National Assessment Framework on Enabling Environment, Technology Innovation Ecosystem for Making Sustainable Energy Options Affordable and Accessible

(For Indonesia and Lao People's Democratic Republic)

Prepared for

Asian and Pacific Centre for Transfer of Technology (APCTT) of the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP)

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Development of sustainable energy options/technologies in a country depends on its enabling conditions such as national scenario for sustainable energy, technology enabling environment and eco-system, business enabling environment and eco-system, business models for sustainable energy technology delivery and South-South Cooperation. Analysis of information on different parameters of these enabling conditions is required to understand the current status of and future potential for adoption of sustainable energy options which are affordable and accessible in the country.

A. National Scenario for Sustainable Energy

Before referring any sustainable energy option / technology for adoption in a country, the current status of sustainable energy as well as potential of sustainable energy resources is required to be studied in detail. Similarly, the enabling environment for the promotion of such options / technology needs to be judged before finally recommending the strategy for development. The criteria for assessment are given below.

1. **General Information**

	Particulars		Information
1.1	Topology	Total land area (sq km)	
		Geographical maps indicating spread of plain and hilly areas.	
1.2	No of provinces / states in the country		
1.3	Administrative set-up	Provide information on levels of governance related to energy: Federal government / provincial government / local government.	
		Ministries / departments responsible for looking after sustainable energy programme at national / provincial level.	
		Ministries / departments responsible for looking after energy efficiency programme at national / provincial level.	
		Does any Electricity Regulatory Authority exist to regulate the business of power sector including tariff setting?	
1.4	Population	Rural	
		Urban	
		Sex ratio: Rural Urban	
		Below poverty line (please specify definition of poverty line)	
		Electrification rate in terms of population in urban areas (%)	
		Electrification rate in terms of population in rural areas (%)	

		Per capita energy consumption by rural and urban population (toe[1])			
		Per capita electricity consumption by rural and urban population (kWh[2])			
1.5	Households	Rural			
		Urban			
		Electrification rate[3] in terms of households in urban areas (%)			
		Electrification rate in terms of households in rural areas (%)			
1.6	Current power sector set up[4]	Generation			
		Transmission			
		Distribution			
		Retail supply			
		Average retail tariff (US cents/kWh)	Domestic consumer		
			Commercial consumer		
			Industrial consumer		
1.7	Example of suitability of established technology with respect to grid-connected and off-grid applications	Grid-connected technologies	Geographical location		
			Post installation maintenance mechanism		
			Consumer acceptability with respect to cost		
		Off-grid technologies	Geographical location		
			Post installation maintenance mechanism		
			Consumer acceptability	Cost	
				Service	
				Reliability	
1.8	Capital cost range for	Grid-connected RE technologies (US$/MW)	Wind		
			SPV		
			Solar thermal		
			SHP		
			Biomass		
			Geothermal		
			Any other (specify)		
		Off-grid RE technologies (US$/kW)	Stand- alone solar PV application	for water pumping (kW)	
				for lighting (kW)	
			Roof-top solar PV (kW)		
			Solar water heating system (in sqm)		

[1] toe : tones of oil equivalent

[2] kWh : Killowatt-hours

[3] Percentage of household have access to conventional grid

[4] Provide information on the administrative set up and whether the generation, transmission, distribution business is vertically integrated or unbundled in different utilities.

			Solar thermal applications	For space heating (sqm)	
				For drying (sqm)	
			Biomass gassifier (kW)		
			Biogas (million cum)		
			Geothermal applications		
			Small wind turbine (kW)		
			Any other (pl specify)		
1.9	Financing norms (for grid-connected and off-grid RE projects)	Availability of loan (in terms of % of capital cost or % of any other parameter)			
		Upper limit of loan			
		Existence of collateral guarantee and its form			
		Rate of interest (%)			
1.10	Tariff setting methodology for grid-connected RE technologies (Pl provide information in brief)	Cost plus (feed-in tariff)[5]			
		Tendering/competitive bidding			
		Avoided cost method			
1.10.a	In case cost plus feed-in tariff methodology is being practiced provide information on the financial parameters adopted :	Interest on debt			
		Interest on working capital			
		Discount rate			
1.11	Cost of generation of grid-connected technologies (US cents/KWh)	Wind			
		SPV			
		Solar thermal			
		SHP			
		Biomass			
		Geothermal			
		Any other (specify)			
1.12	Investment made in RE/SET projects (billion US$)	Grid connected technologies	By Government sector		
			By Private sector		
		Off-grid technologies	By Government sector		
			By Private sector		

[5] Preferential tariff determined considering the actual cost incurred power plant and reasonable returns to investor

2. Resource Availability and Access

Knowing about the various available energy resources and their access is important for analysing the national scenario for sustainable energy.

	Particulars				Information
2.1	Percentage share of different primary sources of energy[6] in country's energy portfolio				
2.2	Share of different sources of electricity in country's energy portfolio in terms of % as well as installed capacity in MW		%	MW	
		Coal			
		Gas			
		Nuclear			
		Hydro			
		RE			
		Any other			
2.3	Number and percentage of households using	Coal			
		LPG[7]			
		Electricity			
		Biomass			
		Animal dung			
2.4	Whether resource assessment for fossil fuel has been carried out				
	If yes, please provide information along with resource assessment map(in soft and hard copy)				
2.5	Whether renewable energy (RE) resource assessment has been carried out				
	If yes then please provide information along with resource assessment map(in soft and hard copy)				
2.6	Gross potential (in MW) of grid- connected RE technologies identified in the country	Solar			
		Biomass			
		SHP			
		Wind			
		Geothermal			
		Bagasse Cogeneration			
		Any other (pl specify)			
2.6.a	Technically and economically feasible potential (in MW)	Solar			
		Biomass			
		SHP			
		Wind			
		Geothermal			
		Bagasse Cogeneration			
		Any other (pl specify)			
2.7	Potential of off-grid RE technologies/applications identified in the country	Stand-alone solar PV application	for lighting (kW)		
			for water pumping (kW)		
		Roof top solar PV (kW)			
		Solar water heating system (in			

[6] Primary energy is an original energy , not yet processed : crude oil, coal, biomass, wind, solar etc

[7] Liquefied petroleum gas

		sqm)		
		Solar thermal applications For space heating (sqm) For drying (sqm)		
		Biomass gassifier (kW)		
		Biogas (million cum)		
		Geothermal applications		
		Small wind turbine (kW)		
		Any other (pl specify)		
2.8	Installed Capacity (in MW) of grid connected RE technologies in the country	Solar		
		Biomass		
		SHP		
		Wind		
		Geothermal		
		Bagasse Cogeneration		
		Any other (pl specify)		
2.9	Installed capacity of off-grid RE technologies / applications in the country along with number of operational projects	Stand alone solar PV application	for lighting (kW)&(number of projects)	
			for water pumping (kW))&(number of projects)	
		Roof top solar PV (kW))&(number of projects)		
		Solar water heating system (in sqm))&(number of projects)		
		Solar thermal applications	For space heating (sqm)	
			For drying (sqm)	
		Biomass gassifier (kW) &(number of projects)		
		Micro hydro (kW) & (number of projects)		
		Biogas (million cum))&(number of projects)		
		Geothermal applications (kW)&(number of projects)		
		Small wind turbine (kW))&(number of projects)		
		Any other (pl specify)		
2.10	Information on un-electrified areas away from the conventional grid	Location of un-electrified[8] area (Number of un-electrified village in a province)		
		Licensee's future plan for extension of grid and electrification		
2.11	Information on the sustainable energy	Grid –connected programme[9]		

[8] Area having households which are not connected / away from the centralized conventional electricity grid
[9] Programmes associated with grid connected renewable energy projects / technologies

	programmes sponsored / implemented by national government	Off-grid programme	
2.12	Information on the Best practices of implementing sustainable energy programmes at provincial government	Grid-connected programme	
		Off-grid programme	
2.13	Success / failure factors of above programme	Grid-connected programme	
		Off-grid programme	
		Briefly explain with the help of 3-4 case studies	

3. **Need and Demand for Energy**

   Analysing needs and demand for energy may provide information on present scenario in the country with respect to energy access and standard of living.

	Particulars		Information
3.1	Energy usage in various sectors (tonnes of oil equivalent) (Please mention all energy sources separately for every sector)	Domestic	
		Industrial	
		Commercial	
		Agricultural	
3.2	Grid electricity availability	Availability of electricity (Hrs / day) in urban areas.	
		Availability of electricity (Hrs / day) in rural areas.	
		Distribution loss (%)	
		Load shedding[10] protocol in urban / rural areas.	
3.3	Quality of power supply in urban/rural areas (Pl. indicate quality of supply with regard to operation).	Industrial load	
		Commercial load	
		Household equipment	
		Agricultural load	
3.4	Information on previous year electricity consumption patterns (MU)	Domestic	
		Industrial	
		Commercial	
		Agricultural	
		Public services [11]	
3.5	Next 5 year load forecast for electricity consumption to understand and predict potential demand as aspired by the community	Domestic	
		Industrial	
		Commercial	
		Agricultural	
		Public supply	

[10] Power supply shut down by utility to match the demand and supply of electricity in region / province .

[11] Electricity supply to government run establishments to serve public at large

4. Energy Demand-Supply Gap

Assessment of the demand and supply gap will indicate the scale and type of project that needs to be undertaken in the present scenario and also certain measures needed to enhance demand and strengthen supply.

