

**Lao People's Democratic Republic National  
Sustainable Energy Strategy Report**

**on**

**Enabling Environment and Technology  
Innovation Ecosystem for Affordable  
Sustainable Energy Options**

*Prepared for*

Asian and Pacific Centre for Transfer of Technology (APCTT)  
of the Economic and Social Commission for Asia and the Pacific (UNESCAP)

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## ABBREVIATIONS

AC	: Alternating current
AICTE	: All India Council for Technical Education
APB	: Agricultural Promotion Bank
APCTT	: Asian and Pacific Centre for Transfer of Technology
BCEL	: Banque pour le Commerce Exterieur Lao
BOMT	: Build, operate, maintain and transfer
CEF	: Community Energy Fund
CFL	: Compact fluorescent lamp
CIP	: Cleaning in place
CoG	: Cost of generation
DC	: Direct current
DEB	: Department of Energy Business
DEM	: Department of Energy Management
DEM	: Digital elevation model
DEMO	: District Energy and Mines Office
DEPP	: Department of Energy Policy and Planning
DFCC	: Development Finance Corporation of Ceylon
DG	: Director General
DK	: Danish krone
DTI	: Danish Technological Institute
EC	: Energy conservation
ECS	: Electricity Consumer Society
EDL	: Electricit de Laos
EDL-Gen	: EDL Generation Public Company
EEC	: Energy efficiency and conservation
EMI	: Equal monthly instalment
ESCO	: Energy Service Company
ESD	: Electricity services delivery
FIT	: Feed-in tariff
GDP	: Gross domestic product
GIS	: Geographic information system
GoL	: Government of Lao People's Democratic Republic
GPI	: Greenpeace International
GS	: Grameen Shakti
Ha	: Hectare
HPP	: Hydro power plant
HPS	: Husk Power Systems
HRD	: Human resource development
IEC	: International Electrotechnical Commission
IIM	: Indian Institute of Management
IIT	: Indian Institute of Technology
INR	: Indian rupees
IPP	: Independent power producers
IREP	: Institute of Renewable Energy Promotion
IRR	: Internal rate of return

ITI	:	Industrial Training Institutes
ITSL	:	Intermediate Technology Sri Lanka
JICA	:	Japan International Cooperation Agency
JRF	:	Junior research fellowship
kgce	:	Kilogram of coal equivalent
ktoe	:	Kilo tons of oil equivalent
LDB	:	Lao Development Bank
LDC	:	Less developed country
LHSE	:	Lao holding state enterprise
LIRE	:	Lao Institute of Renewable Energy
LLDC	:	Landlocked developing country
LPG	:	Liquefied petroleum gas
LSX	:	Lao Securities Exchange
M.Sc.	:	Master of Science
M.Tech	:	Master of Technology
MDG	:	Millennium Development Goal
MEM	:	Ministry of Energy and Mines
Mfg	:	Manufacturing
MNRE	:	Ministry of New and Renewable Energy
MONRE	:	Ministry of Natural Resources and Environment
MOST	:	Ministry of Science and Technology
MoU	:	Memorandum of understanding
MPWT	:	Ministry of Public Works and Transportation
NGO	:	Non-government organization
NREF	:	National Renewable Energy Fellowship
NSEDP	:	National Socio-Economic Development Plan
NUOL	:	National University of Laos
O&M	:	Operation and maintenance
OGS	:	Off-grid Promotion Support Office
PDEM	:	Provincial Department of Energy and Mines
PDP	:	Power development plan
PESCO	:	Provincial Energy Service Company
PSHD	:	Policy on sustainable hydro power development
PV	:	Photovoltaic
PWD	:	Public Works Department
R&D	:	Research and development
RA	:	Research associate
RE	:	Renewable energy
REDP	:	Rural Energy Development Programme
REDS	:	Renewable Energy Development Strategy
REMI	:	Renewable Energy and New Materials Institute
RERED	:	Renewable Energy for Rural Economic Development
RESDALAO	:	Renewable Energy for Sustainable Development Association of Lao
RET	:	Renewable energy technology
RPO	:	Renewable purchase obligation
Rs.	:	Indian rupees
S&T	:	Science and technology

SBC	:	System benefits charge
SE4 All	:	Sustainable energy for all
SET	:	Sustainable energy technology
SEZ	:	Special economic zone
SHP	:	Small-hydro power
SHS	:	Solar home system
SLACO	:	Sino-Lao Aluminium Corporation.
SLRS	:	Solar lantern rental system
SME	:	Small and medium industry
SPEED	:	Smart power for environment-friendly economic development
SRF	:	Senior research fellowship
SSC	:	South-South cooperation
SWH	:	Solar water heating
SWHS	:	Solar water heating system
UN	:	United Nations
UNDP	:	United Nations Development Programme
UNEP	:	United Nations Environment Programme
UNESCAP	:	United Nations Economic and Social Commission for Asia and the Pacific
USD	:	US dollar
VCS	:	Village Cooperative Society
VEC	:	Village Energy Committee
VEM	:	Village energy manager
VGf	:	Viability Gap Fund
WHO	:	World Health Organization
WISE	:	World Institute of Sustainable Energy

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# EXECUTIVE SUMMARY

## Background

Lao People's Democratic Republic is blessed with ample hydropower potential and at present meeting its own electricity needs through hydropower. The present planning approach of the government is largely focused on the development of hydropower potential in the country. The government encourages hydropower development through independent power producers (IPPs) for export purpose. However, in the long run the country needs to diversify its generation portfolio and formulate a comprehensive policy for development of other potential RE sources such as solar, wind, biomass, biofuel and small-hydro. The use of decentralized off-grid renewable energy based applications is important from the point of view of meeting the electricity, heating and cooking needs of the population located in remote areas where extension of conventional grid is economically and technically difficult.

## National Enabling Environment for Sustainable Energy Options

The Law on Electricity, 2011 has made Ministry of Energy and Mines (MEM) responsible for framing policies and strategies for the energy sector including developing Laws and Regulation, supervision of business of electricity companies and assisting the government in deciding the tariff. The Institute of Renewable Energy Promotion (IREP) under MEM oversees the implementation of renewable energy, energy efficiency and rural electrification programmes in Lao People's Democratic Republic.

The Law on Electricity, 2011 has recommended the use of RE-based power plants for rural electrification, either in grid tied or off-grid mode. The Law also recommends special promotional policies to promote investment in sustainable energy. Condition of the concessional agreement is relaxed in case of small-hydro power (SHP) below 15 MW and other RE technologies like solar, wind, and biomass. Project approval powers for the power projects up to 15 MW capacities are vested with the Provincial/District Governor. The law also has provision for generating funds for rural electrification.

Electricite du Laos (EdL) is the vertically integrated state sector utility responsible for generation, transmission and distribution of electricity in Laos. As of 2013, around 85% of the households in Laos have access to grid electricity; remaining 15% households are located in relatively remote and inaccessible areas, where extension of grid may not be economically viable.

The Lao government announced the 'Renewable Energy Development Strategy (REDS) for Lao People's Democratic Republic during October 2011. The REDS aims to increase the share of renewable energy to 30% of the total energy consumption by year 2025 in final energy terms.

There is no independent 'Electricity Regulator' for tariff determination purpose and monitoring the power sector operations in Laos. The tariff for sale of electricity from RE generating stations to the utility EdL is decided by the latter through negotiations with the RE generator on case-to-case basis. The retail tariff structure is finalized by the MEM.

At present, no special financial / fiscal incentives are being offered by the Lao government for encouraging development of sustainable energy options in the country. However, as per the Investment Promotion Law of Lao People's Democratic Republic, investors, including sustainable energy investors, are eligible for obtaining some fiscal / non-financial incentives like tax holidays,

exemption of fee on concession agreement, etc. The Banking sector in Laos is not sensitized enough about the need for promoting sustainable energy sources. The government so far has not integrated renewable energy into the national agenda such as the Socio-Economic Development Plan, Rural Electrification Plan, Poverty Eradication Plan, etc.

The Lao government has successfully implemented few off-grid RE-based rural electrification Programmes with the help of international funding (World Bank, JICA), wherein, the use of solar home lighting systems have been successfully demonstrated in rural un-electrified areas. The public-private partnership models like those of Provincial Energy Service Companies (PESCOs) and Sunlabob (100% Lao owned company engaged in selling hardware and providing commercially viable energy services for remote areas), have been successfully implemented. However, these programmes have not resulted in large scale deployment of off-grid RE technologies for rural electrification due to dependence on subsidy. The energy efficiency and conservation in Lao People's Democratic Republic is at an early stage, and the government is yet to develop a comprehensive national strategy for it.

The government, so far, relies mostly on international funding and donor contribution to support RE programmes in the country. Budgetary provision from own resources is limited.

The enabling environment thus creates certain opportunities for development of sustainable energy options in the country along with other infrastructure projects. However, the national strategy for development of renewable energy is not backed by a legally binding policy, regulations and implementation plan for time-bound development of sustainable energy technology options.

### **Technology Innovation Ecosystem for Sustainable Energy**

The enabling environment for technology innovation ecosystem for sustainable energy in any country is governed by effective policies from the government, and most importantly, the active involvement of the small and medium manufacturing industries, research and development institutions, academia and universities contributing towards sustainable energy development. Besides, the availability of adequate infrastructure also facilitates technology innovation in the country.

Research and development is the first step in technology innovation. Institute of Renewable Energy Promotion (IREP) implements the sustainable energy and energy efficiency programmes in Lao People's Democratic Republic. However, as far as R&D is concerned, the role of Renewable Energy and New Materials Institute (REMI) working under the aegis of the Ministry of Science and Technology is vital in conducting R&D on renewable energy technology suitable for local conditions and requirements.

The National University of Laos (NUOL) offers subjects related to renewable energy at the Faculty of Engineering and Faculty of Science as part of bachelor degree courses. Besides, the NUOL, with cooperation from international organizations has developed a technical handbook on solar technology, and conducts solar radiation assessment. However, apart from NUOL, no other institution offers specialized courses on renewable energy either at the degree, diploma, or lower level.

Besides above government owned institutions, Lao Institute of Renewable Energy (LIRE), a non-profit organization established in 2006 is a part of the Lao Union for Science and Engineering

Association. LIRE, in collaboration with ETC (a Dutch NGO), has implemented the ‘Pico-Hydropower Innovation and Capacity Building Programme’ in Lao People’s Democratic Republic.

Sunlabob a 100 % Lao-owned Company is engaged in providing sales, hire (rental), installation and after-sales service, training and promotions / demonstrations in the renewable energy field (predominantly solar PV and solar heating systems). Sunlabob has been active in developing solar PV markets in Lao through a number of private-public partnerships.

Manufacturing sector in Lao People’s Democratic Republic is dominated by the garment and food processing industries. At present, the country does not have any manufacturing facility to produce RE technology equipment / applications. Lao People’s Democratic Republic has not yet established the testing laboratories for quality control of the goods imported from neighbouring countries. The country adopts IEC standard as national standards as far as electrical and electronic goods testing is concerned.

The role of facilitating infrastructure like Science and Technology Park, Science and Technology Information Centres, Technology Incubators etc are equally important in facilitating technology innovation. The Lao People’s Democratic Republic government has not yet created such facilitating infrastructure to encourage innovations in sustainable energy technology and services.

Physical infrastructure like road networks is not good in Lao People’s Democratic Republic. Lack of adequate infrastructure makes expansion of transmission and distribution network uneconomical. Besides, energy products and services become costly due to inadequate infrastructure, which in turn makes access to energy unaffordable in many parts of the country.

The Government of Lao People’s Democratic Republic should encourage participation of Small and Medium Industries (SMEs) in Renewable energy equipment/applications manufacturing by providing special incentive structures and financing mechanisms. The government needs to make budgetary provisions for funding the R&D institutions. The Renewable Energy and New Materials Institution (REMI) needs to be strengthened, diversified and expanded, considering the diversity of renewable energy technologies. It should be made autonomous with adequate funding and time-bound targets. Under the ambit of REMI, specialized research centres for diverse renewable energy technologies need to be established. REMI needs to network with various institutions working in renewable energy related R&D in the country in order to exchange the latest knowledge.

## **Suitable Sustainable Energy Technology Options for Lao People’s Democratic Republic**

Five sustainable energy technologies suitable for meeting the electricity, heating and cooking requirements of the people living in remote areas in Lao People’s Democratic Republic have been identified. These are as follows:

### **Solar Thermal Application for Domestic Heating and Industrial Heating / Cooling**

Ample solar resource availability and convenient rooftop structures in the urban areas make solar water heating systems (SWHS) a low cost solar heating application. The solar thermal applications have huge potential for substitution of electricity in the urban areas and biomass and furnace oil substitution in rural areas. Similarly, the process heat requirement in the food processing and agro industries can be met by concentric solar technologies.

## **Solar Photovoltaic Applications for Domestic Lighting**

Individual households located in un-electrified remote villages/hamlets inaccessible by grid or which have not been covered through micro-grid systems could be the targeted beneficiaries under this scheme. It can be safely assumed that the present spending on kerosene can be utilized towards payment for meeting the lighting load through alternative sources of electricity.

## **Small-Scale Biogas Plant to Cater to Individual/Community – Cooking / Heating Requirements**

Lao People's Democratic Republic has many small- and-medium scale pig farms, beer breweries, textile and silk industries and other sources of municipal solid waste, where, small scale biogas plants for individual / community use can be set up. This will help in reducing the use of biomass in Lao People's Democratic Republic, where 60% of final energy consumption comes from burning the biomass.

## **Small-hydro Power and Biomass Based Gasification Technology for Off-Grid Generation and Distribution**

The identified small-hydro power potential in Lao People's Democratic Republic is around 2000 MW. Similarly, Lao People's Democratic Republic being a rice producing country, can use rice husk as a raw material for decentralized power generation using biomass gasification technology. Both these technological options have advantage in terms of technology robustness, ease of operation, and maintenance, and least operational cost, and therefore can be good options for providing electricity to non-electrified areas in Lao People's Democratic Republic.

## **Policy Approaches, Programmes, Delivery Mechanism and Business Mechanisms for Increasing Affordability of and Access to Sustainable Energy in Lao People's Democratic Republic**

- The new policy approaches, programmes, delivery mechanism and business mechanisms suggested for accelerating sustainable energy / renewable energy development in Lao PDR are based on the gap analysis of the current national enabling framework for sustainable energy and technology innovation ecosystem in Laos.
- There is need for a clear renewable energy policy for Lao People's Democratic Republic stating the periodic targets for grid-connected and off-grid RE projects, as well as sustainable energy applications. The roles and responsibilities of the various implementation agencies involved needs to be clearly spelt out in policy documents. An empowered committee consisting of senior representatives from various ministries shall be constituted. Such committee shall be made responsible for renewable energy policy and plan formulation, ensuring coordination among the various Ministries / Departments of the Lao government, devising strategies for grid-connected and off-grid sustainable energy projects, notifying standard technical specifications for the off-grid renewable energy equipment/devices to be procured by investors; strategies for financing renewable energy development, promoting local RE manufacturing, and strategies for R &D, HRD, and institution building.
- There is need for scientific potential assessment of renewable energy sources in Lao People's Democratic Republic. The scientific resource assessment studies with resource assessment data and maps compiled at regional or country level can provide broad technology options and help the developer in making informed decisions about investing

in renewable energy projects. Such resource assessment studies shall be endorsed by the Lao Government so that the investor can trust the same.

- In terms of final energy consumption, the share of biomass is around 60% in Lao People's Democratic Republic. Biomass is primarily used for cooking and domestic heating requirement. The government, therefore, should encourage use of improved energy efficient cooking stoves and implement a long-term programme on improved cooking stoves.
- Lao People's Democratic Republic being a rice producing country can use rice husk as a raw material for decentralized power generation using biomass gasification technology. Assessment with regards to rice growing area in Lao People's Democratic Republic, quantum of rice husk production and spread of rice mills within the provinces should be carried out. A rice-husk-based gasification technology are commercially used in India for decentralized power generation and supply in the off-grid areas, and has the potential to be transferred and replicated in Lao People's Democratic Republic under South-South cooperation.
- Ranking of potential hydro sites on the basis of cost of generation (CoG) will be useful in view of prioritizing the large number of identified hydropower schemes to harness vast untapped hydro resources in the order of their attractiveness for implementation. This will also facilitate decision making on allocation of hydro sites to those independent power producers aiming for export of electricity.
- The government intends to develop SHP projects (< 15 MW) with the help of private entrepreneurs. The Geographical Information System (GIS) tool recreates streams and sets up hypothetical hydropower schemes at regular intervals, and then makes it possible to estimate altitude and hydrology for each one of these positions.
- The Government of Lao People's Democratic Republic has an ambitious target of introducing 10% biofuels in the transportation sector by 2025. The government needs to prepare the land management plan and agro-zoning plan before implementing the biofuel programme on a large scale in Lao People's Democratic Republic. Strategies must be directed to ensure food security for the country, without diverting the fertile agricultural land for biofuel crop production.
- The present trend of oil and gas prices indicates that the bill on account of oil and gas may be increased substantially in future and can disturb the macro-economic condition of Lao People's Democratic Republic. In such circumstances, gradual shifting of private and public transport vehicles to hybrid and electric mode would be an ideal choice for the country.
- It is important to include renewable energy as a separate sector and make budgetary allocations in the Five-Year National Socio-Economic Development Plan formulated by Ministry of Planning and Investment, Government of Lao People's Democratic Republic.
- Regulations on pricing mechanism such as the feed-in tariff for renewables should be implemented to provide guaranteed price and off-take for the electricity generated from renewable energy sources. The regulations on 'net metering' should be introduced to encourage individuals to install solar roof-top systems on of commercial/residential buildings.

- It is important to have a simplified procedure for getting various clearances for setting up RE power projects as well as simplified norms for availing the duty/tax related incentives offered by the Ministry of Planning and Investment.
- At present, Lao People's Democratic Republic provides both financial and non-financial incentives to the investors based on different sectors and zones. In order to establish an RE manufacturing base in Lao, the role of SMEs shall be most important. Therefore, to encourage participation of SMEs in RE manufacturing, special type of incentive structure needs to be devised.
- Budgetary provisions from the government should be increased. At present the development depends on the foreign funding and private sector (IPPs)
- Review of RE lending policies and practices is required. RE finance should be included under 'priority sector lending.' Banking institutions particularly the Agricultural Promotion Bank should be involved in providing soft loans for encouraging sustainable energy technologies in rural areas. There is need for government support for R&D in renewable energy and sustainable applications. It is important that academic institutions be encouraged to participate in technology innovations related to RE and sustainable energy applications.
- Public-private partnerships should be encouraged to promote solar home applications in rural areas. In doing so, the government should clearly specify its grid expansion plans, and identify regions that are suitable for off-grid solar applications. Further, the government should prepare phase-wise targets for system deployment, establish a cost sharing mechanism, ensure product quality and provide partial subsidy to reduce upfront cost of solar systems. The public-private partnership may be implemented through Energy Service Company (ESCO) mechanism involving government, ESCOs empanelled by the local authorities and banks. Solar power deployment programme shall be implemented by introducing solar photovoltaic systems for rural home lighting, solar thermal applications for cooking and industrial heating/drying, and solar thermal systems for water heating.
- Community participation should be encouraged in promoting off-grid technologies. The government should build awareness about community-based projects, facilitate private participation through information dissemination, provide finance through banks, and provide subsidy to reduce upfront costs. Community participation may be promoted through a joint venture between the community cooperative and private entity with clear distribution of labour among the cooperative, private entity and a local NGO responsible for community capacity building.
- Operation of Mini-grid project under Public Private Partnership mode shall be encouraged to generate and supply electricity in the non-electrified remote areas away from the centralized grid. Private entrepreneurs may be encouraged to operate and maintain such projects for which necessary viability gap funding may be provided by the government. In case of extension of grid in future, such mini grid project may be allowed to connect to the grid and the mini grid plant operator may allow to work as distribution franchises of distribution company.
- For effective implementation of the sustainable energy programme, the role of Institute of Renewable Energy Promotion (IREP) and Renewable Energy and New Materials

Institute (REMI) are important. Both these institutes should be strengthened. Enough budgetary and staff provision should be made from year-to-year to facilitate such capacity building.

- There is need for knowledge dissemination and institutional capacity building at provincial/district level with regard to sustainable energy options and sustainable energy services.
- Human resource development can be done through education from school level to doctoral level, management courses and specialized training courses at various levels. The curricula of educational and training institutions should be revised to include sustainable energy related subject, and laboratory infrastructure should be strengthened.
- It is important to have information on appropriate technologies and sustainable business mechanisms for promoting sustainable energy options and sustainable energy services in Lao People's Democratic Republic.
- Lao People's Democratic Republic can engage in South-South cooperation with other developing countries whose experience in promoting sustainable energy technologies may become helpful for the country. It may gain an understanding about government's participation, women's participation in decision making and capacity development from Nepal's experience in rural energy development programme as well as dissemination of solar home system by Grameen Shakti in rural Bangladesh. Rice-husk-based biomass gasification technology used by Husk Power Systems and similar technology developed by Ankur Scientific Pvt. Limited for power generation from biomass in India may be transferred to Lao People's Democratic Republic under South-South cooperation. The Ministry of New and Renewable Energy in India has taken initiatives to develop human resources in the RE sector. The experience of MNRE shall prove important in building human resources in the area of sustainable energy in Lao People's Democratic Republic.

# Chapter 1

## INTRODUCTION, OBJECTIVES AND METHDOLOGY

### 1.1 Background of the study

The Economic and Social Commission for Asia and Pacific (ESCAP) is implementing a project under the UN Development Account titled “Strengthening South-South Cooperation to Increase the Affordability of Sustainable Energy Options in Asia and the Pacific”. The project’s purpose is to increase affordability and access to sustainable energy options such as biomass, solar, wind, small-hydro and others, as well as energy saving building materials through enhanced South-South cooperation (SSC) in Asia and the Pacific, with the overall goal of achieving sustainable development. This project also aims to contribute to the objectives of the UN Secretary-General’s Sustainable Energy for All (SE4 All) Initiative to achieve universal access to modern energy services, doubling the global rate of improvement in energy efficiency and doubling the share of renewable energy in the global energy mix by 2030. The project’s intended outcomes are two-fold:

- (i) Strengthen capacity of policy makers and other relevant stakeholders, especially in Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, to develop and/or strengthen national policy frameworks which promote enabling policy and business environments for increased affordability and accessibility of sustainable energy products and services;
- (ii) Support implementation and dissemination among the countries in the region of good practices and successful business-mechanisms to provide sustainable energy products and services.

In line with the broader objectives stated under SE4 All initiative, the Asian Pacific Centre for Technology Transfer (APCTT) under ESCAP had contracted Mr. G.M. Pillai, Founder Director General, World Institute of Sustainable Energy (WISE), Pune, India as an international consultant to develop national strategy reports in cooperation with national consultants from two pilot countries, Lao People’s Democratic Republic and Indonesia. Along with preparation of national strategy reports, Mr. Pillai was also entrusted with the responsibility of (1) assisting in organizing and actively participating in the national workshops on sustainable energy options and national strategy development at Lao People’s Democratic Republic and Indonesia, (2) preparing workshop reports, and (3) assisting APCTT in identifying institutions and businesses in two or three countries, and organizing the study tours for policy makers and decision makers from pilot countries.

Focus of this report is to suggest suitable policy options for affordable sustainable energy and possibilities of South-South cooperation for Lao People’s Democratic Republic<sup>1</sup>.

### Affordability

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<sup>1</sup> United Nations ESCAP, Expert Group Meeting on the Regional Assessment on Increasing the Affordability of Sustainable Energy Options

In this context, affordability and South-South cooperation requires special attention. There is lack of a unique definition of affordability and it is different for different social groups within the country. Income is considered to be the most important factor in defining affordability. However, cultural and social preferences are also important aspects of affordability. While income determines ability to pay, cultural and social preferences influence willingness to pay and decision making for energy services. There are different approaches to measure affordability. One approach is to consider percentage of income paid towards procuring energy services. Another approach is to compare cost of production with respect to ability and willingness to pay.

Market development is important. An underdeveloped market hinders access to sustainable energy services as technologies and services do not reach people. In this regard, the government should declare grid expansion plans and identify regions which will be served by off-grid sustainable energy technologies. This, in turn, will eliminate dilemmas from the mind of consumers and consumers from identified regions will choose sustainable energy options. Thus, market for off-grid sustainable energy technologies will be expanded. Another way to expand market for sustainable energy options is to provide feed-in tariff for power producers using renewable resources. This will increase investment in sustainable energy power projects. Consequently, injection of electricity from sustainable energy sources into the grid increases. Initially price of grid connected electricity may be higher. However, over time the price will come down due to economies of scale and technology up-gradation.

Moreover, sustainable energy options should be linked with income generation activities so that affordability increases through linkage effect. For example, installation of solar home systems or community based off-grid projects provides with the opportunities of working for extended hours. This is helpful, particularly for women who can devote evening hours behind productive works. Entrepreneurial activities such as electronic goods repairing shops are created due to availability electricity. These activities improve economic health of the locality which in turn increases affordability for electricity.

## **South –South Cooperation**

South-South cooperation should be extended beyond technology transfer between developing countries. South-South cooperation provides with the opportunities to share experience, knowledge, information and build and strengthen existing regional networks and initiatives. Besides, South-South cooperation may help in better understanding of technology and associated aspects (such as management, administration, operation and maintenance etc.) through capacity building of local people. Local people may be trained by forerunners in related areas for acquiring soft skills pertinent to the project.

There is a need for evaluating existing studies and pilot projects to find out reasons for success and failure of projects. These lessons need to be made available to regional and national policy makers. In this context, regional centres of excellence and APCTT's existing renewable energy technology database may be used for information sharing platform.

It is felt that only exchange workshops and study tours are not sufficient to execute South-South cooperation. The follow up management for peer-to-peer interaction on transfer of technology, knowledge, strategy and networking is crucial. For example, exchange visits should be followed

by appropriate plans and government support for extending South-South cooperation in the long term. A forum should be created where all stakeholders including the government and the private sector will discuss the needs and strategies for affordable sustainable energy.

However, there are limitations to South-South cooperation. For example, different countries have diverse economic, political, social and cultural system which should be considered while engaging in South-South cooperation with another country. Thus, South-South cooperation is suitable between two countries having more or less similar milieu for dissemination of technology and associated aspects. Moreover there are tendencies to show only the positive factors of a project. But negative factors should also be considered to address the gaps in the system.

