



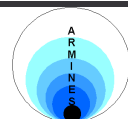
**REDEO
RURAL ELECTRIFICATION
DECENTRALIZED ENERGY OPTIONS
EC-ASEAN Energy Facility
Project Number 24**



REPORT FOR ACTIVITY 5

RURAL ELECTRIFICATION PLANNING FRAMEWORKS IN CAMBODIA, LAO PDR AND VIETNAM

OCTOBER 2004



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Introduction

The report on Rural Electrification Status in Cambodia, Laos and Vietnam has been done by analyzing the available documents after the mission to those countries during May 2004 to July 2004.

I. Country background

Cambodia

Cambodia is located in South East Asia lying between Thailand to the west and north and Vietnam to the east. The country also shares a land border with Laos in the northeast. Cambodia has a sea coast on the Gulf of Thailand. The country has an area of 181,040 km² and a population of 13,124,764 people (2003 est.). The average annual growth rate is (2003 est.) 2.5% with a GDP (2003 est.) of \$ 4.0 billion, per capita GDP (2003 est.) is \$282 (*Bureau of East Asian and Pacific Affair, 2004*). It is a predominantly rural, agricultural economy. Agriculture accounts for 40% of GDP and 80% of the work force. Other industries include forestry, garments and tourism. GDP growth has averaged about 4% pa during the last decade (ECA, 2002).

Laos

Laos shares borders with China in the north, Cambodia in the south, Vietnam in the east, Myanmar in the northwest and Thailand in the west. The country has an area of 236,800 km². It has a population of 5,921,545 people (2003) and average annual growth rate (2003 est.) 2.45% with a GDP (2002) of \$ 1.8 billion. Its per capita GDP (2002) is \$320 and the GDP growth has averaged about 5.7%. Agriculture, mostly subsistence rice farming, dominates the economy, employing an estimated 85% of the population and producing 50% of GDP (2002), while industry and services share 25% of GDP (2002) each (*Bureau of East Asian and Pacific Affair, 2004*).

Vietnam

Vietnam shares borders with China in the north, Laos in the northwest and Cambodia in the west. The country has an area of 331,114 km². It has a population of 80.7 million people (2003) and average annual growth rate (2003) 1.18% with a GDP (2003) of \$39 billion. Its per capita income (2003) is \$483 and the GDP growth has averaged about 7.24%. Agriculture and forestry producing 21.8% of GDP (2003), industry and construction shares 40% of GDP (2003) and services shares 38.2% of GDP (2003) (*Bureau of East Asian and Pacific Affair, 2004*).

II. Objective and scope of the report

2.1. Objectives

The objective of this report is to provide a review of rural electrification status in Cambodia, Laos and Vietnam (CLV). The specific objectives are following:

- Review of power sectors.
- Review of Rural electrification status.
- Review of Rural electrification framework.

2.2. Scope and limitations

This report provides background information on issues which are relevant for the rural electrification in CLV in general. The report does not give universal recommendations and the future of rural electricity supply technology and management.

III. Power sectors in CLV

Cambodia

The electricity sector is very small in size and in an early stage of development. The responsibility for the coordination of electricity sector policy, planning and development rests with the Ministry of Industry, Mines and Energy (MIME). The per capita electricity consumption is only about 45kWh per year and less than 16% of households have access to electricity in the whole country (EDC, 2003).

Electricity supply in Cambodia is currently organized through three providers:

- Electricité du Cambodge (EDC) is government-owned. The national company has the responsibility to supply electricity to Phnom Penh and 5 towns and accounts for approximately 90% of total electricity consumption of the country.
- Under management of the Ministry of Industry, Mines and Energy (MIME), there are 10 small generators (not ‘companies’) who have responsibility to supply electricity for a further 5% of total consumption of the country.
- Small, private entrepreneurs, the Rural Energy Enterprise (REEs), of whom there are estimated 600 supplying a further 5% of total consumption (ECA, 2002).

The organizational structure of the electricity sector is depicted in figure 1.