	Particulars		Information
4.1	Statistical numbers, if available (mtoe)	Energy demand	
		Energy supply	
4.2	Electricity demand supply	Electricity Demand (BU)	
		Electricity Supply (BU)	
4.3	Domestic availability of fossil fuel	Coal (MT) Studied Recoverable	
		Oil (MT) Studied Recoverable	
		Gas (MMBTU[12]) Studied Recoverable	
4.4	Fossil fuel import (last 5 years)	Coal (MT)	
		Oil (MT)	
		Gas (MMBTU)	

5. Current and Potential Market for Energy Services

The market potential for the energy services and their applicability needs to be analysed for assessing the national scenario for sustainable energy.

	Particulars		Information
5.1	Identification of potential category of customers for decentralized RE technology[13] / application	Rural areas	
		Households	
		Small scale industries	
		Urban areas	
		Energy intensive buildings	
		Commercial establishments	
		Industries	
5.2	Decentralized RE technology / applications and services suitable to cater to the needs of urban and rural areas. Provide qualitative information	Urban areas	
		Rural areas	

[12] Million metric British thermal unit

[13] Stand alone Renewable energy projects /applications catering electricity/heat requirements

6. **Energy Efficiency**
   Resources need to be used efficiently to reduce costs and increase the energy reach of available resources.

<table>
<tr><th></th><th colspan="2">Particulars</th><th>Information</th></tr>
<tr><td>6.1</td><td colspan="2">Information on the energy efficiency programmes implemented by national / provincial government</td><td></td></tr>
<tr><td>6.2</td><td colspan="2">Information on policy / law / mandate with regard to energy efficiency programme implemented.</td><td></td></tr>
<tr><td rowspan="3">6.3</td><td rowspan="3">Has any time bound national target been specified for energy efficiency</td><td>Domestic</td><td></td></tr>
<tr><td>Industrial</td><td></td></tr>
<tr><td>Agriculture</td><td></td></tr>
<tr><td rowspan="3">6.4</td><td rowspan="3">Information of national energy efficiency plan</td><td>Identified list of energy intensive[14] industries</td><td></td></tr>
<tr><td>Energy consumption benchmark established for different industries</td><td></td></tr>
<tr><td>Provision for mandatory energy audit</td><td></td></tr>
<tr><td rowspan="8">6.5</td><td rowspan="8">Information on energy efficiency standards and labelling programmes at national level/best practices at provincial level</td><td>Existence of such programme</td><td></td></tr>
<tr><td colspan="2">If yes, then applicable for:</td></tr>
<tr><td>Tube lights</td><td></td></tr>
<tr><td>Fans</td><td></td></tr>
<tr><td>Refrigerators</td><td></td></tr>
<tr><td>Washing machines</td><td></td></tr>
<tr><td>Air conditioners</td><td></td></tr>
<tr><td>Any other (please specify)</td><td></td></tr>
<tr><td rowspan="2">6.6</td><td rowspan="2">Awareness level of community to use energy efficient products /services</td><td>Acceptance level of individuals to buy energy efficient product (Pl specify names of such products).</td><td></td></tr>
<tr><td>Acceptance level of industry to implement energy efficiency measures.</td><td></td></tr>
</table>

B. Technology Enabling Environment and Ecosystem

Prevalence of technology enabling environment provides sufficient financial and technical support for expansion of sustainable energy technologies and energy services.

1. **Government Initiatives to Promote Sustainable Energy Technologies (SETs)**
   Role of government is to be examined in creating enabling conditions for the development of sustainable energy options and energy services and provisions for access to energy for the poor.

[14] Energy consuming

	Particulars		Information
1.1	Details of existing national policies/law/regulations for development of SETs[15], grid-connected and off-grid. Provide documents in support of this.		
	Provide information on dynamic renewable energy target setting at national / provincial level		
	Provide information on renewable purchase obligation specified at utility level		
	Any specific policy designed for providing energy access		
	Whether policy changes would take place with change in government		
1.2	Measures undertaken by government for private sector participation in SETs		
1.3	Information on regulations framed to promote grid connected / off–grid renewable energy (RE) technologies by electricity regulatory authority		
1.4	Subsidies rolled out for fossil fuels (provide document in support)	Mining / transportation	
		Infrastructure support	
		Capital subsidy	
		Fiscal subsidy [16]	
1.5	Subsidies rolled out for renewables. Please specify the RE technologies eligible (provide document in support)	Capital subsidy	
		Infrastructure support[17]	
		Fiscal support	
		Interest subsidy[18]	

2. **Institutional and Human Resource Development Framework**

   Institutional and HR capacity building is critical for successful implementation of SET programmes in a country.

	Particulars		Information
2.1	Provide information on Institutions engaged in implementing RE and SET programmes at federal and provincial level	Name of institution/s	
		Functions	
2.2	Provide information on Institutions engaged in implementing energy efficiency programmes at federal and provincial level	Name of institution/s	
		Functions	
2.3	Provide information on	Name of institution/s	

[15] Sustainable energy technologies
[16] Tax related incentives
[17] Support for creation of civil / electrical infrastructure for Renewable energy projects
[18] Availability of loan at rate lower than market rate of interest

	financial institutions and the service offered by them in grid-connected and off-grid RE and SET development at federal and provincial level	Functions	
2.4	Provide information on micro-financing institutions involved in RE and SET financing	Name of institution/s	
		Functions	
2.5	Role of institutes: Instances of capacity development of local and national institutes for project implementation and possibility of taking over project functions once financial and technical support is withdrawn		
2.6	Status of academic / trade curricula in respect of coverage of sustainable energy		
2.7	Existence of specialized course in sustainable energy at different level of education		
2.8	Institutes having expertise in various technologies and policy making	Engineering institutes	
		Research institutes	
		Institutes with specialty in policy and governance	
		Technology development and incubation centres	
2.9	Institutions responsible for undertaking R&D[19] in SET and services		
2.10	Ministries/agencies involved in collaboration for projects and promoting the best technologies	Name of Ministry /agency	
		Contribution	

3. RE and SET Manufacturing Capacity

RE and SET manufacturing capacity indicates the capability of a country to produce components domestically. A good RE and SET manufacturing capacity reduces cost of projects because of low cost components used in the project.

	Particulars		Information
3.1	Provide information on type of industries involved in manufacture of SET products and services		
3.2	Provide information on RE and SET manufacturing base in the country (location and production capacity MW / annum)	Solar PV	
		Solar thermal	
		Geothermal	
		Wind	
		Biomass	
		Any other (pl specify)	

[19] Research and Development

3.3	Provide information on support offer by government to RE and SET manufacturing sector	Policies / laws on domestic content requirement	
		Reduction in duty for RET/SET equipment/component import	
		Infrastructure support like creation of SEZ[20]	
		Any other (pl specify)	
3.4	Examples of effectiveness of national and local environment in attracting private entrepreneurs, investors, foreign direct investment, etc.		

C. Business Enabling Environment and Ecosystem

Businesses play different roles, depending on size and type of product and service they provide and their value proposition.

1. **Financing of SETs and Delivery Services and Risk Management**
   Financial assistance encourages promotion of sustainable energy technologies and their delivery.

	Particulars		Information
1.1	Public fund available for loan guarantee, risk mitigation and insurance support to help address policy risk for SE investments		
1.2	Information on risk mitigation instrument practiced	Credit guarantee	
		Equity support	
		Any other (pl specify)	
1.3	Provide information on import regulations in case of SETs with supporting documents	Custom duty relaxation	
		Excise duty relaxation	
		Any quota for imported products and services	
		Effect on imported SET products and services (high price/less supply of imported SETs leading to supply of low quality products in the market	
1.4	Existence of clean energy fund by levying cess on electricity generated from fossil fuel / fossil fuel consumption. (pl provide information along with supporting document)		
1.5	Whether the financial institutions / banks are considering RE / SE finance under priority sector lending[21]. (pl provide information with supporting documents)		

[20] Special Economic Zone
[21] Preferential treatment in providing loan

1.6	Existing mechanism for SET finance (both for grid-connected and off-grid technology)	Soft loan[22] (indicate % of interest subsidy provided sector wise)	
		Generation-based incentive[23]	
		Revolving fund	
		Production tax credit[24]	
		Investment tax credit	

2. Project and End User Financing Options

The affordability of the energy option depends on the financing options given to the project owners and end user.

	Particulars	Information
2.1	Subsidies rolled out by the national governments to encourage use of the off-grid renewable energy technologies /applications and services (pl provide information along with supporting documents)	
2.2	Whether the financial incentives offered by government is proved useful for development of market for off-grid RE / SE technologies and applications (pl provide relevant information with 2-3 supporting case studies)	
2.3	Instances of income generation activity due to sustainable energy projects that increase affordability (pl provide information with 2-3 supporting case studies)	
2.4	Examples of use of micro-credit to expand RE / SE services and for providing start up and working capital loans	
2.5	Examples of financial assistance given to national micro financing institutions and development banks which are often considered as effective vehicles for providing loans	
2.6	Examples of involvement of local co-operative society in financing SE/ RE products /services	

3. Promotion of Participation of Private Sector In RE

The private sector participation is important for development of RE and SET.

3.1	Provide information on existing policies/laws/regulations for providing market access to private sector for introducing required technologies		
3.2	Examples of prevailing institutional framework for sanctions of private sector in the country. Provide relevant documents in this regard		
3.3	Financial and fiscal	Tax incentives	

[22] Availability of loan at rate lower than the market rate of interest
[23] Incentive linked and disbursed after actual electricity generation from renewable energy plant
[24] Incentive offered in the form of tax benefit

	incentives	Subsidies	
		Infrastructure support	
3.4	Barriers (policy /legal/regulatory /institutional /economical) Please provide information on above with relevant documents.		