This report analyzes the existing enabling environment for the development of renewable energy options and technology innovation ecosystem in Lao People's Democratic Republic . This report also analyzes existing prominent business mechanisms in the country. The report suggests suitable renewable energy technology options for the country from the context of enabling environment. In suggesting suitable renewable energy technologies, few case studies from other developing countries have been cited. In the end, the report suggests suitable policy options with business mechanisms and programmes for developing renewable energy in Lao People's Democratic Republic and possibilities of South-South cooperation with other countries.

## **1.2 Scope of Work for Designing the National Strategy Report**

The International consultant had to prepare national strategy reports presenting:

- (a) an analysis of salient features of challenges and opportunities in the current national enabling environment and innovation eco-system for sustainable energy;
- (b) key elements of technology delivery and business mechanisms for increasing affordability of and access to sustainable energy and energy saving products, paying particular attention to the role of South-South cooperation;
- (c) sustainable energy options relevant to the pilot countries from the context of their enabling environment, identify specific projects/case studies that could be successfully implemented as pilot/demonstration projects making sustainable energy affordable and accessible;
- (d) recommendations on policy approaches, Programmes, delivery mechanisms and business mechanisms to implement the national strategy with examples from other developing and least developed countries;

Last point in the scope of work discusses about business mechanisms which are integral part of policy recommendation and implementation. In Lao People's Democratic Republic, many households lack not only financial resources for getting access to electricity, but also necessary electricity demand to support financially viable electricity programmes. Therefore, innovative business mechanisms are required to ensure access to finance and demand for electricity. Through a business mechanism, various institutions and stakeholders are entrusted specific roles. The main objective of a business mechanism is to prioritize the financially viable, efficient RE technologies within the existing regulatory and policy framework.

There is no one-mechanism-fits-all solution for business mechanisms for electrification. Business mechanisms vary depending upon the topography of a region, demographic character,

institutional structure, characteristics of the stakeholders, nature of demand, economic activities of the region or locality, existing legal, regulatory and policy framework and available energy technologies. Thus, experiments with different types of business mechanisms for electrification are visible across the globe. Examples of business mechanisms pertinent to the grid-connected technologies are state-owned utilities model in India or co-operatives in Bangladesh. The examples of business mechanisms pertinent to off-grid technologies include Energy Services (ESCO) mechanisms in India and Zambia, leasing mechanism in India and Laos, community managed systems of Nepal and Sri Lanka etc.

In the case of Lao People's Democratic Republic, suitable business mechanisms have been adopted keeping in mind the need for different sections of the society. One example is the 'Energy Services Company (ESCO)' mechanism which involves banks as finance providers, energy services company as service provider and households as the beneficiary. Another model suggested is mini-grid project under public private partnership mode involving government as bid administrator and private sector as responsible for project commissioning, operating and maintaining. The private sector firm is selected based on least viability gap quoted in the tendering.

### **1.3 Methodology**

The national strategy report suggesting the policy approaches, programmes, delivery mechanism, business mechanisms in the context of an enabling environment for increasing affordability of and access to sustainable energy options / services is a result of extensive research of literature available on the authentic websites on the internet, academic reports, as well as media materials. However, the national assessment framework on enabling environment, technology innovation ecosystem for making sustainable energy options affordable and accessible remains the axis of the study and this was prepared keeping in mind the parameters required for creating a robust national enabling environment and technology innovation ecosystem. The entire assessment framework is divided into six broad sections, namely, national scenario for sustainable energy, technology enabling environment and ecosystem, business enabling environment and ecosystem, business mechanisms for SET delivery, social economic factors and South-South cooperation. A set of questions on different parameters were posed under each category of the assessment framework. Information on these questions and parameters is provided below.

### **National Scenario for Sustainable Energy**

Under this section information on topology, number of states and provinces in the country, administrative set up, population, electrification ratio, and current power sector set up were asked to understand the country perspective. Under resources availability and access section information were asked on share of different sources of energy in country's primary energy mix, resource potential on fossil fuel and renewable energy, installed capacity of grid-connected and off-grid RE technologies, and programmes implemented at various levels of government in the country along with their success and failure factors. Information on sectoral and household level energy and electricity consumption in the past, forecasted demand for energy and electricity, and availability of electricity in urban and rural areas were sought for need and demand for energy section. For analyzing Laos current energy shortage, questions on energy demand-supply and energy efficiency were raised. Market for energy services were captured through questions on

identification of customers for decentralized RE application and suitable RE technologies, services for rural and urban areas.

### **Technology Enabling Environment and Ecosystem**

There are three subsections under technology enabling environment and ecosystem. These sections are government initiatives to promote sustainable energy technologies (SETs), institutional and human resource development framework and SET manufacturing capacity. Under government initiatives to promote SET, information was sought for assessing role of government in creating an enabling environment to promote SETs. Information asked in this section included how favorable are existing laws, regulations and policies for SETs, whether RE targets and renewable purchase obligations (RPO) have been specified, how do government measures facilitate private participation in the energy sector, how much subsidy is dolled out for fossil fuel and renewables. Under institutional and human resource development section information was sought for institutes involved in implementing RE and energy efficiency programmes, services offered by financial institutions for grid connected and off-grid SET development, instances of capacity development of local and national institutes for project implementation, academic curricula in respect of coverage of RE, specialized courses on RE, institutes having expertise in policy making and R&D and ministries involved in promoting SETs. As per as RE manufacturing capacity is concerned, information on RE and SET manufacturing base in the country, government support in RE manufacturing and effectiveness of local environment in attracting private entrepreneurs, investors, foreign direct investment were asked in the assessment framework.

### **Business Enabling Environment and Ecosystem**

Under this section information on public financing of SETs, end user financing and participation of private sector in RE were asked. Under public financing section questions were asked on availability of public fund for credit guarantee, risk mitigation and insurance support, import regulations, clean energy fund, considering RE sector for priority sector lending and incentive mechanism such as tax credit, soft loans, generation based incentives, revolving fund etc. Under end user financing, information was sought on examples of government incentives in promoting use of RE, usefulness of micro finance institutions, financial arrangements for micro finance institutions and development finance organizations, examples of income generating activities for RE project implementation so that affordability is increased and involvement of local co-operative society in financing SE, RE products and services. Regarding private sector participation in RE, information were asked on existing policies, laws, regulations for providing market access to private sector, institutional framework for sanctions of private sector in the country, barriers faced by the private sector and financial and fiscal incentives provided to remove these barriers.

### **Business Mechanisms for SET Delivery**

Under this section questions were posed to judge existing business mechanisms with respect to certain parameters that epitomize affordability of and accessibility to SETs. Discussion under this section is catered around character of the business mechanisms, service provision and distribution mechanism and country-specific risks that could impede project implementation. For assessing character of business mechanisms questions were asked on robustness of SET project with respect to economic viability, type of approvals required from concerned authorities and ease of getting such approvals, improvement in standard of living in the community and benefits to disadvantaged segments by setting up the RE project, challenges in terms of logistics and

distribution mechanisms in remote areas, quality control mechanism for building up consumer confidence, government initiative on entrepreneurial capacity building, monitoring mechanism set for evaluation of efficiency of the project. Under service provision and distribution mechanism information was sought on fiscal and financial benefits available to local community to suit their needs, possibilities on building local energy services distribution chain and problems of reaching rural population for goods and services. For assessing country specific risk to a business mechanism questions were asked on instances of lack of community involvement during the implementation stage, lack of commitment shown by the government, non-participation by financial institutions, availability of alternative solutions other than the one considered by the project proponent.

### **Socio Economic Factors**

Socio economic condition influences decision making regarding sustainable energy. Issues in this section cater around two aspects—social factors and affordability. Questions in social factors section are based on issues such as awareness efforts made by the government in promotion of SET, openness to adopt of technology, community participation in energy product development and energy services, suitability of SET product and service based on difference in consumer preference, cultural diversity and rural-urban characteristic of population, involvement of women and disadvantaged groups, NGOs and local community in promotion of SET. Economic factors have been discussed through analysis of affordability and accessibility. Information sought for affordability are various applications used along with their average unit prices, monthly spending on alternative to RE energy sources, subsidies on fossil fuel, end user financing schemes, end user's ability to afford sustainable energy services, social and cultural preferences.

### **South-South Cooperation**

In this section possible area for country level cooperation with countries of global south has been discussed. In this section information has been sought mainly on coordination with private sector, NGOs and organizations for plans and programmes, RE systems deployment, project life cycle, waste disposal, skill and capacity building, and trade.

National consultants provided information on the above national assessment framework questionnaire developed by the International consultant. The international consultant relied on the information provided by the national consultants on the current national assessment framework on enabling environment, and technology innovation ecosystem for making sustainable energy options accessible and affordable. The consultant also benefited from the outcomes of the two day national workshops on sustainable energy options and national strategy development organized at Vientiane, Lao People's Democratic Republic, during 11-12 February 2014 and 15-16 May 2014.

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## Chapter 2

# ANALYSIS OF CURRENT NATIONAL ENABLING ENVIRONMENT FOR SUSTAINABLE ENERGY DEVELOPMENT IN LAO PDR

### 2.1 Introduction

Affordable energy services are among the essential ingredients of economic development for any country, including eradication of extreme poverty as called for in the United Nations Millennium Development Goals (MDGs). Modern energy services—mainly provided by liquid and gaseous fuels, as well as electricity—are essential for building enterprises and creating jobs. Convenient, affordable energy is also important for improving health and education, for reducing drudgery of conventional cooking, and meet other basic needs.

Meeting these essential energy needs economically and sustainably requires a balanced energy portfolio that is suited to the economic, social, and resource conditions of individual countries and regions. Renewable energy sources such as wind, solar, hydro, geothermal, and bio-energy thus have an important role to play, alongside fossil fuels, in an energy portfolio aimed at achieving sustainable development and inclusive growth of the nation.

Sustainable energy technologies/ options face a number of barriers which causes delay in scaling up their production and use in developing countries. Unlike conventional energy sources which have benefited from decades of research and development, established industrial base, and government subsidized infrastructure support, sustainable energy options are just gaining popularity in many regions. New policies can have a dramatic impact on the pace of introduction of renewable energy, as several developing countries have demonstrated. The present chapter presents an analysis of the prevailing national enabling environment and ecosystem for sustainable energy development, along with the challenges and opportunities for sustainable energy development in the current national enabling environment.

### 2.2 Country Profile



Laos People's Democratic Republic is a landlocked country of about 236,800 square kilometres, located in the heart of the Indochina peninsula. The country is divided into 17 provinces and Vientiane is the capital. Its longest borders are those with Thailand to the west and Viet Nam to

the east; it is also bordered by China to the north, Cambodia to the south and Myanmar to the northwest.

The country stretches 1,700 km north to south and between 140 to 500 km from east to west. Lao People’s Democratic Republic is heavily forested and mountainous. There is an abundance of rivers, including a 1,900 km section of the Mekong River (Nam Khong). The terrain comprises of mostly rugged mountains, with the highest point at 2,820 m, which gives the country good hydroelectric potential. Forest and woodland cover 47% of the land area.

Lao People’s Democratic Republic also has natural resources, including coal, hardwood timber, hydropower, gypsum, tin, gold and gemstones. These resources all play a significant part in the economy. The country has a tropical monsoon climate, and experiences three distinct seasons. The cool season lasts from October to February, when the average temperature drops to about 16 degrees Celsius. The hot season is from the end of February to April when the temperature in the south can reach 40°C. The rest of the year is the rainy monsoon season. The mountainous regions experience more than 10°C cooler temperatures, and these regions can become very cold during winter. In January, highland temperatures can drop to even 0°C.

Lao People’s Democratic Republic is a country rich in natural resources which is traditionally agrarian, but is now in transition phase, becoming more urbanized, with a market-oriented economy increasingly integrated with neighbouring countries in the Greater Mekong Sub-region. Between 2002 and 2012, Lao People’s Democratic Republic has experienced robust economic growth averaging 7%–8% annually. Mining and hydropower investments have increased significantly in recent years, making important contributions to economic growth.

**Table 1: Key Economic Indicators<sup>1</sup>**

Indicator	Value	Unit
Land area	236,800	km <sup>2</sup>
Population*	6.51	million
GDP*	72,727	Billion KN
GDP per capita*	1,396	USD

(\* reference year 2012)

## 2.3 Energy Resources<sup>2,3</sup>

### 2.3.1 Conventional Sources of Energy

**Coal and Lignite:** Lao People’s Democratic Republic’s coal reserves are estimated to be about 600 million–700 million tons, occurring mostly as lignite with smaller amounts of anthracite. The largest reserve of lignite has been found in Hongsa in Xayabouly province; it is estimated to contain about 400 million tons, or more than half the estimated total reserves of the country. The mid-grade lignite is suitable for electricity generation and meeting other industrial thermal energy requirements. Coal consumption is currently limited to a cement factory, using about 35,000 tons per year, and a few smaller users.

**Oil and Gas:** There are no proven resources of oil and natural gas in Lao People’s Democratic Republic.

<sup>2</sup> National Assessment Framework on Enabling Environment, Technology Innovation Ecosystem for making Sustainable Energy options Affordable and Accessible – Report prepared by National Consultants, Lao People’s Democratic Republic

<sup>3</sup> Asian Development Bank, Independent Evaluation Department, Sector Assistance Programme Evaluation for the energy Sector in Lao People’s Democratic Republic

### 2.3.2 Renewable Energy Sources and Applications

**Hydropower:** The Mekong river sub-basins in Lao People's Democratic Republic have an estimated 20,000 MW of technically viable hydropower potential. By 2013, 2,971 MW of this capacity has been developed and is operational for both domestic consumption and export. Another project under construction has a total installed capacity 6,054 MW, in which IPP export accounts for 4,413MW; and domestic use 1,495.5 MW.

Additionally, 75 new hydropower projects are in various stages of study, approval, and design. Hydropower plants (HPPs) provide electricity both to domestic customers (through the grid) and foreign markets (Thailand and Viet Nam).

**Small-hydropower:** Hydropower installations in Lao People's Democratic Republic with capacity less than 15 MW are considered as small-hydro. The estimated potential for small-hydropower in Lao People's Democratic Republic is around 2000 MW. To date, around 30 MW capacity projects have been developed, out of which 19.7 MW capacity projects are connected to the grid. Projects with a total capacity of 82.7 MW are currently under construction.

**Biomass:** Every year, the agriculture and forestry sectors produce large amounts of waste, such as rice straw and husks, sawdust, and corn cobs. The annual energy potential of this waste is estimated at 500 million tons of oil equivalent (mtoe), which can be used as feedstock for power generation. So far, biomass is only used at the household level, as more than 80% of the population still relies on biomass energy, especially for cooking. Biomass is also used for small-scale rural industrial production (e.g., alcohol production and tobacco processing). The country also has high potential for bio-fuel production from oily crops such as jatropha, oil palm, and soybean. The estimated potential from biogas and solid waste resources is around 313 MW and 216 MW respectively. Lao People's Democratic Republic is developing a national Programme on bio-fuel development, with a vision to introduce 10% bio-fuel in the transport sector by the year 2025.

**Solar:** Lao People's Democratic Republic has an average of 200-300 sunlight days per year, with more sunlight days in the south. The potential capacity of solar energy is estimated at around 4.5-5.0 kilowatt-hours (kWh) per square metre (m<sup>2</sup>) per day. Solar power has the potential to play a major role in providing off-grid electric power for remote rural areas. At present, around 13,000 households, mostly in remote areas have been supplied with solar home systems. However, limited progress has been made in the grid-connected solar sector, with only one existing rooftop solar photovoltaic (PV) system (of 236 kW capacities) installed at Watty airport.

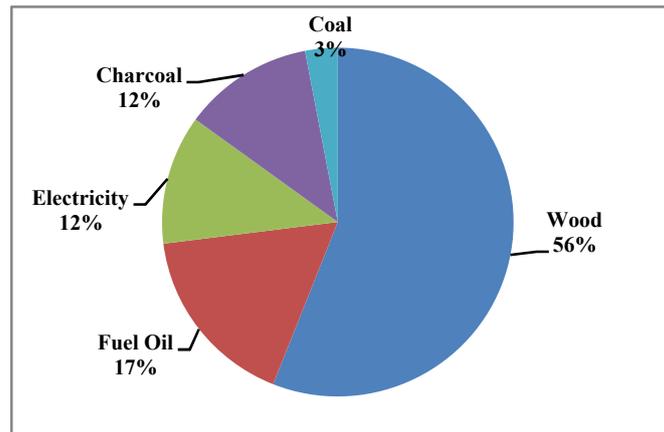
**Wind Power:** Scientific wind resource assessment for identifying the wind power potential has not yet been undertaken in Lao People's Democratic Republic. The preliminary GIS base resource assessment study conducted by WISE reveals 4-5 m/s wind speed at 80 m hub height.

The Lao Government has signed an MOU with Impact Energy Asia Limited for conducting wind resource assessment in Lao People's Democratic Republic. The basic feasibility study conducted at 2 sites at Nong and Xonbuly districts of Savannakhet Province indicate wind power potential of 64 MW.

### 2.4 Primary and Final Energy Consumption (during 2013)

The primary energy source in Lao People's Democratic Republic, as in many developing countries in the region, is biomass. In terms of final energy use, biomass accounts for less than 60%, petroleum products account for about 17%, electricity for 12%, and charcoal and coal for 14%.

**Figure 1: Final Energy Use by Source**

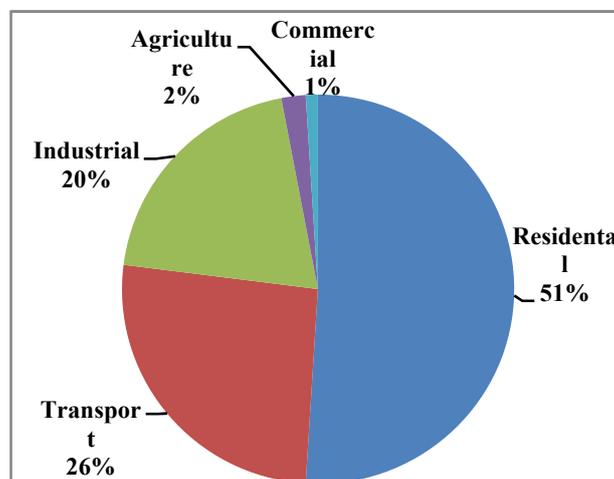


Source: Presentation made by Mr. Bounchanh DOUANGVIAIY, Deputy General, REMI, 11-12 Feb 2014

## 2.5 Sector-wise Energy Consumption (during 2013)

In 2012, total final energy consumption was 2,336 kilotons of oil equivalent (ktoe). Households account for 51% of total final energy consumption, the transport sector for 26%, the industrial sector for 20%, agriculture sectors 2%, and commercial sector 1%. The high share accounted for by households reflects their reliance on biomass, which has low efficiency. The sector-wise consumption also reflects the relatively low level of industrial and commercial activity. While petroleum fuels are used for transport and industry, they are also used to generate electricity by households yet to be connected to the grid. All petroleum fuels are imported.

**Figure 2: Sector-wise Energy Consumption**



Source: Presentation made by Mr. Bounchanh DOUANGVIAIY, Deputy General, REMI, 11-12 Feb 2014

## 2.6 Installed Capacity of Power Projects in MW

The current installed capacity of power generation projects stand at 3020.27 MW as on February 2014. The energy mix is dominated by hydro (98.61%). The hydropower projects consist of projects installed by EDL (electrical utility in Lao), those set up by independent power producers for domestic use, and for export purpose.

**Table 2: Installed Capacity of Power Generation Projects (as on February 2014)**

Source	Installed capacity (MW)
Hydro	2,978.17
Biomass	39.74
Diesel	1.491
Solar	0.873
<b>Total</b>	<b>3,020.27</b>

## 2.7 Access to Grid Electricity

As on December 2013, a total of 943,599 households out of 1,080,342 were electrified across the country, which means that 87.34% households were electrified. Out of this, about 2% were electrified by RE based / hybrid off-grid systems. This indicates that there are 1,696 villages in which 136,743 households (12.66%) remain un-electrified, located in the remote, less dense parts of the country.

## 2.8 Energy Demand<sup>4</sup>

Future energy demand has been projected to increase at an annual average rate of 6.7% for real GDP growing at an annual average of rate of 7.1% for the period 2010-2025; therefore GDP elasticity to energy is 0.94. Coal and electricity will expand their shares from 4.4% in 2010 to 19.9% in 2025, and 8.7% in 2010 to 14.6% in 2025 respectively; however, these shares will still be only half of that of fuel wood and charcoal (35.1%) and petroleum products (28.0%).

By sector, the industrial sector, which is assumed to have high real GDP growth, will rapidly increase demand (annual average 15.3%), expanding its share from 9.6% (2010) to 31.1% (2025), which will be higher than the transportation sector (29.2% in 2025), and household (residential) sector (29.3% in 2025). On the other hand, the annual average increase in the rate of residential use will remain at 2.6% from 2010-2025. The energy demand by source and sector are illustrated in table below.

**Table 3: Energy Demand by Source (in ktoe)**

Source	2000	2010	2015	2020	2025
Coal	0	106	355	746	1,268
Petroleum products	272	592	981	1,355	1,781
Biodiesel	0	0	0	46	127
Bioethanol	0	0	0	11	27
Electricity	55	210	393	633	927
Fuel wood	1,103	1,386	1,561	1,752	1,954
Charcoal	71	128	174	226	279
<b>Total</b>	<b>1,502</b>	<b>2,442</b>	<b>3,464</b>	<b>4,769</b>	<b>6,364</b>

<sup>4</sup>National Assessment Framework on Enabling Environment, Technology Innovation Ecosystem for making Sustainable Energy options Affordable and Accessible – Report prepared by National Consultants , Lao People’s Democratic Republic

**Table 4: Energy Demand by Sector (in ktoe)**

Sector	2000	2010	2015	2020	2025
Industry	63	232	615	1,193	1,977
Transportation	266	564	939	1,354	1,859
Commercial	210	332	431	528	611
Residential	959	1,269	1,466	1,651	1,865
Agriculture	3	21	26	30	35
Non-energy	0	3	7	12	17
<b>Total</b>	<b>1,502</b>	<b>2,442</b>	<b>3,464</b>	<b>4,769</b>	<b>6,364</b>

### 2.8.1 Electricity Demand<sup>5</sup>

The demand for the residential sector is expected to grow gradually from year 2010 to 2020, with an average rate of increase of about 7%. Non-residential demand is expected to increase substantially due to the rapid growth of demand from factories and mines. The average growth rate of non-residential demand, except SLACO, is 33% a year from 2010 to 2020.

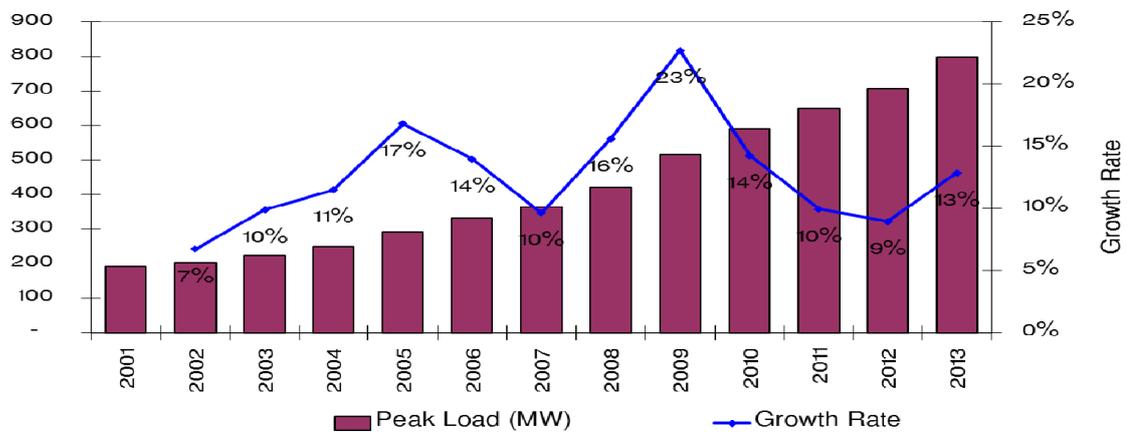
**Table 5: Demand Forecast (in MW)**

Year/consumers	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Residential	492	522	557	592	631	673	718	769	838	916	1,004
Factory	17	45	133	214	260	475	578	778	785	793	794
Mining	75	77	168	176	192	320	536	539	521	524	527
SEZ	-	-	10	35	58	70	116	120	180	180	210
Construction	-	24	33	27	159	395	311	143	147	70	41
Railway	-	92	120	120	120	49	21	21	21	21	21
Subtotal	584	758	1,021	1,165	1,420	1,982	2,281	2,371	2,492	2,504	2,597
SLACO	-	-	-	-	100	900	900	900	900	900	900
<b>Total</b>	<b>584</b>	<b>758</b>	<b>1,021</b>	<b>1,165</b>	<b>1,520</b>	<b>2,882</b>	<b>3,181</b>	<b>3,271</b>	<b>3,392</b>	<b>3,404</b>	<b>3,497</b>

### 2.8.2 Peak Load Served

There is a continuous increase in peak load requirement from year 2010 as shown in the figure below. The peak load served during year 2013 was around 800 MW.

**Figure 3: Growth Rate of Peak Load from 2001 to 2013**

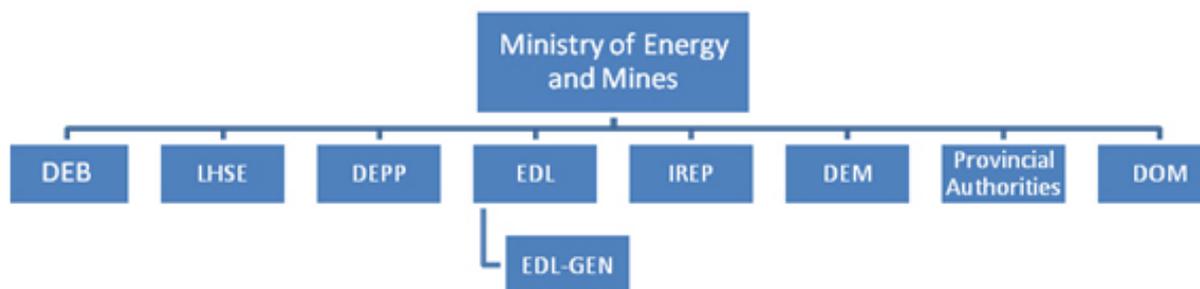


Source: Presentation made by Mr. Mr. Vilaphorn Visounnarath , Deputy Director, EDL 11-12 Feb 2014

<sup>5</sup> National Assessment Framework on Enabling Environment, Technology Innovation Ecosystem for making Sustainable Energy options Affordable and Accessible – Report prepared by National Consultants , Lao People’s Democratic Republic

## 2.9 Organization of the Energy Sector

Management of energy-related activities in Lao People’s Democratic Republic is looked after by the Ministry of Energy and Mines (MEM), EDL, and Lao Holding State Enterprise (LHSE), with support from the Ministry of Finance and the Ministry of Natural Resources and the Environment (MONRE). The MEM is responsible for energy policy and overall strategic guidance, as well as management of sector development. The various departments under MEM are shown in the following diagram.