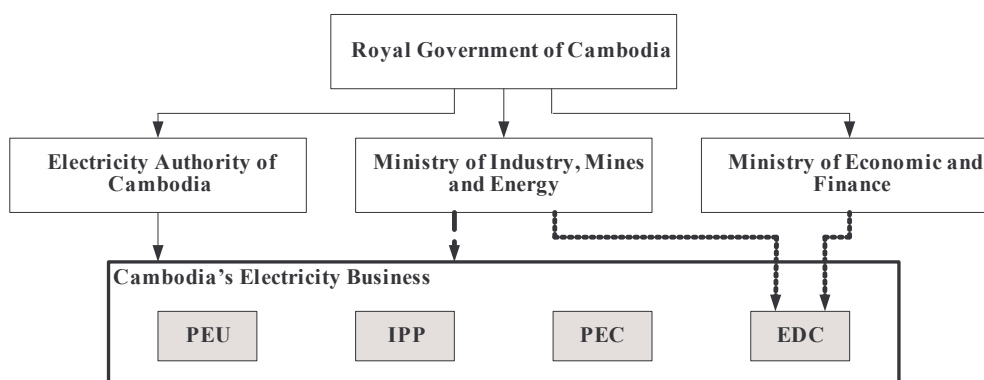


Figure 1: Structure of Cambodia Electricity Sector

Source: Ministry of industry, Mines and Energy, Electricite de Cambodia, 2003

Notes: *PEU*-Public Electricity Utility; *IPP*-Independent Power Producer; *PEC*-Private Electricity Company; *EDC*-Electricité du Cambodge.

-----> Ownership Control of EDC

- - -> Policy; Planning; Development; Technical standard

-----> Tariff, license, Review the Planned Investments, finances and performance; enforce the regulations, rules and standards

There is no national grid and all electricity services have been operated by EDC and MIME control base on isolated systems. A 115 kV single circuit transmission line of 120 km to Phnom Penh from Kirirom mini-hydropower station rehabilitated under a BOT system by a Chinese company CETIC was put into operation in May 2002. Power supply is available through small isolated systems using diesel generators with medium and low voltage distribution systems. The total installed capacity of the country is about 150 MW, of which 100 MW is in Phnom Penh. The electricity demand of the country is being met by 22 isolated systems, mostly from diesel generators.

Because of the small size of the system and dependence on oil-based generation, and large distribution losses, the unit cost of electricity in Cambodia is among the highest in the region. Therefore, electricity prices averages about 16 USc/kWh in Phnom Penh and a little higher in the other provincial towns served by Electricité du Cambodge (EDC). In the rural areas served by the private rural electricity enterprises (REEs) the prices typically range between 30 to 90 USc/kWh. This compares with prices in two of its neighbours which range from the low level of around 3 USc/kWh in Laos to 7-12 USc/kWh in Vietnam (ECA, 2002).

Electricity demand is expected to face a significant increase in the future as shown in the table 1. The majority of this growth will occur in Phnom Penh. To meet the future demand, the Royal Government has developed a Generation and the National Transmission System Master Plan.

Table 1: Cambodia Electricity Demand from 2000 to 2016

Year	2000	2002	2004	2006	2008	2010	2012	2014	2016
Power, MW	129	212	273	331	404	477	558	651	746
Energy, GWh	415	956	1,036	1,215	1,454	1,700	1,968	2,292	2,634

Source: Electricity de Cambodia, 2000

Laos

The organization of the power sector in Laos is presented in figure 2:

