Innovation Energie Développement (IED)

CAP-REDEO project

RURAL ELECTRIFICATION IN CAMBODIA AND LAO PDR

ANALYSIS OF STATUS, POLICIES, INSTITUTIONS AND PLANNING APPROACHES

DELIVERABLE D2A

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1. Background introduction

1.1. Introduction

Lao People Democratic Republic (Lao PDR) is a rural and mountainous landlocked country bordered with Cambodia, China, Myanmar, Thailand and Vietnam. It stretches more than 1700 km from north to south and 400 km from east to west. Topography is predominantly mountainous with cultivated floodplains. The climate is typically tropical monsoon. Rainy season starts from April to October, with average annual rainfall of 1600 mm. It has significant natural resources like forestry, minerals and hydropower.

Cambodia is located in South East Asia lying between Thailand to the west and north and Vietnam to the east. Cambodia shares also a land border with Laos in the northeast and it has a sea coast on the Gulf of Thailand. Cambodia's climate is tropical monsoonal with a pronounced wet and dry season. During the wet season from May until early October, rainfall is largely derived from the southwest monsoon drawn landward from the Indian Ocean. The average annual rainfall varies across the country from between 1,000 to 2,500 mm.

In general, Cambodia's mineral resources appear to be limited. The country's hydroelectric generating potential is considerable (about 10000 MW), especially from the swift current of the middle Mekong River where it flows through Stoeng Treng and Kracheh provinces. Another natural resource is the forests, which cover approximately 70 percent of the country and which potentially constitute a second pillar of the economy in addition to the primary one, agriculture.

1.2. Socio-economic situation

Table 1 : Selected key socio-economic indicators, year 2006

		Cambodia	Lao PDR
Total land area	*thousand km^2*	181 035	236 800
Total population	*thousand*	13 996	6 135
Population density	*persons per km^2*	77	26
Annual population growth	*percent*	2,5	2,5
GDP product (at current prices)	*US$ million*	6 105,2	3 527,4
Gross domestic product/capita	*US$*	436,2	574,9
	US$ PPP	2 406,4	2 280,4
Growth rate of GDP, constant prices	*percent per year*	5	5,6

Source: ASEAN secretariat.

Cambodia has a population of 14 million people with annual growth rate of 2.5% (data 2006). Its GDP per capita is 436 US$/y. The agriculture, mostly subsistence rice farming dominates the economy, employing an estimated 85% of the population and producing of 50% GDP, while the industry and services share 25% of GDP each.

The Cambodian economy continues economic boom during last years, most from tourism sector. The tourism is one of the main economic sectors in Cambodia with more than 1.5 m tourists/y, 1 billion US$ revenue, growth rate about 15-20%/y (Cambodian statistical office 2006). This increase creates a pressure on infrastructure development in Cambodia, particularly on electricity and water demand.

In following up on the Millennium Declaration, