Stock changes account for 10% of the imports (as per government regulation).
- Bitumen is imported into the country. However, there is no data available on the consumption of bitumen in 1990. The consumption is estimated at 912 tonnes in 1996, from which time period data is available. Hence, it is assumed that bitumen consumption in 1990 would not significantly alter the emissions from fossil fuel combustion.
- Coal production in 1990 is estimated at 1784 tonnes. Given the low level of extraction it is assumed that the fugitive emissions from coal mining are negligible.

**Table 2.2** GHG emissions from fossil fuel combustion (1990)

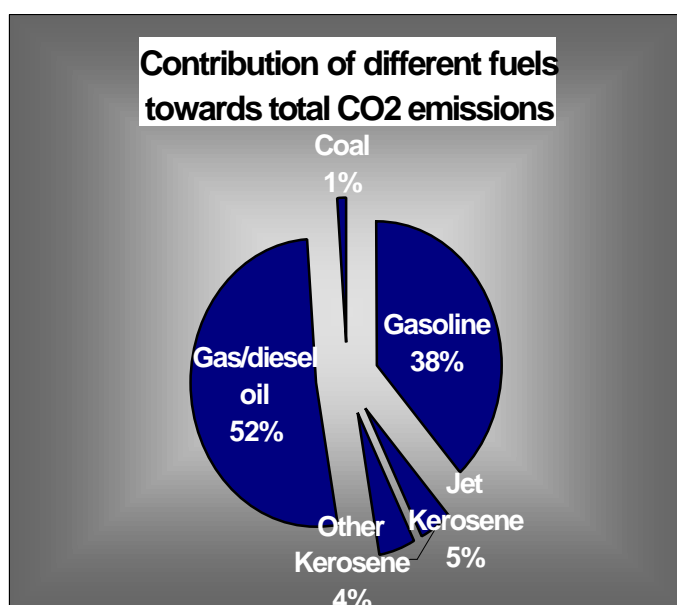
Fuel type	Consumption (TJ)	CO <sub>2</sub> emissions (Gg CO <sub>2</sub> )
Gasoline	2313.6	158.73
Other kerosene	250.56	17.83
Jet kerosene	267.1	18.91
Gas/diesel oil	2936.1	215.29
Coal	43.13	4.15

Fuel wood and charcoal are the two main sources of traditional biomass fuels. Two assumptions were made in estimating the emissions of these fuels.:

- 1 Fuelwood also includes sawdust
- 2 It is assumed that for each tonne of charcoal produced, 4 tonnes of dry wood is consumed.

**Table 0.3** GHG emissions from the combustion of traditional biomass fuels.

Fuel type	Consumption (kt dm)	CH <sub>4</sub> emissions (Gg CH <sub>4</sub> )	CO emissions (Gg CO)	N <sub>2</sub> O emissions (Gg N <sub>2</sub> O)	NO <sub>x</sub> emissions (Gg NO <sub>x</sub> )
Fuelwood	2440	16.30	142.66	0.11	4.05
Charcoal production			10.36		
Charcoal consumption	41	0.06	4.48	0.003	0.13



Tier 1 reference approach method was used to estimate the emissions from the energy sector in absence of data availability for quantity of fuel used by each 'end-use' activity. Therefore, only CO<sub>2</sub> emission related to the energy consumption in the economy is presented here. Gas/diesel oil is the major source of emission. It is used in the industry, transport, and

**Figure 2.1**

Contribution of different fuels to total energy sector emissions

agricultural sector, and for decentralized power generation. Power, which is the major source of emission in most countries, contributes little to total emissions, as the source of electricity in the Lao PDR is hydropower. The second major source of emission is gasoline. Coal has negligible share in total emission as its use has recently begun in the country.

## 2.4 Agriculture sector

About 83% of the total cultivated land is under rice cultivation and only 2% is cultivated under continuously flooded condition by using canal irrigation between December–May with an average temperature of 27.2 °C. It is assumed that rainfed rice is cultivated under intermittent aeration. The average growing season temperature for intermittently cultivated rice is 26.4 °C between June and November. The duration of the crop growth is 125 days. IPCC default values were used as emission factor for both continuously flooded and intermittently flooded rice.

**Table 2.4** GHG emission from rice cultivation (1988–1990 average)

Cultivation type	Harvested area (Mha)	Methane emissions (Gg CH <sub>4</sub> )
Continuously flooded	0.011	8.11
Intermittently flooded	0.361	150.86

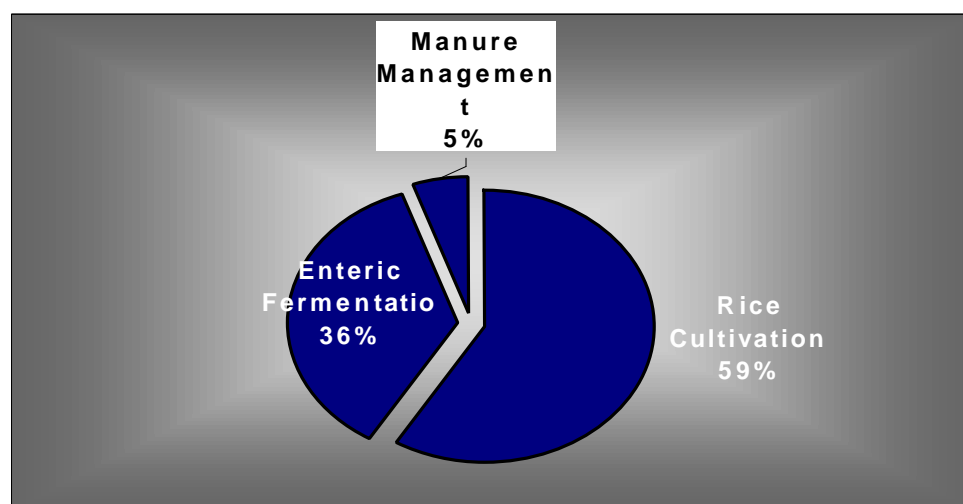
Tier I methodology was used in estimating the emissions from enteric fermentation and manure management. The three main categories of livestock in the Lao PDR are cattle, buffaloes, and pigs. Goat and sheep too are reared in the country but their population is negligible. Field grazing is the prevalent mode of feeding and the reported data states that only a small fraction of the dung is used as manure. Therefore it is assumed that the prevalent manure management system in the country is dry management.

The N<sub>2</sub>O emission from manure management is negligible (less than 2 order decimal Gg) and, hence, are not reported. The rice straw is not removed from the fields and only the pinnacle is harvested. There is no burning of agricultural residues in the field in the Lao PDR. Further, there is no recorded information on the use of fertilizer or organic material in agricultural. Hence, both these are not included in the calculation of GHG emissions from the agricultural sector.

IPCC default value for emission factors are used to estimate emissions. All animals have been classified under warm climate as the mean temperature is more than 25 °C.

**Table 2.5** CH<sub>4</sub> (Gg) emissions from livestock (1988–90 average)

Livestock	Population (1000 heads)	Enteric Fermentation	CH <sub>4</sub> manure management	Total CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )
Non-dairy cattle	875	38.5	1.75	40.25
Buffalo	1,046	57.53	3.14	60.67
Sheep	111	0.56	0.02	0.58
Swine	1,330	1.33	9.31	10.64



Poultry	7,668		0.16	0.16
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**Figure 2.2** Contribution of different activities to total agricultural sectors emissions

Methane emission from paddy fields is the largest contributor to emission in the agriculture sector. The reliability of the number is not very high because of the assumption that rained paddy is intermittently flooded during the growing season. The second largest contributor is enteric fermentation. This number too doesn't have high reliability, as there is no information on the age structure of the livestock, which can make considerable difference to the total emissions. Further it was assumed that the cattle population in the Lao PDR is non-dairy live stock therefore, there is some uncertainty introduced in total emission estimate from enteric fermentation. Manure management has a negligible contribution to the total emissions because of two factors, absence of dairy cattle and the small population in the economy is very small.

## 2.5 Forestry sector

The emissions from land use change and forestry was estimated for the following activities

- changes in forestry and other woody biomass stocks
- forest and grassland conversion
- abandonment of managed lands

The immediate release of non-CO<sub>2</sub> trace gases from the burning associated with forest/grassland conversion too were estimated. The land use in the Lao PDR is classified according to the following types:

- Current forest. Area with a crown cover exceeding 20%.
- Potential forest. Forest area with less than 20% crown cover. This also includes areas under shifting cultivation.
- Other wooded areas. Areas where the site conditions are poor and crown cover can never exceed 20%.
- Permanent agriculture area. Land area under permanent crops and also grazing lands.
- Other land use. Area under habitation, barren and rocky grasslands and swamps.

The total forest area of Lao PDR in 1989 was 11.17 Mha covering current and potential forests. During the period 1982–89 the area under forest cover with crown density over 40% (closed forest) decreased by nearly 60000 ha annually. Nearly 32000 ha of the forest area were lost due to conversion to other land use. The total standing volume of the forests has been estimated at 1200 mcum by the TFAP (Tropical Forestry Action Plan), 1990.