**Figure 4: Organization Chart of Ministry of Energy and Mines**

DEB: Department of Energy Business, LHSE: Lao Holding State Enterprise, DEPP: Department of Energy Policy and Planning, EDL: Electricite du laos, EDL-GEN: EDL Generation Public Company, IREP: Institute of Renewable Energy Promotion, DEM: Department of Energy Management, DOM: Department of Mining

The Electricity Law of Lao People’s Democratic Republic amended in year 2011 prescribes that the Ministry of Energy and Mines (MEM) is responsible for making the policy and strategy for the nation's electricity sector. MEM also has the responsibility to develop and implement laws and regulations, and to supervise the businesses of electricity companies. The task and responsibilities assigned to the various departments under the MEM are elaborated below.

**Department of Energy Business (DEB):** Formerly known as the Department of Energy Promotion and Development, the DEB is in charge of private sector investments in the power sector. DEB is responsible for overseeing the investment in transmission projects and coal-fired thermal power projects. While DEB is involved in planning, development, and appraisal of project proposals, its main role is in negotiating project development agreements, concession agreements, and power purchase agreements. DEB’s duties also include monitoring project implementation.

The department has four divisions: Administrative Division, Contract Division, Project Development Division, and Project Monitoring Division.

**Department of Energy Policy and Planning (DEPP):** DEPP is in charge of policy-making and planning, and is responsible for energy policy-making, energy /electricity supply planning.

**Department of Energy Management:** This newly created department is in charge of drafting energy-related laws, regulations, guidelines, and technical and safety standards. The DEM also monitors government agencies, state-owned enterprises, and private operators to ensure that they operate in accordance with the rules and regulations. Further, the DEM monitors the energy use of enterprises, factories, and buildings and presents energy awards to the most efficient users. Another important function of the DEM is inspecting the technical standards of electrical equipment and appliances, either domestically produced or imported. The department issues energy business licenses and approves or rejects extensions. The DEM also provides technical consultation services, and information on energy administration and management.

**Institute of Renewable Energy Promotion (IREP):** Equivalent to a department, the IREP is mainly responsible for promoting renewable energy and conservation by implementing the Renewable Energy Policy and Strategy prepared in 2011. In support of renewable energy, the IREP is tasked with developing small-scale hydro, biodiesel, and biogas projects, and with preparing a manual on renewable energy production and use. In support of rural electrification, the institute formulates and implements a rural electrification master plan. In support of EEC, the IREP formulates regulations, guidelines, and a user's manual on EEC. Its conservation targets include developing more efficient cooking stoves and implementing a mechanism project on EEC.

**Electricité du Laos (EdL):** EdL is a state-owned electric power utility, supplying electricity to domestic consumers through its transmission and distribution lines. EdL also manages import and export of electricity. EdL owns transmission lines and distribution lines for domestic supply countrywide, obtains electricity from EdL-owned power stations, EdL-Gen, IPP set up for domestic supply, off-takes from IPP set up for export of power, other power stations, and imports from neighbouring countries. EdL was initially a vertically integrated utility, which owned generation, transmission, and distribution facilities, and was responsible for generate, transmit, and sell electricity. In 2010, following directives from the Government of Lao on restructuring the electricity industry in the country, the function of electricity generation was handed over to EdL-Gen Company.

**EdL-Gen:** EdL-Generation Public Company (EdL-Gen) was established on 15 December 2010 as the first publicly-held enterprise in Lao People's Democratic Republic listed on the Lao Securities Exchange (LSX). The main objectives of EdL-Gen are (1) to generate energy for EdL for wholesale, and in the future to export (this includes development of transmission lines and substations, as necessary), (2) to invest in or set up joint ventures with other electricity generation projects, and (3) to provide management and maintenance services for other electricity projects.

**Lao Holding State Enterprise (LHSE):** Lao Holding State Enterprise (LHSE) is a state-owned stock-holding enterprise established in 2005. The mission of LHSE is to hold and manage shares of IPP projects.

Besides the above mentioned departments/companies, the government has also set up the provincial department of energy and mines (PDEM) and district energy and mines office (DEMO) which work under the MEM, at the provincial and district levels respectively.

## **2.10 Energy Policy, Law, Regulations**

Lao People's Democratic Republic does not have a comprehensive national energy policy setting out a systematic approach to energy planning, policy formulation and sector development. However, the government has notified a Law on Electricity, as well as few policies / strategies for development of large hydro and renewable energy sources. Besides the Lao Electric Power Technical Standards, and the grid code, the country does not have any regulation to manage the power sector operations.

**Law on Electricity:** The Law on Electricity for Lao was amended in 2011 and enacted on 20 December 2011 by replacing the earlier Law on Electricity notified on 8 December 2008. The Law on Electricity specifies the principles, rules and measures on the organization, operation, management and inspection of electrical activities for the high effectiveness of electricity generation and business operation with the aim to use the natural resource potential in an economical and sustainable manner, to encourage the implementation of the national socio-economic development plan, and to improve the living conditions of the multi-ethnic people. The

law is divided into ten chapters and 81 articles specifying the principles and guidelines for conducting electricity generation, transmission, and distribution business in Lao People’s Democratic Republic. The Law also recommends the strategies for development of rural electrification network and methodologies for pricing of electricity.

**National Socio-Economic Development Plan (NSEDP) 2011-16:** The main objectives of the government’s NSEDP for 2011–2015 include rapid economic growth and poverty eradication; achievement of the MDGs by 2015; graduation from least-developed country status by 2020; and sustainable economic, social, and environmental development. The NSEDP, 2011–2015 identifies the energy sector as a strategic development sector, both for the short and longer terms. Its performance is vital for meeting the country’s energy requirements, notably with respect to the still-elusive goal of nationwide electrification. Development of the sector is central to modernization and industrialization of the country, which is the primary basis for raising the living standards and poverty reduction.

**Renewable Energy Development Strategy:** The government of Lao People’s Democratic Republic launched the Renewable Energy Development Strategy in October 2011, which so far is the main policy framework for the development of renewable energy in the country. The strategy targets to increase the share of renewable energy in total energy consumption to 30% by 2025. The government also aims to replace 10% of transport fuels by bio-fuels during the same period, the target detail of each renewable energy are illustrated in table below.

**Table 6: Renewable Energy Capacity Addition proposed in Renewable Energy Strategy<sup>13</sup>**

Item	Phase Description	2015 MW	2020 MW	2025 MW
1	Electricity	140	243	725
1.1	Small-hydropower	80	134	400
1.2	Solar	22	36	48
1.3	Biomass	13	24	58
1.4	Biogas	10	19	51
1.5	Municipal solid waste	9	17	36
1.6	Wind	6	12	73
2	Biofuels production	ML	ML	ML
2.1	Ethanol	15.42	34.62	97.6
2.2	Biodiesel	22.25	63.93	194.5
3	Heat	Ktoe	Ktoe	Ktoe
3.1	Biomass	23	29	113
3.2	Biogas	22	44	178
3.3	Solar	17	22	109

**Policy on Sustainable Hydropower development in Lao People’s Democratic Republic:** The policy on sustainable hydropower development in Lao People’s Democratic Republic (PSHD) applies to all hydropower projects larger than 15 MW throughout the project development process (planning, construction, operation, and transfer/closure stages) and incorporates technical, engineering, economic and finance, and environment and social impacts aspects. The PSHD is being reviewed by the MEM at present.

**Power Development Plan:** Article 9 of the Electricity Law states that the electricity enterprise shall prepare the electricity development plan. EdL has been preparing the Power Development Plan (PDP) every three to five years. EdL formulated the PDP 2010-2020 in August 2010, revising

the former PDP 2007-2017. In August 2011, EdL updated PDP 2010-2020 by reflecting the latest electricity demand forecast and prospective project developments in the generation and transmission sector.

**Development of Regulation/law on Bio-fuels:** Lao People’s Democratic Republic is developing a national programme for bio-fuel development with a vision to introduce 10% bio-fuel in the transport sector by year 2025. Further, the (draft) Decree for regulation and utilization of bio-fuel in Lao People’s Democratic Republic, dated 11 September 2013 had classified the size of bio-fuel production and level of approval into three levels. Family business size production (less than 200 litres per day) requires licensing approval by the Energy and Mine District Office in accordance with the agreed organizations concerned. Small to medium size of business production (capacity between 201-9,999 litres per day) shall require licensing approval from the Energy and Mine Provincial Division, whereas large scale businesses with product capacity over 10,000 litres per day shall require licensing approval by the Ministry of Energy and Mines.

## 2.11 Electricity Market and Pricing Mechanism

EdL is a state-owned corporation under the Ministry for Energy and Mines which owns and operates the country's main generation, transmission, and distribution assets in Lao People’s Democratic Republic, and manages electricity imports into its grids and exports from its stations. EdL also has a project development role and has been the implementing agency for government hydropower power projects, and is also the government's shareholder in the case of IPP projects. It has been the past practice for EdL to take over from MEM the responsibility for a project, once a shareholder’s agreement is executed and the project loans are closed.

EdL’s own generating capacity is almost 100% hydro-based. The utility has 10 hydropower projects totalling 390.7 MW capacities, mostly of small capacity (less than 50 MW). Its largest power plant is Nam Ngum 1 (155 MW), commissioned in 1971. EdL’s own generation is insufficient for supplying to the domestic market; hence it buys power from a number of domestic IPPs. Currently, the largest domestic IPP is the Nam Lik 1/2 HPP, with a capacity of 100 MW. The total capacity of IPPs supplying electricity to domestic use stands at 285 MW.

**Table 7: Installed Hydropower Project Capacity in Lao People’s Democratic Republic**

HPP owned by EDL		HPP set by IPPs for domestic use		HPP set up by IPPs for export	
Name of project	Capacity (MW)	Name of project	Capacity (MW)	Name of project	Capacity (MW)
<b>Nam Ngum-1 (155 MW)</b>	155	Nam Lik 1/2	100	Theun Hinboun	220
<b>Xe Labam (5 MW)</b>	5	Nam Tha-3	1.2	Theun Hinboun Ext.	220
<b>Nam Dong (1MW)</b>	1	Nam Ngone	3.2	Houay Ho	152
<b>Nam Xeset-1</b>	45	Nam Phao	1.7	Nam Theun-2	1088
<b>Nam Ko</b>	1.5	Nam Ngum-5	120	Nam Ngum-2	615
<b>Nam Leuk</b>	60	Nam Gnouang	60		
<b>Nam Ngai</b>	1.2	Tat Salen	3		
<b>Nam Mang-3</b>	40				
<b>Xeset-2 (76 MW)</b>	76				
<b>Nam Song Ext</b>	6				
<b>Total</b>	<b>390.7</b>		<b>285.3</b>		<b>2295</b>

Source : presentation made by Mr. Chansaveng BOUNGNONG, Deputy Director General, MEM

Prior to 2009, EdL’s operations in Lao People’s Democratic Republic’s 17 provinces were divided into four areas–northern, central 1, central 2, and southern. Each area had a 115 kilovolt (kV) grid but they were not interconnected. During the 2009–2011, the 115 kV network has been expanded and interconnected, consolidating to three areas (central 1 and 2 have been combined). In addition to EdL’s network, the provincial authorities operate 85 mini grids, supplied either with diesel generators or small-hydropower stations. These facilities primarily serve remote areas not yet connected to the EdL grid.

### 2.11.1 Electricity Pricing Mechanism

Electricity tariffs in Lao People’s Democratic Republic are framed by the government; there is no independent regulatory authority for tariff determination purpose. With regard to retail tariff, EdL submits a draft electricity tariff proposal to MEM, and the government of Lao People’s Democratic Republic approves modification of the tariff in principle. The cost plus methodology in deciding feed-in-tariff (FIT) is not practiced in determination of generation tariff for the RE sources of energy. At present, the tariff for sale of electricity from renewable energy power projects are agreed based on the negotiations between power producers and power utility EdL.

The retail tariff determination of electricity is guided by the socio-economic conditions of the consumers, the types of use and of the user. The Ministry of Energy and Mines consults other departments to study the electricity price structure of each type to be submitted to the government for consideration within each period. The electricity tariff is set in nine categories for low voltage supply, and four categories for medium voltage supply. The tariff for residential use and irrigation are set at a lower level than that for other categories of consumers. The residential tariff and agricultural tariff are cross-subsidized to some extent by the industrial and commercial consumers.

**Table 8: Retail Tariff Structure in Lao People’s Democratic Republic<sup>6</sup>**

(Figures in kip<sup>7</sup>)

Category		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Low voltage 0.4 kV	Residential	0-25 kWh	75	99	113	115	133	154	177	203	203	269
		26-50 kWh					276	284	293	301	301	320
		51-150 kWh	176	231	265	265						
		150 kWh-	508	667	765	765	773	773	773	773	773	773
	Irrigation	196	257	295	295	313	247	345	362	362	399	
	Government Office	469	616	706	706	703	694	684	674	674	656	
	Industrial	422	555	636	636	634	625	616	607	607	591	
	General Business	549	721	826	826	835	835	835	835	835	835	
	International	9.9	9.9	9.9	1,066	1,077	1,077	1,077	1,077	1,077	1,077	
	Entertainment	727	955	1,095	1,066	1,066	1,066	1,066	1,066	1,066	1,066	
Medium voltage 22-35 kV	Irrigation	196			251	266	210	293	308	308	340	
	Industrial	422			541	539	531	524	516	516	502	
	Government Office	469			600	598	590	581	573	573	557	
	General Business	549			702	709	709	709	709	709	647	

<sup>6</sup> National Assessment Framework on Enabling Environment, Technology Innovation Ecosystem for making Sustainable Energy options Affordable and Accessible – Report prepared by National Consultants , Lao People’s Democratic Republic

<sup>7</sup> Lao currency

## 2.12 Fiscal and Financial Regime for Development of Energy Business<sup>8,9</sup>

As per the provision under the Investment Promotion Law of Lao People's Democratic Republic, the government provides both financial and non-financial incentives to investors based on different promoted sectors and promoted zones.

- Tax holidays offered up to 10 years.
- Exemption from export duty on export products.
- Exemption from land lease or concession fee up to 15 years.
- Exemption from import duties and taxes on raw materials and capital equipment using for production.
- Additional tax holidays are available upon negotiation for large concession projects.

Foreign investments subject to the Foreign Investment Law pay an annual profit tax at a rate of 10%, 15%, and 20% according to the promotion zone (other investments are taxed at 35%). The Lao Government specifies 3 promotion zones based on geographical location and socio-economic conditions. The zones are:

- Zone 1: Mountainous, plain and plateau zones, with no economic infrastructure to facilitate investments.
- Zone 2: Mountainous, plain and plateau zones with a certain level of economic infrastructure suitable to accommodate investments to some extent.
- Zone 3: Mountainous, plain and plateau zones with good infrastructure to support investments.

As far as investment in renewable and sustainable energy projects is concerned, there are no specific promotional incentives being offered by the government. However, for the sugar factories and biodiesel developers, the following incentives are allowed.

- Free import duty for production machinery, equipment, and raw materials;
- Free import duty for chemical materials necessary for biofuels production within seven years;

The Renewable Development Strategy of Lao People's Democratic Republic mentioned that all investments in renewable energy projects in Lao People's Democratic Republic, including that for bio-fuels production, grid-connected or isolated systems, off-grid projects, and individual systems, are entitled to investment incentives under the Investment Law of Lao People's Democratic Republic updated in 2009. The financial incentives include the following:

- Import duty free on production machinery, equipment and raw materials;
- Import duty free on chemical materials necessary for bio-fuels production within 7 years;

### 2.12.1 Overview of the Banking Sector

The current financial sector in the country consists of four state-owned commercial banks, 12 private banks (8 international, 4 domestic), two joint venture banks, 3 affiliated banks, three insurance companies (of which two are representative offices), one National Treasury under the Ministry of Finance, and the Agriculture Promotion Bank (a government institution that grants loans for agricultural development).

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<sup>8</sup> Investment Promotion Law 2009

<sup>9</sup> Investment in Lao People's Democratic Republic, KPMG Lao Company Limited, March 2009

The state-owned banks dominate the banking sector, accounting for 67.41% of all banking sector assets, and 62.98% of all bank loans (as of the fourth quarter 2009). There are four state-owned commercial banks in the Lao People’s Democratic Republic: Banque pour le Commerce Extérieur Lao (BCEL), Nayoby Bank, Agricultural Promotion Bank (APB) and Lao Development Bank (LDB).

Although the banks does not have adopted any specific policies for providing financial support to the sustainable energy/renewable energy business, the banks have provided loan for the renewable energy projects: for example, the Agricultural Promotion Bank have supported several biogas and bio-fuel projects. The Lao Development Bank is provided finance to the hydropower projects like ‘Namlong HPP’.

**Table 9: Snapshot of the Banking Sector in Lao People’s Democratic Republic<sup>1</sup>**

	Number	Assets Millions USD	Deposits Millions USD	Loans Millions USD	Loan-to- Deposit Ratio
State Owned Banks	4	1,486.98	1,035.95	654.29	63.16%
Joint Venture Banks	2	138.65	77.20	80.73	104.58%
Private Banks	4	152.58	134.78	97.77	72.54%
Affiliated Banks	3	142.41	55.72	53.29	95.64%
International Banks	8	284.96	117.32	152.86	130.29%
<b>TOTAL</b>	<b>21</b>	<b>2,205.59</b>	<b>1,420.97</b>	<b>1,038.94</b>	<b>73.11%</b>

*SOURCE: Bank of the Lao PDR, 4<sup>th</sup> Quarter Review 2009*

### 2.13 Energy Conservation Initiative

Energy conservation (EC) in the Lao People’s Democratic Republic is at an early stage. The government has yet to develop a comprehensive national strategy for Energy Efficiency and Conservation (EEC). There has been some assistance provided by multilateral and bilateral donors, most notably the World Bank assisted Rural Electrification Project concerning demand-side management.

With the creation of the Institute of Renewable Energy and Promotion (IREP), and the Department of Energy Management (DEM) under the Ministry of Energy and Mines, EC initiatives are now expected to be more coordinated. The IREP is preparing a national EEC strategy and draft regulations, and the DEM is preparing requirements concerning monitoring of energy use and labelling for electricity appliances.

The EdL is promoting efficient use of electricity in government offices, residential and industrial sectors by providing energy efficient lamps and air conditioning systems, and creating awareness on energy efficiency by providing training, and through mass media.

### 2.14 Institutional and Human Resource Development Framework<sup>10</sup>

The energy sector business including sustainable energy development work in Lao People’s Democratic Republic comes under the purview of the Ministry of Energy and Mines (MEM). Implementation of renewable energy / sustainable energy programmes is looked after by the Institute of Renewable Energy Promotion (IREP). The Lao Women’s Union, National University of

<sup>10</sup> National Assessment Framework on Enabling Environment, Technology Innovation Ecosystem for making Sustainable Energy options Affordable and Accessible – Report prepared by National Consultants , Lao People’s Democratic Republic

Laos, and EdL are some other organizations which are involved in implementing RE and sustainable energy Programmes. In general, renewable energy sources will most likely be developed under the direction of MEM.

**Table 10: Institutional and HR Framework for Sustainable Energy Development in LAO PDR**

No	Name of the Institution	Function
01	Institute of Renewable Energy Promotion/MEM	Implementation of RE Programme in Lao People’s Democratic Republic in consultation with government. Promote and develop renewable energy. Promote and develop rural electrification. Promote energy efficiency and conservation. Develop and manage renewable energy database and information.
02	Renewable Energy and New Materials Institute (REMI)/ MOST	REMI plays the role of secretary to MOST in research, development, transfer, promotion, application and service on Science and Technology. REMI plays a vital role in conducting research and development in an applied and adaptive research platform on renewable energy technology in conjunction with traditional technology for demonstrative and dissemination applications of renewable energy technology to support government guidelines, policies and development programmes. It is also involved in studying, researching, and selecting international progressive technologies suitable for the country in order to achieve national socio-economic development. Also, involved in transferring the successful result of research, adjustment or development on the science and technology within the country.  MOST created REMI as a training centre, and demonstration and research centre promoting the development and use of renewable energy technologies (RETS). This Institute will also offer training in the utilization of the various technologies to national technicians in the region.
03	Provincial Department of Energy and Mines	Provides provincial level support for the implementation of RE and EEC.
04	Faculty of Engineering, National University of Laos	Is mainly involved with research and educational issues on renewable energy; over 200 students have graduated in this field since 2000s.
05	Faculty of Science, National University of Laos	Mainly involved with research and education issues on renewable energy.
06	Lao Institute for Renewable Energy (LIRE)	Consultancy, conducting research and providing renewable energy technological (pico hydro, biodiesel, biogas, improved cooked stoves, rural energy) socio-economic and energy efficiency services. Providing public resources for information and advice on the use of renewable energy technologies. Capacity building and training related to renewable energy.
07	Ministry of Natural Resources and Environment (MONRE)	Main coordinating agency for environmental planning and Management across all sectors.
08	Renewable Energy for Sustainable Development Association of Lao (RESDALAO), Sunlabob	Private sector organizations, heavily involved in the introduction of renewable energy equipment using innovative mechanisms such as hire purchase scheme for PV systems, solar powered water pumping, etc.

## 2.15 Key Findings: Challenges and Opportunities for Sustainable Energy Development in the Current National Enabling Environment.

- Lao People's Democratic Republic is immensely blessed with economically viable hydropower potential— one of the cleanest and least cost option for energy generation. The solar insolation level and traditional agrarian base of the country indicates ample solar and biomass resource availability. However, there is gap with respect to scientific resource assessment studies for estimating the RE potential which has not been yet conducted in the country.
- The present planning approach of the government is largely focused on the development of hydropower potential in the country. The government encourages hydropower development through IPPs for export purpose.
- Power export to the neighbouring countries is an important policy objective of the Lao government. Revenue generated from power export in the form of royalties, taxes and dividends are important sources of income for Lao.
- There are gaps in creating a comprehensive national energy policy defining the national goal, implementation plan and strategies for sectoral development.
- The Ministry of Energy and Mines (MEM) is the main authority responsible for the management of energy sector, including the development of renewable sources of energy in Lao People's Democratic Republic. The Institute of Renewable Energy Promotion (IREP) under MEM oversees the implementation of renewable energy, energy efficiency and rural electrification Programmes in Lao People's Democratic Republic.
- Electricite du Laos (EdL) is the vertically integrated state sector utility responsible for generation, transmission and distribution of electricity in Laos. As of 2013, around 85% of the households in Lao have access to grid electricity; the remaining 15% households are located in relatively remote and inaccessible areas where extension of grid may not be economically viable.
- The government announced the 'Renewable Energy Development Strategy (REDS) for Lao People's Democratic Republic during October 2011. The REDS aims to increase the share of renewable energy to 30% of the total energy consumption by year 2025 in final energy terms. However, gap exists in the system as there is no clear renewable energy policy and implementation plan to back REDS.
- REDS is more focused towards the promotion and development of bio-fuels to be used as transportation fuel. However, there are gaps in REDS as it does not suggest any clear strategy for promotion of other off-grid sustainable energy options / services.
- In terms of final energy consumption, share of biomass resource is around 60% indicating wider use of biomass for meeting the cooking and heating energy requirements. Future energy demand projection shows increase in transportation and industrial demand. This makes a case for renewable energy based solutions in residential, industrial and transportation sectors.
- No independent 'Electricity Regulator' creates gaps in the system for tariff determination and monitoring the power sector operations in Lao. The tariff for sale of electricity from RE generating stations to the utility EdL is decided by the latter through negotiations with the RE generator on case-to-case basis. The retail tariff structure is finalized by the MEM.

The residential and agricultural tariff is cross-subsidized by the industrial and commercial sector tariff. For many years, however, the electricity tariff has been set at a low level undermining EdL's financial position.

- The Law on Electricity for Lao 2011 specifies the principles, rules and procedures for managing power sector activities in Lao People's Democratic Republic. The law on electricity has gaps as it does not have any enabling provisions for promotion of sustainable energy options in the country; however, the Law mentions the need for encouraging renewable sources of energy, as well as the use of off-grid renewable energy sources for rural electrification.
- No special financial / fiscal incentives for encouraging sustainable energy options are available which creates gaps in investment environment. As per Investment Promotion Law of Lao People's Democratic Republic, the investor including the sustainable energy investor are eligible for obtaining some fiscal / non-financial incentives like tax holidays, exemption of fee on concession agreement, etc.
- There are gaps in the banking sector in Lao as it is not sensitized enough about the need for promoting sustainable energy sources and incentivizes such projects by offering soft loan, and longer repayment periods.
- The government has successfully implemented few off-grid RE based rural electrification Programmes with the help of international funding (World Bank, JICA) wherein, the use of solar home lighting systems have been successfully demonstrated in rural un-electrified areas. The public-private partnership (PPP) mechanisms like those of Provincial Energy Service Companies (PESCO) and Sunlabob (Laos based full-service energy-provider selling hardware and providing commercially viable energy services for remote areas) have been successfully implemented.
- The government so far has not integrated renewable energy into the national agenda such as the Socio-Economic Development Plan, Rural Electrification Plan, industrialization and modernization strategy, etc. which creates gap in system for promoting sustainable energy technology.
- Energy conservation (EC) in Lao People's Democratic Republic is at an early stage. The government is yet to develop a comprehensive national strategy for EEC.
- There are gaps in financing RE as budgetary provision from own resources is limited. The Government so far relies mostly on the international funding and donor contribution to support RE Programmes in country.
- There is presence of government academic institutions, international institutes working on RE, private entrepreneurs providing energy services in rural areas; however proper co-ordination and sharing of knowledge seems to be missing.

This chapter highlights national enabling environment for sustainable energy options in Lao People's Democratic Republic. In doing so, the country's overall energy situation along with policies, incentives, electricity market structure have been discussed elaborately to highlight the opportunities that exist in the enabling environment. However, there are certain gaps that create hindrances in promotion of sustainable energy in the country. This chapter ends with discussions on these opportunities and gaps. While analysis of enabling environment is necessary, its

effectiveness in promoting sustainable energy technologies should also be judged. This has been done in the next chapter by discussions on sustainable energy business mechanisms in the country. The discussion caters around three existing business mechanisms, their strengths and weaknesses.