D. Business Models for SET Delivery

The communities in a country differ in culture, languages, social-political organization, size and resource endowment. This affects the model for SET delivery. In order to understand the success of business models in delivering the desired results, it is important to judge the different business models practiced in RE/SET and energy service area with regard to the following parameters. It is expected that the national consultant should provide information on following parameters for prominent business models practiced in the country.

Please provide information on following parameters for a maximum of five prominent operational business models in RE/SET and energy service area.

1. **Character with Associated Factors**

   In order to judge a business model, its character and associated factors should be analyzed.

	Particulars	Information
1.1	Robustness of RE/SET and energy services with user convenient design, economic viability with regard to the technology used in the selected business models	
1.2	Experience of the project proponent in setting up RE/SET project. The type of approvals required from concerned authorities and ease of getting such approvals (please provide information on the project under the selected business model)	
1.3	Improvement in standard of living in the community and benefits to disadvantaged segments by setting up the RE/SET project/energy service the energy product/service	
1.4	Availability and price of RE/SET service/product, their availability and price as compared to other products available in the market and acceptability of RE/SET energy service/product in the community	
1.5	Experience of project proponent in extending the reach of RE/SET service/product i.e. rural or remote locations which present challenges in terms of logistics and distribution models	
1.6	Information on capacity building training provided to the community for operation and maintenance of energy service/product	
1.7	Existing quality control mechanism for building up consumer confidence	

	Provide information on the support made available from government/private sector for strengthening capacity of entrepreneur	
1.8	Provide information on monitoring mechanism set for evaluation of efficiency of the RE/SET project/energy service delivery with regard to the set standards.	

2. **Service Provision and Distribution Mechanism**

   The effectiveness of local government and authorities, community representatives and the private sector have a prominent role to play in the distribution cycle.

	Particulars	Information
2.1	Subsidies, grants or tax benefits available in remote areas	
2.2	Examples of local orientation on programme objective and methodology	
2.3	Available financial packages well suited to needs of community and other income generating activities	
2.4	Possibility of a build up for local energy and services distribution chain	
2.5	Reaching rural areas for goods and services	

3. **Country-specific Risks that Could Impede Project Implementation**

   Analysing country, industry, or project-specific risks help to provide effective solution to tackle the issues and enhance chances of success.

	Particulars	Information
3.1	Instances of lack of community involvement during the implementation stage (Pl provide information with supporting document)	
3.2	Example of lack of commitment shown by the government	
3.3	Example of non-participation by financial institutions (FI's) including micro finance organizations (Pl provide information)	
3.4	Example of advancement in technology	
3.5	Availability of alternative solutions, other than the one considered by the project proponent (Pl provide information with supporting document)	

E. Social-Economic Factors

Various socio-economic factors impact the environment for development of sustainable energy options in a country. It is thus important to assess the sustainable energy options with respect to parameters that indicate suitable social and economic environment for selecting suitable energy options for a country.

1. **Social factors**

   Various social factors influence the adoption of renewable energy technologies among the communities in a country.

<table>
<tr><th></th><th colspan="2">Particulars</th><th>Information</th></tr>
<tr><td rowspan="4">1.1</td><td rowspan="4">Provide information on awareness efforts made by the government in promotion of RE and SETs</td><td>Through electronic media</td><td></td></tr>
<tr><td>Through print media</td><td></td></tr>
<tr><td>Training programme</td><td></td></tr>
<tr><td>Direct campaigning</td><td></td></tr>
<tr><td>1.2</td><td colspan="2">National and society openness to technological innovations (examples of hindering adoption of new technologies/anti-technology movement may be cited)</td><td></td></tr>
<tr><td>1.3</td><td colspan="2">Examples of community involvement in developing RE and SET product and service (provide 2-3 case studies)</td><td></td></tr>
<tr><td>1.4</td><td colspan="2">Consumer preferences and product development due to cultural diversity, rural and urban population (provide brief information on likeness of a particular RE/SET and the reason for same)</td><td></td></tr>
<tr><td>1.5</td><td colspan="2">Example of involvement of women and disadvantaged groups that impact project success (provide 2-3 case studies)</td><td></td></tr>
<tr><td rowspan="2">1.6</td><td rowspan="2">Instances of involvement of local and national-level NGOs[25]</td><td>Type of involvement (like implementation stage/O&M stage)</td><td></td></tr>
<tr><td>Mode of activities</td><td></td></tr>
<tr><td rowspan="2">1.7</td><td rowspan="2">Assistance from local community groups in promoting SETs / RETs</td><td>Residential associations</td><td></td></tr>
<tr><td>Community forums</td><td></td></tr>
</table>

2. **Affordability and accessibility :**

   Affordability of energy options is an important factor that influences the decision making ability of end users, whether to use the conventional technologies or renewable energy technologies and services. Accessibility in terms of reach of the people to access finance for buying the RE technologies and sustainable energy services as well as availability of centralized grid power also influence the decision making process. This in turn affects the dissemination of renewable energy products/services in the society.

<table>
<tr><th></th><th colspan="3">Particulars</th><th>Information</th></tr>
<tr><td rowspan="2">2.1</td><td rowspan="2">Information on type of energy source being used for various applications along with average unit price of source of energy</td><td rowspan="2">Domestic</td><td>Lighting (Electricity/Kerosene)</td><td></td></tr>
<tr><td>Cooking (electricity/ LPG /biomass/kerosene)</td><td></td></tr>
</table>

[25] Non-Government Organization

	being used		Heating (electricity/ LPG /biomass/kerosene/ coal)	
		Commercial	Lighting (Electricity/diesel)	
			Cooking (electricity/ LPG /biomass/kerosene)	
			Heating (electricity/ LPG /biomass/kerosene)	
		Industrial	Lighting (Electricity/ diesel)	
			Cooking (electricity/ LPG /biomass/kerosene)	
			Heating (electricity/ LPG /biomass/kerosene)	
2.2	Average monthly spending on use of technologies[26] for requested applications (US $/month)(Please provide information separately for all energy sources)	Domestic	Lighting (Electricity/Kerosene)	
			Cooking (electricity/ LPG /biomass/kerosene)	
			Heating (electricity/ LPG /biomass/kerosene)	
		Commercial	Lighting (Electricity/ diesel)	
			Cooking (electricity/ LPG /biomass/kerosene)	
			Heating (electricity/ LPG /biomass/kerosene)	
		Industrial	Lighting (Electricity/ diesel)	
			Cooking (electricity/ LPG /biomass/kerosene)	
			Heating (electricity/ LPG /biomass/kerosene)	
2.3	Information on subsidies available for conventional fuel	Petrol		
		Diesel		
		Kerosene		
		LPG		
2.4	Please provide information	Rural sector		

[26] Like water heater, diesel generator set, kerosene lamp, boilers, etc.

	on end-user financing schemes for purchasing RE technologies and services (Including involvement of banks, manufacturers, any other intermediaries; type of scheme; loan tenure and interest rate; capital subsidy if available)	Urban sector	
2.5	Provide information on end user's ability to afford sustainable energy services, like cost of affording solar lantern rental scheme, ESCO services practised in the country. Please provide information on charges collected from the end users for extending such sustainable energy services in US cents / month.		
2.6	Examples of social preference that influences affordability for a particular product/service		
2.7	Examples of cultural preference that influences affordability for a particular product/service		

F. South-South Cooperation

South-South Cooperation at the country level acts as an impetus to the process of expansion of sustainable energy technologies in the country.

	Particulars		**Nature of co-operation**	**Country**
1.	Energy co-ordination	Co-ordination with different organizations, private sectors and NGOs for country-level energy plans and programmes		
2.	Policy and planning			
3.	Power sector	New and alternate energy sources		
4.	Renewable energy	RE systems and deployment		
		Public-private partnership		
5.	Environment	Project life-cycle		
		Waste disposal		
6.	Efficiency and conservation	Demand-supply management		
7.	Skill building and institutional capacity	Training: Vocational training		
		R &D		
		Standardization and harmonization		
		Innovation stroke and technology development		

8.	Trade	Concessional duties		
		Trade Zones		
		Integrated infrastructure development		
9.	Private sector participation			
10.	Pro-poor policies	Involvement of poor and addressing the gender issues		

Case Study 1: ESD and RERED, Sri Lanka

South Asia
Year: (1997-2002); (2002-2011)

Introduction

The Government of Sri Lanka (GoSL), during 1997 and 2002 with assistance from the International Development Association (IDA) and the Global Environment Facility (GEF), implemented Energy Services Delivery Project (ESD). In 2002, ESD was succeeded by the Renewable Energy for Rural Economic Development Project (RERED).

The energy sector in Sri Lanka is managed by the Ministry of Power and Energy (MoPE), which oversees the import, generation, distribution and consumption of energy resources. The MoPE implements policies and programmes in rural electrification, renewable energy (RE) development, energy efficiency and demand management.

ESD and RERED have provided the basis for a market-based approach to the introduction of renewable energy development in Sri Lanka operating through commercially viable delivery and financing channels and streamlined project management structures. Both projects aim to improve the quality of life and bring about economic development by improving access to electricity with the use of renewable energy technologies (RETs).

Both ESD and RERED projects were managed through an Administrative Unit (AU) set-up within DFCC Bank which channelled funds and grants through participating banks to a large number of sub-projects implemented countrywide. The projects have together provided energy access to over 134,000 households and have added power generation capacity of over 120 MW to the national grid.

In the case study, we assess the models used in the ESD and RERED with the help of finances obtained from IDA, GEF and government of Sri Lanka (for RERED project) and the sustainability and replication potentials of such programmes.