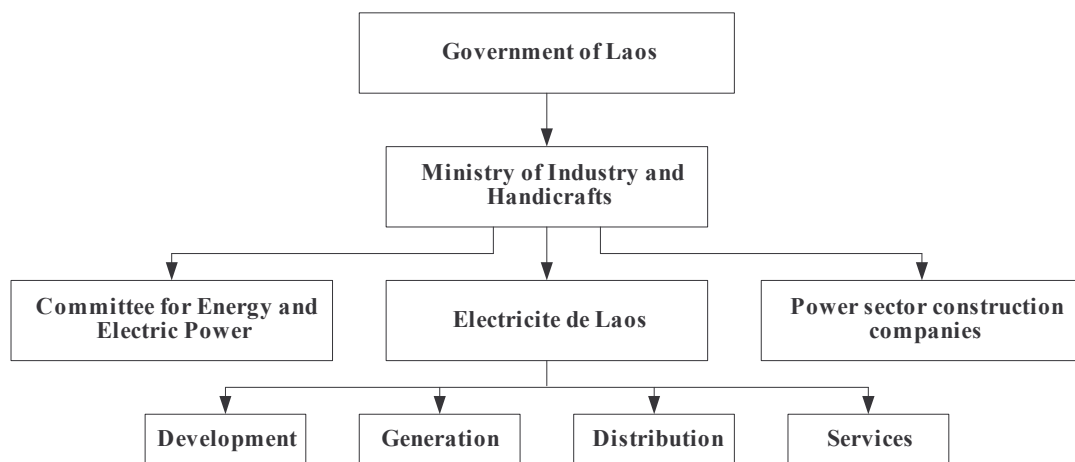


Figure 2: Structure of Laos's power organization

The Ministry of Industry and Handicrafts has responsibility to develop the natural resources, industries and electricity supply in the country. In the electricity supply, the Department of Electricity is in charge and oversees the overall development of power stations and grids. In 1999, the Rural Electrification Division was established to strongly promote rural electrification. Electricite de Laos is operating under the Ministry of Industry and Handicrafts as the state owned Power Company undertaking power generation, transmission and distribution.

As of December 2002, the installed capacity of the power system in Laos was recorded as of 645.2MW of which 627MW (97.3%) was from hydropower and the remaining from diesel and other sources. The hydropower plants, the Electricity de Laos manages directly 269MW (41.7%), while 360MW (55.8%) are IPP projects and the rest 16.2MW (2.5%) belongs to the provincial authorities and communities (Electricity de Laos, 2003).

The country has been divided into 4 regions as follows:

- Central 1: Vientiane Municipality, Vientiane province, Luangpabang, Xayabuly, Xiengkhouang, Xaysomboun special region and Boikhamxai.
- Central 2: Khammounae province and Savannakhet province.
- Northern: Phongsaly, Oudomxai, Luangnamtha, Bokeo and Huaphanh.
- Southern: Champasak, Salavan, Attapeu and Sekong.

The energy consumption and peak load of each region of the country are presented in table 2.

Table 2: Laos Electricity Demand from 1993 to 2003 (GWh)

Descriptions	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Growth rate (%)	
												95-03	99-03
Northern				1.0	2.8	4.4	5.5	7	15.7	18	22.2	-	-
Central 1	200.9	213.2	258.9	287.8	323.1	375.4	402.1	462.0	518.2	556.6	645.3	12.0	13.0
Central 2	38.2	45.0	53.2	61.7	72.1	87.1	102.2	114.2	119.5	125.8	141.3	13.0	8.0
Central 3	17.8	21.2	25.3	29.4	36.1	47.7	57.3	65.4	74.6	85.0	97.0	19.0	14.0
Whole country	256.9	279.4	337.5	379.9	434.1	514.5	567.0	648.6	728.0	785.4	905.7	13.0	12.0
Northern				0.4	1.0	1.2	2.7	4.2	5.1	7.8	8.9		35.0
Central 1	50.5	55.7	64.0	70.6	77.0	90.1	102.7	119.9	132.8	140.6	161.2	12.0	12.0
Central 2	10.4	11.7	13.8	16.9	20.7	21.2	25.5	29.4	32.6	32.3	35.7	13.0	9.0
Central 3	5.1	6.1	7.2	7.5	10.3	13.6	16.5	18.6	21.2	23.9	26.5	19.0	13.0
Whole country	66.0	73.4	85.0	95.4	109.0	126.2	147.4	172.1	191.7	204.7	232.3	13.0	12.0

Source: Electricity de Laos, 2003. The data for 2003 is estimated for the last month of the year.

Regarding the future demand, the forecasting method is generally based on government policy and target on electrification and poverty reduction such as 45% of total households to be electrified by 2005, 70% by 2010 and 90% by 2020. For this, System Planning Office of Electricity de Laos has conducted the electricity demand forecast by considering the population, households and villages, existing power network and particular characteristics of the country. The electricity demand forecast will be basic in system expansion planning such as generating plants, transmission line and substation. The demand forecast is presented in table 3.