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## **Chapter 3**

# **ANALYSIS OF EXISTING SUSTAINABLE ENERGY BUSINESS MECHANISMS**

### **3.1 Introduction**

Implementation of sustainable energy business mechanisms are driven from different sources – from regional governments looking to increase economic activity, from communities looking for access to energy, as well as from private entrepreneurs looking to build for-profit energy businesses. These mechanisms of course have different strengths. Community-driven mechanisms will often provide superior local support. Government mechanisms typically reach a broader range of consumers. For-profit ventures often focus more heavily on financial viability. On a smaller end, some have focused on implementing end-consumer products — selling individual lanterns, solar home systems, or other products. Others have focused on installing mini-electricity grids, using a village-scale power plant. The present chapter presents the analysis of the existing sustainable energy business mechanisms from the context of prevailing enabling environment in the country, and identifies their strength and weakness.

Lao People’s Democratic Republic has the experience of implementing two types of business mechanisms, namely:

- (i) ESCO/Fee for Service Mechanism
- (ii) Public-Private Sector Mechanism

### **3.2 ESCO / Fee for Service Mechanism<sup>11</sup>**

In 1999, the government of Lao People’s Democratic Republic with support from the donor community and working with the private sector initiated an off-grid pilot programme to establish the capacity for sustainable implementation of off-grid systems. The emphasis was on cost recovery from operations and the use of low-cost technologies. The programme focused primarily on the delivery of solar home systems (SHS) to villages not expected to be connected to the grid in the next 10 years. The Off-Grid Promotion Support Office (OGS) in the Department of Electricity of MEM was established to manage the programme. In March 2001, MEM’s Power Sector Policy Statement established the policy and regulatory mandate for Provincial Energy Service Companies (PESCOs) as intermediary entities to plan, help organize and install, and then provide support to off-grid schemes in rural areas of Lao People’s Democratic Republic.

#### **3.2.1 Supply and Service Delivery Chain**

The SHS pilot programme was implemented by small private companies based in the respective provincial capitals. Under the model adopted by OGS, these private companies—PESCOs—work in cooperation with the Provincial Department for Energy and Mines (PDEM) offices responsible for rural electrification. PESCOs have a participatory planning process, designed by OGS, that identifies villages that meet the off-grid criteria, procures equipment, and employs village energy managers (VEMs) who are responsible for installing and maintaining the systems and collecting bill payments. Payments to the PESCOs and VEMs themselves are linked to their performance in

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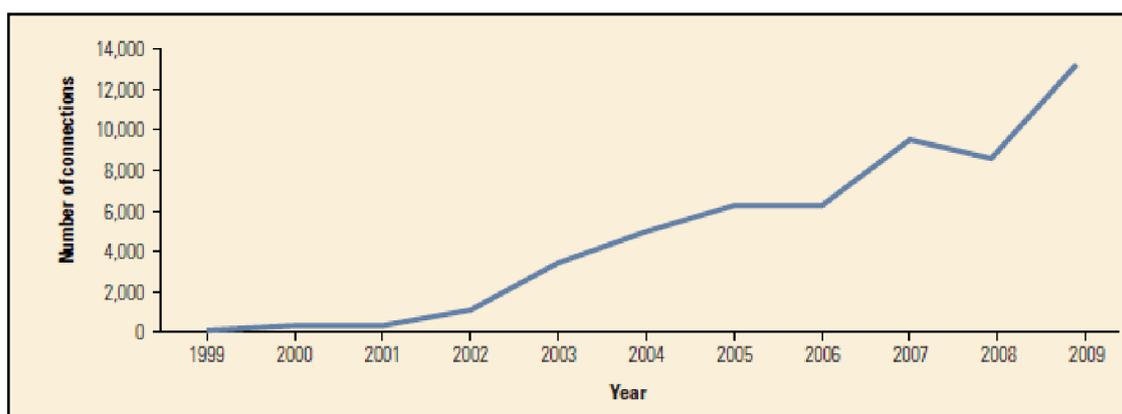
<sup>11</sup>The World Bank Asia Sustainable and Alternative Energy Programme, Lao People’s Democratic Republic Power to the People: Twenty Years of National Electrification, the International Bank for Reconstruction and Development / The World Bank Group

planning, installation, and payment collection and reporting. At the end of the pilot project in 2004, more than 5,700 SHS were installed in more than 50 villages in 6 provinces.

### 3.2.2 Financing and Purchase: Hire Purchase Scheme

Solar home systems are available to remote households through hire purchase agreements. Households have a choice of a range of solar PV panel sizes and must pay an installation fee, the lowest of which is about kip 130,000 (about US\$16), then lease the system and make monthly payments of between kip 10,000 to kip 25,000 (about US\$1 to US\$3) over 5 or 10 years. The household can choose the 5- or 10-year lease term depending on the affordability of monthly payment. They become the owners of the system at the end of the lease period. The least expensive panel costs 10,000 kip (about US\$1) per month for 10 years.

Figure 5: Progress of SHS Connections from Government SHS Programme (1999-2009)



#### Strengths and Weaknesses of the mechanism

<b>Strengths</b>	<ul style="list-style-type: none"> <li>• The consumers do not have to raise capital to purchase the SHS upfront; rather, they are allowed to pay in instalments of over 5-10 years, and then transfer the SHS in the consumer's name.</li> <li>• The consumer is motivated to take care of the SHS since they know that at the end of repayment term, the SHS shall be owned by them.</li> <li>• Better customer service and grievance redress system since the Provincial Energy Service Companies (PESCOs) are registered with and work under control of Off-Grid Promotion Support Office (OGS).</li> <li>• Representation of the locals (village head, village women union, youth) in village electricity committees increase the sense of ownership and ensure smooth operation of the programme.</li> <li>• Provides employment opportunities to the local youth to get trained in O&amp;M of the SHS.</li> <li>• OGS ensures that PESCOs run the SHS programme efficiently by collecting a minimum average of 95% of the repayment charges from the consumers served by it.</li> </ul>
<b>Weaknesses</b>	<ul style="list-style-type: none"> <li>• The end consumer is required to pay 50% of the initial cost of SHS. Balance is provided by government to PESCO in the form of support.</li> <li>• The mechanism is not fully economically viable – PESCOs need to rely on government subsidies to cover the partial I cost of SHS.</li> <li>• Complex institutional arrangement may lead to higher transaction cost to the end</li> </ul>

users as well as to PESCOs.

- To ensure a cost recovery mechanism, the PESCOs may target only the relatively affluent households within rural areas.
- Top-down approach of management as PESCOs are controlled by OGS and hence little operational autonomy for them.

### 3.3 Public-Private Sector Mechanism (Sunlabob Renewable Energy Ltd)<sup>12,13</sup>

Sunlabob is a Laos based commercial company which operates as a profitable, full-service energy-provider selling hardware and providing commercially viable energy services for remote areas where the public electricity grid not reached yet. It provides a range of products such as solar PV systems, solar heaters, lighting systems, hybrid systems, etc. Solar lanterns are one of the important applications developed by Sunlabob that has had a significant impact at the grassroots level. The Solar Lantern Rental System (SLRS) is an innovative public private-partnership, wherein Sunlabob has partnered with the local village entrepreneurs and village energy committees to deliver lighting services to the community.

Sunlabob has developed a package whereby a village entrepreneur operates a large solar charging station rented from Sunlabob. The solar charging stations are installed somewhere at a centrally accessible location. The entrepreneur then charges portable lamps which are financed from a public fund and circulates them within the households of the villages. Such lamps are compact units with a rechargeable battery. Each lamp is set to provide power for 10 hours. The households only pay a refundable deposit and a charging-fee, which makes it affordable to them. For each recharging, the entrepreneur collects a fee. All collected fees together cover all the costs of operating the whole system on a commercial basis. The recharging fee for the solar lanterns is based on local kerosene prices and rural household incomes. The village entrepreneurs who rent the charging stations from Sunlabob are in a franchise agreement with Sunlabob, which encompasses the installation of the charging station, regular servicing of the charging station, sale of lantern units, and replacements for their components, regular training for maintaining quality, and implementing emerging technical advances, operational advice, business advice, assistance in local marketing, demonstrations and campaigns, assistance in accessing soft loans, etc.

The mechanism has resulted in the economic development of the villages. Renting and operating a recharging station is a sustainable village-based enterprise, technically and operationally safeguarded by a franchise arrangement with Sunlabob. The village entrepreneur may not make a living just from operating a charging station, but it will be a regular and reliable income that can fit with other income streams.

#### Strength and Weakness of the mechanism

Strengths

- Innovative public – private mechanism, where the public funds are used to bear the initial cost of solar lantern, while the entrepreneur provide the service for charging the lantern.
- The franchise agreement between the company and the village entrepreneur ensures adequate operation and maintenance of the charging station, and the

<sup>12</sup>Final Report - Rural Electrification Frameworks Study September 2004 , prepared by Maunsell Ltd, Auckland New Zealand

<sup>13</sup> Working paper - 9 Review of Alternative Participatory Business Models for Off-grid Electricity Services - 28 March 2011 EPSRC/ DfID funded Research Grant Project EP/Go63826/1

	<p>individual solar lantern.</p> <ul style="list-style-type: none"> <li>• Private sector competition can lead to innovation and ability to experiment easily with new mechanisms.</li> <li>• Provides employment opportunities to the local people by involving them for O&amp;M as village technicians, charging station operators, etc.</li> <li>• User does not have to bear the cost of solar lantern. The user charges are decided so as to cover charging station rent, village technicians' salary, VEC member remuneration and contribution to maintenances fund.</li> </ul>
Weaknesses	<ul style="list-style-type: none"> <li>• Need public fund / donor support to cover the initial cost of the system.</li> <li>• Threat of comparison with grid electricity and prices considering the fact that the system provides light energy, and not electrical energy.</li> <li>• The user charges should be decided appropriately; otherwise user may find it excessive and switch over to kerosene for lighting.</li> <li>• Possible kerosene vendors' retaliation</li> <li>• Unfair competition with other government supported schemes, where the users pay less charge than the actual.</li> <li>• In the case of grid extension, dismantling of equipment and the re-shifting of the scheme to other areas.</li> </ul>

### 3.4 MEM Micro-hydro Public Private Partnership<sup>14</sup>

The Ministry of Energy and Mines has considered this model on pilot basis for implementing four micro-hydropower plants in the province of Huaphan. This will act as a pilot project to test the financing mechanisms and the possibility scale-up. The project is based on a lease purchase agreement, where:

- The investor/project developer makes the upfront investment for the overall system (generation, distribution and supply).
- The investor/project developer operates the system for a period between five to ten years.
- The Government of Lao People's Democratic Republic (GoL) pays a fixed lease term to the investor/project developer.

This financing mechanism is principally based on the availability of funds with GoL. It is meant to overcome institutional and financial risks. The initiative will make use of a bidding system, where the selected investor/project developer is selected on the basis of cost-efficient proposal. Although price will be a key factor of the proposal, investors/project developers have no interest in under-evaluating the project cost. In other words, the fixed leasing payment agreed at the proposal stage acts as a guarantee of the project's return on investment.

#### Strength and Weakness of the mechanism

Strengths	<ul style="list-style-type: none"> <li>• Focused attention to electrification of rural areas, thereby increasing the pace of rural electrification.</li> <li>• Selection of the developer through bidding process to ensure cost effective project proposal.</li> <li>• Granting of payment from the government; investor can project the returns.</li> </ul>
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<sup>14</sup> National Assessment Framework on Enabling Environment, Technology Innovation Ecosystem for making Sustainable Energy options Affordable and Accessible – Report prepared by National Consultants , Lao People's Democratic Republic

Weaknesses

- Computation of lease payment based on the project cost and paying capacity of the consumers can be tricky and can put the investor at risk at a later stage.
- Getting loan from the financial institutions / banks may become difficult.
- Resource assessment and technology risk is entirely on account of the investor.
- Low Paying capacity of the end consumer and collection efficiency.

This chapter analyses three business mechanisms that are adopted in Lao People's Democratic Republic. The ESCO mechanism supplies SHS to households through hire purchase model and ensures after sales service of the devices. The solar lantern rent programme of Sunlabob Renewable Energy Ltd. is an example of public private model which rents solar lanterns at minimal cost and the micro hydro project is another example public private partnership model which is implemented in rural areas of Lao People's Democratic Republic. However these programmes were not succeeded in large-scale deployment of off-grid RE technology due to dependence on government subsidy.

The country needs to develop renewable energy technologies more intensively, in order to establish an RE manufacturing base in Lao, the role of Small and medium enterprises shall be most important. Therefore, the SMEs are required to encourage technology innovation in off-grid RE applications. For this, Lao government needs to put emphasis on technology innovation. The next chapter identifies existing institutional mechanism for technology innovation and analyzes prevailing innovation ecosystem in the country.

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## Chapter 4

# ASSESSMENT OF TECHNOLOGY INNOVATION ECOSYSTEM FOR SUSTAINABLE ENERGY OPTIONS

### 4.1 Introduction

Current rural electrification systems and technologies in use in Lao People's Democratic Republic include:

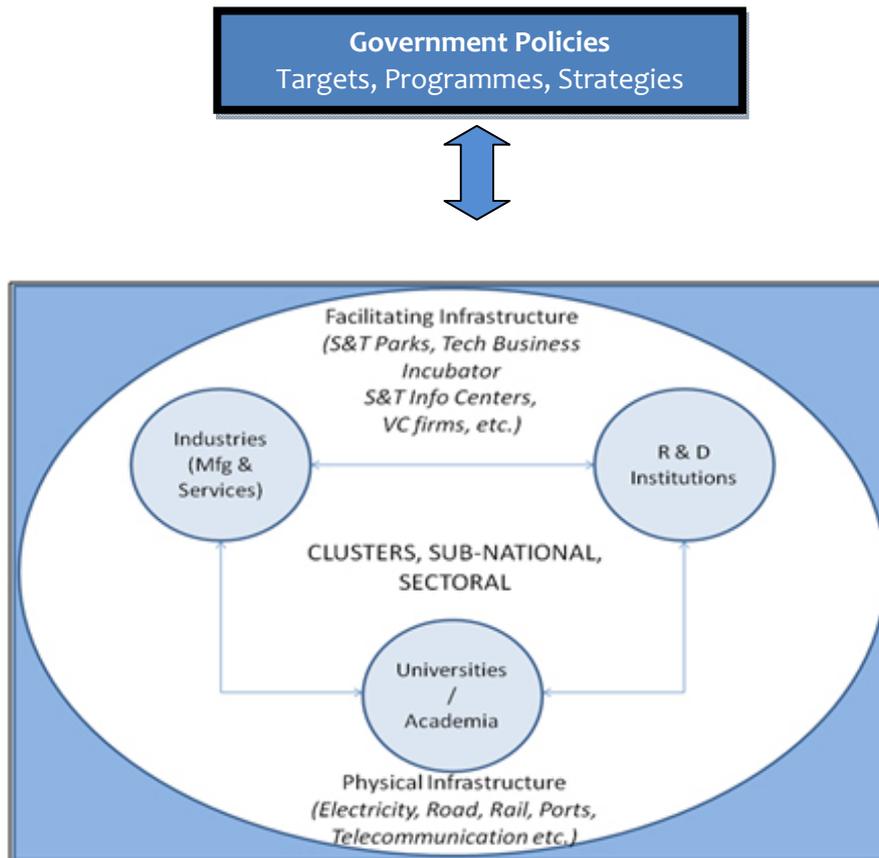
- Main grid distribution systems owned and operated by EdL, which distribute electricity to most provincial centres and to district centres and villages within economic reach of the system. (Approximately 85% of population is covered under centralized grid)
- Isolated / mini distribution grid systems, powered by either diesel generating sets, cross-border supplies, mini hydro power stations (i.e. 100 kW to 5 MW) or micro hydro power installations (i.e.< 100 kW). These systems are generally focused on provincial or district towns that are beyond the reach of the main distribution system, and are in some cases owned / operated by EdL and in most cases owned / operated at the provincial or district level.
- A small number of village grid systems (powered by micro hydro or micro diesel generator sets (gensets), typically of capacity 1–10 kW) that supply micro-grid distribution systems serving villages, or small clusters of villages, that are beyond the economic reach of main or isolated distribution systems.
- Solar PV systems and Pico hydro generator units supplying individual households, health clinics, institutional facilities, etc.

As mentioned earlier, modern energy services—mainly provided by liquid and gaseous fuels, as well as electricity—are essential for building enterprises and creating jobs. Convenient, affordable sustainable energy technology options are also important for improving health and education, for reducing drudgery of conventional cooking, and meet other basic needs. After studying the overall electrification status, renewable energy resource availability, and present practices of using large scale biomass for heating purpose, the following potential renewable energy technologies are seen to suitable for providing sustainable energy solutions to Lao People's Democratic Republic.

- Solar PV system for electrical applications
- Solar thermal system for domestic and industrial heating application
- Pico/micro-hydro technology for off-grid electrification
- Biomass gasification technology for off-grid electrification
- Solar-biomass-bio-fuel hybrid technology for off-grid electrification

The enabling environment for technology innovation ecosystems in any country is governed by effective policies from the government, and most importantly the active involvement of the small and medium manufacturing industries, research and development institutions, academia and universities contributing towards sustainable energy development. Besides, the availability of adequate infrastructure facilitates also facilitates technology innovation in the country. As noticed from past experience, in many LDCs, LLDCs, basic manufacturing capacity exists; and this could be further leveraged into manufacturing higher value added products relevant to the energy efficiency and renewable energy technologies.

**Figure 6: Enabling Environment and Technology Innovation Ecosystem**



The assessment of present enabling environment and technology ecosystem is presented in following sections.

#### **4.2 Government policies and programmes for sustainable energy development**

The Lao government has notified the National Strategy on Development of Renewable Energy in the country which specifies long term targets for renewable energy supply in total energy mix as 30 by year 2025. The Law on Electricity amended in the year 2008 spelt the need for using the natural resource potential in an economical and sustainable manner. The Law also mentions use of off-grid RE based generation technologies to facilitate rural electrification. However, the national strategy for development of renewable energy is not backed by a clear renewable energy policy and implementation plan required for time-bound development of sustainable energy technology options. With regard to the programmes on sustainable energy technology, the Lao government has limited experience of implementing Solar Home Systems (SHS) mainly through small provincial Electricity Service Company (ESCO) operations set up under the MEM Off-Grid Rural Electrification Promotion and Support Programme. The majority of their business is in subsidized solar PV systems. The other programme is a ‘private public initiative’ of private, Lao-registered company Sunlabob, which promotes, sells and hires solar PV systems (and other renewable energy technologies), operates a franchise system (mainly with individual entrepreneurs) that covers un-electrified remote rural areas of the country.

#### **4.3 Research and development**

Research and development is the first step in technology innovation. The Ministry of Energy and Mines (MEM) is the apex policy making organization under which the Institute of Renewable

Energy Promotion (IREP) implements the sustainable energy and energy efficiency programmes in Lao People's Democratic Republic. However as far as R&D is concerned, the role of Renewable Energy and New Materials Institute (REMI) working under the aegis of the Ministry of Science and Technology is vital in conducting R&D on renewable energy technology suitable for local conditions and requirements. Ministry of Science and Technology (MOST) has created REMI to act as a training centre, demonstration and research centre promoting the development and use of renewable energy technology. REMI has the role of continuously tracking studies, conducting research on international progressive science and technologies; selecting appropriate technologies or suggesting necessary modifications in the technologies to suit local conditions.

#### **4.4 Universities**

Lao People's Democratic Republic has a total of four universities, and around 154 technical schools that have enrolled a total 122,026 students in year 2010. The National University of Laos (NUOL) offers subjects related to renewable energy at the Faculty of Engineering and Faculty of Science as part of bachelor degree courses. The Mechanical Engineering Department at the Faculty of Engineering offers subjects on biomass technology, small-hydro, and solar, whereas Electrical Engineering Department offers solar power as an elective subject.

The Faculty of Engineering offers Master's Programme in Environmental Engineering with RE as specialized subject. Besides, the NUOL with cooperation with international organizations has developed a technical handbook on solar technology, and conducts solar radiation assessment. However, apart from NUOL, no other institution offers specialized courses on renewable energy either at the degree, diploma or lower level.

#### **4.5 Other Institutions working in Sustainable energy development**

**Lao Institute for Renewable Energy:** LIRE is a non-profit organization established in 2006 in Vientiane, Lao. LIRE is part of the Lao Union for Science and Engineering Association. LIRE provide free public resource for information and advice on the use of renewable energy technology in Laos. LIRE in collaboration with ETC (a Dutch NGO providing technical know-how) implemented the 'Pico-hydropower Innovation and Capacity-building Programme' in Lao People's Democratic Republic from 2008 to 2010 in two phases.

**Sunlabob Renewable Energy Co Ltd:** Sunlabob was legally established as a 100 % Lao-owned Company at the end of the year 2000. The company provides sales, hire (rental), installation and after-sales service, training and coaching and promotions / demonstrations in the renewable energy field (predominantly solar PV and solar heating systems). The company operates across most areas of Lao People's Democratic Republic, has headquarters based in Vientiane and operates with the help of provincial franchises (agencies) in Lao People's Democratic Republic. The company has recently extended its services into neighbouring countries. Sunlabob has been active in developing solar PV markets in the country through PPPs.

#### **4.6 Manufacturing**

The manufacturing sector in Lao People's Democratic Republic has grown at an average of 9.4% per year between 2006 and 2010. The manufacturing sector in Lao People's Democratic Republic is dominated by garment and textiles, wood and food processing industries. The total number of manufacturing enterprises is 24,331, accounting for 19.2% of total number of enterprises.

However, at present, Lao People's Democratic Republic does not have any manufacturing facility to produce renewable energy technology equipment / applications. There are few entrepreneurs

dealing in electrical equipment and machineries, however there is no manufacturing capability for electrical and electronics products including lighting products. Most of the electrical and electronic goods are imported from the neighbouring countries. Lao People's Democratic Republic has been a member of the IEC affiliate countries and adopted IEC standard of 50 electrical and electronics products as Lao national standards. At present, Lao People's Democratic Republic does not have testing laboratories for quality control of the electrical and electronic goods imported from neighbouring countries. It is learnt that, in the past, Sunlabob while implementing the Programme on SHS with support from MEM has procured all the ancillary parts like the cable, switches, and wires from the local suppliers.

## **4.7 Infrastructure**

**Transport:** Lao People's Democratic Republic is characterized by inadequate supply of infrastructure and ranks low among countries as compared to quality of infrastructure. Currently, Lao People's Democratic Republic relies on four modes of transport (i) mechanized road transport covering 37,768 km, handling 80% of total transport volume, which has enabled supplying of goods and passenger transport to all districts throughout the country. (ii) Water transport covering more than 3,000 km, accounting for 18% of total transport volume (iii) air transport managed by 11 airports accounting for 2% of total transport volume, and (iv) rail transport which is not adequately developed yet.

**Communication:** Optical cables have been laid across 11,500 km length. There are 99 telecommunication centres, 38 government enterprises, 58 Lao corporations, two Star Telecom centres and one Milicom Lao Centre. All the telecommunication centres together provide 3.6 million connections. The 2009-10 Plan entails encouraging firms to expand telecommunication services to rural areas, providing high quality services and expanding services from cities to villages to provide 80% coverage.

### **4.7.1 Facilitating Infrastructure**

The role of facilitating infrastructure like Science and Technology Park, special economic zone for sustainable energy technology manufacturing, science and technology information centres, etc, is equally important in facilitating the technology innovation. The Lao government has not yet created such facilitating infrastructure to encourage and promote investment in sustainable energy technology and services. However, under the Foreign Investment Law, the government gives differential concession in profit tax based on the promotion zones classified, depending on the geographical location and socio-economic conditions. The Banking system in Lao is not sensitized enough to support the renewable energy and sustainable energy technologies. The Agricultural promotion Bank of Lao has good consumer base and network in rural area of Lao.

### **State of Infrastructure**

Basic infrastructure, particularly the road network in Lao People's Democratic Republic is not good. Only a small proportion of the roads are paved. Most roads are constructed from natural rocks and earth, especially the provincial, district and village roads. These roads are not operational throughout the year. The state of the roads impairs benefit which could otherwise be reaped by the country by providing transit transport services. Lack of adequate infrastructure makes expansion of transmission and distribution network uneconomical. Besides, energy products and services become costly due to inadequate infrastructure, which in turn makes access to energy unaffordable in many parts of the country. Consequently, technology dissemination is hindered.

#### **4.8 Suggestion on National Enabling Environment and Technology Innovation Ecosystem**

Prevalence of technology enabling environment provides sufficient financial and technical support for expansion of sustainable energy technologies and services. In order to create enabling environment for technology innovation, the role of each of the actors shown in above figure No 6 is important. The government's role is vital in designing appropriate policies and implementation programmes signalling the potential sustainable energy technologies / services and targets to be achieved. South-South cooperation and experience-sharing with other developing countries should also be encouraged. The role of Small and Medium Enterprises (SMEs) is of utmost importance, and therefore to encourage participation of SMEs in RE manufacturing special incentive structures and financing mechanisms need to be devised. Sustainable energy technology manufacturing capacity indicates the capability of a country to produce components domestically. A good RE and SET manufacturing capacity reduces cost of the project because of indigenously manufactured components used in the project. The Role of banking institutions particularly the Agricultural Promotion bank in providing soft loans for encouraging the sustainable energy technologies in rural areas shall be important.

Equally important is the coordination between the government institution, R&D institution and academia, and other institutions working in the field of sustainable energy technologies and services. For effective promotion of sustainable energy technologies and applications, the role of REMI is important in the future. REMI needs to be strengthened, diversified and expanded, considering the diversity of renewable energy technologies. It should be made autonomous with adequate funding and time bound targets. Under the ambit of REMI, specialized research centres for diverse renewable energy technologies need to be established. REMI also needs to network with various institutions working in renewable energy related R&D in the country in order to exchange the latest knowledge.

Based on national enabling environment and existing technology innovation ecosystem, Lao People's Democratic Republic should choose appropriate sustainable energy options for the country. In the next chapter, different applications have been identified that suits the requirement and environment of the country.