A. National Scenario for Sustainable Energy (SE)

Sri Lanka, officially the Democratic Socialist Republic of Sri Lanka is an island nation in South Asia, having an area of 65,610 km and is home to about 21 million people.[27] It has a long history of international engagement, being a founding member of SAARC and a member of the United Nations, the Commonwealth of Nations, the G77 and the Non Aligned Movement.

Sri Lanka's primary energy sources are biomass, petroleum and hydropower, and with no proven oil, natural gas or coal deposits, the dependency on the three sources mentioned increasess. According

[27] http://en.wikipedia.org/wiki/Sri_Lanka

to the Ceylon Electricity Board,(CEB) Sri Lanka has 2,645 MW of total installed capacity for electricity generation. (2009)

Population	21 million **(2011)**
Electrification achieved	Sri Lanka has 2,645 MW of total installed capacity for electricity generation**(2009)**
Commercial Energy	Hydro, thermal and wind energy account for 50.8, 48.6 and 0.1 percent of total power.
Traditional Fuels:	Primary energy sources include biomass (47.9 percent), kerosene, diesel (43.4 percent).
Per capita consumption energy consumption (estimated)	412.86 **(2009)**
Price of energy with respect to global norms	-

For three decades ending in 2009, Sri Lanka experienced persistent armed conflict. Despite an annual gross domestic product (GDP) growth of 6 percent in recent years, poverty levels in Sri Lanka remain high. Approximately 25 percent of the rural population lacks access to electricity, and 80 percent of the total population uses wood as cooking fuel.

B. Technology Enabling Environment and Ecosystem

Several off-grid community-based village hydro projects (VHPs) have been implemented by non-governmental organizations (NGOs) and a number of solar home systems (SHSs) were also installed by private companies, demonstrating the technical viability of these technologies. But there are several barriers to the expansion of renewable energy in Sri Lanka, in terms of the technology application and also the enabling environment.

The ESD and RERED projects have undertaken a number of initiatives to popularize and establish RETs as a viable alternative to the national grid in off-grid areas.

The ESD project comprises three components–a credit programme, a pilot grid-connected wind farm and a capacity building component for the Ceylon Electricity Board.

The key field activity undertaken under ESD is the installation of grid-connected micro hydro projects, off-grid community-based VHPs as well as household SHSs. RERED promotes the same technologies as ESD.

Brief Description of the Technologies

Off-grid community based VHPs: The VHPs are small run-of-the-river micro-hydropower systems. A typical 10 kW-capacity VHP can provide electricity to about 40 households, each receiving approximately 250 W of power.

Household SHSs: A SHS sold under the project consists of a 40-60 Wp solar photovoltaic (SPV) panel, five or six 12 volt direct current (DC) compact fluorescent lamps and socket outlets for plugging in a DC television, a mobile phone charger or other appliances.

Grid-connected Micro hydro projects (MHPs): Grid-connected MHPs are commercial, private sector investments with up to 10 MW installed capacity.

Pilot Wind Farm: To demonstrate the commercial viability and long-term economic potential of wind power in Sri Lanka, and to catalyse future private sector wind farm development, the Ceylon Electricity Board (CEB) has implemented the 3 MW pilot wind farm in the Hambantota district.

Institutional Framework

The Ministry of Finance and Planning (MoFP) oversees the project. The Project Management Department of the DFCC Bank functions as the project Administrative Unit (AU) and it reports to the Ministry. Specifically, the AU is responsible for administration of project credit, grants, subsidy and implementation of project support activities. The project offers credit facilities through the IDA credit component for individual investments in grid-connected MHPs, SHSs and community-based VHPs. The IDA disburses credit amount to the Central Bank of Sri Lanka (CBSL) and CBSL disburses credit to the investors through participating credit institutions (PCIs). The grant support from the GEF reaches the electricity consumer societies (ECS) through the CBSL. Besides, the government of Sri Lanka funds (for the RERED programme) reach solar home system vendors (SHS vendors) and project preparation consultants (PPCs) through the AU.

The ECSs implement and own the VHPs. ECSs calculate and collect flat monthly subscription fees from ECS members for electricity use (in place of a tariff). ECSs are also responsible for ensuring there is no overloading of the system and that members use only the agreed amount of electricity, disconnecting defaulters and providing new connections.

Project preparation consultants (PPCs) provide technical assistance to ECSs with all tasks related to establishing VHPs, including design, construction and O&M. They also mediate between ECSs and other relevant stakeholders such as provincial councils, lending institutions and the AU.

SHS vendors provide and install solar home systems.

C. Business Enabling Environment and Eco-System

The Credit Programme provided medium to long-term funding to private investors, non-governmental organisations (NGOs) and co-operatives for:

- off-grid electrification infrastructure through village hydro (VH) schemes and solar home systems (SHS)
- grid-connected mini hydro (GCMH) projects and
- other renewable energy investments

The ESD Credit Programme addressed two key issues to enhance the policy and regulatory environment for private investments in renewable energy services delivery through the development of (i) a standardised Small Power Purchase Agreement (SPPA), and (ii) non-negotiable Small Power Purchase Tariff (SPPT) to enable independent, grid-connected power generation in Sri Lanka.

The follow-on Renewable Energy for Rural Economic Development (RERED) project builds on the success of the ESD Project

How it started

The ESD programme received USD 19.7 million credit line from International Development Association of the World Bank (IDA) and USD 3.8 million grant from the Global Environment Facility (GEF) and the RERED received USD 115 million credit line from the IDA and USD 8 million grant from the GEF.

Broadly, GEF grant funds are used for providing transparent subsidies for off-grid VH schemes and SHS to overcome initial cost disadvantages inherent in the technologies and for consultancy services covering off-grid project promotion, project preparation, compliance with technical standards and consumer protection. ESD did not receive funding from the GoSL. When RERED was introduced, the GoSL began contributing 20 percent of the cost for most of the project support activities, including project promotion and capacity building.

Financing Model

Credit delivery is through PCIs which meet defined eligibility criteria. They initially comprised two development banks and three commercial banks, all privately owned and controlled.

The availability of long-term financing to PCIs was necessary to match the long payback periods of mini and village hydro projects. The two development banks, by virtue of their in-house capabilities and nature of business, were quick to finance grid-connected mini-hydro projects.

The credit delivery channels for consumer loans for solar home systems (SHS) proved to be different. The ESD credit programme was originally designed for dealers/developers of SHS to provide the marketing, technical support as well as consumer credit. They were to access commercial finance from PCIs for this purpose. Dealers/developers soon realised that micro-credit evaluation, delivery and recovery were specialised functions beyond their capabilities. The success of such rural micro-credit largely depends on a rural presence, local connections and an understanding of the people themselves. For these same reasons, the PCIs too were not equipped to provide consumer credit in such geographically scattered and remote locations. The ESD Project thus turned to microfinance institutions (MFIs) for extending SHS consumer credit.

D. Business Models for SET Delivery

SHSs are provided and installed by SHS vendors. Vendors occasionally demonstrate and promote their products in off-grid areas; potential customers may also visit a branch office or a franchisee of a vendor. If interest is shown, the vendor's technician visits the customer's household and evaluates their electricity needs. If the customer requires a credit facility, the technician also performs a preliminary credit assessment and directs the customer to a microfinance institution (MFI).

Capacity Building

Under the ESD and RERED project several initiatives were undertaken to conduct training programmes for capacity building of relevant stakeholders. Few of these initiatives are discussed below.

MHPs: Over the years, need-based training programmes were conducted for micro hydro communities.

VHPs: The project trained potential PPCs in technical and management skills, trained chartered engineers with relevant background to develop verification consultants, provided multiple training opportunities to VHP equipment suppliers. The federation of electricity consumer societies (FECS) trained ECS members in leadership skills necessary for social mobilization, maintenance of electro-mechanical equipment and financial management of the ECS.

SHSs: With help from Solar Industries Association (SIA) and a microfinancing institute Sarvodaya Economic Enterprise Development Services (SEEDS), the project provided training in SHS installation and O&M to over 500 technicians, including credit officers from MFIs.

Awareness and Promotion

To address the lack of awareness, the ESD Project executes a generic promotion campaign on SHS and VH schemes. The promotion targets end-users, government authorities, community-based organisations, MFIs and the general public. It educates end-users on the advantages and limitations of SHS and VH power, informs them about service and warranty arrangements, and about available loan schemes. A variety of communication channels are used, including workshops and demonstrations at villages.

E. South-South Cooperation

Sri Lanka has become a source of development assistance to other developing countries and this has been highlighted by the United Nations Industrial Development Organization (UNIDO), in one of its report to the United Nations General Assembly (UNGA) in New York.

ESD/RERED is a market-based project. Sub-project developers (PPCs, IPPs, etc.) are expected to make use of credit available under project-refinanced facilities (from PCIs) or under commercial terms (from non-PCIs).

Best Practices

Creating commercially viable delivery and financing channels
Leveraging donor finance to expand the market for RE
Streamlined project-management structures: AU DFC

Sustainability

Grant funding is available primarily for capacity development and technical assistance only. For long term sustenance, there needs to be a lucrative financing model for off-grid community models, which is largely unavailable. But through concerted efforts in capacity building and training of various stakeholder groups, the project has helped many entrepreneurs to enter the RE market.

Replication and Scalability Potential

ESD and RERED have contributed to the development of the RE sector in Sri Lanka for well over a decade. Recently, however, issues have surfaced that may affect the long-term sustainability of certain market segments of the RE sector, particularly off-grid solutions.

Case Study 2: Solar Lantern Rental Systems, Lao People's Democratic Republic

South-East Asia
Year: Incorporated in the year 2006

Introduction

Sunlabob Renewable Energy Ltd is a Laos-based social enterprise founded in 2001, specializing in renewable energy and clean water projects in developing areas of the world. Its headquarters and base are in Vientiane, the capital of the Lao People's Democratic Republic. Andy Schroeter, a German national who first came to Laos in 1995 while working with GTZ, is the founder of Sunlabob.