Table 3: Laos Electricity Demand from 2003 to 2020

Items	Units	2003	2005	2010	2015	2020
Energy Consumption	GWh	1,101.7	1,608.7	2,648.1	3,650.8	4,854.7
Average growth rate	%	14.9	21	11	6	6
Peak load	MW	232.3	328.3	510.7	694.6	923.6
Average growth rate	%	13.5	19.0	9.0	6.0	6.0
Load factor	%	54.1	55.9	60.0	60.0	60.0

Source: Electricity de Laos, 2003.

Vietnam

The organization of the power sector in Vietnam is presented in figure 3:

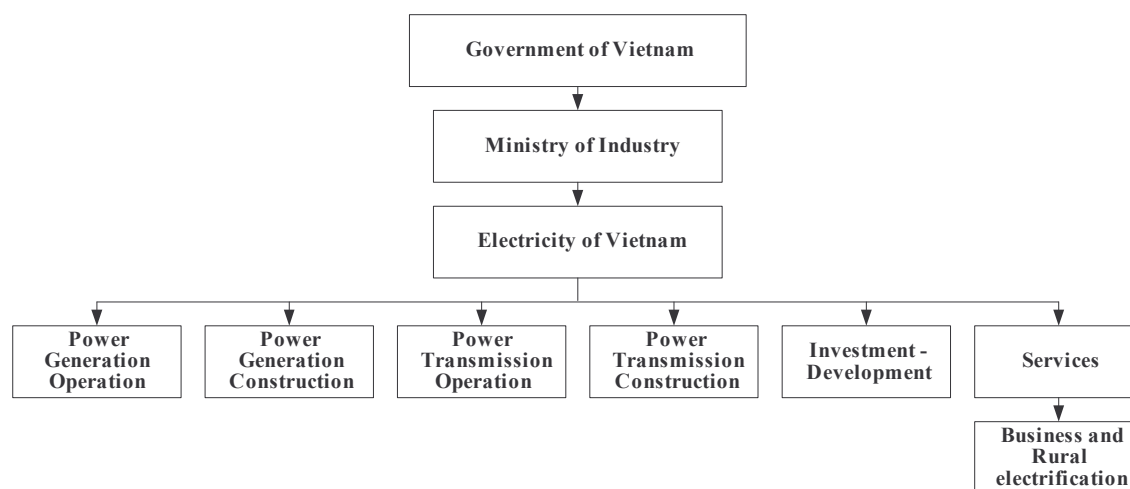


Figure 3: Structure of Vietnam's power organization

Electricity of Vietnam (EVN) is a state-owned utility under Ministry of Industry, established by Government of Vietnam decree in 1995. The EVN oversees the various entities or business units engaged in generation, transmission, distribution, and associated service functions along commercial lines. These business units are grouped as either dependent (generation and transmission entities attached to EVN accounts) or independent accounting units (distribution and supply entities detached from EVN accounts). In spite of strong government regulation of power tariffs, the EVN is capable of raising profits out of its operations and to source external funds subject to approval of appropriate government agencies for infrastructure development, network expansion, and human resource management.

By the end of 2003, Vietnam power system had 17 large and medium-sized power plants, dozens of small diesel and mini-hydro stations, all belonging to Electricity of Vietnam (EVN). Besides, there are 8 power plants (includes thermal, gas turbine and hydro power) which are IPPs. The total installed capacity was 10,010MW. Generation in 2003 was 41,275GWh of which hydro electricity was approximately 46.04%, while gas-turbine power generation contributed 20.32%, coal-fired power generation 17.42%, steam turbine power generation 8.67%, and other power generation including oil fired thermal, diesel, and IPP shared 7.54% of the total generation mix.

Hydro-power sources dominate the supply of power in Vietnam. It provides about 44.1% of the total capacity. Hoa Binh hydro-power plant (1,920MW) in the North plays a key role. In 2003, the new committed power plants, especially Phu My 3 power plant (IPP) with 805MW (gas turbine) installed capacity in the north and Pha Lai 2 (600MW – coal fired thermal) in the south were commissioned.

The existing power generation is just sufficient to satisfy the demand. It has low reserve margin, therefore electricity shortage often occurs during the dry season and in the beginning of rainy season.

For estimating the energy demand in future, the method of forecast is based simulation and the relation between increased electricity demand and economic development. Based on three scenarios of economic development, detailed energy and demand are forecasted as given in table 4.

Table 4: Average Growth of Energy and Capacity in 2004-2010.