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## Chapter 5

# SUSTAINABLE ENERGY TECHNOLOGY OPTIONS RELEVANT TO LAO PEOPLE'S DEMOCRATIC REPUBLIC

Lao People's Democratic Republic is immensely blessed with economically viable hydropower potential. Besides, the solar insolation level and traditional agrarian base of the country indicates ample solar and biomass resource availability. At present in terms of final energy consumption, share of biomass resource is around 60%, indicating wider use of biomass for meeting the cooking and heating energy requirements. Nearly 15% of the population resides in remote, rural areas without access to grid electricity. Extension of the centralized grid in such areas may be technically and economically un-viable, and therefore the role of off-grid renewable energy technologies assumes importance.

Lao People's Democratic Republic has many small and medium-scale pig farms, beer breweries, textile/ silk industries and other sources of municipal solid waste, where community scale biogas and municipal solid waste-to-energy projects can be set up. Based on the understanding of renewable energy resource availability in Lao, the present energy consumption practices, and socio-economic culture of the country, the following sustainable energy technology options are suggested.

### 5.1 Solar Thermal Application for Domestic Heating and Industrial Heating/Cooling

**Rationale:** Ample solar resource availability and convenient rooftop structures in the urban areas make solar water heating systems (SWHS) a low cost solar heating application having huge potential for electricity substitution. Biomass and furnace oil can be used for heating purposes in domestic and industrial sectors.

Target Area (solar flat plate collector system)

- Individual residential buildings having plinth area of more than 100-150 sqm
- Hotels
- Hospitals
- Hostels

Target Area (solar concentrating system)

- Industrial and commercial buildings
- Food processing , juice concentration, milk pasteurization
- Wood processing
- Solar based air conditioning and refrigeration systems
- Solar assisted cooling system using Vapour Absorption Machine.

#### Case Study 1

##### Large-scale deployment of flat plate collector type solar water heating system in India

The Ministry of New and Renewable Energy (MNRE), Government of India, provides support to municipalities/municipal corporations who adopt and notify modifications to their building bye-laws for making the installation of SWHS mandatory in certain categories of buildings. A model Regulation/building bye-laws for the installation of SWHS in certain categories of buildings (covering all the government and semi-government establishments and individual residential

buildings having more than 150 sqm plinth area) has been circulated by the Ministry of Urban Development to all the states and union territories of India with a request to circulate the same to their local bodies for incorporating in their building bye-laws. The states have to issue orders to the municipalities within the state for making the SWHS mandatory. A total of 21 states in India have amended the building bye-laws to make SWH mandatory in the specified categories of buildings.

Besides, some of the state governments have offered incentives to the end users in the form of property tax reduction/rebate on electricity bill to promote the use of SWHS in individual buildings.

**Table 11: Ways to promote deployment of SWHS**

Action required	Implementing Agencies/Govt Departments
Issue of orders to local government/municipalities for mandatory use of SWHS.	Ministry of Urban Development/ PWD
Amendment in building bye-laws to ensure mandatory use of SWHS.	Local government /Municipalities
Rebate in Property Tax of individual house owners to encourage use of SWHS.	Local government / Municipalities
Rebate in electricity bill of individual house owners to encourage use of SWHS.	Electricity utility

**Model Regulation / Bye Laws for Installation of Solar Assisted Water Heating Systems in Functional Buildings**

The following provisions are proposed for inclusion in the building bye-laws of different states.

“No new building in the following categories in which there is a system or installation for supplying hot water shall be built, unless the system or the installation is also having an auxiliary solar assisted water heating system:

- 1 Hospitals and nursing homes
- 2 Hotels, lodges and guest houses
- 3 Hostels of schools, colleges, training centres
- 4 Barracks of armed forces, paramilitary forces and police department
- 5 Individual residential buildings having more than 150 sq m plinth area
- 6 Functional buildings of railway stations and airports like waiting rooms, retiring rooms, rest rooms, inspection bungalows and catering units
- 7 Community centres, banquet halls, wedding halls, and buildings for similar use.”

**SCHEDULE**

**1) Definitions**

i)	“Solar Assisted Water Heating System”	A device to heat water using solar energy as heat source.
ii)	“Auxiliary backup”	Electrically operated or fuel fired boilers/systems to heat water coming out from solar water heating system to meet the continuous requirement of hot water.
iii)	“New Building”	Such buildings of above said categories for which construction plans have been submitted to competent authority for clearance.
iv)	“Existing Building”	Buildings that are licensed to perform their respective business

## 2) Installation of Solar Water Heating Systems

- a. **New Buildings:** Clearance of plan for the construction of new buildings of the aforesaid categories shall only be given if they have a provision in the building design itself for an insulated pipeline from the rooftop in the building to various distribution points where hot water is required. The building must have a provision for continuous water supply to the solar water heating system. The building should also have open space on the rooftop which receives direct sunlight. The load bearing capacity of the roof should at least be 50 kg per sq m. All new buildings of above said categories must complete installation of solar water heating systems before obtaining a license to commence their business.
  - b. **Existing Buildings:** Installation of solar assisted water heating systems in existing buildings shall be made mandatory at the time of change of use of above said category provided there is a system or installation for supplying hot water.
- 3) **Capacity:** The capacity of solar water heating system to be installed on the building of different categories shall be decided in consultation with the local bodies. The recommended minimum capacity shall not be less than 25 litres per day for each bathroom and kitchen subject to the condition that maximum of 50% of the total roof area is provided with the system.
  - 4) **Specifications:** Installation of Solar Assisted Water Heating Systems shall conform to BIS (Bureau of Indian Standards) specification IS 12933. The solar collectors used in the system shall have the BIS certification mark.
  - 5) **Auxiliary System:** Wherever hot water requirement is continuous, auxiliary heating arrangement either with electric elements or oil of adequate capacity can be provided.

**Table 12: Physical Progress of SWHS programme in India <sup>15</sup>**

SWHS Collector Area (million m <sup>2</sup> )	Target		Achievements during the Year (up to January)		Cumulative Achievements	
	FY 2012-13	FY 2013-14	FY 2012-13 (% of Target)	FY 2013-14 (% of Target)	(as on 31.01.2013)	(as on 31.01.2014)
	0.60	0.50	1.41 (235.00 %)	0.51 (102.00 %)	6.87	7.51

## Case Study 2

### Solar refrigerators for vaccine storage in rural areas <sup>16</sup>

Refrigeration of vaccines and food is problematic in parts of the world where there is no electricity or where the electricity supply is unreliable. In these regions vaccines are maintained by either kerosene or battery-based solar refrigeration. Kerosene refrigerators are also used for food preservation. There are significant concerns with both kerosene refrigeration and with the existing generation of solar-vaccine coolers.

The need for environment-friendly and affordable solar vaccine coolers and refrigerators was realized in 1998-2000 through separate discussions between United Nations Environment Programme (UNEP), World Health Organization (WHO) and Greenpeace International (GPI). Independently, around the same time, the Danish Technological Institute (DTI), funded by the

<sup>15</sup> JNNSM Progress Report FY 2012-13, 2013-14

<sup>16</sup> Renewable Energy Vision for Union Territory of Puducherry, Oct 2007. Report prepared by WISE, Pune

Danish Energy Agency, began the development of a new solar refrigerator SolarChill that bypassed the use of batteries. DTI worked in cooperation with the Danish refrigerator manufacturer Vestfrost. The direct current hydrocarbon compressor was developed by Danfoss Company of Denmark.

Solar Chill is developing a versatile refrigeration technology that is environmentally sound, battery free, technologically reliable, and affordable and multi-source powered. It is expected that SolarChill technology will improve the cold chain for vaccines as well as provide more reliable refrigeration for perishable foods.

**SolarChill** technology is publicly owned. The technology is described on the SolarChill website. The SolarChill technology will be freely made available to the world. For more information please visit <<http://www.solarchill.org/>>

### Features at a glance

Prototypes: Upright and chest refrigerator models

- Can be used as a vaccine cooler or as household or small commercial refrigerator.
- Energy storage in ice-packs through the use of direct current compressor — no lead battery required.
- Powered by 3 X 60W photo-voltaic panels — no contribution to global warming and no electrical grid required.
- Energy efficiency through efficient insulation.
- R-600 hydrocarbon compressor and cyclopentane blown insulation foam — no contribution to ozone depletion or global warming.
- Temperature control through natural convection between ice storage compartment and vaccine compartment — no electronic control devices required.
- One SolarChill unit can be used for preserving vaccines to serve a population of 50,000 people.
- Expected commercialization price between US\$ 1500-2000 (including solar panels) which is 50% to 60% cheaper than currently available solar refrigerators meeting WHO standards

**Figure 7: Use of SolarChill Refrigerators in Cuba**



## **Breakthrough technology**

### **No batteries**

The unique feature of SolarChill is that the energy of the sun is stored in ice instead of in batteries. An ice compartment keeps the cabinet at desired temperatures during the night. The key to the technology is the use of a direct current (DC) compressor instead of the standard alternating current (AC) compressor used in normal refrigerators, or in other solar coolers. Thus, the sun's energy is captured by the solar panels and converted to DC electricity. The DC current starts up the compressor which then runs the refrigeration cycle. Ice is produced in an ice storage compartment. The cool air is then circulated by convection and by a fan into the cabinet and maintained at the desired temperature by a thermostat.

### **Environmentally friendly**

SolarChill incorporates environment-friendly Greenfreeze refrigeration technology. Greenfreeze was developed and made freely available to the world by Greenpeace in the early 1990s. Greenfreeze utilizes hydrocarbons for the insulation foam and the refrigerant cycle, and thus bypasses the reliance on ozone layer depleting and potent global warming fluorocarbons, such as HCFCs and HFCs. This is the first ever application in the world of a direct current hydrocarbon compressor. SolarChill also symbolizes the environmental imperative of humanity needing to shift reliance on fossil fuels as our primary source of energy to renewable energy sources. SolarChill harnesses the power of the sun and turns it into life sustaining refrigeration.

### **Versatility**

A converter enables SolarChill to be powered by multiple sources of energy. In addition to plugging into the electrical grid, SolarChill can also run on independent sources of power, such as solar, wind, biomass and diesel.

### **Affordability**

The projected cost of SolarChill vaccine coolers and refrigerators, together with solar panels, will be in the range of \$1500-\$2000 (units produced in Western Europe). This is 40% to 50% lower than existing solar vaccine coolers available in the market today. SolarChill is able to reduce the cost of production by using commercially mass produced freezer cabinets, instead of having the cabinets custom-made. It is expected that the lifetime maintenance costs of SolarChill will also be considerably less than that of comparable solar vaccine coolers. Obviously, the initial capital lay-out for SolarChill refrigerators will be greater than the cost of kerosene refrigerators. However, the difference in purchase price can be recovered during operation of the units. The price of kerosene fluctuates significantly from one region to the next and can cost up to \$1 per liter. Depending on the price of kerosene (which increase with the fluctuations in the price of oil), and the efficiency of the kerosene refrigerator, the cost differential can be recovered within 5 to 8 years. After cost recovery, SolarChill will provide inexpensive cooling. The initial cost of SolarChill may also decline with the economy of scale, and with variations in manufacturing costs in different parts of the world.

### Case Study 3

#### Solar Concentrating dish at Dairy Unit in Maharashtra<sup>17</sup>

**Mahanand Dairy Unit** is located in Latur, Maharashtra is processing about 20,000 to 25,000 litres of milk per day. Following are some of the activities which consume thermal energy in the plant:

- Pasteurization
- Milk Chilling
- Cleaning in Place (CIP)
- Can and Crate washing
- Sterilization

To save on expensive furnace oil, Mahanand dairy unit has installed a solar thermal concentrator for their thermal energy requirements. ARUN-160 Dish Concentrator was installed in 2006 with technical support from IIT Mumbai and financial support from MNRE as an R&D project. The project helps in generating hot water for processing 20,000 to 25,000 litres of milk per day.

#### Project Description:

The solar parabolic concentrator has a collector area of 169 m<sup>2</sup> and is equipped with a double axis tracking system for hot water generation at a temperature of 80-90 °C. The system uses a Fresnel Paraboloid Solar Reflector with reflector facets fixed on to a tracking surface.

Figure 8: Milk Pasteurization Unit



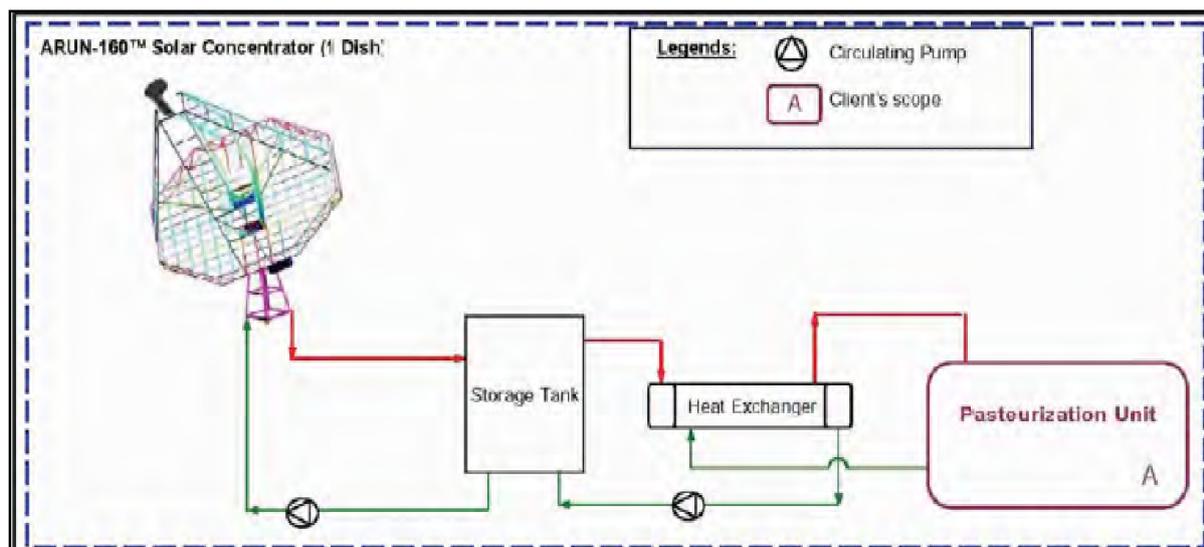
Figure 9: ARUN DISH in Sunny day



An insulated pressurized water storage tank has been provided for storage of thermal energy. Pressurized water was selected as the medium of heat transfer and storage as it has high specific heat, free from fire hazards, zero possibility of accelerated oxidization, compatibility with food products and low operational cost. This system totally replaces the furnace oil that was earlier used for heating requirement of milk pasteurization.

<sup>17</sup> Case study booklet on Renewable Energy, Vol II published by Confederation of Indian Industries , 2013

Figure 10: Indicative schematic diagram



### Technology Specification

Parameter	Units
Technology	ARUN 160 dish
Collector Area	169 m <sup>2</sup>
Heat Delivery (Annual Average)	80 – 100 kW Th
Temperature	80 °C to 90 °C
Efficiency (%)	60 – 65%
Application	Pasteurization, CIP, Can & Crate Washing

### Financials:

Project Cost	USD 61,666 <sup>18</sup> (after deducting subsidy, includes civil, transportation, integration)
Subsidy from MNRE	USD 16000
O&M Cost	USD 1600 per annum
Cost Savings	USD 16,666
Payback Period	3.6 Years

## 5.2 Solar photovoltaic applications for domestic lighting

**Rationale:** Individual households located in un-electrified remote villages/hamlets inaccessible by grid or which have not been covered through micro-grid systems could be the targeted beneficiaries under this scheme. It can be safely assumed that the present spending on kerosene can be utilized towards payment for meeting the lighting load through alternative sources of electricity. Solar PV stand-alone systems/home packs are suitable systems for small houses with

<sup>18</sup> Exchange rate of 60 INR per USD considered for conversion

two to three LED luminary. Use of solar PV systems will offset the recurring expenses on kerosene, improve health, and will have additional potential for carbon reduction by replacing kerosene.

The Lao government has implemented the SHS programme under Rural Electrification scheme through authorized ESCOs with financial support from the Ministry of Energy and Mines (MEM). Under public-private partnership, a similar programme has been implemented by Sunlabob Renewable Energy Co Ltd. However, for large scale deployment, such programmes will be implemented by encouraging micro-finance institutions in facilitating finance to suit the economic conditions of the local population. Micro finance institutions should be flexible in terms of loan offers by creating different categories of customers, cash collection systems, and may operate on community responsibility for payments.

With the involvement of the community for O&M services, such programmes can be implemented without financial support from the government. The dissemination of SHS by Grameen Shakti in Rural Bangladesh is a good example of this type of model.

#### Case Study 4

##### Dissemination of SHS by Grameen Shakti in Rural Bangladesh

Being a young technology, renewable energy systems are comparatively expensive. The initial capital investment is especially prohibitive for the poor to bear. Thus, one of the initial challenges was to find a way to reduce this high upfront cost. Grameen Shakti (GS), a non-profit organization in Bangladesh facilitates the adoption of SHS in rural areas through an instalment-based financing scheme, which reduces the monthly cost of a solar home system compared to that of kerosene. This allowed GS to expand its market which led to economies of scale, making it possible to reduce unit costs even further. As a result, the company became a profitable and sustainable social business. The financing scheme promotes ownership (as opposed to a rental model), and this leads to better care and longevity of the systems. At the beginning of 2011, over 140,000 customers had become owners of their own energy source this way. Huge subsidy on fossil fuels and high upfront costs of the technology are major obstacles in motivating the shift away from fossil fuels. One option is to reduce the cost of upfront investment in sustainable energy options to make it affordable. GS has made it possible for lower income households to purchase products by developing a number of payment schemes, which allows for clients to pay in instalments. Clients who cannot pay the whole sum upfront can select one of the other payment schemes as shown in the following table:

**Table 13: Loan Installment Schemes introduced by Grameen Shakti <sup>19</sup>**

Mode of Repayment	Down Payment	Instalment	Service Charge (Flat Rate)
<b>Option 1</b>	35%	12 months	5%
<b>Option 2</b>	25%	24 months	6%
<b>Option 3</b>	15%	36 months	8%
<b>Option 4</b>	100%	-	4% discount
<b>Option 5</b>	10%	36 months	5% (exclusively for micro-utility clients)
<b>Option 6</b>	25%	12 months	Nil (specially for religious institutions)

<sup>19</sup> Grameen Shakti – A case study by Grameen Creative Lab

## **Creation of a strong grassroots network to provide after-sales service right at the doorsteps of the rural customers**

Rural people are unlikely to invest in a technology which is not durable, and which they do not fully understand. To assure its customers that the systems would be looked after well, GS introduced after-sales services. It focused on creating a vast network of rural engineers who developed one to one rapport with their customers. They visited each client's home monthly to offer free after-sales service for nearly 3 years. GS offered long-term warranty (20 years for panels, five years for batteries and three years for charge controllers) plus buyback options under which a client can return his /her system, if the area becomes grid-connected.

### **5.3 Small scale biogas plant to cater to individual / community - cooking / heating requirements<sup>20</sup>**

**Rationale:** Lao People's Democratic Republic has many small and medium scale pig farms, beer breweries, textile and silk industries and other sources of municipal solid waste, where, small scale biogas plant for individual / community use can be set up. This will help in reducing the use of biomass in Lao People's Democratic Republic, where 60% of final energy consumption comes from burning the biomass. The Lao Institute of Renewable Energy (LIRE) is developing biogas digester for individual as well as to be used in the silk / textile industries for meeting process heat requirements.

Around 16 million rural households all over the world cook and light their homes using biogas produced in household-scale anaerobic digesters. This includes 12 million households in China and 3.7 million households in India. In Nepal, the Biogas Support Programme, a Clean Development Mechanism project under the Kyoto Protocol, proposes to supply 200,000 new biogas plants by 2009. Currently, around 20,000 new systems are being installed there each year.

A typical digester of 6–8 cubic meters in size produces 300 cubic meters of biogas a year and, if manufactured domestically, costs \$200–250 and pays for itself over time. These units can be supplied by local companies, as digesters are a simple technology with no need for advanced expertise. After receiving training, farmers can build the digesters themselves. A new government programme in China, started in 2002, subsidizes farmers who build their own units, providing nearly \$100 per digester. Estimates suggest that more than 1 million biogas digesters are being produced in China each year. Biogas has advantages over other technologies because it has the added benefit of producing a soil amendment that can boost agriculture productivity.

Moreover, in addition to providing energy for cooking and heating, the systems can be potentially combined with a generator that produces electricity and motive power.

## **Case Study 5**

### **Biogas digester in China**

In 2003, approximately 1 million households in China had biogas digesters, and between 2003 and 2005, some 11 million additional rural families reportedly began using them. As the digesters are powered with livestock or domestic waste, generally speaking, a family with one head of cattle or three pigs is able to supply a digester. Lianshui County, just east of Xu Huai plateau, is an under-developed county whose economic structure is based on agriculture. In 2001, 3,600 biogas digesters were installed in six villages, and in 2003 hundreds of families in these villages were

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<sup>20</sup> The Potential Role of Renewable Energy in Meeting the Millennium Development Goals Paper prepared for the REN21 Network by The Worldwatch Institute

surveyed to evaluate the impact of the project. According to the survey, families in the county primarily use energy for cooking (62 percent) and for heating water and raising animals (25 percent). Per-capita energy consumption in families possessing biogas digesters is 337 kgce due to higher heat efficiency, while those without them use 451 kgce. Consumption of stalk and straw in these families is 168 kgce and 322 kgce, respectively. Biogas mainly substitutes stalk and straw and a small amount of firewood, and does not substantially substitute LPG, which in the countryside is used only by a few families with high incomes. With incomes in Lianshui County comparatively low and the price of LPG high, places to buy or recharge the fuel are limited and most people are not willing to spend the money. While families without biogas digesters mainly use straw and stalk as fuel, families with biogas digesters can reuse straw and stalk in their fields as organic fertilizer. Statistics also show that families with biogas digesters spend near 100 yuan (US\$12) less than those without them. Of the families surveyed, 74 percent find it convenient to use biogas, and nearly half of the families without a digester have decided to build one.

#### **5.4 Small-hydro Power for Off-grid Generation and Distribution**

**Rationale:** The identified small-hydro power potential in Lao People's Democratic Republic is around 2000 MW, out of which only 30 MW has been explored by EDL. At present, such small-hydro power plants are operated in the un-electrified areas of Lao by EDL or its authorized ESCOs.

Experience across the other developing countries like Sri Lanka and Nepal shows that the development of such projects can be accelerated and effectively managed by involving local communities in operation and maintenance. These countries have encouraged community based small and micro hydro power projects with or without private participation through direct financial intervention by means of grant, subsidy, tax benefits for private entities, etc. They have formulated and promoted private/community cost sharing models at all stages of the development and operation of small-scale hydropower projects.

#### **Case Study 6**

##### **Small-hydropower in Nepal <sup>21</sup>**

In Nepal's rural areas, only 6 percent of people have access to electricity. The Rural Energy Development Programme (REDP) was initiated by the Nepalese Ministry of Local Development in 1996 in 15 districts, and has since led to the implementation of programme activities by some 100 Village Development Committees. REDP has been successful in scaling up micro-hydro plants, through the development of Community Energy Funds (CEFs), a basket of funds mobilized by the local people from equity contribution, loans, investment, grants, and subsidies. Tariffs is collected from the consumers and deposited into the CEF, out of which the cost of operation and maintenance is paid. The most useful and effective end uses for the electricity generated by the micro-hydro plants include clean and better lighting, agro-processing mills, rural enterprises such as a rural bakery, Thangka painting, incense stick making, rural soap making, poultry farming, running computer institutes, and recreation centres. Other important end uses and benefits include the added facility of irrigation and drinking water, improved health and sanitation, and well-managed greening of the surroundings

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<sup>21</sup> The Potential Role of Renewable Energy in Meeting the Millennium Development Goals Paper prepared for the REN21 Network by The Worldwatch Institute

## **Case Study 6a: Village Micro Hydro Projects in Sri Lanka**

The growth of village micro-hydro schemes in Sri Lanka can be traced in two phases. Phase 1 saw the emergence of welfare-oriented community projects, while the second phase was more market-oriented, driven primarily by the private sector (discussed in detail in the next section on private sector models). In the first phase (early 90's), Intermediate Technology Sri Lanka (ITSL) embarked on an innovative model to provide electricity to rural households in Sri Lanka through micro-hydel based generation. As Sri Lanka is abundantly bestowed with rainfall, there is a great hydro potential to generate adequate power for household use. ITSL capitalized on this idea to provide rural electrification based on community management. While the concept of micro hydro was not new in Sri Lanka, the micro-hydro turbines available in the open market had poor safety record. ITSL improved this technology by incorporating new developments and safety features. ITSL first studied the electricity needs of a few off-grid communities with water sources and analyzed the financial viability and economic benefits of micro hydro for village applications. Community management approach was adopted wherein Electricity Consumer Societies (ECS), a village organization was formed for development, function and maintenance of village hydro schemes. This was done to instill a sense of ownership among the communities.

Further, given the geographical location of these micro hydro sites, external agencies were not able to manage on a long term basis. Membership of ECS was essentially from the village. ECS functioned as an autonomous body, responsible for raising funds, contributing labour, setting tariff structures and managing operation and maintenance. ECS was ably supported by the technical advisory committee of ITSL. A monthly fee of SL Rs 600/ household for a maximum usage of 100watts/household was fixed by the ECS. Tariff subsidies or free power were given to poor and invalids so that they will not be dropped out of the rural electrification process. Households were willing to donate their share of power to households in need of extra power at the times of social functions. These projects were functioning with aid from development organizations and donors.

In the second phase, the micro-hydro projects were included in the World Bank ESD project. However, under the commercial orientation of the World Bank Programme, the ECS were not eligible for loans and had to be converted into limited liability Electricity Consumer Companies. The new model under ESD/RERED project allows a project developer to submit a proposal to the bank (DFCC), and on the strength of the proposal, a loan is approved for implementation. ESC has to repay the loan with interest after a stipulated time. The new model denies the benefit of micro hydro schemes to poor households because of the high costs of generation and the technical limitation of transmitting power beyond 1.5 km. Households which can contribute towards the initial project costs, voluntary labour for civil works and pay for the internal wiring are favoured more in the new model. While initially the micro hydro model was only for lighting purposes, later on the concept of productive end uses was also introduced. Two main uses were: battery charging, and grinding and paddy milling. However, ECSs do not encourage day time productive end uses which consume substantial power, leading to power fluctuations and consequent disputes between high power users and normal users.

While these are minor setbacks, the village micro hydro model in Sri Lanka has by and large been successful with increased role of decentralized provincial institutions.