The estimates for changes in forest and other woody biomass stocks include only increase in biomass in the tropical mixed-hardwood forest areas. There is no information available for plantations in the country and hence they have not been included in the calculations. Forest clearing is assumed to supply four per cent of the fuelwood, and this is subtracted from the wood removal calculated under the 'change in forest and woody biomass stock' category. Of the total biomass from forest conversion, 50%–55% is used for fencing, 3%–5% for fuelwood, and the rest (leaves and small twigs) is burnt on-site. Biomass used for fencing is considered as biomass that decays on-site.

There is no abandonment of managed lands in the Lao PDR and hence is not included in the computation of GHG emissions from this sector. All the emission factors as well as growth rates are default IPCC values.

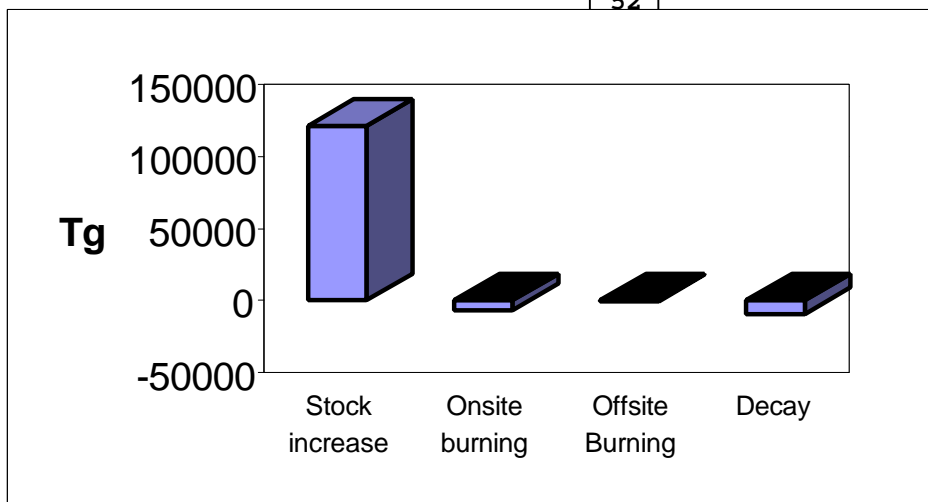
**Table 0.6** Net GHG emissions from change in forest and woody biomass stock (1988–1990 average)

Forest type	Area of forest/biomass stocks	Growth rate	Net annual CO <sub>2</sub> removal
Tropical forests mixed hardwoods	11,168	6.8	121,614

**Table 0.7** GHG emissions from forest and grassland conversion (1988–1990 average)

Forest type	Area converted annually (kha)	Net change in biomass (t dm/ha)	CO <sub>2</sub> emission (Gg)	Emission estimates (Gg)			
				CH <sub>4</sub>	CO	N <sub>2</sub> O	NO <sub>x</sub>
Forest conversion: aboveground CO <sub>2</sub> released from on-site burning							
Tropical moist primary forests	225	47	6,752.67	29.5	258	0.2	7.3
2. Forest conversion: aboveground CO <sub>2</sub> released from off-site burning							
Tropical moist primary forests	225	47	628.16				
3. Forest conversion: aboveground CO <sub>2</sub> release from decay							
Tropical moist primary forests	225	47	9,247.84				

The increase in biomass in the forest area is of the order of 10 times the total carbon release from conversion of forestland. The large sequestration potential is because of the large tracts of forest that are untouched and also inaccessible. Though, given the fact that these are mature forest areas, the growth rate used here might be an overestimate. Therefore, the inventory number related to accumulation of carbon in forest areas is highly uncertain.



**Figure 2.3** Emissions from land use change and forestry sector

## 2.6 Waste

Anaerobic decomposition of organic matter by methanogenic bacteria in solid waste disposal sites results in the release of  $\text{CH}_4$  to the atmosphere. There is no systematic collection of data on waste generated. The norm for solid waste generation at the national level is taken as an average of the values obtained from five cities in the Lao PDR through a sample survey namely Vientiane, Luang Prabang, Savannakhet, Champassak, and Saravane.

There are no estimates of waste incineration, waste handling activities and hence this was not included in the computations. In absence of information on composition of solid waste generated in urban areas, the reported fraction from an Indian case study was assumed as the default DOC (degradable organic carbon) content of waste. The waste generated in the Lao PDR is disposed off through landfill and the fraction of solid waste generated was estimated from the above-mentioned survey. The total waste generated includes only the urban waste as it is assumed that rural waste generated tends to decay aerobically and hence results in negligible emissions. Further, it is assumed that the waste in urban areas that is not disposed off in landfills too decays aerobically and hence doesn't add to emission levels.



**Table 0.8** GHG emissions from landfills (1990)

	Solid waste generated (Gg)	Land filled (%)	CH <sub>4</sub> emissions (Gg)
Landfill	88	0.62	11.20

Waste water streams, including domestic, commercial, and some industrial stream, with high content of organic matter, can emit significant amount of CH<sub>4</sub>. The organic content for commercial and domestic waste is based on biological oxygen demand and that for industrial waste on chemical oxygen demand. There is complete absence of information on waste water generated in the country. The estimates of waste generation, biological oxygen demand and emission factor are default IPCC values and are based on urban population and only for domestic and commercial sector.

**Table 0.9** GHG emissions from wastewater (1990)

	Population (1000)	BOD value (Gg BOD5/1000 persons)	Water anaerobically treated (%)	CH <sub>4</sub> emissions (Gg)
Domestic and commercial wastewater treatment	708	0.0146	0.10	0.23

## 2.7 Conclusions.

As is evident from the Table 2.10, the Lao PDR is a net CO<sub>2</sub> sequester. The net annual CO<sub>2</sub> removal is of the order of 121641 Gg, which is two orders of magnitude larger than all other emissions in the economy. Methane emissions are largest from the agriculture sector followed by the forestry sector. The agricultural sector accounts for 81% of the country's methane emissions, with rice cultivation accounting for about 50%. The uncertainty in emission estimates is significant, because of lack of country specific emission factors. The uncertainty is specially likely to be large for the forestry sector.

**Table 0.10** Summary of the GHG inventory for the Lao PDR (Gg).

Sources	CO <sub>2</sub>	CH <sub>4</sub>	CO	N <sub>2</sub> O	No <sub>x</sub>
Energy sector					
Fossil fuel consumption	414.9				
Traditional biomass burned for energy		22.75	157.92	0.12	4.18
Agriculture sector					
Enteric fermentation		97.92			
Manure management		14.38			
Rice cultivation		158.97			
Forestry sector					
Change in forest and woody biomass	-121614.00				
Forest conversion: Aboveground CO <sub>2</sub> released from on-site burning	6752.67	29.5	257.8	0.2	7.3
Forest conversion: Aboveground CO <sub>2</sub> released from off-site burning	628.16				
Aboveground CO <sub>2</sub> release from decay	9247.84				
Waste					
Landfills		11.20			
Waste water		0.23			
Grand Total	-104 570	312	258	0	7

## **Policies, Programmes and Measures**

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### **3.1 Background**

Climate change is a new concept in the Lao PDR. The understanding of this subject—the science, mitigation aspects, impacts and adaptations, and its relevance to Lao PDR’s economy – are mainly restricted to a few institutions and individuals. The Lao National GHG Inventory Project is the first exposure of policy makers and technical persons to the climate change issues. Though this project has built limited capacity, a much wider dissemination of this issue and capacity building would be required before the country is in a position to have a stated or fully considered national perspective on policies and measures to respond to climate change.

However, climate change activities in the Lao PDR have been growing since its participation at the Rio Earth Summit in 1992. Since then, interactions with IPCC and participation at COP (conference of the parties), including the above-mentioned project, have encouraged limited national consultations and activities relevant to the UN FCCC. These consultations and activities, while not constituting stated government policy, give indications of national thought on issues relating to climate change.

Lao PDR is signatory to the FCCC, and ratified the Convention on 5 January 1995. The country has undertaken a number of measures, which are also the stated policies of the government, to achieve a sustainable development path. The environmental concern has been built into the planning process. These measures apart from making the process of development sustainable, will also have positive implications for the GHG emissions. The following sections describe the measures undertaken to address environmental concerns.

### **3.2 Sustainable Development Efforts in the Lao PDR**

The Lao PDR economy is heavily reliant on natural resources for income generation: water resources for generating hydroelectricity, forests for timber exports, minerals, and agricultural production. The country is undergoing reform process since 1986 to increase the economic growth rate realizing the importance of natural resources to the economy and possible adverse implications of unmanaged growth process, the government has a

stated policy of strengthening the environment management of the economy to achieve sustainable development. The protection of environment is anchored in the constitution of the country: all organizations and citizens 'must protect the environment and natural resources; land, underground, forest, fauna, water resources and atmosphere'.

The agency responsible for environment management in the Lao PDR is the STEA. STEA founded in 1993, is the outcome of Government's commitment to the process initiated by the Rio earth Summit. The main responsibility of the STEA is to research, apply, and expand scientific and appropriate technologic activities into the national socio-economic development to avoid environmental and social impacts, and ensure sustainable development. The STEA prepared a draft environmental strategy for the period 1998–2000 and beyond to meet the environmental challenges the country is likely to face. The strategy was elaborated by STEA in order to integrate environmental concerns into development planning, particularly the national socio-economic development plan. For better coordination of development and environment in the country an IMWG (Inter Ministerial Working Group) was constituted by all the key ministries. The IMWG helps STEA to keep track of developments in various ministries and to build trust and confidence between them. Though the macro-level environmental management is being carried out by the STEA, each technical ministry has responsibility over their respective environment in close cooperation with the STEA. The STEA also has the responsibility of training the IMWG members on environmental awareness, negotiations and on drafting of environmental legislation, and other related environmental issues.