Sunlabob has successfully explored and initiated a rental service for energy systems at prices starting lower than the spending on kerosene for lighting allowing most households and villages to afford electricity. The demand for these rental services is such that, it has fast exceeded the capital resources of Sunlabob.

The company has expanded far beyond its initial focus in Laos, now providing its integrated expertise of rural electrification to governments, multilateral development agencies, multinational companies, NGOs and private individuals throughout Southeast Asia, India, Africa and the Pacific.[28]

The company's success has been based on their understanding of the rural community's decision making processes and the development of operational approaches that are compatible with these processes.

A. National Scenario for Sustainable Energy (SE)

Lao People's Democratic Republic is a landlocked country in the heart of Southeast Asia; around 70% of its terrain is mountainous and has a population of approximately 5.6 million. As in many developing countries, the electricity grid in Laos is concentrated mainly in the urban areas - towns and cities, many poor people in remote rural areas rely on firewood for cooking and kerosene for lighting.

Population	Approximately 6.646 million (2012)
Electrification achieved	58% of households out of which 50% are connected to the regional grids, while 8% depend on off-grid mini-hydropower plants (*Messerli et al., 2008)*.
Commercial Energy	Imported oil and LPG are mainly used in the industrial sector.

[28] Official Website : http://www.sunlabob.com/about-us.html

Traditional Fuels:	Fuel wood ,petroleum products and dung
Per capita energy consumption (estimated)	135 kWh

The energy situation in Lao People's Democratic Republic is characterized by low conventional energy consumption. The households with no access to electricity rely on other energy sources, including petroleum products, fuel wood and dung. Also, Lao People's Democratic Republic imports almost all of its petroleum products.

Energy Access and Affordability

Most people use kerosene lamps and firebrands for lighting in their homes, with the associated risks from burns, fire and air pollution. Family land is fragmented; so people often spend several days away from home to tend their fields, and kerosene lamps and firebrands are taken on these trips as well. The country's transport infrastructure is poorly developed making access to remote areas difficult and poverty being particularly acute in remote areas, presents a major barrier to grid connection and decentralized solutions. Andy Schroeter, in one of his interviews while residing in a remote part of Northern Laos summarises the situation, "I saw that there was no water delivery, no medical services, and no energy provision."[29]

Sunlabob has enabled villagers to overcome the high costs of initial investment in equipment as well as upkeep, consequently helping them reduce their reliance on wood, charcoal, and kerosene.

B. Technology Enabling Environment and Ecosystem

Sunlabob's Solar Lantern Rental System (SLRS) model promotes the use of rechargeable solar lanterns in off-grid areas using a fee-for-service rental model.

The Technology

Photovoltaic (PV) modules generate electricity from sunlight and if supplemented with re-chargeable batteries to store electricity, they can provide an independent DC electricity supply system that can be used during day/night time.

Sunlabob solar-home-systems (SHS) typically use 20 to 120 Wp of PV modules. The PV module is installed on the top of a wooden pole instead of the tradition of keeping it on the rooftop, which allows it to be placed at the ideal orientation to the sun in order to generate maximum power. In order to store power, initially car batteries were used, but later deep-cycle lead-acid gel batteries were used, owing to longer lifetimes and to avoid the risk of acid spills. The most popular system used in 60% of homes, has a 20 Wp PV module and a 33 Ah battery.

[29] Arthaplaform/case studies/sunlabob renewable

Sunlabob also supplies solar lamps which use a 2–4 W compact fluorescent bulb and a 7.5 Ah lead-acid gel battery, enclosed in tough plastic and a steel cage to make them very robust and also resistant to heavy rain. The lamps are recharged by a 24 V charging station based in the village, which uses two solar panels to give an output of 160 – 240 W.

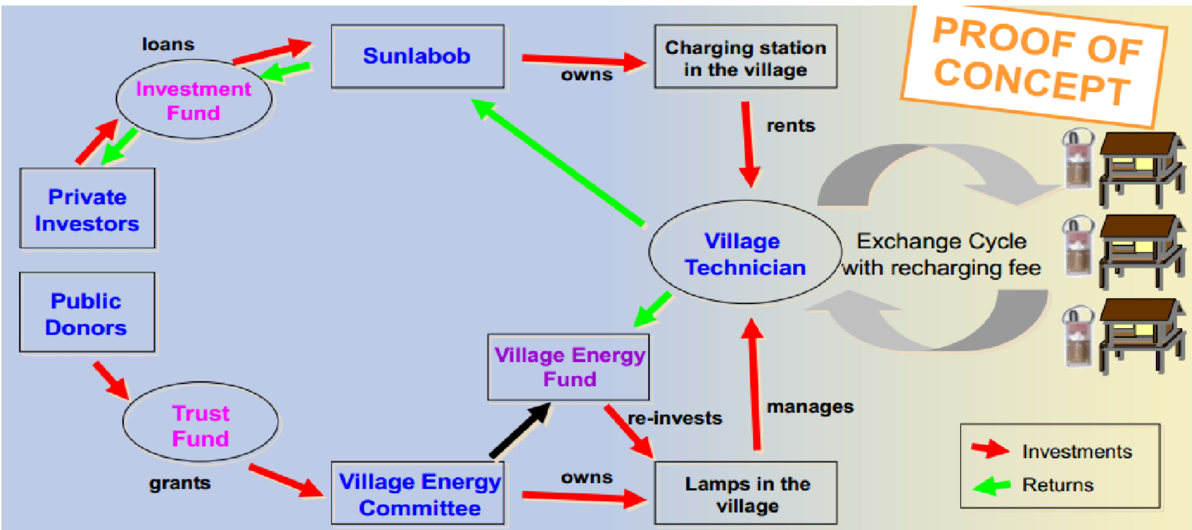
Most of the technology used by Sunlabob is imported from Germany or China, with an emphasis on high-quality components to ensure reliable service and to avoid unplanned maintenance of the systems.

Innovation

The uniqueness of the Sunlabob solar system is the robustness of the product with tamper proof casing to protect internal components, a polypropylene cover for protecting the light bulb, repositioning electronic components to top of the lantern to avoid potential water damage and additional LED indicator to indicate the hours left for charging. Added function to measure lantern's usage in hours for carbon-trading opportunities shows the ingenuity of the product design in ensuring community acceptance as a reliable and user-friendly product.

Institutional Framework

The institutional framework consists of three major actors, namely the village energy committee (VEC), the village technician (VT), and Sunlabob.



Institutional framework and interlinkages

Source: Best Practices and Learning's of an Inclusive Business: Sunlabob Renewable Energy -Andy Schroeter, Co-founder and CEO, Sunlabob

A VEC is established at every SLRS village. The VEC consists of four or five village representatives, usually including a village chief, a representative of the Lao Women's Union (LWU), and a representative of the Lao People's Revolutionary Youth Union (LPRYU). The VEC acts as a governing body, and as a platform for taking collective decision.

A village technician (VT) is usually a village entrepreneur identified by Sunlabob as someone who is interested in the SLRS and who can be trained as a village technician. A VT rents a charging station and charges solar lanterns for a cost-covering fee. It is also responsible for maintenance and servicing.

Sunlabob has set up a rental programme for users of PV SHS and lanterns to make up for the unreliable financial system in Laos which makes it difficult for individuals in remote areas to take out loans. So the rental approach means that Sunlabob retains control of quality, maintenance and training.

C. Business Enabling Environment and Eco-System

Sunlabob has created strong relationships with the Laos' Ministry of Energy and Mines, to NGOs, and to grassroot decision-makers, and believe that entrepreneurial approach and private-public partnerships (PPP) are key to greater energy expansion.

Once the scheme is accepted by the community and required infrastructure (the charging station and the lanterns) is acquired, VECs and VTs play vital roles in its operation making full use of existing institutional structures found in rural Lao People's Democratic Republic.

Financial Model

Sunlabob does not rent equipment directly to the end users; instead it requires each participating community to set up a Village Energy Committee (VEC), to whom it rents the PV equipment. The community selects the members of the VEC, and the VEC rents the equipment to individual households. The VEC is responsible for collecting payment from households, usually made by women, who generally manage household finances, a task from which Sunlabob has absolved itself.

Solar lanterns are financed by a recharging fee. The village technician rents a charging station and charges solar lanterns for a cost covering fee. For the first fully charged lamp, the household makes a deposit. From then on, the household brings depleted lamps and takes home fully charged ones, paying only the charging fee.

Initial investment comes from two types of sources: private and public sources. Loans from private investors are used for installation and servicing of charging station which is owned by Sunlabob. On the other hand, funds from public donors are used for initial purchase of solar lanterns which are owned by the village energy committee and managed by the VTs. Thus initial finances for SLRS are a result of public-private partnership.

Sunlabob signs contracts directly with the VECs, and uses a network of 34 franchisees to carry out installations, training and repairs. Each franchisee is vetted for competence, and receives both initial and follow-up training from Sunlabob. The franchisee then trains technicians in each community, who are selected by the VEC, and are responsible for the day-to-day running of the charging station for the solar lamps, as well as the rented out SHS.

Employment and Job Opportunities

Sunlabob has provided direct as well as indirect employment benefits to the people in Lao People's Democratic Republic. It purchases as much material as possible from local suppliers, including all SLRS accessories such as cables, outer boxes and straps, helping the local manufacturers to grow and create more opportunities. The programme in itself has created both full-time and part-time work for 34 franchisees and over 80 village technicians.