## Case Study 7

### Biomass gasifier for village electrification <sup>22</sup>

Under the SPEED programme, a biomass power plant was set up at Bara village in Bihar in 2012 by DESI Power. Bara is a 300 household village in Araria district of Bihar situated at the foothills of Himalayas. The village has a population of around 3000. Like several other villages in Bihar, grid has not reached Bara village. In spite of being blessed with extremely fertile land and ample water availability to grow three crops, the farmers were constrained by the total absence of infrastructure like roads, power which are crucial for overall development. Due to lack of grid power, the villagers were forced to irrigate the fields using diesel pump sets which are proving to be a heavy economic burden on the farmer.

Figure 11: Household and Business Activities near vicinity of Biomass power plant



Kerosene lamps are used for lighting the households in the village and average expenditure on kerosene per household comes to INR 150-200. Few telecom towers in the village are also running totally on diesel with all its attendant problems. DESI Power which is a rural power producer based in Bangalore come forward to electrify the Bara village using a biomass gasifier power plant DESI Power has set up a Biomass power project in Bara village in 2012 to harness electricity from biomass. The 32 kW down draft Gasifier produces 100-120 kWh of energy per day. The gasifier runs on locally available feed stocks such as Ipomea, Dhaincha, Corn Cobs and waste wood available in and around the village. The gasifier consumes around 1.40 kg of feed stock to generate one kWh of energy.

The gasifier currently operates 5-6 hrs/day supplying power to the village. Major part of the power generated goes for energizing the village micro-enterprises such as chura mill, oil expeller, rice huller and irrigation pump sets. The plant is also supplying power to a few telecom towers. The village also has few telecom towers which is run by diesel is now running on biomass based power.

<sup>22</sup> Case study booklet on Renewable Energy, Vol II published by Confederation of Indian Industries , 2013

## Technical Specification

<b>Total Installed Capacity</b>	32 kW
<b>Technology</b>	Biomass Gasifier
<b>Type of System</b>	Down Draft
<b>Manufacturer</b>	Ankur Scientific
<b>Gasifier Rating</b>	50 kg/hr
<b>Engine Rating</b>	32 PG kWe
<b>Biomass Feedback</b>	Ipomea, Dhaincha, Corn Cob, Jungle Wood
<b>Calorific Value</b>	36000 kCal/kg
<b>Power Generation</b>	100-120 kWh per day
<b>Feedstock Consumed / day</b>	150 kG
<b>Operational Hours and Days</b>	5-6 hrs / day, 330 days / year

## Financials:

Project Cost	USD 53,333
Subsidy by MNRE	USD 8000 / annum
Savings through Kerosene	USD 9166 / annum
Income from Power Generation	USD 3000 / annum

## Benefits:

The plant is creating new jobs in the village. Better irrigation facilities are resulting in higher farm income and better quality of life. There is considerable improvement in education opportunities as children are able to study in the night due to better quality lighting and women work on handicrafts.

The benefits from the power plant can be summarized as follows:

- Improvement in quality of life as households are illuminated with electricity
- Earning capacity has increased due to regular power supply to micro enterprises.
- The project helped in skill up-gradation & employment generation in the village.
- Increase in farm productivity due to timely supply of irrigation water for fields
- Telecom tower players are able to save money spent on diesel.

On the whole, around 50 people have benefited directly and indirectly due to this project.

This chapter discusses rationale for adopting suitable sustainable energy options along with their applications in Lao People's Democratic Republic. Besides, relevant case studies for different applications have been discussed. However, for proper adoption of these technologies and smooth implementation of different sustainable energy options and applications, suitable

strategies and policies are required. In the next chapter, we have outlined various strategies and discussed necessary policy actions required for promotion of selected sustainable energy options.

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## **Chapter 6**

# **RECOMMENDATION ON POLICY APPROACHES, PROGRAMMES, DELIVERY MECHANISM AND BUSINESS MECHANISMS**

### **6.1 Introduction**

Lao People's Democratic Republic has recognized the importance of promoting sustainable energy options in the country as reflected from the efforts taken by the Lao government in the form of creating an institutional structure, enacting a Law on Electricity, and notifying national renewable energy strategy for Lao People's Democratic Republic. Unlike most countries, it has specified long term targets for renewable energy supply in the total energy mix. The Law on Electricity of Lao People's Democratic Republic spelt the need for using natural resources in an economical and sustainable manner. The Law also mentions use of off-grid RE based generation technologies to facilitate rural electrification. However, the Lao government has not yet notified the comprehensive renewable energy policy and the implementation Plan. This chapter is built on the learning from the previous chapters, wherein, analysis of the current sustainable energy promotion environment, programmes and business mechanisms have been conducted. An attempt has been made to identify the gaps in the present national enabling environment for sustainable energy development and to suggest new policy approaches, Programmes and business mechanisms to overcome these shortcomings in order to make the sustainable energy options accessible and affordable in the country.

### **6.2 General Policy Approaches**

- **Dynamic RE target setting:** Setting long-term dynamic RE targets in terms of electricity or final energy sends the right signal to investors by showing government commitment towards renewable energy promotion. The Lao government under its renewable energy development strategy specifies 30% target for renewable energy by year 2025 in terms of final energy consumption (ktoe). The proposed RE target is divided among three types of energy carriers viz electricity (28%), bio-fuel (44%) and heat energy (28%), implying that the government has given more importance for bio-fuel production over renewable based electricity generation. It is well understood that Lao People's Democratic Republic has ample land for growing tree borne oil seed species, and such plantations will not conflict with the food producing farmlands. In spite of this, it is advisable to specify RE based electricity target as percentage of total consumption of electricity in the country. The present renewable based electricity target if projected as a percentage of electricity requirements in the year 2025 shall effectively become 16%.
- **Scientific Resource Assessment:** There is an urgent need to access the physical renewable energy resources potential in Lao People's Democratic Republic including solar, wind, hydropower, and biomass. Resource assessment data and maps compiled at regional or country level can provide broad technology options and help the developer in making informed decisions about investing in renewable energy projects. Higher resolution data that covers narrower geographic zones is necessary for making precise decisions on energy generation and planning. There is a need to conduct research on possible impact of climate change on the hydropower potential of Lao People's Democratic Republic. An analysis of historical rainfall data, changes in river flow, variation in power generation over a time period, etc, may be useful to understand the impact of climate change on the hydropower potential.

- **Ranking of Potential Hydropower Sites for Development:** Lao People's Democratic Republic is endowed with vast hydropower potential. This has often been looked as a potential source for energy import by the energy starved neighbouring countries. Pursuit of this opportunity requires optimal development of the country's hydropower resources in a sustainable way by maintaining a balance between the exploration of the hydropower potential for export and for domestic use. Ranking studies will be useful in view of prioritizing the large number of identified hydropower schemes to harness vast untapped hydro resources in the order of their attractiveness for implementation. The Ranking Study gives inter-se prioritization of the projects based on their cost of generation which could be considered for further implementation. Such a study will prove helpful in making informed decisions while allotting hydropower sites for IPPs interested in export of power, and IPPs interested in domestic supply of power.
- **Use of Geographical Information System (GIS) to Identify Potential Small-hydro Sites for Development:** Renewable development strategy in Lao People's Democratic Republic specifies the governments' intention of developing SHP projects with the help of private entrepreneurs. The use of GIS with the help of limited amount of numerical data: a digital elevation model (DEM) and runoff data. The GIS tool recreates streams and sets up hypothetical hydropower schemes at regular intervals, and then makes it possible to estimate altitude and hydrology for each one of these positions. The tool calculates the characteristics of each potential project in terms of available head, discharge including energy generation, cost of generation and internal rate of return (IRR) from the project. The private investor will be able to get all the information about potential SHP scheme online.
- **Use of Bio-fuels for Rural Electrification and Industrial sectors:** The Lao government has an ambitious target of introducing 10% bio-fuels in transportation sector by 2025. Lao has ample land to cultivate tree borne oil seed species without encroaching farmlands, and therefore the government can pursue the ambitious blending targets.

The land utilization pattern in Laos shows that agricultural land has been increasing at a rate of 3.8% per year (2008 to 2011). The total land required for bio-fuel production in 2025 to meet the 10% blending target would be 0.36 million Ha (with least productive crops) or 0.20 million Ha (with highest productive crops). This would be 15% to 8.4% of current available agricultural land. Lao had a total of 2.38 million Ha of land under agriculture in 2011, out of which nearly 50% has been categorized as arable land. The strategy must be to ensure food security for Lao, without diverting the fertile agricultural land for bio-fuel crop production.

Alternatively, biodiesel can be effectively produced in decentralized ways to facilitate remote village electrification. IREP needs to identify the potential areas and devise an appropriate policy in this regard. Study of some important aspects like availability of land required for cultivation, estimated yield, cost of producing bio-diesel, etc, would be prerequisites before announcing the policy. Same is the case with ethanol. Realistic assessment of the potential for production and possible application areas needs to be done if the policy is to be effective.

- **Gradual Shift to Hybrid and Electrical Vehicles:** Diesel and gasoline import in Lao has increased at an annual growth rate of 14.78% and 10.79% respectively during the years 2009 to 2011. This implies an increasing pressure on the import bill for the country, and in the long run, this will surely affect the economy of Lao. On the other hand the export earnings of Lao to some extent depend on surplus hydroelectricity sale to neighbouring countries. The imports and exports have increased at an annual average growth rate of 19.42% and 22.36%

respectively for diesel and gasoline during 2005 to 2012. The trade deficit reached 0.78 billion US\$ in 2012. The Ministry of Planning and Investment (MPI) export and import data from year 2011 to the middle of 2013 indicates that, exports had reached 76% of the goal set in the 7th Five-Year National Socio-Economic Development Plan (2011-2015). Whereas the imports underwent a major increase during the same period. The value of imports has exceeded the figure set in the plan by 28%—increasing by an average of 42% annually. The present trend of oil and gas price indicates that the bill on account of oil and gas may be increased substantially in future and can disturb the macro-economic condition of Lao People's Democratic Republic. Therefore the possible strategy must be directed to reduce the increasing trend of oil and gas import in Lao.

In such circumstances, gradual shifting of private and public transport vehicles to hybrid and electric mode would be an ideal choice. Lao People's Democratic Republic has an advantage in implementing this programme in terms of availability of least cost electricity produced from a hydropower and predominantly north-south stretch of road network. The Programme on electrical vehicles if implemented on a large-scale can significantly reduce the oil import bill and help in improving the trade deficit. The bio-fuel blending programme, on the other hand does not have the capacity either to reduce the emissions or cut the oil import bill significantly. Therefore the government should implement both these Programmes simultaneously.

A major national level Programme may be designed to promote utilization of hybrid and electric vehicle in a phased manner. The infrastructure for large scale roll-out of electric vehicle may be developed by the government. The necessary funding can be made available from international donor agencies, and may be designed on the basis of public private partnership.

### **6.3 Renewable Energy Policy and Implementation Plan**

The Lao People's Democratic Republic Government has specified renewable energy development strategy for the country; however, the government has not yet notified the renewable energy policy and implementation plan for accelerated development of renewable energy and realizing the RE targets specified in renewable energy development strategy. A comprehensive renewable energy policy outlining the overall goals and targets of the government should be put in writing to be easily accessible for any interested party. A comprehensive renewable energy policy serves as a vision / framework and reference point and shall be designed to commit all government departments, other stakeholders to join the agenda of change for providing impetus for development of renewable and sustainable energy options in the country.

After understanding the current socio-economic factors, cultural aspects, energy use pattern, future energy demand, import bill on account of gaseous and liquid fuel, market for sustainable energy service and resource potential for the grid connected, as well as off-grid renewable energy based options, following guiding factors and strategies are suggested for formulation of a comprehensive renewable energy policy and implementation plan for Lao People's Democratic Republic.

### **6.3.1 Formulation of an Empowered Committee on Sustainable Energy Development Programme and its Role**

For better implementation of the sustainable energy Programmes in the country, the Ministry of Energy and Mines, Government of Lao People's Democratic Republic, by notification, shall establish an Empowered Committee on Sustainable Energy Development.

**Constitution of the Committee:** The Committee shall consist of the following members namely,

- (a) The Minister in-charge of the Department of Energy and Mines, Government of Lao, who shall be the Chairperson of such a Committee;
- (b) The Director General of IREP, who shall be the Member Secretary of such a Committee;
- (c) The number of members including Chairman and Member Secretary shall not exceed 15, and shall not be less than 10 at any given point of time;
- (d) The Committee shall consist of DG level Officials from the Ministry of Agricultural and Forest, Ministry of Natural Resources and Environment, Ministry of Science and Technology, Ministry of Industry and Commerce, Ministry of Public Works and Transportation, Ministry of Finance, Ministry of Planning and Investment and EDL. Other non-government members representing various stakeholders such as non-government organizations working in the field of renewable energy, academia, etc, shall be the members of the Committee.

**Role of the Committee** – The primary responsibility of the Committee would be to advise and guide the Lao government on the following issues relating to deployment of sustainable energy projects / options and services in Lao People's Democratic Republic.

- (a) Development of Renewable Energy Policy and Execution Plan for promotion and deployment of sustainable energy projects / options with support from MEM and in collaboration with private entrepreneurs in Lao People's Democratic Republic;
- (b) Development of provincial level renewable energy resource assessment to map the potential areas across the province for implementation of sustainable energy projects / options;
- (c) Coordination among the various Ministries / Departments of Lao government involved in implementation of sustainable energy projects / options and monitoring of such schemes to ensure effective implementation;
- (d) Facilitate on simplified procedure for getting various clearances for setting up RE power projects as well as simplified norms for availing the duty / tax related incentives offered by Ministry of Planning and Investment, Government of Lao.
- (e) Standardize the technical specifications for the off-grid renewable energy equipment / devices to be procured by investors;
- (f) Development of fiscal, financial, regulatory and institutional mechanisms for development and large-scale deployment of sustainable energy projects / options;
- (g) Devising ways and methods to support research and development in the field of sustainable energy;

- (h) Development of a policy to create awareness and educate the masses for adoption of sustainable energy options and services in their respective fields for achieving the goal of sustainable development;

### **6.3.2 Allocation of budget for the Committee**

For the purpose of discharging the duties and responsibilities of the Committee, and the projects and Programmes initiated by it, a separate budget shall be provided by the Ministry of Energy and Mines within its annual budget every year.

### **6.3.3 Renewable Energy Policy**

The Ministry of Energy and Mines (MEM), in due consultation with the Empowered Committee On Sustainable Energy Development should prepare a comprehensive Renewable Energy Policy with specific provisions for promotion of both grid-connected, as well as distributed /off-grid renewable energy systems.

While preparing the policy, the MEM will be guided by the following factors:

#### **In the case of MW scale grid connected RE projects,**

- Overall energy security of the country;
- Public and private sector participation in MW-scale RE projects, especially solar, wind, small-hydro, and biomass power generation. Wherever possible, such projects should be established with provision for storage of electricity.
- Promotion of RE park concept, wherever suitable, with adequate infrastructure and single window clearance mechanism in place.
- Mandatory purchase of electricity from RE power projects by EDL.
- Reduction of greenhouse gas emissions.

#### **In the case of Off-grid Renewable Energy Systems**

- Energy access to the rural population.
- Off-grid/distributed renewable energy generation systems.
- Usage of solar energy in all public buildings in a time-bound manner, reducing dependence on conventional electricity.
- Use of solar thermal application for meeting process heat requirements in industry.
- Provision for time-bound solar water heating in all buildings with defined floor areas and appropriate roofing structures.
- Setting up small scale off-grid solar and biomass power projects to meet the energy needs of the vulnerable sections of society who do not have access to grid electricity.
- Use of biomass based improved cook stove, solar thermal cooker for community application and electric appliances at later stage
- Integration of RE development with Socio Economic Development Plan, rural development and poverty eradication implementation Plan, electricity infrastructure development schemes and various employment and welfare schemes of the government.
- Schemes for international cooperation through government-led/supported MoUs;
- Development of quality control mechanism for RE equipment/products.
- Development of standards based on performance.
- A comprehensive mass media strategy to promote use of OFF-GRID applications in remote areas.

### 6.3.4 RE Implementation Plan

The MEM shall in due consultation with the empowered committee and developers, and on the basis of the resource assessment report and Renewable Energy Policy, prepare an implementation plan for promotion and large-scale deployment of RE sources of energy including off-grid RE system from time to time.

The MEM, while preparing the implementation plan, may consider the following aspects:

- (i) Development of grid-connected MW-scale RE projects with the help of public and private sector participation. The implementation plan shall mention the yearly RE technology-wise implementation targets.
- (ii) Implementation plan for off-grid RE schemes with targets for different technologies, strategies for execution, and roles and responsibilities of agencies involved in implementation.
- (iii) Off-grid RE scheme implementation in association with the manufacturer / service provider / end user, and financial institutions/cooperative rural societies.

The MEM shall publish such an implementation plan once in five years (co-terminus with the five year plans), and give wide publicity to the same.

### 6.3.5 Progress Report

The MEM shall publish every year the 'Annual Sustainable Energy Report', covering progress of implementation of RE Programmes as envisaged under the policy.

### 6.3.6 Implementation strategies

#### *For grid connected RE projects*

- 1 Grid-connected RE power plant:** The appropriate authority shall assist and encourage the development of grid-connected RE projects based on renewable resources like small-hydro (>15 MW), solar PV and solar thermal, biomass, bagasse, geothermal along with other new RE technologies, as may be approved by the government from time to time
- 2 Target for Renewable Electricity Generation:** The MEM in consultation with the other departments, EDL, IPPs shall specify the target as percentage of total energy input for purchase/generation of electricity from renewable sources of energy.
- 3 Access to Grid**
  - (i) The EDL shall be obliged to connect the renewable energy generator to the system. The EDL shall extend the grid as per the requirement of the RE generator, and shall upgrade the network to ensure reliability of the interconnection as per specified standards.
  - (ii) The EDL shall be obliged to provide open access to the RE generator for its transmission and distribution systems for facilitating third party sale and captive use of electricity.
  - (iii) The Merit Order Dispatch principle shall not be applicable for dispatch of electricity generated from renewable based power projects. EDL shall provide priority dispatch for the electricity generated from all RE based power projects.

#### 4 Grid Cost Bearing

- (i) The costs associated with evacuation line and other associated equipment up to the interconnection point shall be borne by the renewable energy generator. 'Interconnection Point' shall mean interface point of renewable energy generating facility with the transmission system or distribution system, as the case may be.
- (ii) The costs associated with laying the evacuation line and upgrading the grid beyond the interconnection point as defined in (i) above in order to connect new RE power plants as above/or accepting and transmitting energy fed into the EDL grid for public power supply, shall be borne by the EDL.
- (iii) The implementation of the connection must comply with the EDL's technical requirements in a given case, and the RE generator shall be entitled to have the connection implemented either by EDL, or by any such third person or agency, as the case may be.

#### 5 Feed-in- tariff Regulations: The MEM in consultation with EDL shall notify the FIT regulation for procurement of power generated from RE-based power projects. While notifying the FIT regulations, the MEM should be guided by the following factors:

- (i) Technology being used by the generator;
- (ii) Costs associated with construction, commissioning, operation and maintenance of the plant;
- (iii) Operating norms for the specific technology under consideration;
- (iv) Reasonable returns to the investors;
- (v) As far as possible, the tariff shall be specified for the life of the plant.

#### 6 Regulations on net metering: The MEM in consultation with EDL shall notify the regulation on net metering to enable procurement of excess power generated from rooftop solar and other RE-based micro-generation projects.

#### 7 Other Regulations : Other national regulations such as Grid Code, regulation on performance standard of power utility and grievance redress forum for end consumer including the International regulation on connectivity with the state transmission lines with the transmission lines of export-oriented IPPs.

#### **For Off-grid RE Systems**

- 1 **Off-grid Distributed Micro-generation/Distributed RE systems:** The MEM, while developing renewable energy policy, shall give due consideration to micro-generation for promoting off-grid and stand-alone systems of power generation in the rural and urban areas of the country.
- 2 **Development of Supply Chain for Off-grid RE system:** The IREP shall focus on the development of supply chain and outlets to facilitate easy availability of off-grid RE applications and services, particularly those based on solar energy in all areas of the state. The activities shall include:
  - (i) Introduction of new delivery mechanisms of distribution like renting, leasing, BOMT (build, operate, maintain and transfer), etc.

- (ii) Enterprise development Programmes to develop entrepreneurs delivering RE applications and services locally.

### **3 Off-grid RE Development & Demonstration Programmes**

- (i) The MEM/IREP shall carry out R&D Programmes, development, demonstration, and commercial application of off-grid RE in view of improving the reliability and efficiency of off-grid energy resources and systems.
- (ii) The MEM shall make competitive, merit-based grants to deserving not-for-profit research agencies for the research, development, and pilot demonstration of innovative micro-generation energy technologies for:
  - a. The use of small-scale combined heat and power in residential heating and cooling appliances.
  - b. The use of power generated in-situ to operate residential appliances, and the supply of excess power generated to the grid.
  - c. Industrial heating and cooling application using solar power.
  - d. Solar/biogas/other RE for cooking applications.
  - e. RE-based irrigation pumping systems.
  - f. Other RE-based micro innovations.

**4 Off-grid Application and Implementation Strategy:** The MEM shall incorporate the off-grid RE schemes detailed under following sections hereafter in the country-level implementation plan suggested above. This will help to provide electricity for meeting the minimum lighting and productive load of the rural population from the viewpoint of improving income, as well as living standards of the rural population. In the case of the urban populace, the off-grid application shall be aimed towards replacement of fossil fuel used for heating / cooking purpose.

#### **A. Solar Photovoltaic Systems for Rural Home Lighting**

- (i) The MEM in consultation with the other government departments and relevant stakeholders shall prepare and launch a Programme of SPV home lighting systems in areas inaccessible to the grid, or not serviced by the micro-grid.
- (ii) Depending on the social and local conditions, individual solar lighting solutions based on a minimum of 3 to 4 lighting points in a household or setting up a solar charging station in the vicinity of un-electrified hamlet should be pursued.
- (iii) A network of accredited solar product suppliers and service providers shall be created to provide quality assured solar home lighting systems.
- (iv) Alternatively, the Programme can be implemented through the authorized channel partners / NGOs who can aggregate the solar home lighting proposals of the end users and submit them to the bank, along with the collateral guarantee to enable the bank to sanction the loan.

## **B. Promotion of Biomass/Biomass–Solar Hybrid Stand-alone Power Plant with the Village Grid**

- (i) The MEM shall in consultation with the government departments and other stakeholders prepare and launch a Programme to promote off-grid biomass/biomass–solar-based micro-grid projects to cater to the electricity needs of people in un-electrified areas, as given below.
  - a) The Programme shall be implemented by the IREP / Provincial Department of Energy and Mines / district level department of Energy and Mines through a Village Cooperative Society (VCS) promoted by the IREP. The project after completion shall be operated and maintained either by the Village Energy Committee (VEC) or the Village Cooperative Society, as the case may be, provided that:
  - b) The tariff, in such case shall be mutually agreed between the VEC and the implementing agency;
  - c) In case such projects avail any special state financial assistance, then the tariff shall be approved by the MEM.
  - d) The VEC shall collect the tariff from the end-user and pass on the same to the implementing agency.
- (ii) In case of a VCS implemented project, the tariff will directly be collected by them.
- (iii) In case such a off-grid stand-alone project is set up by a private entrepreneur (private implementing agency) without availing any government incentives for generation and distribution of electricity in rural areas,
  - a) The tariff for sale of electricity in such cases shall be determined through mutual agreement between the VEC and the private implementing agency, and collected directly by the private implementing agency.
  - b) If the private implementing agency has availed any government incentives, then the tariff shall be determined by the MEM.

## **C. Rooftop Solar PV for Urban Use**

The MEM in consultation with the Ministry of Public Works and Transportation shall establish a Programme on implementation of solar PV-based rooftop systems in public buildings. The following shall be the objectives of the Programme:

- (i) To demonstrate the use and viability of solar PV to the general public.
- (ii) To develop the Programme performance data to support future policy decisions.
- (iii) To encourage private commercial buildings for installation of solar PV based rooftop systems.
- (iv) To introduce the ‘net metering’ concept and enable injection of surplus generation from rooftop PV plant into the grid.
- (v) The MEM shall administer the Programme with the help of the other stakeholders as follows:

- a. Issue such resolution as may be appropriate to implement the Programme.
- b. Implement the Programme phase-wise, i.e. urban public buildings in the first phase; while public buildings like rural public health centres, rural veterinary clinics, schools in rural areas, etc., shall be covered in the second phase.
- c. After successful demonstration of the Programme in public buildings, the same should be implemented in commercial buildings.

**D. Solar Thermal Application for Cooking and food processing/ Industrial Heating / Drying**

- (i) The MEM in consultation with the government departments should initiate a Programme for solar cooking / improved stove and encourage the manufacturers to develop a variety of solar cookers / improved stove to meet the diverse consumer needs across the country.
- (ii) The MEM, in consultation with the government departments shall initiate a time-bound Programme for utilization of solar concentrating technology for industrial applications such as:
  - a. Food processing, juice concentration, particularly sugarcane, milk pasteurization, etc;
  - b. Wood processing;
  - c. Solar-based drying, heating, air-conditioning, and refrigeration systems;
  - d. Processing of and preservation treatment for wood-bamboo composites.

**E. Solar Thermal Systems for Water Heating Applications**

- (i) The Ministry of Public Works and Transportation (MPWT) , in consultation with other stakeholders shall initiate a nation-wide Programme for making solar water heating mandatory in all buildings with defined floor area and appropriate roofing structure; provided that this should be done in phases, after considering the situations prevailing in different parts or geographical regions of the country.
- (ii) The MPWT shall formulate a definite time-bound Programme in coordination with provincial / district/ local government such other local bodies to amend building laws, bye-laws or rules and regulations, to facilitate such mandatory use so as to ensure that this Programme shall be completed within a stipulated period.

**6.3.7 Selected Policies and Measures to Promote Energy Efficiency and Energy Conservation**

The energy conservation and energy efficiency Programmes in Lao are at an early stage of development at present, and the government has not yet specified any strategy for energy conservation. Following guiding factors seem to prove useful while formulating energy conservation and energy efficiency strategy for Lao People’s Democratic Republic.

- **Building codes:** Establishes codes for energy-efficient technologies in buildings, including insulation, cool roofs, passive lighting and heating, window sealants, and use of renewable energy technologies such as solar water heaters.
- **Appliance standards:** Sets standards for most common appliances in the household, business, and industrial sectors, including air conditioners, refrigerators, televisions, heaters, ovens, clothes dryers, computer hardware, and heavy machinery. Adapting appliance

standards from countries with successful efficiency programmes can guide new appliance standards.