The STEA is assisted by the UNDP in the creation of a comprehensive environmental law. The aim of the project is to develop a total framework for the protection and management of natural resources and the environment. The programme has developed capacity in the country on drafting environmental law, legal evaluation, identifying weakness in the existing framework, and developing plans to overcome them. The UNDP is also helping build capacity in developing environmental management framework at provincial and lower level governments.

### **3.3 Managing natural resources**

Natural resources extraction will remain, over the years to come, the basis for income generation. The government acknowledges that some of its natural resources (such as

forest, non-woods forest products, etc.) are renewable. Good management is therefore crucial for the economic development of the country.

Legislation and policies concerning management of natural resources were discussed earlier in Section 2.

### *3.3.1 Forest Resource Management*

As regards the forestry sector, the government's main objective is to increase the total forest area from 47% to 70%. In order to reach this objective the government plans to actively preserve the existing forests and to enrich degraded forestland by intensifying re-forestation programmes in each province and locality.

As mentioned earlier, the Lao PDR is highly dependent on forest resources as a source of foreign exchange and income. Given the country's limited export base the forestry sector is going to stay an important source of forex in the near future. In addition to commercial logging in the country, another 100000 cubic metres are estimated to be cut annually by forest-based communities for sale and to meet local needs (building materials, etc.). A major part of this comes from open area, scattered stands, and individual trees and does not affect potential commercial forests. Finally, some 80% of the country's energy consumption are wood based. It has been estimated that per capita fuelwood consumption averages 1 cubic metres per annum. Most of this is harvested by local communities for their own use and often is taken from understorey shrubs, and natural mortality of larger canopy tree. Fuelwood harvesting does not appear to represent a serious environmental problem, particularly in rural areas. What is therefore needed, in view of various demands on forest resources and their ecological functions, is a balance between sustainably managed production forests and protection forests in key areas, such as critical watersheds and areas worthy of protection because of their rich biodiversity.

The total forest area of the Lao PDR has decreased by 67000 ha per year over the last decade. In addition to loss of forest land, there was also considerable degradation of the remaining area, causing concern within the government and leading to the declaration of 20 national protected areas, which cover approximately 12% of the country's total area. Provinces and districts are empowered to declare their own conservation areas. The Government emphasizes in-situ conservation and is now considering setting apart more conservation areas, particularly on wetlands. To ensure sustainable commercial timber extraction from the forest areas, the government approved the National Tropical Forestry Action Plan and the adoption of the forest law in 1996. Based on the National Reconnaissance Survey of 1992, the sustainable annual allowable rate of timber extraction from the country's commercial forests is 288000 m<sup>3</sup>.

The depletion of the country's forest resources is due to a number of factors, including poorly planned and supervised logging, forest fires, encroachment, and shifting cultivation. According to government statistics, approximately 300000 ha are annually cleared and planted under shifting cultivation. Although, at present, the three causes of deforestation (logging, encroachment, and shifting cultivation) seem to be equally important, it is estimated, that to the extent that population continues to grow rapidly and fertility in the uplands continues to decline, expansion of shifting cultivation into forest lands will increasingly become an issue.

In order to protect the environment and forest resources, the government has given high priority to the protection and stabilization of shifting cultivation in the country. The Vision 2020 for the forestry sector states that the 'the challenge of reducing/stabilizing shifting cultivation in upland areas requires addressing the concerns of poverty reduction, conservation and development of upland habitat and, ensuring a measure of social justice in distribution of land'. Reduction of shifting cultivation is one of the priority areas in the national programme.

### 3.4 Power Generation

The emissions from the power generation sector are very small, as the main source of electricity in the country is hydro power. The current installed capacity is 565 MW which is three per cent of the total exploitable potential of the country. The hydroelectricity potential of the Mekong river and its tributaries is about 18000 MW of installed capacity and 110 000 Gwh/year of energy. The hydropower potential also provides enough energy to serve the region and provides an opportunity to reduce emissions. The use of such development, however, needs to be carefully assessed with regard to resettlement requirements, environmental, socio-cultural impacts.

In the short term the installed capacity is likely to grow to 3000 MW by the year 2006, most of which will be utilized for export to neighbouring countries. The hydroelectric generation projects expected to be constructed and completed before 2006 are listed below.

Sepian-Senamnoy	420 MW
Nam Theun-2	681 MW
Sekong-5	253 MW
Nam Ngum-2	415 MW
Nam Ngum-3	460 MW
Nam Mo	100 MW
Total:	2,330 MW

About 1458 MW capacity projects are expected to come up between 2006 and 2010.

Xekaman-1	486 MW
Xekong-4	450 MW
Nam Ngiep-1	440 MW
Nam Lik ½	100 MW

Installed capacity of 2189 MW is expected to come up between after 2010 and 2015.

Nam Theun-3	237 MW
Nam Theun-1	400 MW
Nam Khan-1	85 MW
Nam Ou-2	500 MW
Nam Tha-1	263 MW
Nam Ngum-5	100 MW
Nam Kong-1	166 MW
Xekaman-3	198 MW
Donsahong	240 MW

The government is aware of the environmental impacts of large hydropower projects. To ensure an environmentally friendly development, the need for conducting an EIA (Environmental Impact Assessment) for major hydropower stations has been made compulsory in the recently promulgated Electricity Law. Further, all future projects in the Lao PDR will require a catchment management programme to be implemented that will fully focus on reforestation of the catchment and re-establish fauna habitats. This programme would be integrated within a protected area management system that would be funded mainly from income generated from the hydropower development. UNDP is building capacity within the department of electricity to manage, minimize, and mitigate adverse environmental and social impacts of hydropower projects.

### **3.5 Alternative Energy**

Alternative forms of energy, once affordable, will play a big role in developing the country's rural areas. The electrification ratio is 30% for the country as a whole, but only

16% of the rural people have access to electricity. The connection to the national grid is far too expensive due to the mountainous terrain of the country. Therefore, the government encourages all projects for assessing, investigating, field-testing and implementing alternate energy schemes. Some micro hydropower stations have been successfully implemented and other forms of renewable energy (wind, solar, biogas, geothermal, etc.) are being explored.

A few small hydropower projects are under construction.

Nam La (Ban Tao ) 104 KW in Xamtai district, Hoaphanh province.

Nam Sadt 250 KW, in Viengthong district, Hoaphanh province.

Houaykasen 75 KW, in Pakbeng district, Oudomxai province.

Nam Mong 70 KW, in Nambak district, Louangphrabang province.

Solar energy is a promising alternative to grid based electricity. The Lao PDR is situated in the tropics in an area where the annual mean daily global solar radiation ranges from 4.5 to 4.7 Kwh/m<sup>2</sup>/day. This makes it a potentially good site for solar energy projects. The initial utilization of solar energy was made in the telecommunication (microwave repeaters and radio HF stations) and health sector (vaccine storage refrigerator). Currently Technology Research Institute , STEA, completed three projects on installation of solar home system in different provinces. 200 Wp was installed under the Lao–Vietnam cooperation project, and 5 solar home systems of 55 Wp and a battery charging station of 1.5 kWp each under CIDA–Thailand and SIDA funded projects have been installed. The aim of these projects was to demonstrate the use of and training staff in installation and maintenance of these systems.

The availability of manure provides an alternative source of energy and also a source of fertilizer that can help increase productivity of agriculture. The government, from the environmental perspective, has taken a policy decision to promote use of organic fertilizer. The government has undertaken biogas demonstration projects at select sites in order to promote its use. Till date 16 such plants have been constructed in different provinces of the country and there are plans to construct biogas plants in 6 more provinces by 1999/2000. These projects have been supported through grant-aids received by the government.



### **3.6 Climate Change initiatives**

First major climate change activity in the country was Lao National Greenhouse Gas Inventory Project and the capacity building project of the GEF, implemented through the UNDP. Its aim was to assist the government in fulfilling its obligations under Articles 4 and 12 of the FCCC which it ratified on 5 January 1995, particularly in undertaking greenhouse gas inventory of source and sink, identifying greenhouse gas mitigation option, formulating GHG mitigation strategy and national implementation plan and the first national communication. The Lao PDR also benefited from the project by raising public awareness on climate change. In addition government officials have been attending international training workshops, to identify GHG mitigation options, thematic workshop on greenhouse gas inventory and mitigation of greenhouse gas emissions, workshop on national communication, and the ASEAN workshop on multilateral environmental agreement. The project has also helped institutionalize climate change with the STEA.

The government's main goals for climate change activities in the future are

- increase public awareness activities on climate change
- implement a GHG mitigation plan
- regularly monitor and control climate change activities, for example data collection on temperature, rainfall, water flow, etc; and
- cooperate with international agencies on climate change activities and related issues.