D. Business Models for SET Delivery

Rental model

The rental model promotes ownership. The SLRS model is designed to suit the established behaviours of rural households. Specifically, the lantern recharge fee is a small regular expense, comparable to typical household purchases of diesel.

Training and Capacity building

There are regular regional and national meetings of franchisees to share problems and solutions, and upgrade their training; selected village technicians also take part in these.

For each village, the cost of capacity building is about USD 500 comprising of the initial training sessions and three coaching visits over a period of 18 months. Sunlabob's master trainers carry out regular checks to make sure everyone is properly trained.

Quality control mechanism

Quality control and customer support have been priority for Sunlabob and have contributed to their success. Every piece of equipment that they rent out has a unique serial number, and the company can track any individual item to an end-user. No PV modules have failed during the time the programme has been running.

E. South-South Cooperation

In Programme

According to the UNEP, the project is highly replicable. Replication of its models in Africa and other parts of Asia are evidence that there are commercially viable ways to bring energy sources to remote areas in developing countries.

In May 2009, after being approached by the United States Agency for International Development (USAID), Afghanistan Small and Medium Enterprise Development (ASMED), and Development Alternatives, Inc. (DAI), Sunlabob carried out an assessment of the feasibility of the solar lamp project in Afghanistan, taking into account the local human, social and technical constraints.

In April 2009, Sunlabob embarked on its first development in Africa. Together with its Ugandan franchise partner, TSSD, Sunlabob visited Ssazi village in Northern Uganda and introduced its Solar Lantern Programme.

Sunlabob also has operations in other parts of the world. In January 2008, Sunlabob extended its activities to the Kingdom of Thailand through their franchise partner Samui Service Solar power Ltd. While the focus in the Lao People's Democratic Republic is more on rural electrification, the market in Thailand is more focused on promoting solar water heating and energy efficiency consulting, both for homes and businesses.

Best Practices

- Providing a high quality, robust product: Solar lamps are much safer to use than kerosene lamps or the torches people used to take when they went to the fields and forests.
- Matching service with consumer demand and behaviour
- Ensuring local ownership
- Ensuring a profitable and sustainable business for all stakeholders

Sustainability

The SLRS model is the product of several years of experience and have helped introduce innovate energy solutions to the most remote corners of Laos, bringing a basic need to thousands of households across the country.

VECs safeguard the sustainability of SLRSs and actively contribute to the development of their communities, thereby reasserting their role as village-governing entities.

Replication and Scalability Potential

As mentioned, Sunlabob has extended its activities to the Kingdom of Thailand, and it is fast spreading to other parts of the world. Overall, the SLRS experience in Lao PDR, Uganda and Afghanistan shows that the model is sustainable and can be replicated worldwide.

Future Challenges

While continuing to streamline the company's internal operations and increase its growth through greater efficiency and funding, the company will likely also continue fine-tuning existing energy schemes and introducing new ones.

Case Study 3: Improved Water Mill, Nepal

South Asia

Year: 2003-2012

Introduction

The Centre for Rural Technology (CRT/N) in Nepal runs a programme under the Renewable Energy Sector Support (RESS) project to upgrade traditional water mills called improved water mill programme (IWM) with support from the Government of Nepal (GoN) through Alternative Energy Promotion Centre (AEPC) and the Netherlands Government through Netherlands Development Organisation (SNV Nepal). AEPC, which was established in 1996 under the Ministry of Environment, Science and Technology (MoEST),GoN is the lead agency for promoting RETs in Nepal.

The Improved Water Mill (IWM) programme has found some success in Nepal and promotes a simple and versatile technology that uses water resources to produce 3-4 kW of mechanical and electrical power. The IWM programme wherever implemented has had a positive impact on rural households by promoting micro-enterprises, generating income and employment opportunities, reducing drudgery for women and allowing more free time for engaging in other activities.

A. National Scenario for Sustainable Energy (SE)

Nepal has one of the lowest per capita incomes in the world at around US$ 340, and more than 30% of its population lives below the national poverty line. Of Nepal's total land area, 82% is mountainous, and the difficult topography present challenges in providing modern energy services. At 14.8 gigajoules per year, Nepal has the lowest per capita energy consumption among the South Asian countries[30].Nepal's total hydro power resources are estimated at 83,000 MW, of which about 42,000 MW can be economically tapped.

Population	National population of 26.6 million,83% population live in rural areas **(Census 2011, Economic survey, MoF, 2011)**
Electrification achieved	56% population have access to electricity including 10% from Renewable Energy Technologies (RETs).
Commercial Energy	Commercial energy comes mostly from fossil fuel and electricity (11.5%) (MoF, 2009)
Traditional Fuels:	Nepal draws largely upon traditional energy sources, with biomass making up 87.8% of the total energy consumed.
Per capita energy consumption (estimated)	Total annual energy consumption 11.9 mtoe[31] and per capita energy consumption is 14 GJ whereas electricity consumption is 120 kWh

It is therefore evident from the above table that with 83% of the population living in rural areas, with limited access to energy services the country needs to urgently tap indigenous sources of energy, which are important sources of energy for rural households in Nepal.

Energy Access and Affordability

Being an agrarian economy, the country is dotted with thousands of traditional water mills, which are utilized by rural communities for agro-processing services like cereal grinding and paddy hulling. The diesel operated mills have increased the dependency of the villagers on imported machinery and diesel oil, thus reducing their self-reliance. They also pollute the environment through the emission of exhaust fumes. The traditional mills can be easily improved to double their efficiency rate; resulting in benefits such as saving of time for rural communities leading to increase in income of water millers, making access to energy affordable and providing increased access to clean energy sources for rural communities.

B. Technology Enabling Environment and Ecosystem

It has been widely accepted that Renewable Energy Technologies (RETs) can contribute to rural development by providing energy services and enhancing opportunities for improved livelihood and income generation: the Improved Water Mill (IWM) technology has proven this with increased

[30] WECS, 2006
[31] Million tons oil equivalent

efficiency over traditional water mills, resulting in increased energy output achieved by replacing wooden parts with metallic parts.

IWM Technology

IWM is a high-flow and low-head technology that transforms the kinetic energy of running water into mechanical energy or motive power. The improved runner is hydraulically shaped and the blades are cupped to catch the water more effectively, and it can work down to water flow rates of about 10 litres per second rather than the average flow of 40 litres per second thus increasing the efficiency of the mill. This benefits the community during lean flow of water especially during the dry months.

The IWM programme in Nepal uses two types of water mills: short-shafted and long-shafted water mills. The former type is only applied for grinding, while the latter is also used for paddy hulling, oil extraction, and rice polishing. The technology is not only used for agro-processing. One IWM can also generate up to 3kW electricity, which is sufficient to light and operate small electronic devices for up to 50 households.[32]

How it started

There have been several efforts to improve the water mills in Nepal. Initially, these activities were carried out under the 'Promotion and Dissemination of Improved Water Mills in Nepal' project, (as a pilot from 1991-1993 and then with a follow-up from 1996-1999), supported by the German Technical Cooperation, Nepal (GTZ/N).[33] By the end of the project term are about 500 mills had been improved, paving the way for more improved water mills.

The Centre for Rural Technology, Nepal (CRT/N) is a professional non-governmental organization engaged in developing and promoting appropriate/rural technologies [34] took the lead in implementing the programme and carried out a number of activities with local partner organisations. The current national IWM programme established in 2003, has extended operations from the initial 6 years until mid-2012. The programme is funded by the GoN and the Directorate General for International Cooperation of the Netherlands (DGIS), with EUR 1,316,125 contributed to the current phase of the programme.

Manufacturing

CRT/N contracts manufacturing to twelve existing metal workshops, which it has approved to produce parts for improved water mills. Service centres offer a one-year warranty on the parts that they install, after which users have to pay for servicing and repairs.

The required support services to millers are imparted through local service providers such as service centres, manufacturers and financing institutions.

[32] SNV: Improved Water Mill
[33] ENERGIA: Opening Productive Avenues for Rural Women through Improved Water Mills in Nepal
[34] Official CRT/N Website

Service Centres

CRT/N has established 16 local service centres, which install IWMs and are responsible for after-sales service and promotional activities. The service centres comprise local NGOs, metal workers and Watermillers' Associations authorised to provide service.

The service centres are used to train the millers, and provide repair and maintenance services. CRT/N helps build capacity for both manufacturers and service centres, and continuously monitors them to ensure they are providing quality service. Eventually, it plans for the Watermillers' Associations to take over the servicing.

Community involvement and Gender Focus: Role of Women

Since the users are mostly women, the water mill improvement programme considers women as important stakeholders and has sought their active participation because they are aware that the improved technology addresses their needs. Women are also motivated to take on the operation, repair and maintenance of improved mills as they generate an attractive income

IMPACT 1

Mrs. Parbati Paudel of Ghyang VDC, Dolakha through her diligence and hard work has shown the male dominant society that a woman can also equally succeed in so called 'male's work'. Because of the IWM in their village, the women of Shanti Danda don't have to work all night in '*dhiki*' and '*janto*' (the primitive form of grinding stones and vessel) and more importantly, the belief that women should only be involved in cereal processing work has now passed.

Employment and Job Opportunities

The IWM programme has led to the creation of additional employment for more than 1,000 people in the IWM sector and has increased the output from agro-based activities, leading to more income generation.