- **Weatherization programmes:** Provides energy efficiency measures to low- income residents free of charge, such as adding weather stripping to doors and windows, installing insulation, and tuning heating and cooling units.
- **Energy audits:** Provides energy assessments to determine home energy usage and efficiency measures, through techniques including a blower door test, thermo graphic scan, and air infiltration measurement.
- **Public education:** Provides residents with information about cost-saving efficiency measures. Education programmes in schools can also ensure that energy conservation becomes a cultural priority with younger generations.

### **6.3.8 Institutional Capacity Building:**

The role of the Institute of Renewable Energy and Promotion (IREP) is critical in ensuring sustainable energy development in Lao People's Democratic Republic. At present, the IREP is responsible for the implementation of three Programmes, namely the renewable energy, energy efficiency / energy conservation and rural electrification. For effective implementation of the renewable energy policy, the key implementer IREP will have to be strengthened. Enough budgetary and staff provision is made from year-to-year to facilitate such capacity building. In fact, a master-plan for such capacity building covering financial growth, infrastructure development (both soft and hard infrastructure), staff deployment, human resource development, etc. would be necessary to empower IREP to achieve the objectives of this policy. A separate Deputy Director General-level officer may be deployed under the Director General, IREP, to look after the energy efficiency and energy conservation Programme in Lao People's Democratic Republic.

Another Institute whose role is critical in developing sustainable energy technologies to suit local environment is the Renewable Energy and New Materials Institute (REMI) working under the Ministry of Science and Technology. REMI has to play a vital role in conducting R&D for applied and adaptive renewable energy technologies, which suit the local need and support government policies and programmes. The role of REMI is thus important in making sustainable energy affordable through technology innovation. For effective promotion of sustainable energy technologies, REMI needs to be strengthened, diversified and expanded considering the diversity of renewable energy technologies. It should be made autonomous with adequate funding and time-bound targets. Under the ambit of REMI, specialized research centres for diverse renewable energy technologies need to be established. The REMI also needs to network with various institutions working in renewable energy related R&D in the country in order to exchange the latest knowledge.

### **6.3.9 Academic Sector**

The role of academic and R&D institutions is of prime importance in developing sustainable energy technologies to meet the RE capacity addition targets specified in Renewable Energy Development Strategy. To ensure timely quality manpower to achieve RE targets, there is a need to revise the curricula of educational and training institutions across various levels. At present the National University of Lao offer elective subjects on renewable energy during the degree course. There are no specialized degree / diploma courses affiliated to renewable energy / sustainable energy being offered by academic institutions in the country. Along with the curricula, related laboratory infrastructure should be created to demonstrate proper practical

experiments to the students. Such detailed greening of the academic sector should be undertaken through a national project for revamping curricula and courses in technical and management institutions during the 7<sup>th</sup> Socio Economic Development Plan period.

**Table 14: Proposed Revision Required in the Curricula of Educational and Training Institutions**

Institutions	Courses or Programmes
Schools	Revised curriculum
Industrial Training Institutes	Technician-level Programmes for skilled workers (9 months to 1 year)
Pre-degree level	Diploma-level Programme for supervisory staff (1 year to 2 years)
Engineering colleges / other premier engineering institutes	Graduate courses Postgraduate courses Doctoral-level courses
Management Institutes	Masters in Energy Management (with emphasis on RE)
Training institutes in the govt. and non-govt. sector	On the job training Certificate courses up to 3 months Training of trainers

### 6.3.10 Financial and Fiscal Incentives for promotion of RE

The RE investors in Lao People’s Democratic Republic are granted few incentives like import duty relaxation on production machinery, equipment and raw material and import duty free on chemical materials necessary for bio-fuel production within 7 years.

Worldwide, a number of policies are designed to provide incentives for voluntary investments in renewable energy by reducing the costs of such investments. These policies can be characterized as falling into five broad categories: policies that (i) reduce capital costs upfront (via subsidies and rebates); (ii) reduce capital costs after purchase (via tax relief); (iii) offset costs through a stream of payments based on power production (via production tax credits); (iv) provide concessionary loans and other financial assistance, and (v) reduce capital and installation costs through economies of bulk procurement.

Lao People’s Democratic Republic has ample hydro potential to cater to the energy needs of the majority of the population via clean and least cost grid electricity. Therefore, the scope for renewable energy is limited to providing off-grid sustainable energy options to the urban, and particularly, to the population located in remote rural areas where the extension of centralized grid is not economically and technically viable. The Lao government, depending on the availability of funds can think of offering some tax relief to investors / end users in view of increasing the affordability of sustainable energy technologies / options in the country.

Tax relief policies to promote renewable energy have been employed in the United States, Europe, Japan, and India. Tax relief is especially popular in the United States, where a host of federal and state tax policies address energy production, property investments, accelerated depreciation, and renewable fuels.

- **Investment Tax Credits:** Investment tax credits for renewable energy have been offered for businesses and residences. In the United States, businesses receive a 10% tax credit for purchase of solar and geothermal renewable energy property, subject to certain limitations. Some U.S. states have investment tax credits of up to 35%.

- **Accelerated Depreciation:** Accelerated depreciation allows renewable energy investors to receive tax benefits sooner than under standard depreciation rules. The effect of accelerated depreciation is similar to that of investment tax credits. In such circumstances, businesses can recover investments in solar, wind, and geothermal property by depreciating them over a period of five years, rather than the 15- to 20-year depreciation lives of conventional power investments. India's accelerated depreciation policy allowed 100% depreciation in the first year of operation, helping spur the largest wind power industry among developing countries.
- **Production Tax Credits:** A production tax credit provides the investor or owner of qualifying property with an annual tax credit based on the amount of electricity generated by that facility. By rewarding production, these tax credits encourage improved operating performance. A production tax credit in Denmark provides DK 0.10/kWh (US 1.5 cents/kWh) for wind power, but few other countries have adopted similar credits.
- **Property Tax Incentives:** These incentives are implemented on many scales—state, county, city, town, and municipality. These are generally implemented in one of the three ways: (i) renewable energy property is partially or fully excluded from property tax assessment, (ii) renewable energy property value is capped at the value of an equivalent conventional energy system providing the same service, and (iii) tax credits are awarded to offset property taxes.
- **Personal Income Tax Incentives:** Credits against personal state income taxes are offered for purchase of and/or conversion to eligible renewable energy systems and renewable fuels. In some cases, taxpayers can deduct the interest paid on loans for renewable energy equipment.
- **Sales Tax Incentives:** Retail sales tax exemptions for eligible renewable energy systems and renewable fuels. Most exempt 100% of the sales tax for capital expenses, and provide specific cents-per-gallon exemptions for renewable fuels. Some policies specify maximum or minimum sizes for eligible systems.
- **Pollution Tax Exemptions:** The Netherlands is an example where “green” power is exempt from a new and rising fossil fuel tax on electricity generation that is paid by end-users. Starting in 2001, that fossil-fuel tax rose to the equivalent of US 5 cents/kWh, providing a large tax incentive for Dutch consumers.

### 6.3.10.1 Policy Measures to Create Fund to finance RE/ market for RE

At present the Lao government relies entirely on international funding and donor contribution for promotion of sustainable energy development. The finance for supporting the sustainable energy options and sustainable development can be arranged from various ways. The options relevant for Lao People's Democratic Republic are discussed below:

**Eco-taxes:** Involves taxing a range of products and activities to reduce carbon emissions or other environmental impacts, including via carbon-based taxation of cars and fuel suppliers, traffic congestion fees, and a direct tax on carbon emissions.

**Domestic Public Financing:** Creates a specialized financial institution within the government to leverage the private capital necessary for sustainable energy. Domestic public funds can provide the financial backing necessary for a range of incentives including feed-in tariffs and loan packages for energy development projects.

**International Funding Options:** Includes harnessing international funding sources such as the Clean Development Mechanism and Joint Implementation funds under the UN Framework Convention on Climate Change, World Bank loans, and bilateral development assistance.

**Capacity Building in Banking and Financial Sector:** Aims at addressing a lack of available capital to invest in renewable energy sources, as well as a lack of available borrowing (soft loans, credit, grants, tied and untied loans) and guarantee instruments for renewables, based on the assumption that in the long term, the private sector, backed by commercial banks, will need to be the main source of renewable energy finance.

- **Public Benefit Funds:** Public funds for renewable energy development are raised through a System Benefits Charge (SBC), which is a per-kWh levy on electric power consumption. Some analysts suggest that state clean energy funds seem to be one of the more effective policies in promoting renewable energy development to result from electricity restructuring. It is estimated that fourteen U.S. states will collect \$3.5 billion through 2011 in system benefits charges. Similar levies exist in some European countries for fossil fuel-based generation. In general, the funds serve a variety of purposes, such as paying for the difference between the cost of renewable and traditional generating facilities, reducing the cost of loans for renewable facilities, providing energy efficiency services, funding public education on energy-related issues, providing low-income energy assistance, and supporting research and development. Maharashtra state in India has successfully created a clean energy corpus of Rs. 1 billion by levying cess on electricity consumed by the industrial and commercial consumers in the state.
- **Government Procurement:** Government procurement policies aim to promote sustained and orderly commercial development of renewable energy. Governmental purchase agreements can reduce uncertainty and spur market development through long-term contracts, pre-approved purchasing agreements, and volume purchases. Government purchases of renewable energy technologies in early market stages can help overcome institutional barriers to commercialization, encourage the development of appropriate infrastructure, and provide a “market path” for technologies that require integrated technical, infrastructure, and regulatory changes.

### 6.3.11 Promoting Local RE Manufacturing

The Lao People’s Democratic Republic government shall announce a special package of incentives, under the Investment Promotion Law of the country, for promoting local manufacturing of RE equipment, components, etc., across the entire value chain, keeping in mind the following aspects.

- Conditions that would ensure at least 70% real manufacturing (as against local assembling) within the country shall be included to prevent misuse of such incentives.
- Small and medium enterprises should be given priority.
- The main objective of the package of incentives shall be to make the country create a manufacturing hub for RE equipment, components, etc., and generate employment for local people, wherever possible.

Alternatively, the Lao government shall launch a Programme for creation of special industrial parks for RE manufacturing on the lines of the Special Economic Zone (SEZ) policy of the Government of Lao, provided that:

- Such Programmes are tailored to suit local conditions in the state.
- Productive agricultural land is not be diverted for the purpose.
- There should be minimum or no displacement of people for this purpose, as far as possible.

Other policy measures to promote local manufacturing include:

- **Tax incentives :** Tax incentives may be provided via reduced corporate income tax, import tax exemption for raw materials, manufacturing tax credit (This incentive provides tax credit to new, expanded or re-equipped advanced energy manufacturing projects), exemption on VAT. The government, however, already provides reduced income tax and VAT exemption.
- **Import quota or restriction:** Through import quota, restriction is imposed on imported commodities up to a certain quantity. As a result domestic manufacturers are protected from foreign products.
- **Certification and testing programme:** Certification and training programme helps manufacturers to produce according to the need of the industry. This increase acceptability of domestically manufactured products in the industry.
- **Research, development and demonstration programme:** Higher investment on research and development for manufacturing improves product quality, helps innovation. Demonstration of new products through industry parks creates markets for newly invented products.

### 6.3.12 Suggested Business Mechanisms

Lao People’s Democratic Republic has an experience of Public – Private partnership mechanism in executing the rural electrification schemes through off-grid RE based applications like solar home system / lanterns and RE based mini-grid projects in rural area. A private-sector mechanism can take different forms according to the ownership of the system and the mini-grid, the type of contracts (with end-users, the utility), and the type of subsidies. However, the principal advantage is that it usually provides electricity more efficiently than any other mechanism. If a business plan is well structured, companies are also able to ensure long-term O&M and have the technical ability to address urgent problems and replacement issues. Moreover, the private sector might have the investment capacity that is much needed in rural areas. Finally, in developing countries many private sector companies involved in the generation of electricity from mini-grids have a local interest in providing electric power services and therefore an added motivation for their own involvement. Compared to public utilities, private firms may be better able to navigate political interference.

However, given the situation of most rural areas in developing countries, the private sector cannot generally be expected to build up a system and/or serve rural populations without some form of public financial support. Experiences in many developing countries show that it can be quite difficult to find enough interested and qualified companies to bid for rural electrification concessions. Therefore, the interest in these types of long term projects usually comes from smaller local private companies, which tend to be have limited technical skills and financial resources. After studying the experience of earlier Public – Private partnership mechanisms practiced in Lao People’s Democratic Republic, following business mechanisms are suggested for improving the affordability and access to the sustainable energy technologies / options.

#### **Operation of Mini-grid Project under Public Private Partnership mode <sup>23</sup>**

The MEM / IREP / Provincial government shall notify the area to be served by setting up renewable energy based Mini-grid project. The government will prepare feasibility study of such

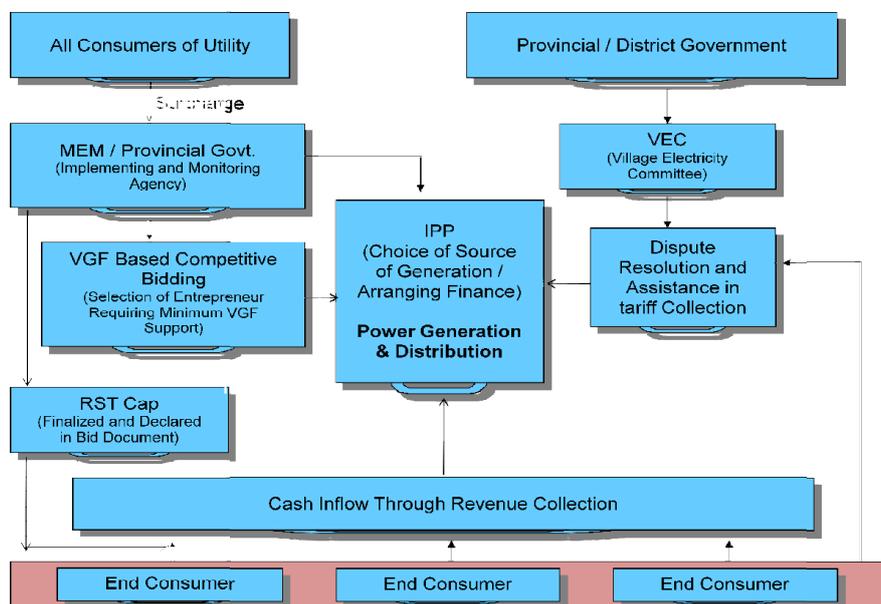
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<sup>23</sup> Hybrid Mini-Grids for Rural Electrification : Lessons Learned , USAID

projects to indicate RE resource availability, energy consumption pattern of surrounding area, paying capacity of end consumer. The feasibility study reports will be made available to the interested private entrepreneur to provide initial information of the project characteristics. Thereafter the private entrepreneur is free to carry out his own survey and investigation to ascertain the resource availability, selection of RE technology and have freedom to secure finance for the project from any financial institution. However the private entrepreneur is solely responsible for successful operation and maintenance of the plant.

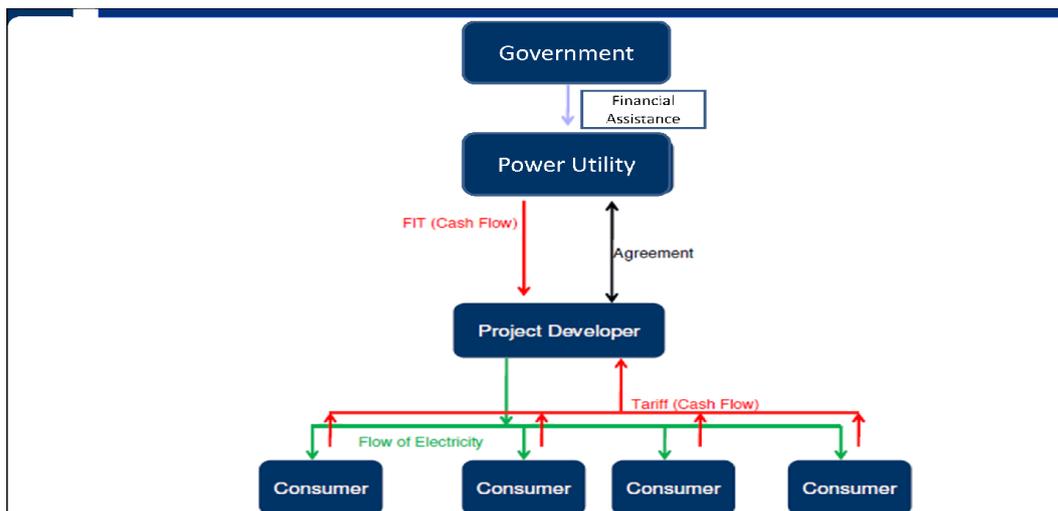
The selection of the private entrepreneur will be done by MEM / provincial government after following a bidding process, wherein the interested bidder shall be asked to quote the Viability Gap Fund (VGF) required for successful operation of plant for lease period equal to the life of the plant. The VGF shall be the difference between the true cost of generation of the mini-grid and reasonable tariff collected from the end consumer, which could be capped by the government to the level equal to the retail tariff of the utility (EDL) in the adjoining electrified area. After examining the technical and financial capability of the bidders, the bidder who quotes least VGF requirement shall be selected for implementation of the mini-grid project. The selected private entrepreneur have to install and commission the mini-grid project, look after the O&M , collect the revenue from the end user as per the tariff approved by MEM. In addition, the government will disburse the VGF at pre-decided interval after ensuring efficient operation of the plant. Such type of business mechanism ensures transparency in pricing and true cost recovery to the investor. The fund requirement for meeting the VGF shall be collected by imposing a uniform cess on all consumers of the EDL.

**Figure 12: Schematic of Business Mechanism for Mini-grid Plant**



In case of extension of the centralized grid to such project area, the mini-grid system can be integrated with centralized grid. At that time the private entrepreneur /operator of such mini-grid plant can work as distribution franchisee of the utility (EDL) and receives franchisee fee from distribution utility.

Figure 13: Off-grid distribution based franchise business mechanism



In this type of arrangement the plant operator shall inject electricity generated from mini-grid plant into the grid and receive the feed –in tariff to be determined by the MEM. Thus the revenue flow of the developer/operator is assured through two sources - generation income as per FIT determined by MEM and franchisee fee. In such situation the VGF shall be discontinued with effect from the year in which the micro-grid plant operates in grid-interactive mode.

### Large-scale deployment of Solar Home System through Private sector <sup>24</sup>

These applications may be in the form of solar home systems or solar lanterns. This is suitable for regions with sparse population where grid expansion is uneconomical and no other source of energy is available.

The Government of Lao People’s Democratic Republic has adopted solar home system programme for rural areas, the programme faces challenges in terms of large scale penetration, after sales service, complete dependence on government financing etc. The inclusion of private sector may help in eliminating these problems.

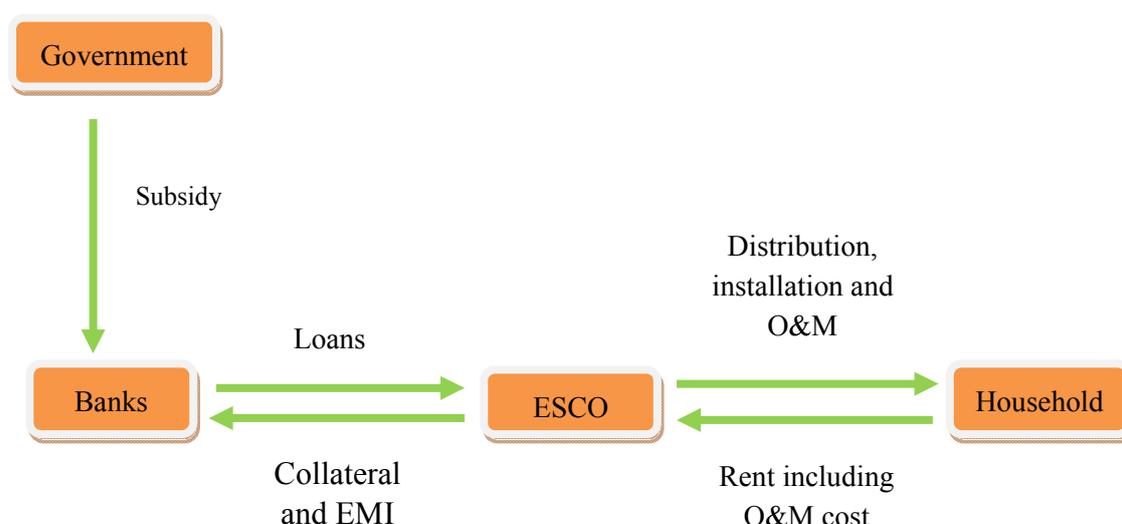
There are two ways in which the private sector may participate in promotion of solar home applications. One is entirely private mode and the other is public private partnership mode. The difficulty with entirely private mode is higher costs to consumer as government subsidy is absent. The consumers may lack the capacity to pay in longer run. On the other hand, public-private partnership a mechanism relies either on government subsidy or support to make the cost calculation effective, but is implemented through private agents. For Lao People’s Democratic Republic public private partnership mechanism is proposed. One such mechanism is ESCO-based mechanism for solar home system deployment, but a portion of the capital cost of solar system is financed through government subsidy.

A suitable business mechanism involving energy service company (ESCO) for solar home systems to the rural households is described below.

<sup>24</sup>Creation of a Legal, Policy and Regulatory Framework for accelerated Renewable Energy Development in Bihar , Greenpeace and World Institute of Sustainable Energy

There are four stakeholders in the mechanism i.e. Government, Banks, ESCO and the households. The government provides capital subsidy for the product, but only partially which is disbursed to the bank. ESCOs are responsible for project implementation, operation and maintenance; banks provide loans to the ESCOs for purchase of the solar home systems which are then rented out by ESCO to the consumers for house hold use. The household owner pays the rent to ESCO and ESCOs in turn pay the EMI to the bank. The ownership of the product is initially remaining with the ESCO and after loan tenure is over, ownership is transferred to the customer. Lao People’s Democratic Republic can effectively utilize the network and consumer based of Lao Agricultural Promotion Bank to implement such scheme.

**Figure 14: The schematic representation of interaction between different stakeholders**



The business mechanism for the scheme is presented in Table 15.

### 6.3.13 South-South Cooperation

#### Rural Energy Development Programme of Nepal and Possibility of South-South Cooperation<sup>25</sup>

Nepal launched rural energy development programme in 1996 to introduce off-grid renewable energy service in the remote parts of the country. The programme introduced micro hydro power systems, improved cook stoves, solar home systems and biogas. These systems generate energy services including lighting, communications, mechanical power and clean water. The lessons learned from the programme were helpful in formulating Nepal’s National Rural Energy Policy, 2006.

Lao People’s Democratic Republic has past experience of implementing Programmes on SHS, biogas, Micro-hydro, improved cook stoves. All these Programmes are implemented by government with financial support; however, these technologies and Programmes are yet to be applied in large scale. Nepal’s experience in large scale promotion of these technologies may be helpful for Lao People’s Democratic Republic. Thus, analyzing enabling factors in scaling up of sustainable energy in Nepal’s remote villages are important.

<sup>25</sup> UNDP; Case Studies of Sustainable Development in Practice

**Table 15: Roles and Responsibilities of stakeholders**

Financial institution	ESCO	Households
ESCO will apply for loans to the bank.	The ESCOs will be empanelled with the local authorities responsible for RE project sanctions and implementation.	Will pay regular rent (which is the EMI including the operation and maintenance cost of the ESCO) to the ESCO.
Bank will receive subsidy amount from the government.	ESCOs will act as implementing agency.	Will take custody of the Solar home lighting system.
Bank will grant loan net of subsidy to the ESCO at subsidized rate of interest and provide the subsidy to the ESCO.	Will rope in the interested buyers.	Will take over the solar PV system on completion of the agreed rent period of 3 to 5 Years.
Bank will receive loan Instalments from ESCO.	Will submit application with collateral security to bank for The loan.	
On successful repayment of loan by the ESCO, bank will release the collateral guarantee of ESCO.	Will get loan and subsidy amount from bank and contribution from beneficiary.	
	Will buy and distribute the SPV home lighting system to buyers.	
	Will provide O&M for the tenure equivalent to the loan repayment period.	
	Will collect rent from the beneficiaries so as to take care of EMI and O&M service.	
	In case beneficiary defaults six instalments, ESCO shall repossess the solar PV system.	

**Commitment of the National Government:** Since the beginning of the programme, the government has shown strong long term commitment for the project. This has been reflected through establishment of Alternative Energy Promotion Centre to lead the programme. The centre has formulated policies, legal and financial framework for rural energy development. The centre has also employed monitoring and evaluation systems that have documented social and economic costs and benefits of rural electrification programme.

**Local Engagement:** The local governments have worked to integrate this programme into local development planning. Also local governments provided finance to support capacity development.

**Arranging Finance for the Programme:** Initially the Nepal Electricity Authority provided 80% of the financing needed to cover the capital investment required in construction and communities provided 20% of the cost. This commitment helped to attract foreign funding from partners such

as Danish International Development Agency, the World Bank, UNDP, NGOs, local governments, and ultimately banks, as well as from local governments, who contributed financing under subsidy provisions and for capacity building. The community contribution to the project cost gradually increased from 20% in 1996 to 40% in 2006.

**Community Mobilization and Local Partnerships:** The programme was successful because of using the existing local governance structures for energy service delivery. Community empowerment ensured effective local service delivery and longer term financial sustainability. The community participants were organized into village level functional groups based on common interests that included representative of vulnerable groups. Collaboration was built up with local entrepreneurs and civil society organizations to provide better service of micro finance services.

**Capacity Development at all Levels:** The Rural Energy Development Programme focused on capacity development both at the national level and local level. The objective of capacity development was to create appropriate policy framework at national level and ensure effective energy service through community members at the local level. Capacity development activities focused on organizational and skills development, training in environmental and technological management, project design and implementation, monitoring and evaluation, resource mobilization, and vulnerable community empowerment.

**Possibility of South-South Cooperation:** The programme provides opportunity to develop South-South learning for Lao People's Democratic Republic. The government participation in the programme has contributed to upscale the project. The programme also illustrates the possibility of capitalizing on existing government priorities for development using renewable energy options. For example, the programme directly contributed to increase women's participation in community life and decision making process. The capacity development through the programme was designed using UNDP's capacity development expertise which is applicable for off-grid access programmes in other countries. The experience of Nepal may be shared with Lao People's Democratic Republic to upscale the implementation of sustainable energy programmes for rural areas in Lao People's Democratic Republic. Training programmes and workshops may also be arranged for capacity building of policy makers, local authorities and communities.