### **3.7 GHG mitigation strategy: the available options and their prioritization**

The GHG mitigation strategy for the Lao PDR should be seen in perspective of its national circumstances and capacity of the economy to undertake these measures without affecting its economic growth. The FCCC recognizing the need for development in the developing countries clearly states that any action taken by these countries will have to be within the framework of its national development objectives. FCCC also enjoins on all the countries to carry out actions that are possible to limit the emissions.

A number of mitigation options were identified in all the sectors based on the level of technology in the country and the development goals. The GHG mitigation strategy presented here is developed based on simple cost-benefit analysis of different mitigation options and expert judgement on possibility of undertaking these measures in the respective sectors. There is a lack of data and expertise for undertaking an economy wide exercise of projecting the change in the economic structure and analysing the

mitigation options within this framework. This restricts identifying the least cost combination of mitigation options and the extent of achieving emissions reduction through them. Estimates for potential emission reduction using a particular mitigation option were undertaken for the forestry and agricultural sectors alone. The exercise for forestry sector is based on the government's objectives and does not factor in the availability of resources or other social factors that could affect the pace of implementing these options. In the agriculture sector the extent of reduction is based on expert judgement. Expert judgement which was based on the government goals and its capacity to implement measures to achieve these goals.

A possible timeline presented here and indicating the likelihood of the mitigation options being adopted is based on the following factors:

- Development goals of the country .
- Possibility of effectively implementing these options within the constraints of cost to the economy.
- The technical capability to implement the options and absorption capacity of the economy.
- The availability of donor funding to support these programmes.

The timeline used in presenting the implementation is in three phases: short-term 2000–2005; medium-term-2005–2020; and long-term beyond 2020. The effort here is to cooperate with the international community through information on possible mitigation options.

### *3.7.1 Energy use and Industrial emissions*

The mitigation options for the energy sector are broadly classified under the following heads.

- 1 Energy conservation and improvements in energy efficiency through upgradation of currently employed technologies.
- 2 Introduction of advanced technologies that are more efficient or based on renewable energy sources .
- 3 Structural change within the consumer sectors.

**Table 3.1** Mitigation options in the energy sector

Power sector	Agriculture sector	Domestic sector	Commercial sector	Transport sector
Hydro (centralized)	Photovoltaic water pumps	Fuel wood to charcoal	Incandescent to 36 W	Public bus replacing tuktuk
Solar	Wind pumps	Fuel wood to LPG	Fluorescent	
		Fuelwood to		

Photovoltaic (decentralized)	Biomass gasifier	electric stoves Charcoal to LPG Charcoal to electric stoves LPG to electric stove	40 W fluorescent to 36 W fluorescent lamps	Public bus replacing two wheelers  4-stroke replacing 2- stroke two wheelers
Micro hydro (decentralized)				
Biomass gasifiers (decentralized)		<u>Efficient appliances</u> (cooking)	36 W Fluores- cent to CFLs	
		Improved cookstoves		
		<u>Lighting</u>		
		Incandescent to 36W Fluorescent 40W Fluorescent to 36 W Fluorescent 36 W Fluorescent to CFLs Solar Home Systems PV lanterns		

The main source of energy in the Lao PDR economy is wood, mainly for cooking needs, a reflection of early stage of development in the country and future increase in energy demand would be in the industrial and transport sector. The country has only exploited a fraction of the total hydro potential in the country and, therefore, this is likely to be the main source of energy in the near future. The possibility of using renewable technology exists in the rural areas, which the government has declared one of the priorities of rural development. This is especially true of remote areas that can't be serviced by gridbased electricity.

Major opportunities exist in the industrial sector, where capital investment is yet to take place, through adoption of more efficient technologies and energy conservation measures. This could be important from a development view point too, as the fossil fuels consumed in the economy are imported, thus putting pressure on the balance of payment. Though the country has cheap and abundant source of electricity, lack of resources to develop and its potential as export earner makes it imperative to use it judiciously.

The mitigation measures suggested above are likely to increase the cost of production. Implementation of these measures therefore needs to be seen from the perspective of competition from imports from neighboring countries and the low buying capacity of the local population. Table 4.2 below reports the cost comparisons of base technology and suggested options. Table 4.3 reports the possible timeline of implementation of the options.

**Table 3.2** Electricity generation cost from different options

Technologies	Cost of energy (dollars <sup>a</sup> /kWh)
Centralized power generation	
Hydropower	0.03
Decentralized power generation	
Solar Photovoltaic	2.60
Micro hydropower	0.036
Biomass gasifiers	
- agro-waste based	0.15
- wood based	0.13

The hydropower option is a low cost option but the cost reported here doesn't include the cost of building a transmission and distribution network for the country. Given the fact that a large part of the country is mountainous the cost of building a transmission and distribution network will be costly and difficult to built. The decentralized options are therefore a real possibility to achieve the goal of rural electrification. Among these options, micro hydropower offers the cheapest source of electricity. A large hilly terrain and abundance of river streams implies this option can be viable in large parts of the country. The biomass gasifier though a relatively cheaper option, is heavily dependent on the availability of wood, whereas being a tropical country, solar energy is abundantly available. Quantum of electricity required would be another factor in choosing an option from the two possibilities.

<sup>a</sup> All USD numbers are 1990 USD unless otherwise mentioned.

**Table 3.3** Time line for implementation of various power generation options

Options	Short term	Medium term	Long term
Hydro (centralized)	Already planned		
Micro hydro (decentralized)	Funded demonstration projects	Only if enough funds are available with the government and balance of payment situation is favorable.	
Solar Photovoltaic (decentralized)	Only demonstration projects	Only if enough funds are available with the government for installing systems.	Two factors will (a) influence creation of capacity investment cost (b) possibility of existing electricity supply being insufficient to meet the demand.
Biomass gasifiers (decentralized)	Only demonstration projects	Only in the long run	
Wind stand-alone	Only demonstration project possible		Commercial applications in the long run if the demand exceeds the supply of electricity or enough profitability in selling it for export.

In the agriculture sector the aim is to double the production of paddy by year 2020. This will be achieved through developing the irrigation infrastructure to increase the paddy area from 12000 ha to 50000 ha in the plains. In areas where exploitation of groundwater will be relied on to provide irrigation, diesel pumps or electricity pumps are the two main options. The possibility of introducing decentralized options depends on ease or difficulty in extending transmission and distribution network and availability of power.

**Table 3.4** Cost comparison for irrigation options

Technologies	Annual cost of operation
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	(dollars)
Diesel pump set	234
PV water pumps	1913
Wind pumps	
- shallow well	171
- deep well	318
Gasifier (agro-wate based)	1512

Centralized hydropower offers the cheapest option followed by the conventional diesel engines. Wind pumps offer a very competitive alternative but is highly dependent on the wind profile of the areas. The PV water pump and biomass gasifier option are very costly and their adoption will depend on either subsidy being provided by the government or decrease in cost of these options in the long run.

**Table 3.5** Time line for possible implementation of irrigation options

Options	Short term	Medium term	Long term
PV water pumps	Demonstration projects	Depends on the possibility of availability of subsidized funding.	Commercialisation, depending on the cost reductions through level of R&D in the world
Wind pumps	Identification of areas where wind power could be promoted.	Demonstration projects	and growth in the rural income.
Biomass gasifier	Identification of areas where it would be viable	Demonstration projects	

Movement up the energy ladder with increase in income is a very well documented fact across the world, and this is visible in the urban areas of the Lao PDR. Two factors apart from income that affect the choice of energy in domestic sector are initial capital cost and fuel cost. Replacement of wood-based systems is possible in areas where the households have to pay for the wood. Shifting to improved cook stove would be easier as it saves both capital cost as well as fuel cost. The pace of adoption could be influenced through demonstration and promotion activities. Shifting to electric stove would be preferred over any other shift as it has low capital cost and low fuel cost compared to both LPG and charcoal-based stove. This is likely in areas where reliable electricity is

available. Reliability factors might make people prefer LPG over electric stove despite the cost factor.

**Table 3.6** Comparative cost of cooking options

Cookstove description	Annual operation costs (dollars )
Traditional cook stove	
- Firewood stove	31
- Charcoal stove	113
Improved cookstove	
Firewood stove	22
Charcoal stove	80
LPG stove	131
Electric stove	46

Efficient lighting options available include the economy are induction of 36 W fluorescent lamps, CFLs and solar home systems in areas that have no access to grid connected electricity. The replacement of 40 W, fluorescent lamp with 36 W fluorescent lamp is a win-win option. The replacement of incandescent lamps in residential sector, both in rural areas and urban areas, with either 36 W fluorescent lamp or CFL is a costly option because of low hours of utilization, though this is not cost-effective option for the commercial sector. The viability of these options in rural areas is totally dependent on the spread of electrification but these can be coordinated with introduction of different options for electrification.