C. Business Enabling Environment and Eco-System

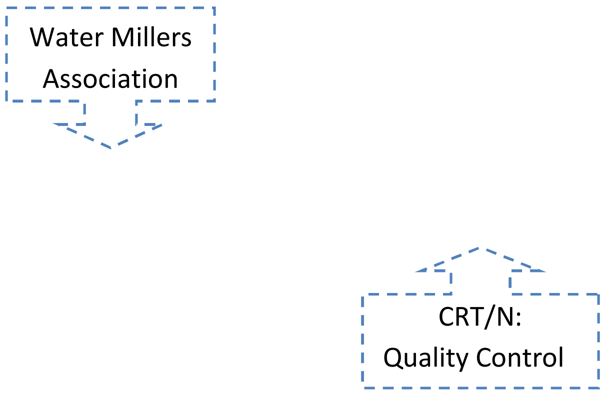
The programme has followed a multi-stakeholder, public-private partnership approach, each having its own roles and responsibilities.

Ghatta Owners /Watermillers Association or GOAs' role is to protect the rights of mill owners and users, and are required to play a key role in IWM installation, and business management and product marketing for members; and as the programme is phased out, GOAs are expected to serve as the main vehicles for IWM technology dissemination.

The GOA sends a recommendation to the water mill owner who then approaches the service centre for the technical inputs. The manufacturer then incorporates the improvements as required by the owner, which is overseen for quality control measures by the CRT/N.

Under the CRT/N programme a report is generated and forwarded to AEPC for release of subsides. The entire process is coordinated by CRT/N.

Business Enabling Environment



Financing model

The millers pay a part of the cost of the improvements, and the remainder is covered by the programme subsidy. The subsidy for the short shaft version was about 50% when the programme began, but this was gradually reduced. In 2007, owners paid US$170-$250 (NR 11,000 to NR 16,000) for a short-shaft upgrade, out of a total improvement cost of US$310 to $390 (NR 20,000 to NR 25,000). The millers' contribution is usually paid partly in cash (sometimes raised as a loan from a local micro-finance organisation) and partly in kind, through providing transport and labour for installation.

Though the IWM technology offers a payback period of four to five years for most end users, the high initial investment cost presents a hurdle to widespread adoption since 90% of water mill owners and users are farmers whose repayment capacity is limited. Moreover, prospective borrowers must submit business plans demonstrating the financial viability of the IWM.

Earlier efforts to mobilize microfinance institutions (MFIs) to extend loans for IWMs did not succeed, primarily because of the perceived associated risks. The IWM programme and GOAs are now jointly developing a pilot revolving fund, with each contributing 50% of the total amount.

D. Business Models for SET Delivery

Capacity Building

The programme's sector capacity development activities are aimed at improving personnel skills at all levels and strengthening concerned institutions. Capacity building is a programme component and makes up 6% of the programme’s budget. By 2009, a total of 5,700 water mills had been upgraded, benefitting about 296,000 families. 735 of the upgrades were of the long shaft type, with 14 generating electricity.

Consumer acceptability

The suitability of technology has been important to the success of the IWM programme. IWMs represent a simple and well-known technology in rural areas. The milling efficiency of an improved water mill is high and thus millers need to work shorter hours only. The improved water mills grind more slowly than diesel mills; the flour does not get so hot and does not pick up the taste of diesel. As a result the product becomes acceptable to the workers as well as to the consumers.

IMPACT 2

Eknath Thapalia is a farmer by profession and came to know about the assistance available from IWM Programme in 2004. He visited the Nuwakot district Service Centre and found that rice husking and polishing machine can be operated using the IWM.. He installed his IWM in March 2005. He has invested NR 147,500 for his IWM installation. To make up for this investment cost, he received Rs.20,000 as subsidy from the IWM Programme. Eknath Thapalia now makes a yearly profit of NR 21,486. He has provided services to 250 households in his locality now.

E. South-South Cooperation

In Programme

The Netherlands Government through Netherland Development Organization (SNV Nepal) in partnership with the AEPC and CRT/N has provided funding to the programme (including funding for the subsidy) and provide technical advisory services to build capacity within the sector.

In future

SNV Nepal's Great Himalaya Trail Development Programme (GHTDP) has been acclaimed for the second time for its outstanding performance in terms of providing benefits to micro, small and medium entrepreneurs along the Great Himalaya Trail in five programme districts, namely: Humla, Dolpa, Gorkha, Solukhumbu and Taplejung of Nepal.

Best Practices

- Locally appropriate technology focusing on productive uses
- Linkage with local associations
- Government promotion of technologies and funding

Sustainability

The approach aims to develop a sustainable IWM sector, in which mill owners are encouraged to enter the market to upgrade their mills and enhance the services they provide to farming communities.

Replication and Scalability Potential

The programme has expanded beyond the initial four pilot districts to 19 districts. A proposal has been prepared by AEPC and CRT/N, setting a target of 4,16,000 households and 8,000 IWMs, taking it to 34 other districts.

Future Challenges

The IWM programme is high priority for the GoN, but it is overly dependent on continuing donor cooperation and coordination. The challenges are

- Funding and organizational constraints slowing expansion, particularly into high potential areas
- Local ownership and management remains a challenge.

Case Study 4: Small Power Producer (SPP) and Very Small Power Producer (VSPP) Program, Thailand

Year: SPP was incorporated in the year 1992 and VSPP was incorporated in the year 2002

Introduction

In 1992, the Government of Thailand introduced the Small Power Producer (SPP) Program with the objective of promoting private sector participation in renewable energy (RE) development. Within the ambit of the project, the government provided various incentives to the eligible projects based on biomass, biogas, municipal solid waste, wind, hydro power and solar projects. The incentives included feed-in tariff, subsidies, technical assistance and soft loans.

The SPP program obliged the only state run utility, Electricity Generation Authority of Thailand (EGAT), to buy power from the SPPs under transparent power purchase agreements. Power plants with a capacity to export up to 60 megawatts (MW) to the grid – later increased to 90 MW – were eligible.[35] Power generated from the renewable energy sources were purchased at the avoided cost, i.e., the cost that would have been incurred by the EGAT for generating the same amount of power.

The SPP program benefited development of some plants using waste biomass such as bagasse, paddy husks or woodchips. However, other RE resources were not competitive at the offered rates. In order to encourage other RE sources, the Thai government introduced regulations on the Very Small Power Producer (VSPP) program in the year 2002. RE plants with an export capacity of up to 1MW – later increased to 10 MW – were eligible under the VSPP project. The VSPPs were enabled to sell power directly to the distribution companies, namely, the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA). The distribution companies paid the same wholesale rate to VSPPs as they would have paid to purchase electricity from transmission network of EGAT, and thus paying avoided cost of purchasing electricity from EGAT.

The SPP and VSPP programs helped in promoting the RE sector in Thailand. As of June 2011, there were 57 renewable energy SPP projects (proposed, under consideration, or operational), which can sell 2,201.62 MW of power to the grid (ADB working paper 352, year 2012). As of June 2011, there were 1,330 renewable energy VSPP projects (proposed, under consideration, or operational) which can sell approximately 5,708.59 MW of power to the grid (ADB working paper 352, year 2012).[36]

[35] CDKN; Inside Stories on Climate Compatible Environment
[36] http://www.adbi.org/files/2012.04.12.wp352.dtet.box.4.pdf

A. National Scenario for Sustainable Energy

Geographically, Thailand comprises four natural regions. Northern Thailand is a complex system of forested mountain ranges divided by four precipitous, fertile river valleys. The Central plains are the Chao Phraya River Basin and support the major part of the population and industry, as well as the majority of agricultural production. The North-east, which is defined by the Khorat Plateau, is sparsely vegetated and largely infertile. The Southern Peninsula is dominated by dense tropical forests.

Population	Thailand has a population of 66.79 million. (http://databank.worldbank.org/data/views/reports/tableview.aspx)
Electrification achieved	99.3% (WEO, 2011 database) (http://www.worldenergyoutlook.org/resources/energydevelopment/accesstoelectricity/)
Commercial Energy	Petroleum products account for 57% of commercial energy consumption, diesel and gasoline power 72% of transport. (http://www.boi.go.th/tir/issue/201009_20_9/42.htm, as of September 2010)
Traditional Fuels	-
Per capita energy consumption (estimated)	1790 kg of oil equivalent (The World Bank, 2011) (http://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE)

Thailand's primary energy consumption comes mostly from fossil fuels, accounting for over 80% of the country's total energy consumption. 39% of total energy consumption in 2010 came from oil and 31% of total energy consumption in 2010 came from natural gas. Besides, the country has promoted use of solid biomass and waste for heat and electricity generation. Almost 16% of Thailand’s energy consumption came from solid biomass and waste. However, due to high demand for energy owing to the growth in the economy, the country remains heavily dependent on oil and gas import, despite substantial increase in natural gas production over the years.[37] According to the Department of Alternative Energy Development and Efficiency (DEDE), oil import accounted for 80% of total domestic oil consumption in 2011. In order to reduce dependence on imports and increase self sufficiency in energy production, the country has launched Alternative Energy Development Plan which calls for increasing the share of RE to 25 percent of total energy consumption by 2021.[38]

The following table summarizes installed capacities of various renewable energy technologies as of 2011[39]

Technology	RE installed capacity in 2011 (MW)
Solar	79
Wind	7

[37] http://www.eia.gov/countries/cab.cfm?fips=TH
[38] The Renewable and Alternative Energy Development Plan for 25 Percent in 10 Years (AEDP 2012-2021)
[39] TKN report : Incentives for Renewable Energy in Southeast Asia: Case study of Thailand

Biomass	1790
Biogas	159
Small Hydro	96
MSW	26

Apart from the above mentioned technologies, Thailand has potential for geothermal, tidal wave and hydrogen based power.