## **Rice Husk Based Power Generation in Rural India**

'Husk Power Systems' (HPS) generates and distributes electricity in the remote villages of Bihar, a state situated in eastern India with a population of over 100 million. Almost 85% of households in the state do not have access to electricity and 82% of households use kerosene as the source of lighting.<sup>26</sup> Businesses turn to diesel generators for power. Although in some rural areas grid connection has been extended, the supply of electricity in those areas is unreliable and intermittent.

The state of Bihar is primarily an agrarian economy and producing huge quantities of rice husk as residue. HPS developed a biomass gasification system which uses rice husk to generate electricity. Each power plant has a capacity of 35 kW to 100 kW and these power plants generate producer gas from rice husk to generate power. The system produces enough electricity to cater to the needs of 300 to 500 households for almost 8 to 10 hours a day.<sup>27</sup>

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<sup>26</sup> Census of India, 2011

<sup>27</sup> Winrock International India (WII), Access to Clean Energy

Apart from producing electricity, the added advantage of these gasification generators is its by-product-silica, which is used as an ingredient in making cement. The rice husk ash produced as a residue is used to make incense sticks and rice husk balls are used as fuel for cooking. Moreover, the HPS initiative saves 42,000 litres of kerosene and 18,000 litres of diesel per year.<sup>28</sup>

**Technology:** Sackloads of rice husk are poured into the gasifier hopper every 30 to 45 minutes. The biomass burns in a restricted supply of air to give energy-rich producer gas. The gas passes through a series of filters which clean it, and it is then used as the fuel for an engine that drives the electricity generator. Electricity is distributed to customers via insulated overhead cables. Key features of the technology are outlined below.

- **Multi-fuel gasifiers:** Gasifiers can use multiple types of feedstock such as
  - Rice husk
  - Wheat husk
  - Mustard stems
  - Corn cobs
  - Wood chips
- **Unique Gasifier Design:** Allows for easy disposal of biomass char, lack of which results in tar formation.
- **Remote Plant Monitoring System:** Low cost system to monitor plant performance via internet.
- **Pre-paid Meters:** Consumers get their meters charged with the amount of money they have and the meter automatically disconnects supply after the credit is exhausted.
- To minimize the cost, locally available gasifiers are used with modified gas engines that are able to operate on 100% producer gas.
- HPS uses standard biomass gasification technology which is suitable for rice husk based power generation.

**Dependence on Local Resources:** Gasifiers are manufactured by a local company and optimised for rice husk (a difficult material to gasify). But gasifiers can also work with other types of agricultural residue or with wood. The engines are manufactured by a local partner who worked with HPS to develop an engine that could run on gas generated by gasification of single fuel alone (rather than dual-fuel operation with diesel fuel).

For day-to-day management, every power plant has one operator and one husk loader, wherein the operator carries out the routine maintenance. In addition, two more people are associated with these plants- one of them handles husk buying and ensures a regular supply of raw material, and the other employee is an electrician in charge of the cluster of villages.

In an effort to secure easy availability of rice husk, recently rice mills are being built up adjacent to the power plants and milling of rice is done free of cost. After milling, the husk is taken and used for power generation. Otherwise, HPS enters into a contract at a fixed price with the rice husk suppliers.

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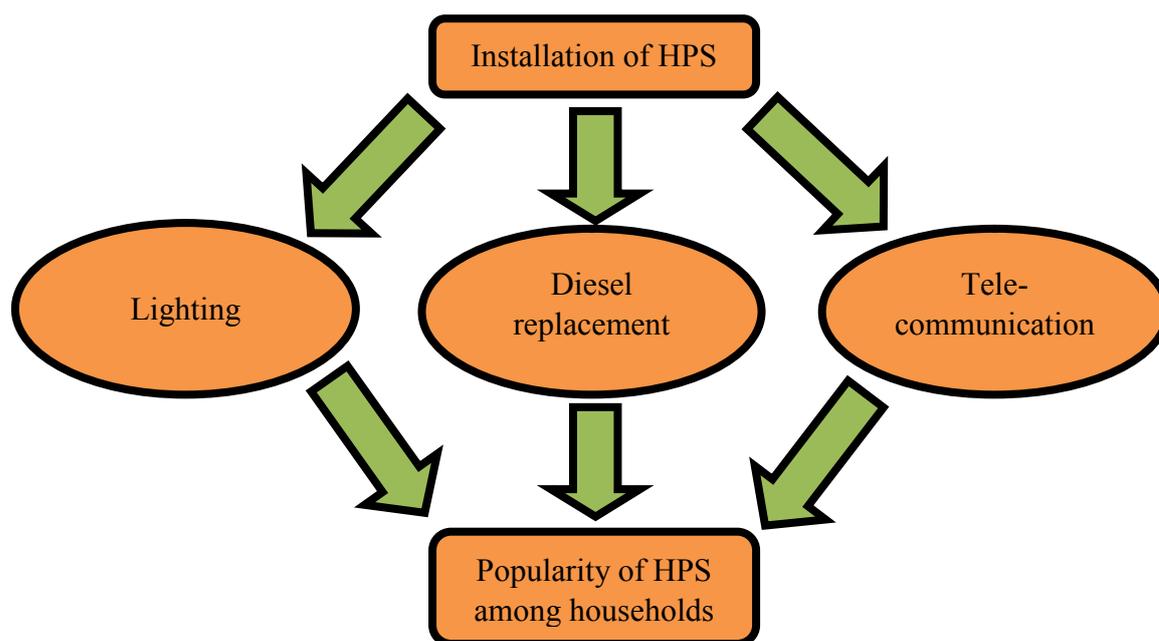
<sup>28</sup> <http://www.devalt.org/knowledgebase/pdf/Case%20Study-3.pdf>

**Business Mechanism for SET Delivery:** HPS follows a demand-driven approach and supplies electricity only to villages with sufficient demand for electricity. In the beginning, the HPS team conducts household level surveys and quantifies the potential demand in watt-hours. The electricity is supplied to the villages where at least 250 households agree to take electricity connection. However, a token installation charge of US\$1.71<sup>29</sup> is collected from the willing households along with verbal willingness. A differential pricing system is being followed by HPS. Every household is charged US\$2.57 (Rs. 150) per two CFLs of 15W, where shops and businesses pay a per month charge of US\$3.42 (Rs. 200). For households seeking connection to operate fans and television sets, etc. charges are calculated on similar wattage basis.

**Social Factors:** Lack of reliable supply of electricity to the families has led to such rapid expansion of the rice husk based power plants in the state of Bihar. Even in villages with grid power, households and businesses choose to connect to the HPS supply because of its greater reliability and lower cost.

- Availability of good-quality lighting throughout the evening serves many purposes of the households.
- Women enjoy extended working hours with the availability of light which allows them to engage in other productive works with higher flexibility.
- Better lighting increases security, and reduces frequency of snake-bites and dog-bites – a common cause of emergency hospital admission in Bihar.
- Removing kerosene lamps and diesel based generators by biomass based power reduces exposure to smoke and fumes. This in turn diminishes negative impacts on health. Further, the risk of fire in bamboo made houses has been reduced.
- The telecommunication system has been facilitated as the use of mobile phones has increased connectivity manifold. In one village, mobile phone ownership increased from 10% to 80% of households after HPS supply was installed.

Figure 15: Benefits of HPS for households



<sup>29</sup> Average annual exchange rate of Rs. 58.48/\$ for 2013 is considered for conversion.

**Affordability:** Households spend \$3.42<sup>30</sup> (Rs.200) per month for kerosene for lighting. By switching to electricity supplied by HPS they are able to save 85.5 cents (Rs. 50) to \$1.71 (Rs. 100) every month. Thus electricity supplied by HPS is very much affordable for the village households. Moreover, the actual value of savings is accentuated by access to electricity as they now involve in more economic and non-economic activities which were hitherto unknown to them.

Access to electricity has helped in business growth. Some new businesses like photocopying and mini cinemas have come up because of HPS supply. Rice mill owners have also benefited since they are paid about \$25 per tonne of rice husk which increases the earning of rice mill owners by an extra \$300 per year.

**Possibility of South-South Cooperation:** HPS is now exploring business opportunities in Tanzania and Uganda. HPS is keen to establish relationships with concerned businesses or institutions or organizations who are interested in building up rice husk based power plants in their country. The technology is suitable for Lao People’s Democratic Republic where rice production is high. The best practices for the husk power systems that suit the country’s conditions are as follows.

- Use of locally available resources and minimum dependence on foreign products
- Use of waste in the form of rice husk for power generation, thus making the supply of raw material sustainable
- Creating employment at the local level for less qualified persons
- Productive use of by-product of the power generation process

#### **Biomass Gasification, Ankur Scientific Pvt. Limited<sup>31</sup>**

Ankur Scientific Pvt. Ltd manufactures biomass gasifier systems for biomass gasification. Biomass gasification is one of the best options for off-grid renewable energy. Two types of gasification technologies are available. One is single fuel mode and the other is dual fuel mode. A comparison of these two modes is discussed in Table 7.3.

**Table 16: Comparison of single fuel mode and dual fuel mode**

Single fuel mode	Dual fuel mode
Only biomass is used as fuel.	Biomass and diesel are used as fuels. 60–75% diesel is replaced.
1.3 kg of wood or 2 kg of rice husk is used for generating 1 unit of electricity.	4 kg of woody biomass or 5–6 kg of rice husk is required to replace 1 litre of diesel.
Uses producer gas engine genset	Uses diesel engine genset

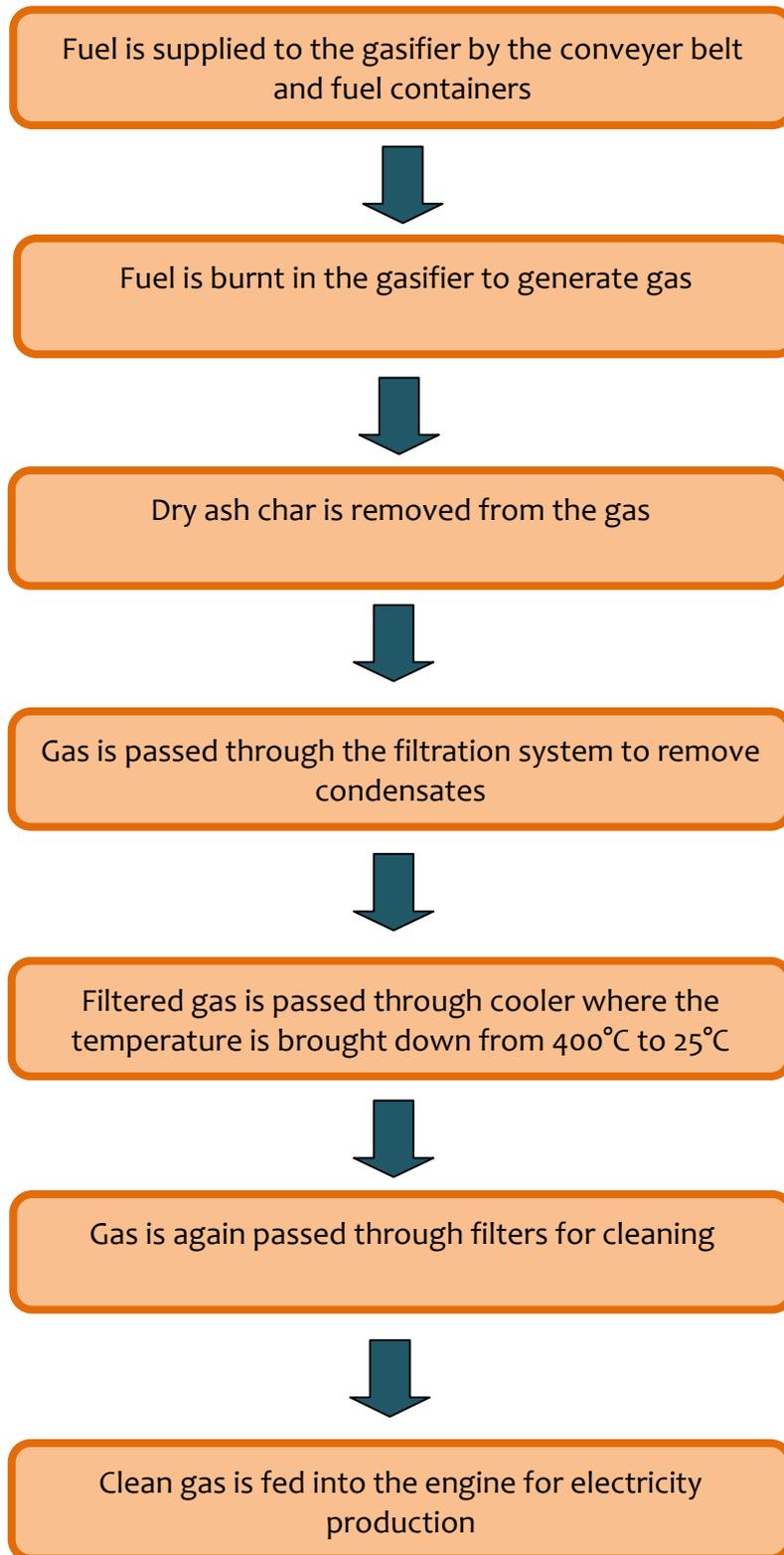
Ankur manufactures gasifiers with capacities ranging from 10 kWe to 1.6 MWe. The technology used by Ankur is described below.

The biomass gasification system developed by Ankur can be operated in dual fuel mode (biomass + Diesel) as well as on 100% gas mode (producer gas produced from biomass). This biomass gasification technology can be made available on modular scale from 11 kWe to 200 kWe as per requirement of end users.

<sup>30</sup> Average annual exchange rate of Rs. 58.48/\$ for 2013 is considered for conversion

<sup>31</sup>Mr. Ashok Chaudhury, <sup>Ankur Scientific Pvt. Ltd.</sup> Biomass Gasification and Distribution Power Generation

**Figure 16: Stages in biomass gasification technology**



**Possibility of South-South Cooperation:** Ankur Scientific Ltd. has experience in building modular gasifier systems of different capacities suitable for different needs. The technology can be used for power generation in single fuel mode and dual fuel mode. Lao People’s Democratic Republic has good biomass potential and therefore Ankur technology can be effectively used for decentralized power generation in the off-grid area of Lao People’s Democratic Republic.

## Human Resource Development Initiative in India<sup>32</sup>

The Ministry of New and Renewable Energy in India started a manpower development effort in 1999-2000 for project planning, system design, product development, operation, maintenance and repair of deployed systems. A scheme was introduced for renewable energy training and study tours, and short duration training programmes of one to two weeks within and outside the country. A National Renewable Energy Fellowship Scheme was also instituted during 1999-2000. To fulfil the requirements for more manpower, these schemes were modified during the year 2008-09 with the following provisions:

- Training of professionals working in the Ministry and its attached offices and autonomous bodies at specialized institutions;
- Training of professionals working in State Nodal Agency/Government/ Utilities on different aspects of technology, its development, and project management;
- Training of manpower on social/economic, trade, legal trade, IPR, administration, managerial and environmental aspects;
- Training of manpower working on various aspects of renewable energy with R&D institutions, NGOs, community based organizations, banking and financial institutions etc.
- (i) Organization of training-cum-study tours;  
(ii) Development of training modules including pedagogy through expert(s)/expert institutions(s);  
(iii) Addressing long-term HRD needs: In order to gravitate students and professionals in the field of renewable energy, and also to prepare manpower through universities/technical institutions, the following actions are proposed by MNRE to meet the short term as well as long term human resources need :
  - Enlarge coverage of renewable energy fellowship scheme by covering more universities/institutions and also R&D institutions, to conduct research on all aspects of renewable energy. This way the R&D programmes will not be limited to a few technology institutions; rather it will have larger spread across the country;
  - In order to address the curriculum needs of technical institutions to cover renewable energy, there is an urgent need to develop model curricula for inclusion in the Industrial Training Institutes (ITIs), diploma and degree courses. The curricula and the course material so developed would be circulated to all such institutions through State Technical Education Boards and All India Council for Technical Education (AICTE).

The modified scheme has been fulfilling the short term requirement of manpower. However, to ensure that long term requirement for manpower is met, there is need to develop an institutional framework in existing institutions for quality education and training in renewable energy sector. In this direction, new provisions have been added to the HRD Scheme. These are as follows:

- There will be augmentation of the existing national renewable energy fellowship scheme by providing fellowship to 400 students/researchers from existing 50 students/researchers. JRF/SRF/RA/PDF will be open for all universities, technical

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<sup>32</sup> <http://www.mnre.gov.in/schemes/human-resource-development/>

institutions, and national laboratories. The M.Tech. and integrated M.Sc. will be implemented in empanelled educational institutions having M.Tech./integrated M.Sc. courses in energy studies/renewable energy with specialization in any branch of renewable energy. A maximum of 20 such institutions with 15 seats per institution will be selected based on open advertisement. For rest of the fellowships, the selection will be made through open advertisement and evaluation of the received applications by a committee of experts.

**Table 17: Distribution of fellowships over the years**

Course	Duration	Intake every year	Fellowship 1 <sup>st</sup> year	Fellowship 2 <sup>nd</sup> year	Fellowship 3 <sup>rd</sup> year (stabilized number for subsequent years)
<b>M.Tech</b>	2 year	200	200	400	400
<b>M.Sc.</b>	2 year	100	100	200	200
<b>JRF</b>	2 year	40	40	80	180*
<b>SRF</b>	3 year	40	40	80	120
<b>RA/PDF</b>	3 year	20	20	40	60
<b>TOTAL</b>		<b>400</b>	<b>400</b>	<b>800</b>	<b>960</b>

\*This includes 100 integrated M.Sc students joining JRF

- Provision of financial assistance will be made to educational and research institutions to setup infrastructural facilities such as laboratory, library and other teaching aids. Educational institutions will be provided one-time financial assistance of Rs. 50 00 000 (\$ 85 499.33)<sup>33</sup> each to upgrade existing laboratory facilities and library facilities for undertaking renewable energy educational programmes. A maximum of five institutions will be provided such grant every year. The selection of such institutions will be done either through open advertisements or selection of five accredited institutions for M.Tech/integrated M.Sc. fellowships. In addition, advanced training institutes of Ministry of Labour will also be provided grant for upgrading trainers' training facility for renewable energy.
- A renewable energy chair will be created in every institution, which will act as a focal point for renewable energy education in the institution. At least one educational institution every year will be provided with one time grant for the purpose. Such chairs will be instituted in 15 educational institutions. Such educational institutions which have been active in the field of renewable energy education can be considered for creation of an RE chair. While 12 chairs will be dedicated to science and technology aspects of Renewable Energy, 3 chairs will be dedicated to legal, environmental, management and economic aspects of renewable energy in institutions such as National Law Institutes, Indian Institute of Managements (IIMs), Institute of Economic Growth, Delhi University, etc. To facilitate sustainability of this concept, a onetime grant of Rs.15 million (\$256,497.95)<sup>34</sup> is being provided to the selected institutions which may be kept in fixed

<sup>33</sup> Average annual exchange rate of Rs. 58.48/\$ for 2013 is considered for conversion

<sup>34</sup> Average annual exchange rate of Rs. 58.48/\$ for 2013 is considered for conversion

deposits and the salary and research grant may be provided through interest of this fixed deposit. The respective institutions may also augment funds from their routine grants.

- Integrated M.Sc. & Ph.D programmes will be initiated in various fields of renewable energy by instituting scholarship schemes. Ministry may institute scholarship of Rs. 4,000 (\$68.40)<sup>35</sup> per month to selected students at post-graduate level during their PG studies followed by awarding NREF for a period of a maximum of five years. 100 such fellowships every year may be granted in ten accredited institutions.
- The Ministry will be empanelling the educational institutions and other entities to undertake short-term training courses on a regular basis. While some of these short term training courses will be supported by the Ministry as per the provisions of the scheme, institutions will be encouraged to undertake self financing courses on various aspects of renewable energy.
- In addition to these initiatives, the Ministry has launched a special fellowship scheme titled 'National Solar Science Fellows Programme', under which 10 eminent scientists will be awarded fellowship of Rs. 1.2 million (\$20 519.84)<sup>36</sup> per annum, contingent grant of \$8,549.93<sup>37</sup> (Rs. 0.5 million) per annum and research grant of \$25 649.79 (Rs.1.5 million)<sup>38</sup> per annum.

**Possibility of South-South Cooperation:** India has been developing courses at various levels of education for human resource development. The Ministry of New and Renewable Energy, Government of India, has taken the initiative to encourage education and training through various educational institutions in the country. The government of Lao People's Democratic Republic can enter into an agreement with the government of India for developing programmes and course curriculum for renewable energy education. Moreover, institution level cooperation may also be built up with premier academic institutions such as Indian Institute of Technologies (IITs) and Indian Institute of Managements (IIMs). The cooperation may be extended up to student and faculty exchange programmes. Thus, there is good scope for South-South Cooperation in the field of human resource development.

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<sup>35</sup> Average annual exchange rate of Rs. 58.48/\$ for 2013 is considered for conversion

<sup>36</sup> Average annual exchange rate of Rs. 58.48/\$ for 2013 is considered for conversion

<sup>37</sup> Average annual exchange rate of Rs. 58.48/\$ for 2013 is considered for conversion

<sup>38</sup> Average annual exchange rate of Rs. 58.48/\$ for 2013 is considered for conversion

## OTHER REFERENCES

1. Country Paper: Rural Energy Development and Utilization, Prepared by Mr. Houmpheng, Theuambounmy, Deputy Director of Renewable Energy Technology Centre, Technology Research Institute.
2. Country Paper: Lao People's Democratic Republic, Chantho Millatanapheng, Environment and Renewable Energy Division, Department of Electricity, Ministry of Energy and Mines.
3. Renewable Energy Country Profile, IRENA
4. Power Sector Policies and Regulations, and future plans, Vilaysone Sourigna Department of Energy Promotion and Development, Ministry of Energy and Mines.
5. Lao People's Democratic Republic Law on Electricity No. 03/NA dated 20 December 2011
6. The Seventh Five Year National Socio-Economic Development Plan (2011-15) Prepared by Ministry of Planning and Investment dated 7 October 2011
7. Draft Decrees on Solar Energy Development
8. Policy Brief on Jatropha LIRE (Lao Institute for Renewable Energy) and LEAP (Lao Extension for Agriculture Project) dated 15 June 2009; Authors: Rietzler J., Vilavong S., Gaillard L., Jordan M., Bormann M., Miclaus N.
9. Renewable Energy Development Strategy in Lao People's Democratic Republic, October 2011
10. A Report – Shared Pico-Hydropower in Juaphan Province 2009 Lao Institute of Renewable Energy
11. National Rio+20 Report for Lao People's Democratic Republic Ministry of Natural Resources and Environment Vientiane June 2012
12. Towards a Locally Adapted Rural Electrification Assessment Framework: A Case Study of the Lao PDR - International Conference for a Sustainable Greater Mekong Subregion, 26-27 August 2010, Bangkok, Thailand.
13. Solar Lantern Rental System (SLRS): Paying for the service, not the hardware By Andy Schroeter, Sunlabob Renewable Energy Ltd, Lao People's Democratic Republic First Session of the ESCAP Committee on Environment and Development Bangkok, dated 4 December 2009
14. Renewable Energy Technology in Asia Project Implementation in Lao People's Democratic Republic by Technology Research Institute Science Technology and Environment Agency Vientiane Lao People's Democratic Republic
15. Final Report - Rural Electrification Frameworks Study September 2004 , prepared by Maunsell Ltd, Auckland New Zealand
16. Implementation completion and results report (IDA-H2180 TF-96084 TF-56700) Report No: ICR2515 , World Bank.
17. Lao People's Democratic Republic , 2013 Update – Asian Development Bank
18. Powering China's Development – Worldwatch Report 175, November 2007

19. Renewable energy policies and technological innovation: Evidence based on patent counts National bureau of economic research, Cambridge, MA 02138 January 2008
20. Lao People's Democratic Republic Transport Sector Assessment, Strategy, and Road Map, Asian Development Bank
21. Sustainable Energy for All - A Global Action Agenda – April 2012
22. LNCCI Membership Directory 2011-12 published by Lao National Chamber of Commerce and Industry
23. Lao People's Democratic Republic – Preparation of National Single Window Blue Print for implementation – Report No. 78553 –LA
24. International experiences and recommendations for implementation in Thailand – Prepared by: Chris Greacen, Ph.D. (Palang Thai) Detlef Loy, Dipl.- Ing. (Loy Energy Consulting) March 2006
25. Asia-Pacific Environmental Innovation Strategies (APEIS) Research on Innovative and Strategic Policy Options (RISPO) Strategic Policy Options Energy for development
26. RE Toolkit: A Resource for Renewable Energy Development dated June 30, 2008
27. Comparative study on rural Electrification policies In emerging economies - Keys to successful policies International Energy Agency , March 2010
28. Asia Pacific Energy Research Centre (APEC) Energy Overview 2012 – APEC Working Group 2013
29. Working paper - 9 Review of Alternative Participatory Business Models for Off-grid Electricity Services - 28 March 2011 EPSRC/ DfID funded Research Grant Project EP/G063826/1
30. Research Innovation And Technological Performance in Germany Expertenkommission Forschung Undinnovation
31. Technological innovation policies to promote renewable energies: Lessons from the European experience for the Brazilian case – Science Direct Renewable and Sustainable Energy Reviews 12 (2008) 65–90
32. Renewable Energy Vision for Union Territory of Puducherry, Oct 2007. Report prepared by WISE, Pune
33. Presentation made during 11-12 February 2014 National Stakeholders Workshop at Vientiane , Lao People's Democratic Republic by Mr. Chantho MILATTANAPHENG, Deputy Director General, Institute of Renewable Energy Promotion, Mrs. Thamma PHETVIXAY, Deputy Director General of Investment Promotion Department, Ministry of Planning and Investment, Mr. Vilaphorn Visounnarath , Deputy Director, Transmission and Substation Department, Electricite Du Laos, Mr. Chansaveng BOUNGNONG, Deputy Director General, Department of Energy Policy and Planning, Ministry of Energy and Mines, Mr. Bounchanh DOUANGVIAIY, Deputy General of Renewable Energy and New Materials Institute , MOST, Lao People's Democratic Republic.