**Table 3.7** Comparison of demand side management for lightening options

Exiting Technology	Proposed Technology	Sector	Simple payback ( years )
Incandescent	36 W Fluorescent	Residential (urban)	10.64
40 W Fluorescent	36 W Fluorescent	Residential (urban)	0.00
36 W Fluorescent	CFL	Residential (urban)	11.36
Incandescent	36 W Fluorescent	Residential (rural)	20.43
40W Fluorescent	36 W Fluorescent	Residential (rural)	0.00

36 W Fluorescent	CFL	Residential (rural)	21.81
Incandescent	36 W Fluorescent	Commercial	2.66
40 W Fluorescent	36 W Fluorescent	Commercial	0.00
36 W Fluorescent	CFL	Commercial	2.84

In the rural areas, in absence of reliable, and even at places availability of, electricity, renewables are an option. The cost comparison of these with standard incandescent lamps indicates that these are very costly options and very unlikely to be used if grid-electricity is available. Even in areas where there is absence of grid electricity these might not be economically viable to the population.

**Table 3.8** Cost comparison of renewable option for lighting

	Incandescent bulb	PV lantern	Solar home systems
Annual operation cost (dollars)	1	29	181
Cost/useful energy (dollars/MJ)	0.003	0.075	0.153

*Note:* It is assumed that a Solar Home System would replace 3 incandescent bulbs.



**Table 3.9** Time frame for possible adoption of options for domestic and commercial sectors

Technology Options	Short term	Medium term	Long term
<u>Fuel switching</u> (cooking)			
Fuel wood to charcoal	In urban areas	In the rural areas	
Fuel wood/charcoal to LPG	Is commercially available	Promotion dependent on the implication for balance of payment and non-availability of electricity.	
Fuel wood to electric stoves	In urban areas	In rural areas where the incomes increase and are connected to electric supply	
Charcoal to electric stoves	In the urban areas	In rural areas as the electricity availability is achieved	
LPG to electric stove	Electric stoves are preferred option, due to lower cost, where availability of electricity is not a problem. So one has to analyse the cause for preference of LPG over electric stove.		
<u>Efficient appliances</u> (cooking)			
Improved cook stove	short term		
<u>Lighting</u>			
Incandescent/fluorescent CFLs		In the commercial sector.	Only when it is expected that costs would decrease with increase in worldwide use. Also this is the time frame in which the demand would grow to levels where demand management might be imperative in the economy
40 W to 36 W Fluorescent	In the short run		
PV lanterns	Continuation of present aided demonstration projects	The cost factor is the main deciding factor in either using government funded programme for promotion or commercial availability becomes a reality.	

### *3.7.2 Transport Sector*

The vehicle population in the Lao PDR consists of privately owned two wheelers and four wheelers, heavy transportation vehicles and a very small percentage of a public transport vehicles. Absence of well developed public transport network in the urban area has led to a fast growth in private ownership of vehicles. Public transport system is the best option that can be pursued to decrease the local emissions and congestion, which is already being witnessed in Vientiane. The 4-stroke two wheelers are already available. Even though the 4-stroke 2-wheeler is cheaper, demand for 2-stroke engine is greater. One of the reasons being the perceived usefulness of 2-stroke engine for long distance journeys. In absence of public transportation for long distance travel, motorbikes are used for within city as well as long distance travel. Other major source of public transport is the Tuktuk–2 stroke engine autorickshaw.

**Table 3.10** Comparison of mitigation options in transport sector

	Bus	Tukt uk	2-stroke two wheelers	4-stroke two wheelers
Cost (dollars/k m)	0.0 1	0.02	0.03	0.02

**Table 3.11** Timeline for implementing various transport sector options

	Short term	Medium term	Long term
Public transport to replace Tuk Tuk	In Vientiane	In other capital cities and provinces	
Public transport to replace two wheelers		In Vientiane and other capital cities of Province	Only possible in the long run provided enough development takes place
4-stroke by 2-stroke engines	Need to identify the barriers to use of 4 stroke.	In the medium term it might be possible to completely eliminate 2- stroke technology	

### 3.7.3 Agricultural sector

The three mitigation options available to reduce emissions in the agricultural sector are

Multiple Aeration Technique

Strategic supplement to feed through MUB (multi-nutrient Urea Block)

Biogas digesters to capture methane for energy use.

The agricultural sector in the Lao PDR is predominantly a subsistence agriculture. The rural areas are not well integrated with the urban economy. The low income and non-monetized economy in rural areas is an will be an important constraint in implementing these options. Therefore, the rate of adoption would be dependent on growth in income, rate of commercialization of agriculture, and subsidization of these options. Agriculture research infrastructure and a good extension service network is a major factor that would affect the adoption of MUB as well as MAT option.

The adoption of MAT will not entail any cost to the farmer but would require expenditure on the part of the government to strengthen extension services to provide training to the farmers. Strengthening of the extension service in the country will help to disseminate this option. The benefits of using biogas plants in terms of fertilizer and wood replacement outweigh the costs, but this is based on the assumption that the wood is purchased and villagers use chemical fertilizer. Also, the capital cost of this option might be a barrier to its adoption. The use of MUB will impose a net cost on the farmers and therefore is very unlikely to be adopted by the famers.

Table 3.12 Timeline for adoption of mitigation options for agriculture sector

	Short term	Medium term	Long term
Strategic supplement	In areas close to urban centres	Wider spread to rural areas as the infrastructure improves	
Small scale biogas digester	Donor aided Demonstration projects	Commercial applications	
MAT		Extension services will have to be in place to implement the option	

#### 3.7.4 Forestry sector

Conservation and sustainable management of existing forest areas, and increasing plantation forest area on deforested land is the top priority of the government. The possible mitigation options in this sector are: increasing area under protection forests, village forests management, and agroforestry and afforestation (the last two are the priorities outlined by the government ). The stress in afforestation is on actively promoting wider participation through distribution of barren land to individuals and families. Further, afforestation measures will be integrated with food production systems to make them more viable. Village forest management system option covers the ecologically fragile areas with slope greater than 30%. These are areas under shifting

cultivation and the stress on village forest management is to ensure protection through increased participation. All the mitigation options have a high overlap with the development goals outlined by the government for this sector.

Table 3.13 below reports the costs of the above discussed mitigation options.

**Table 3.13** Cost of forestry mitigation options

Option	Region	Carbon sequestered (tC/ha)	Initial Cost (dollar/tC)
Village forest management and shifting cultivation area (>30% slope)			
Village forest management		128	0.66
Afforestation	North		
Agroforestry	Teak	162	0.95
	Central		
	Eucalyptus	131	1.18
	Acacia	121	1.28
	South		
	Acacia	115	1.35
Agro forestry on unstocked forest areas (<30% slope)			
Afforestation	North		
Agroforestry	Teak	161	0.95
	Central		
	Eucalyptus	131	1.18
	Acacia	121	1.28
	South		
	Acacia	121	1.28
Protected areas			
Protected Area		59	3

**Table 3.14** Timeline for implementation of forestry mitigation options

Duration	Conservation	Shifting cultivation	VFM	Agroforestry and afforestation

Short term	<b>A total of 3.3 million ha forest estate is under National Biodiversity Conservation Areas. Donors fund the maintenance of these areas. A funding mechanism for continuity will be developed to ensure maintenance of these areas</b>	Containing cultivation within the existing plots for food security and increased economic benefits to individual households through promotion of agroforestry. Prevention of new settlements. <b>Enforcing minimum fallow times.</b> <b>Agricultural research to identify alternative crops like fruits, cereals, coffee, tea, etc. and developed so that the farmers can be converted to permanent agriculture</b>	<b>Testing of various development village forestry models for different forest categories to develop a national forest development model by year 2010</b>	Expected to achieve 500000 ha of plantation
Medium term			Full implementat	
Long term	<b>Full implementation of National Biodiversity Conservation Areas</b>	Stop completely through legal and institutional measures	ion of village forestry	

### 3.8 Implementation plan for abatement of emissions

The preceding section discussed the time frame for implementations and also highlighted the constraints that were likely to hinder the implementation of the mitigation options. This section highlights areas of institutional, legislature, and policy measures that could be adopted and are likely to support the GHG mitigation plan outlined in the previous section. The government has come out with a 2020 perspective plan for development that outlines the objectives and the government is in the process of designing and implementing policies to achieve these objectives. The measures presented here are suggestions that will be considered by the Government within the broader developmental framework. The deciding factor in implementing the policies and measures would be the development needs of the country. In absence of any basic infrastructure it is difficult to put a time frame as to how and when these measures be adopted.

### *3.8.1 General economy wide implementation strategy*

The country is at an early stage of development. It is in the process of developing and strengthening institutions for implementing the policies and other measures effectively for economic development and environmental management. The functioning of the government is decentralized. Though there are some development of institutions at the centre, there is lack of these in the provinces. The strengthening of environmental management institutions is in the process stage. Though some institutions do exist, there still are gaps that will have to be filled. These institutions will also help address the climate change issues. An important institutions for better management of economy and environment is an institution for data collection. The National Statistical Centre is responsible for collecting economic and environmental data in the Lao PDR. It is in the process of being strengthened. This will provide information for proper analysis of environmental impacts and options to address them. Information related to climate change and data collection would have to be built within this framework.

Further, R&D centres are necessary to evaluate technological needs and adopt technologies locally wherever necessary. This step needs to be supplemented with creation of institutions to disseminate technologies in all the sectors. As the nation is at the threshold of industrialization it presents a great opportunity to integrate clean technology initiatives with the policies and measures for industrial growth. The agenda of these institutions can integrate and coordinate research programmes for climate change. A number of measures are being taken to strengthen the research infrastructure and create capacity within the country.