Year	Low scenario			Base scenario			High scenario		
	Energy (GWh)	Gen. (GWh)	Capacity (MW)	Energy (GWh)	Gen. (GWh)	Capacity (MW)	Energy (GWh)	Gen. (GWh)	Capacity (MW)
2004	39,213	45,599	7,779	39,848	46,337	7,905	40,488	47,081	8,033
2005	43,801	50,934	8,690	44,858	52,175	8,901	45,955	53,438	9,118
2006	48,925	56,893	9,706	50,522	58,749	10,023	52,158	60,652	10,348
2007	54,650	63,550	10,842	56,888	66,152	11,286	59,199	68,840	11,745
2008	61,044	70,985	12,111	64,056	74,487	12,708	67,190	78,133	13,330
2009	68,186	79,291	13,528	72,127	83,872	14,309	76,260	88,680	15,129
2010	76,164	88,568	15,111	81,215	94,440	16,112	86,555	100,651	17,171

Source: Electricity of Vietnam, 2003

IV. Rural electrification status in CLV

Cambodia

Eighty five percent of the population of Cambodia lives in rural areas (approximately 1,866,417 rural households) and most of these do not have access to electricity. Only 7% of rural households use grid electricity or combination of grid electricity and local electric generators which are under 600 REEs. Rechargeable, automotive-type batteries are commonly used in rural areas where are without existing grid for basic lighting and powering radio and small TV sets.

In the Second Socioeconomic Development Plan 2001-2005, the Royal Government of Cambodia has emphasized the importance on infrastructure development; promoting agriculture and rural development; and promoting private sector development to achieve the long-term goal of poverty reduction in Cambodia. In this context, MIME is formulating a Rural Electrification Strategy. According to this strategy:

- Rural Electrification forms an integral part of the Government's wider rural transformation and poverty alleviation agenda

- To reduce inequalities in access to electricity and the associated opportunities for increased social welfare, education, health and income generating opportunities and
- To provide stable 24-hour services to 70% of the rural household by 2030 at acceptable price level and with minimum subsidy from the government.

The Royal Government of Cambodia (RGC) plans to extend grid-based electricity supply to provincial and district towns in the near term. In rural areas, with no access to public grids, the RGC seeks to encourage investment for mini-grids based on diesel and/or renewable energy sources. The World Bank and ADB's Rural Electrification and Transmission (RE&T) Project aims to help the RGC achieve all these aims by implementing a wide range of activities including strengthening of Cambodia's existing generation, distribution and transmission capacity; technical assistance for capacity building, institutional strengthening and operational support; and implementation of the Rural electricity fund (REF).

The rural electrification program includes the development of renewable and other energy resources. Rural electrification systems involve grid extension and stand-alone systems (including mini grid with diesel generator, micro-hydropower plant, or solar home system). The Government is promoting rural electrification development with consideration of creating a Rural Electrification Fund to subsidize part of the investment capital of private rural electricity enterprises in order to help lower the cost of electricity for rural households.

The strategy and ten year program for rural electrification will incorporate:

- Grid extension from the existing,
- Cross-border power supplies from neighboring countries,
- Rehabilitation of existing isolated grid systems in provincial towns
- Creation of new isolated grid systems
- Renewable energy such: solar, hydro (mini,micro), wind, biomass, biogas etc. and
- Provision of batteries-based and stand-alone systems for dispersed remote customers.

Laos

The Government's strategy on Rural Electrification is to obtain an electrification ratio of 45% of total household by the year 2005, 70% of total household by the year 2010 and 90% by the year 2020 (EDL, 2004). The target will be met by implementing projects: Southern Provincial Rural Electrification Phase II - SPRE 2, SPRE 3, Power Transmission and Distribution Phase II - PTD 2, and PTD 3. These projects are being supported by financial institutions, such as World Bank, Asian Development Bank.

In the first Rural Development Plan (1999-2000), achieving 50% village electrification was set as the goal, which was to be done primarily by grid extension. Once electrified, medical and educational facilities in the villages will be improved and people will have better access to information through radio and television. In addition, electricity can be used for irrigation and household industry, which will contribute to higher productivity and rural development. Off grid rural electrification by renewable energy sources also needs to be

considered as a viable alternative of grid extension, and should be planned and implemented to meet the needs of remote villages (JICA, 2001).