B. Technology Enabling Environment and Ecosystem

Thailand's major problem has been to ensure energy security and it is understood that the country needs to diversify its energy consumption portfolio. In an attempt to diversify away from the fossil fuel based energy generation, the country has pursued various measures to promote indigenous renewable resource based energy generation. Creating technology enabling environment is one of the measures adopted by the country.

SPP and VSPP Technologies

Eligible SPP projects include biomass, waste, mini hydro projects, photovoltaic (PV) systems, or other renewable energy projects, such as wind. The regulations allow SPPs to deliver up to 60 MW , later increased up to 90 MW, for sale to EGAT. The project can have a nameplate capacity greater than the limit, as long as power sale is limited to the allowed capacity.

The technologies for VSPP projects remain the same, but the capacity for VSPPs is below 1 MW (later increased up to 10 MW). However, VSPPs were benefitted by simplified regulations and were able to sell power directly to the distribution companies: the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA).

Rules for SPPs and VSPPs

The terms of SPP operations, access to customers, and power purchase agreements (PPAs), are set by EGAT and the Thai Energy Ministry. Under the rules established by EGAT, SPPs can sell their electricity either to EGAT or to industrial customers located next to the SPP plant, or both.[40]

While selling to the EGAT, SPPs have long-term PPAs with EGAT as the single buyer. The PPAs allocate market risk to EGAT (and its captive ratepayers) leaving SPPs to manage the operating and fuel price risks. SPP contracts are between 5 and 25 years with terms and specifications set by EGAT. EGAT buys power from the SPPs at the avoided cost of energy.

SPP's direct customers are mainly industrial customers located near the SPP power plants using private distribution lines. At one time, the National Energy Policy Office (NEPO) was drafting rules that would have allowed SPPs access to the state-owned distribution grid, which would allow SPPs' access to customers located outside industrial estates. But the SPPs and utilities were unable to reach an agreement.

Regulations on power purchase provisions from VSPP were approved in May 2002. This program has been initiated because the existing SPP regulations of EGAT are not designed for power producers that are smaller than 1 MW. If small-scale power producers using renewable energy, wastes or

[40] RE ToolKit case study on "Small Power Producers in Thailand"

residues as fuel have to comply with the SPP regulations, a substantial cost for grid connection will be required, making the projects uneconomic.[41]

Regulations on VSPP allow for net metering and a streamlined interconnection process to minimize VSPP connecting costs.[42]

Later, on 4 September 2006, the government, via the National Energy Policy Council (NEPC), approved the increase of capacity purchase from VSPPs from less than 1 MW to less than 10 MW each. Also, the technical interconnection restrictions and requirements were revised to facilitate power purchase from VSPPs.[43]

C. Business Enabling Environment and Ecosystem

Business enabling environment ensures that renewable energy technologies get suitable institutional arrangements along with access to finance for developing RE technologies. Thailand has adopted few financial instruments for encouraging investments in the RE sector from SPPs and VSPPs. The most important one among them is the 'adder rate' offered over the existing electricity tariffs. Besides, there are provisions for getting finance for renewable energy development from other sources.

Adder Program

The adder or feed-in premium program was introduced in 2007. Under the program, private investors receive incentives for investing in renewable energy projects. VSPPs and SPPs that utilize solar, wind, biomass, biogas, hydro, and waste energy are eligible to participate in the program. However, VSPPs and SPPs may be private or public entities, but may not include the utilities themselves.

According to the adder program, investors receive a premium over the utility's avoided cost of producing electricity since 2007. This is called 'premium-price FiT payment' [by Cory et al. (2009)]. The adder rate differs across technology type, installed capacity, contracted capacity, and project location.[44]

There are two types of adder rates for SPPs – fixed adder and adder bidding.[45]

- **'Fixed Adder':** the adder rate for SPPs using **municipal solid waste** and **wind** is 2.50 Baht/kWh (about US¢7.35), and for SPPs using **solar energy** is 8.00 Baht/kWh (about US¢23.53).

[41] Dr. Pallapa Ruangrong, Energy Regulatory Commission of Thailand, Thailand's Approach to Promoting Clean Energy in the Electricity Sector
[42] Renewable Energy in Asia: The Thailand Report, Australian Business Council for Sustainable Energy
[43] Dr. Pallapa Ruangrong, Energy Regulatory Commission of Thailand, Thailand's Approach to Promoting Clean Energy in the Electricity Sector
[44] Dr Sopitsuda Tongsopit and Dr Chris Greacen, Thailand's Renewable Energy Policy: FiTs and Opportunities for International Support
[45] Dr. Pallapa Ruangrong, Energy Regulatory Commission of Thailand, Thailand's Approach to Promoting Clean Energy in the Electricity Sector

- **'Adder Bidding':** For SPPs using **other types of renewable energy**, such as rice husks or wood chips, the adder is provided via a competitive bid. However, the maximum adder rate is set at 0.30 Baht/kWh (about US¢0.88).

The VSPPs received only fixed adders. In December 2006, the government approved the fixed adder rates for less than 10 MW VSPPs that supply power to the grid. Adder for biomass and biogas power was 0.3 Baht/kWh (US¢0.88), for MSW and wind the rate was 2.5 Baht/kWh (US¢ 7.35), for mini hydro (50-200 kW) the rate was 0.4 Baht/kWh (US¢1.18), for micro hydro (less than 50 kW) the adder was 0.8 Baht/kWh (US¢2.35) and for solar the rate was 8 Baht/kWh (US¢ 23.53).

The adder was supposed to be provided for 7 years to all the technologies after commencement of the projects, and from start of sale of electricity to the grid.

However, there was not much response from SPPs and VSPPs for using wind and solar resources as the technologies at the existing adder rate proved to be cost-ineffective. Consequently, for wind-energy power generation, the adder is increased from 2.50 to 3.50 Baht/kWh. For solar power generation, the adder was kept fixed at 8 Baht/kWh. However, the duration of adder provision for both wind and solar energy projects was extended from 7 years to 10 years from the date of commissioning.

Moreover, special adder rates for SPPs and VSPPs were announced for three southernmost provinces of the country, i.e., in Yala, Pattani and Narathivath. This was done in order to reduce investment risks for power generation from renewable energy sources. The special adder rates for different technologies in these southernmost provinces are as follows.

Fuel/Technology	Existing adder (Baht/kWh)	Extra adder (Baht/kWh)	Special Adder for SPPs/VSPPs in the 3 Southernmost Provinces (Baht/kWh)
Biomass, Biogas	0.3	1.0	1.30
Mini hydro (50-200 kW)	0.4	1.0	1.40
Micro hydro (<50 kW)	0.8	1.0	1.80
MSW	2.5	1.0	3.50
Wind	2.5	1.50	4.00
Solar	8.0	1.50	9.50

Financing Mechanism

The cost of adder is passed on to all electric power customers. There are two components of electric rate structure in Thailand: the base tariff (which is adjusted every four years), and an automatic fuel price volatility adjustment tariff, which is adjusted every quarter, and is known in Thailand as the 'Ft charge'. The incremental cost of adder payments to RE generators is passed on directly to the end customers, as a special charge in the 'Ft charge'.

ESCO Funding

In addition to the adder rate, the SPPs and VSPPs enjoy financial assistance from the ESCO fund. The assistance comes in the form of equity investment, venture capital and carbon credit facilities.[46]

Small RE projects receive 10% to 50% of total investment capital with an upper limit of Baht 50 million (US$ 1.7 million) per project. Small RE projects also receive 10% to 30% of registered capital, maximum up to Baht 50 million per project (US$ 1.7 million), as venture capital. Apart from financial assistance, the projects also receive technical assistance for developing and selling carbon credits.[47]

D. Socio-Economic Factors

SPP and VSPP programs were adopted in order to enhance energy security in the country, which was otherwise heavily dependent on imports for meeting its energy requirements. In the process of developing VSPP program and the adder rates, civil society played a crucial role.

Role of Civil Society

There was limited expertise on RE within the Thai electricity sector. However, the civil society brought expertise in RE. For example, a non-governmental organization Palang Thai organized roundtables of regulators, utilities and RE experts. They also organized study tours in Thailand and abroad to showcase successful RE projects.

The Palang Thai also prepared studies showing that RE can make a much larger contribution in meeting Thailand's electricity demand than was projected in the official plans.

Civil society groups identified the RE specialists in the government agencies. They conducted meetings and study tours for personnel from various agencies and utilities.[48]

E. South-South Cooperation

SPP and VSPP projects have helped in attracting entrepreneurs for investing in the power sector. Moreover, most of the entrepreneurs participating in SPP and VSPP projects are SMEs. SMEs lack technical knowledge and experience, especially in the energy business, and this causes technological difficulties for investors. Providing technical assistance and advice, and other assistance, throughout project implementation can help enhance investor confidence, resulting in reduced technological risks.[49]

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[46] Dr Sopitsuda Tongsopit and Dr Chris Greacen, Thailand's Renewable Energy Policy: FiTs and Opportunities for International Support

[47] TKN report : Incentives for Renewable Energy in Southeast Asia: Case study of Thailand

[48] Climate and Development Knowledge Network, Inside Stories on Climate Compatible Development

[49] SPP and VSPP case study, ADB

Best Practices

- SPP and VSPP programs have provided impetus to renewable energy sector of Thailand which in turn has helped the country to diversify its energy sources.
- Use of indigenously available renewable energy technologies has reduced country's reliance on imports.
- Government support has been provided in terms of adder or ESCO funding.

Future Challenges

- SPP and VSPP programs are generated by government policies and not by customer needs or market demand. This makes them quite insecure, given their dependence on EGAT and Metropolitan Electricity Authority (MEA) or Provincial Electricity Authority (PEA).
- Vulnerability to government policy changes that affect their commercial viability.