Education infrastructure to augment literacy level is a necessary measure to increase the absorption of information and its analysis. This is fundamental for elevating public awareness on environmental issues including the climate change issue. Public attitudes and behavior are two important factors in increasing the impact of measures to manage these issues. The concern for efficient use of resources though acknowledged by the government, is not a wider public phenomenon because of lack of public awareness. Increasing awareness of environmental issues including climate change and conservation ethos among the wider public is one of the priorities.

The government aims to achieve a market-oriented economy for increased competitiveness and increasing the growth rate of the economy. A well functioning market economy requires a strong regulatory framework and institutions to implement them. The move towards market based incentives across the economy would be adopted in line with the country's capability to enforce them.



### 3.8.2 Energy use and industry

The measures suggested to assist implementation and adoption of mitigation options are based on the categorization of these options rather than for a specific option. The suggested measures should be seen in light of the present management of energy use and technology in the economy.

The pricing of commercial energy is predominantly market driven. The government has signed a partnership with a multinational to fund construction of large hydropower generation but the pricing is under the control of government. The electricity prices are subsidized for the domestic sector and government offices. In case of domestic consumption the tariffs are tiered and hence subsidy is restricted to a certain level of consumption. In remote areas, private generation at small scale is allowed and the prices are market driven.

State enterprise accounts for about 60% of imports of petroleum products and balance are by private enterprises. The prices are market driven and the government has control only over the total import quota to manage the balance of payment account. Currently there are neither quality control regulations on fuel quality nor any incentive structure for promoting better fuel quality.

Fuelwood is a marketed commodity in large cities, but in small towns and villages fuelwood for house use is free. Wood for charcoal manufacturing is again a marketed commodity, though permission is needed in rural areas from local government to produce charcoal.

There are no mandatory efficiency standards for energy use devices or regulations. Most of the equipment is imported into the country. Import duties are categorized by the type of good and in case of vehicles by horsepower. There is no differentiation in duty structure by efficiency of the equipment. In electricity devices too there is no active promotion of more efficient Fluorescent lamps or CFLs. The efforts currently are aimed at putting in place institutions to implement policies and regulations.

**Table 3.15** Policies, legislative and institutional measures for promoting mitigation options in the energy sector

Options	Policy	Legislative	Institution
Energy Conservation	Incentives to finance higher initial costs of more efficient equipment, for e.g., companies that specialize in financing where the cost of energy saved is the payback.	Mandatory efficiency standards Mandatory energy audits by companies, mandatory ISO certifications	Standards institutions; Information centers for availability of efficient equipment; technical manpower to service industries

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Clean technologies	Tax rebates, accelerated depreciation, and other incentive mechanism for technologies that are better than standards	Technology standards	Information gathering and dissemination on cleaner technologies
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The government plans to electrify 20% of a total of 11000 villages with stand alone renewable electrical systems by 2020. Presently achieving this goal relies is grant-aid received for promotion and demonstration of renewable energy technologies. This strategy is likely to remain unchanged in the near future due to other pressing developmental requirements and scarcity of resources. Large hydro project developers are required to invest a percentage of the total investment in developing PV solar technologies in surrounding areas. Production capacity is completely absent and only a couple of small companies are involved in selling and installing PV panels in the Lao PDR. However, most of their purchasers are NGOs. There is no tax rebate in the renewable energy sector. Even if private companies are allowed to install renewable options, the high cost coupled with low paying capacity in rural areas might not make it viable for these companies to sustain their activities.

**Table 3.16** Policies and legislative and institutional measures to promote renewable energy technologies

Options	Duration	Policy	Legislative	Institutions
Grid-based Options	Long term	Accelerated depreciation of capital; special tariff for electricity; tax rebates / holidays to improve profitability	Mandatory to expand renewable electricity at a pre-determined rate; Mandatory for private companies investing in hydropower to develop certain percentage of renewable capacity	R&D infrastructure; Special credit institutions for innovative loan schemes technical manpower
Stand-alone Options		Tax rebates for private companies that invest in renewable energies subsidized credit, mass procurement schemes by the government (if home industry exists) import duty relief; a surcharge on electricity to fund these options in remote villages	Mandatory for power generators to invest in establishing renewable energy systems	R&D infrastructure to adopt to local needs and certification; servicing and maintenance infrastructure; Creation of manpower; Innovative financing schemes, setting up industrial base for production

### 3.8.3 *Transportation*

The main focus in the transportation sector is on developing road infrastructure in the country. The government is planning to introduce public transport system in the Vientiane municipality area and will slowly introduce it in other urban areas as well. The stress is also on increasing the public transportation infrastructure for long distance travel to connect villages and towns. There are plans to develop a railroad system for

freight and passenger movement. This will be undertaken within the larger project of developing railroad in Southeast Asia region.

Presently Tuk tuks are the main public transport system in urban areas. The government is aware of the increasing congestion and air pollution problems that can occur as the city grows from the experience of other cities in the region. Though the government plans to undertake measures to ensure that air pollution deterioration doesn't take place, at present there are no emission standards for vehicles and neither are there regulations for maintenance of vehicles, but these are under consideration. There are no regulations or measures, like differences in tax on 4 - stroke and 2 - stroke two wheelers, to promote more efficient technology. Even if measures were to be designed, the capacity to implement them is lacking due to lack of adequately training human resources. For e.g., import of second-hand vehicles is allowed only if their efficiency is at least 80% that of a new vehicle. But lack of facility to test efficiency renders this measure ineffective. There are no regulations or incentives to import or assemble better efficiency vehicles.

**Table 3.17** Policies and legal and institutional measure for promoting mitigation options in Transport sector

Options	Policies	Legislative	Institutions
Public transport	Tax private vehicles to develop better public transport systems Limiting growth of private vehicles through quotas Private participation in developing public transportation through mechanism like Boot, or profit sharing-mechanism	Law to implement the policies	Urban planning and transportation planning

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<p>Improving efficiency and better technology</p>	<p>Imposing emission tax on vehicles;          Tax based on age of the vehicle,          Tax based on the efficiency of vehicle, for e.g., most of the vehicles are imported, therefore one can levy import duty based on efficiency of the engine;          Incentive to promote inspection and maintenance of vehicle.</p>	<p>Emissions standards for vehicles.          Mandatory fuel quality standards, Mandatory periodic inspection and maintenance certification</p>	<p>Institutions for certification of vehicles;          Institutional to monitor air pollution and set emission standards;          Certification institutions for vehicle maintenance, Fuel quality standard setting and implementing institution, authorized agency network for inspection and maintenance. The transportation authority for technical inspections can be the implementing agency.</p>
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#### 3.8.4 *Agriculture*

The preferred options in agricultural sector are MUB and biogas plants, as these options fulfil the development objectives and are feasible. Introduction of MUB would require creating conditions where the farmers can pay the cost of purchasing MUB through the profit earned from sale of excess production. Thus introduction in the early stages of any market-based incentive is only possible in areas that are connected to urban areas or have access to market. Second, the markets are also needed to supply the farmers with MUBs. One alternative would be to allocate government resources to supply these in certain areas to create a demonstration affect and also a market for the product.

Biogas digester fits in with the development objective of using organic fertilizers to control the use of chemical fertilizers and reducing consumption of wood for cooking. The by-product of biogas digesters is clean source of energy that can substitute use of wood. But as most of the rural areas have access to free wood, this by-product does not result in any monetary benefit. The only possible avenue for the farmer to recover investment is through substitution of chemical fertilizer with organic fertilizer. This limits the possibility of its use only in those areas where chemical fertilizers are used.

The MAT option doesn't fulfil any development objective but could be promoted through the introduction of improved seed varieties in irrigated areas. The underlying thread for implementation of all the options in the agricultural sector is integrating the rural economy with the urban economy for two - way flow of interaction.

**Table 3.18** Policies, legislative, and institutional measures to promote mitigation options in the agriculture sector

Options	Policy	Legislative	Institutional
MAT	Pricing water extraction	Legal measures to levy water use charge	R&D for developing technique, Extension services, These institution will have to be created for disseminating improved seeds and techniques
Biogas plants	Land rebates to farmers for using biogas Duty rebates on biogas equipment Tax rebates for companies that construct biogas plants	Tax rebates for using biogas	Dedicated financing institute for renewable energy technologies
MUB	Subsidized pricing, Soft loans or tax incentives for sale and distribution of MUB		Extension services, Marketing infrastructure for agricultural produce For e.g., diary Cooperatives which could supply MUB and adjust payment again sale of products

### 3.8.5 Forestry

The Ministry of Agriculture and Forestry which in consonance with local administration is responsible for conducting forest survey, delineating forest areas for administration, preparing management plans, monitoring, and forest data gathering. The Protected and reserved forests are under the administration of the central forestry authority. The plantation forests, regeneration forests, and degraded forests or bald lands can be assigned to local administration or private individuals and enterprises. Central authority formulates the guidelines and regulation for management and use of these lands.