In Laos, the rural electrification options that are being considered are as follows:

- Main grid distribution based rural electrification has been done by EdL to supply electricity to most provincial, district and village centers.
- Diesel generation, mini or small hydro power plants have been used to supply electricity for provincial or district town's level through by isolated or mini grids. Some of these are owned by EdL and others are owned by the provincial or district authorities.
- Small villages or small clusters of villages are powered by micro hydro or micro diesel generation through micro grid
- Individual households, health clinics, institutional facilities, etc. Solar PV systems have been used to supply the electricity demand.
- Small group of households, individual households are being supplied electricity demand by using Pico hydro generator units. These models are found only in the Northern provinces, such as Phongsali, Houaphanh, Louang Phrabang, Louang Namtha and Xieng Khouang.

Currently, the EdL has ability and responsibility to plan the main network expansion for the whole country. However, a collaboration between EdL and the provincial and district rural electrification planning have to be improved in order to reach the target of the Government of Laos to that will be electrified from the main grid. The off grid services can directly supply electricity to the villages which will not be electrified by the main grid or provincial or district grids. Rural Electrification planning is proposed as follows:

- EdL continues planning the main distribution grid expansion based rural electrification.
- EdL has a priority for electrification at villages that the households have higher potential in terms of willingness to pay and connect to the grid. So far, the villages also have a higher potential of economic development.
- Small grids and off grids have to be done by the provincial, district and village authorities with a good collaboration with Rural Electrification Division of MIH.
- Off grid electrification will be done directly to villages that are not covered under either the EdL main grid expansion, or under provincial/district distribution network.
- Rural electrification options, such as main grid, provincial/district grid and off-grid have to be good coordinated in order to avoid overlap and duplication.
- Development of a detailed electrification plan which is realistic, suitable for funding, sustainable, supported by the rural population and local government units, and which promotes private sector participation.
- Obtaining funding and private sector partnership.

Vietnam

According to EVN, from year 2000 to 2010, in the communes having connected to the grid, the target will be extended and upgraded to achieve a connection rate of 50% of rural households in the mountainous areas. During this period, old networks in the plain

communes will also be upgraded and rehabilitated. In order to meet this target, EVN is implementing the project of grid-connected electrification for 700 communes. Investment cost of this project is 2,700.4 billion VND, financed by the World Bank (78%) and Government (22%). The project should be completed in 2003. It means 89.7% of rural communes will be connected to the grid by 2003.

From 2010 to 2015, the target is to connect 100% communes on the mainland to the grid, in which 90% of households will be supplied with grid electricity. Obviously, even by 2015 the national electricity grid will not reach 100% of the rural households and at least 10% of them (1.3 million households) will not be connected to the national power grid.

By the end of August 2003, the Rural Energy Project of EVN in combination with the Hunger Eradication and Poverty Reduction Program has provided grid connection to all 61 provinces and centers, specifically:

- 508 out of 520 districts, equivalent to 97.7% (12 mainland districts have yet to be connected with the national network. However, they already have a local or small hydropower station and 9 island upgraded the network and local plan with diesel – wind hybrid);
- 8,273 out of 8,989 communes, equivalent to 92%;
- 10,636,385 out of the total number of 12,854,393 rural households, equivalent to 82.7%.

Over the country 43 provinces with all their communes kept selling prices applied for rural households below the ceiling price of 700 VND/kWh which is stipulated by the Government. To the end of August the tariff of rural electrification of Vietnam had reached: The communes with power buying price lower than: 700VND/kWh: 8.020/8.989 (97%); the communes with power buying price from 700 to 900VND/kWh: 241/8.989 (2,68%) and the communes with power buying price higher than 900VND/kWh: 12/8.989 (0,1%) (EVN, 2003).

Rural electrification master plan studies for Vietnam in 1998 have been presented the electricity demand for rural areas of Vietnam. Table 5 shows the projected potential demand in the rural areas. In 1998 the total potential demand was 4,348 GWh. In 2010 the potential demand is expected to be 7,515 GWh and in 2020 it is forecast to 11,173 GWh. The potential demand is projected to increase with an annual growth rate of 4.7 % between 1998 – 2010, more than double within ten years, between 2010 and 2020, the annual increase equal 4.1%.

Table 5: Forecast of potential demand in rural areas of the seven socio-economic regions in Vietnam 2010 and 2020, GWh

Regions	1998			2010			2020		
	House hold	Non-residential	Total	House hold	Non-residential	Total	House hold	Non-residential	Total
Nort. Mountainous	281	88	369	612	159	770	969	258	1,228
Red River Delta	1,241	296	1,537	1,888	531	2,419	2,663	865	3,528

North Central Coast	538	65	603	1,058	116	1174	1,619	189	1,808
South Central Coast	282	18	300	610	32	643	956	53	1,009
Central highlands	27	7	34	87	13	99	148	21	169
North East South	343	19	363	542	35	577	764	57	821
Mekong River Delta	1,079	63	1,142	1,720	113	1,833	2,426	184	2,610
Total	3,792	556	4,348	6,516	999	7,515	9,546	6,415	11,173

Source: COWI, 2000

The objective of rural electrification is to supply electricity in an efficient and reliable manner to rural consumers in order to improve rural living standards and livelihoods. The rural electrification program in the coming time continues to require a huge amount of capital, as a result, the development tendencies and mechanism on investments need to be issued unanimously by relevant Ministries and Departments.

For remote areas where nation grid extension based electrification is not economical and renewable energy resources are available. Renewable energy sources to be used are as follows: hybrid system (diesel – solar energy, diesel – small hydro power, diesel – wind power), small hydro power, solar and wind power system, independent households, biogas... However, currently the off grid systems have high price and low flexible generation sources generally, only small and mini hydro power have reasonable and competitive cost.

Institutional and implementation arrangements are presented as follows:

- Ministry of Industry: overall responsibility for the project preparation and implementation: coordination – support – implementation capacity building.
- Provincial people's committees (PPCs):
 - Detailed implementation of the Low voltage portion: prepare project document, approve and implement the resettlement and compensation policy, provision of counterpart funds.
 - Set up a provincial project management unit (PPMU).
 - Set up Project steering committee (PSC) to plan the electrification program in province.
 - Setting up and providing overall supervision of the Local Distribution Utilities (LDUs).
- Electricity of Vietnam: Overall responsibility for the project preparation and implementation related to the Medium voltage system.
- Local Distribution Utilities (LDUs): will be responsible for the operation and management of the rehabilitated Low voltage distribution networks (the technical assistance will largely be aimed at the LDUs before and after their creation).
- Commitment from Provincial People's Committees (PPCs):
 - Formation of legal LDUs for O&M LV network after rehabilitation.
 - Issue regulation of the LV network in the Province.
- Letter from project communes confirming:

- Commune leadership has consulted with the households and all agree with the project.
- Households agree to pay for connection cost.
- Households agree for the replacement of meter that do not comply with technical specification.

V. Conclusions

In Vietnam, almost rural electrification projects in the country are focused mainly on grid extension. Diesel generation and renewable energy, such as, mini hydro and solar have being used only for remote areas where the grid connection is not economic. Currently, the EVN has an effort in order to integrate both grid extension and local resources based rural electrification for reducing the electricity tariff in rural areas. In the other hand, the Government of Vietnam through EVN has a good collaboration with all financial sources in order to reach the target of ability to supply electricity services to 100 communes and 95% of the rural households by the year 2010.

Cambodia has a lowest rural electrified ratio in Asia and among the highest electricity cost in the world. The existing grid has being based rural electrification. Otherwise, off grid based rural electrification has being encouraged from local resources, such as diesel generation, small hydro power, solar home systems etc. Because of the very low level of rural electrification situation, the Government of Cambodia therefore can make great strides in rural electrification under successful collaboration between available funds for investment and the willingness to use electricity by the sufficient tariff in rural areas.

Laos is being in low electrification situation. There are many factors such as demand size, geographical conditions that will determine the approach for rural electrification in the country. Generally, the basic strategy of the government is to priority electrify the district centers and then surrounding rural areas. Rural electrification obviously needs a large amount of investment, thus Electricity de Laos have to collaborate effectively available international funds and local participation. For the mountain and remote areas in the Northern and Eastern of Laos, diesel and mini hydro would be suitable for the supply of electricity in areas where grid extension of the grid is impossible in term of economic. Solar power is suitable for areas where the household demand is small.

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