The main focus in the forestry sector is on reducing shifting cultivation area, increasing plantation on degraded and barren lands and conservation of the undisturbed forest areas. The government has identified increase in population and its inability to meet the demand for food as main causes for increase in area under shifting cultivation, and has

adopted a multi-pronged strategy to address this issue. The focus is on providing alternative sources of income in these areas along with increasing the food production in the plains. Alternative agriculture systems that are more remunerative and suitable to the area will be developed to achieve this objective. Legislative measures like land titling and restrictions on conversion of forests to agricultural land will be used to support the above strategy. Relocating populations from very fragile ecosystems too is under consideration.

Promoting agroforestry systems to enhance regeneration of forests and involving private funds is an important component of the strategy. Afforestation of degraded forest area is being promoted through government efforts and by seeking participation from individuals and private enterprises. Individuals and private enterprises are allowed under present regulations to lease degraded or barren lands from the government for plantations. The legislation gives freedom to plant the area with short, medium, or long rotation species but specifies the species that can be grown in a particular area. Private parties are allowed usufruct rights within the regulations prescribed by the concerned authority. The government grants incentive in terms of credits, tax and duty rebates, increased lease area, etc. as per regulations. The land rights so devolved can be transferred with intimation to the concerned authority. The government heavily regulates logging and transportation for sale. The stress in promoting afforestation is through involvement of many small farmers and integrating it with agricultural activities.

The government plans to involve village communities in managing forests. Areas demarcated for management are given to village community for management through local government. The use of forest by villagers is regulated by government guidelines.



**Table 3.19** Policies and legal and institutional measures to increase sequestration activities

Options	Policy measures	Legislature	Institutional measures
Reducing shifting cultivation on	Identification of most sensitive areas and relocating population; incentive for adopting cropping systems more suited to the area	Legal restriction on extending shifting cultivation area in short term extending to complete restriction on shifting cultivation in notified areas	Extension services in areas to promote alternative farming systems; promote education; marketing and agricultural support services; credit agencies; research infrastructure for developing suitable crops+
Afforestation of degraded forest land and agroforestry	Clearly defining the incentives rather than basing it on case to case basis for private investment in plantations; export promotion incentives; incentive for private nurseries; restrict regulation on harvesting and selling of timber.	Clear laws for inspection and periodical regulation on plantations and penalty structure for violation for e.g., in Canada, private companies are given life - long lease but an inspection every 10 years is carried out to see if the company complies with regulation. There is no restriction on how much to log, etc.	Creation of credit institutions and special mechanisms for funding plantations; R&D of fast - growing tree species and agroforestry systems; development of nurseries to meet the increased demand; institution to inspect and certify nurseries; develop market infrastructure for timber; institution to develop guidelines and implement regulations, research institutions to develop new wood products to increase the wood demand

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Conservation	Tax incentives for contribution to conservation funds; Private management of conservation areas based on benefit - sharing in the long term	Law for private participation in management	Creation of trust funds for financing protection areas network; Development of ecotourism for finance; strengthening village forestry systems to manage forest areas through sustainable exploitation of forest within the conservation framework; institution to continuously develop conservation guidelines and regulate conservation areas
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### 3.9 Project Concepts for GHG Mitigation

Based on the developmental needs and human, institutional, and infrastructural capacity, the Lao government has identified project concepts for GHG mitigation.

#### *3.9.1 Reducing CO<sub>2</sub> emission through use of CFL in the government and commercial sector*

##### 3.9.1.1 Project description

The project aims to develop a comprehensive demonstration programme to promote use of CFLs in the commercial sector and governmental buildings. This will be achieved through collecting information for

- 1 assessing the various means of financing and other measures that will facilitate promotion of CFLs; and
- 2 estimating the amount of energy - saving potential of this option

Current calculations show that the payback period on the CFLs is 12 years. The project will research options for reducing the payback period.

##### 3.9.1.2 Global environmental benefits

CFLs save over 70% of the energy consumed compared to incandescent lamps and last almost ten times longer. By improving the efficiency of electricity use in buildings, CFLs help to lower emissions of carbon and also of other air pollutants. Reduced fossil fuel use will cut GHG emissions by an amount based on the type of fuel used (approximate fuel emission rates are: natural gas-13.7 TgC/EJ; oil 19.2 TgC/EJ and coal 23.8 TgC/EJ).

Mitigation analysis of options under the GHG inventory project indicate that replacement of 36W, fluorescent with CFLs can save as much as 76.65 kWh/annum on each replacement.

### 3.9.1.3 Other Social & Environmental Impacts

The increased use of CFL has the following benefits.

- Economizing energy will help save capital needed for creating additional capacity to meet the demand.
- The saved capital invested in other sectors would increase the growth prospects.
- Decreased use of fossil fuel due to managed demand will reduce emission of local air pollutants.
- People will benefit from savings in energy cost.

### *3.9.2 Developing project proposal for ICS demonstration project*

#### 3.9.2.1 Project Description

There is a complete lack of information on the fuel use in the rural areas; use of firewood and charcoal stoves, the emissions of the stoves; and the efficiency of the stoves. The project will undertake a study to assess the potential of ICS and develop a programme for dissemination of ICS in rural areas. The following activities are planned under the project.

- 1 Survey of fuel used, source of fuel and price for the fuel
- 2 Assess the design and efficiency of cookstove in the rural areas through survey
- 3 Assess the appropriateness of different designs for the rural areas
- 4 Designs program for dissemination of improved cookstove and creating capacity for local production.

### 3.9.2.2 Global environmental benefits

The fuel efficient ICSS stoves are known to save as much of 30% fuel (World Bank, 1996)<sup>a</sup>) emissions reduction per stove. The current cook stove being used for dissemination in the Lao PDR has been developed in Thailand and is reported to save as much 66% wood.

### 3.9.2.3 Other social and environmental impacts

The saved fuel wood from ICS will reduce demand pressures on forest resources. Lower wood requirement implies the time required by the rural population, especially women and girls, in the collection of fuel wood is saved, reducing their hardship. Additionally, reduced smoke from the ICSs will lessen the impact of indoor air pollution on the health of women and children. Further, the use of ICSs will lead to conservation of dung for application on degraded lands.

## *3.9.3 Promoting biogas use for GHG emission reduction*

### 3.9.3.1 Project description

One of the main objectives of the rural development strategy in the Lao PDR is providing rural areas with environmentally friendly energy sources. Availability of animal refuse provides a opportunity to provide cleaner fuel for cooking and also manure for agriculture. The government is currently installing a few biogas plants in the country, all of which are funded through grants. There is a lack of information on techno-economic assessment of biogas plants in the country. This will provide an important input to the government to design policies and programmes for wider dissemination of this option. The project will undertake the following activities to achieve these objectives.

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<sup>a</sup> *rural energy and development: improving energy supplies to two billion people, World Bank, 1996*

1. Assessment of the present biogas demonstration project to study the appropriateness of technology used, and the economic factors that affect commercialization of biogas.
2. Based on the above analysis, study alternative promotion models for biogas.
3. Develop criteria for selection of areas where the promotion of biogas will be successful.
4. Identify measures to remove barriers to use of biogas
5. Develop a program for promotion of biogas in identified areas.

### 3.9.3.2 Global environmental benefits

The use of biogas sludge fertilizer in place of unfermented organic fertilizer is estimated to reduce 0.072 tonne of methane per ha per year or 1.5 tonnes of CO<sub>2</sub> equivalent per year per hectare (ADB 1999).<sup>3</sup> Estimates made as part of the GHG inventory project indicate that use of one cubic metres of biogas for cooking displaces 4.73 kg of wood. Total emission reduction as compared to dry manure management is 5.73 kg of CO<sub>2</sub> equivalent for each cubic metres of gas produced.

### 3.9.3.3 Other Social & Environmental Impacts

The use of biogas will have a number of social and environmental benefits to the local population and the economy.

- It will provide a cleaner fuel for cooking purpose decreasing indoor air pollution.
- It will result in reduction of environmental contamination caused by use of chemical fertilizers by substituting with organic fertilizer.
- Will reduce the pressure on forest area by decreasing the demand for fuelwood.
- It will decrease the demand for foreign exchange in the economy by decreasing the demand for fertilizer.
- Local development of biogas industry will provide employment avenues for rural population.

### *3.9.4 Decentralised energy supply through Solar home systems in rural households*

#### **3.9.4.1 Project Description**

The low level of electrification in rural areas and the difficult terrain in extending grid to a large part of the country has resulted in identification of alternative technologies for providing electricity in remote rural areas. One such technology that could provide electricity and is also environmentally friendly is the solar home systems. A few grant - aided demonstration projects have been implemented by the government, but there is lack of sufficient information to design a comprehensive programme for the country. The proposed projects therefore, aims to address this lacuna. The proposed project activities are

- the project will undertake a technical and economic viability assessment of the Solar Home System based on the ongoing activity in the country;
- further the project would assess the views of various stakeholders on viability of Solar Home System.
- in the light of the above information and international experience, a programme would be developed to promote Solar Home System in the Lao PDR.

#### **3.9.4.2 Global Environmental Benefits**

Currently either diesel lamps are used for lighting purpose in the rural areas or diesel generation sets in some of the villages. The use of Solar Home System by displacing the present fossil- fuel- based lighting will result in CO<sub>2</sub> reduction.

#### **3.9.4.3 Other Social & Environmental Impacts**

Solar Home System will provide a clean source of lighting and a major advantage for education. The use of these electricity can also aid other services like refrigeration of medicines etc. The use of solar home systems could also lead to employment generation at local levels in terms of service providers for maintenance of the operations. The effect on the economy as a whole would be in terms of increase in foreign exchange outlay for procuring solar home systems. Given the present precarious balance of payment situation this might be a major consideration.

### *3.9.5 Assessing small- scale hydropower potential and demonstration project in combination with dissemination of electric cook stove*

#### **3.9.5.1 Project Description**

The mountainous terrain and abundance of rivulets provide a cheap and environmentally friendly alternative to grid electricity in the form of small hydropower. The proposed project is aimed at filling the information gap on techno-economic feasibility of this option and the scope of this option in Lao PDR. The following activities will be undertaken in the study.

- 1 Survey of existing plants.
- 2 Assessment of SHP (small-scale hydropower potential).
- 3 Identification of sites of demonstration projects.
- 4 Analysis of techno-economics of projects.
- 5 Identification of technical capacity building in local staff and people in operating and maintaining the plants.
- 6 Identify the feasibility of replacing traditional cook stove with ECS (electric cook stove)
- 7 Develop a demonstration project based on the above analysis.

#### **3.9.5.2 Global environmental benefits**

The SHP is a renewable energy source and will lead to reduction of carbon emissions in the Lao economy, though this assessment depends on the electricity source in the baseline. In case of Lao PDR, hydroelectricity is the main source of power currently, but given the terrain characteristics, it is more likely that the decentralized source of electricity, whenever it becomes available, is likely to be diesel generators. Replacement of diesel by SHP will reduce 0.7 Kg CO<sub>2</sub>/kwh of electricity produced. Replacing wood with electricity as energy for cooking will save as much as 5.38 tonnes of CO<sub>2</sub> / annum per ECS.

#### **3.9.5.3 Other Social & Environmental Impacts**

The availability of electricity is known to lead to economic development of the area. Around this, a number of economic development activities suitable to the area can be built to increase prosperity. The activity itself will generate some employment in terms of servicing industry for the plants. The availability of alternatives in the uplands will also divert the pressure on forests due to subsistence status of the population. The use of ECS would directly lead to decrease in wood extraction from forest and will also improve

the indoor air quality. This will improve the health status of population, especially the women and children.

Centralized electricity is a major source of foreign exchange earning in the country. Increasing need for electricity in future will decrease this export potential. The development of SHP will provide alternatives to meet the country's growing demand, thus not affecting its export potential. Also as all the petroleum products are imported in the economy, substituting diesel in the economy will reduce the pressure on foreign exchange demand.

### *3.9.6 Removing barriers to adoption of 4 - stroke engine for two wheelers*

#### **3.9.6.1 Project Description**

Growing income in urban areas and absence of an urban public transport system has led to increase in vehicle population in the urban areas. This growth, in future, is likely to result in high concentrations of local air pollutants as well as high GHG emissions.

Technological options in the transport sector can address both local as well as global air pollution issues. More efficient 4 - stroke two wheelers is one such options. The current project is aimed at promoting use of 4 stroke engine in place of the prevalent 2 - stroke two wheelers. The following are the activities under the project.

- (i) A survey of users of two-wheeler, distributors and producers to identify the factors for preference of two-stroke over 4-stroke engines.
- (ii) Analysis of the government's policy on import and export, excise duty structure and environmental policy to identify ways of promoting 4-stroke engines.
- (iii) Designing a program me to increase the awareness of benefits of 4-stroke engine and its promotion.

#### **3.9.6.2 Global environmental benefits**

Estimates from a number of studies show that the use of 4-stroke engine can reduce up to 25 per cent GHG emissions. The mitigation analysis carried out under the Lao PDR GHG inventory project puts the emission reduction at 0.004 kg CO<sub>2</sub>/pkm.

#### **3.9.6.3 Other social and environmental Impacts**

The most important local benefit of the project will be reduction in air pollution in the urban areas. Air pollution in urban areas across the world is known to cause widespread health damages. The social benefit of reduction in air pollution will be decrease in health cost to the population and especially the poorer sections of the society. The increased efficiency will have an income effect on the owners of the vehicle. For the larger



economy, which is totally reliant on imports for petroleum products, increased efficiency would imply lower imports of petroleum products over the baseline. This will help save precious foreign exchange in the economy.

## 4

## Financial and capacity constraints

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The development process of *National Communication* has provided an opportunity to increase the awareness on climate change issue among the policy makers. It has also highlighted the gaps in capacity, existing within the country, to understand the issue and address them in an effective manner. The following sections analyses these constraints and highlights the areas that need immediate attention. This will help the Lao PDR in participating fully in the process of addressing the climate change issue and meeting its obligations under the Convention.

The process of nation building has a very recent history. The country is heavily reliant on primary sector and social and economic infrastructure is minimal. The government has been working on multiple fronts, like developing institutions for governance, regulatory framework and implementation structure, economic infrastructure, social infrastructure and so on, in order to provide the people with basic needs of existence and a rule-based governance.

A main component of achieving these goals is adequate trained manpower for various activities, ranging from policy making, research to implementation which the country lacks. The analysis of climate change issues presented here in this report highlights this fact adequately. The second aspect is the institutional and technological infrastructure to translate thoughts into action. This was highlighted both in the preparation of the GHG inventory for the country and development of policies and programmes for promoting mitigation technologies and options. The third is adequate availability of funds to facilitate action. The country is heavily reliant on bilateral and multilateral aid even for development priorities. Any action that further increases the costs of these will only be possible if funds are made available. In absence of funds, adoption of advanced technologies and mitigation measures will affect the growth of the economy.

The following sections highlight some of these aspects and the immediate requirements that would help Lao PDR in fulfilling its obligations under the Convention and effectively participating in the process of addressing global warming

## 4.1 Enabling activities

The enabling project under which the *National Communication* was prepared was aimed at creating capacity within the government in a number of areas, GHG inventory making, mitigation options analysis, policy analysis and so on. This was the first project of its nature and has been able to meet the objectives but to a limited extent. The reason being a number of underlying assumptions on which the capacity-building aspects of the implemented enabling activity was based on are not adequately developed in the country.

- Data collection mechanism: The National Statistical Center is responsible for collecting and publishing information on important socio-economic parameters in the country. Some of this information is collected by the agency from the respective line ministries. The current data collection mechanism is governed by the development planning needs. The environmental and resource management aspects have recently been added to the planning process. The agency is not well equipped to analyse the data needs for environmental aspects. This is true of climate change activities too. Though the project has highlighted to a limited extent the data requirement for effective management of climate change issue, a much larger initiative is needed to identify the kinds of information that are needed, the agencies that will be responsible for them, and building capacity in collecting this information.
- Technical capacity building for GHG inventory activities: The current inventory was prepared using default technical parameters for emissions across all sectors. The GHG emission inventory is as such very uncertain and to reduce these uncertainties, capacity has to be built in institutions to measure emissions and develop norms.
- Policy analysis: The climate change issue brings a new shift in policy objectives and, hence, policy analysis. The preparation of *The National Communication* has provided a limited exposure to this process to a limited number of people. A wider training involving central government, public sector, research organizations and even private sector organizations needs to be carried out building a more broad-based capacity. This training should be coupled with training on market-driven economic management. The training should expose the participants to different policy tools

employed across the world to achieve environmental objectives in general and climate change related objectives in particular.

- Energy planning and management: There is a lack of information and expertise on projecting energy needs for the future and planning for energy needs in the economy. The information on energy demand is very important for management of climate change issues. This expertise should especially focus on the industrial growth and energy requirement. Such an expertise will help incorporate energy - efficiency measures and make appropriate technological choices into the planning process.
- Curriculum design for climate change: The present awareness of climate change issue is limited to a few select policy makers. A wider dissemination of this information calls for including the climate change information in the educational curricula. This will enable building climate change information into the younger generation.
- Vulnerability and impact assessment: The Lao PDR is highly dependent on natural resources for its prosperity: agriculture, forest resources, and water resources. The likely transition in climate change will, therefore, not only have physical impact on these resources but also a larger impact on the socio-economic situation of the country. There has been no study on the vulnerability of different sectors to climate change in the country. Such a study is necessary in view of likely impacts, so that appropriate adaptation measures can be designed to minimize any likely future impacts.

## **4.2 Financial constraints**

All the mitigation options mentioned in the previous chapter and the enabling activities listed in the above sections are dependent on the availability of funds. The mitigation projects proposed would require funds for preparing project briefs, which than would be used to garner support from various bilateral and multilateral funding mechanisms. The actual support required will be developed in consultation with the funding agencies.

## Conclusions and Recommendations

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The Lao PDR is a responsible member of the world community and will like to cooperate to its maximum capacity in addressing all environmental concerns, not only climate change. Though, the Lao PDR is a net sequester of GHGs and this situation is likely to remain so in the future still the Lao PDR would like to cooperate with others countries in mitigating emissions by incorporating these concerns in its development process. The major constraint that the Lao PDR faces in providing its utmost support, is availability of adequate resources and sufficient human resource trained to understand and design measures. The Lao PDR looks forward to international cooperation in bridging this constraint and enabling the country to work together with the international community.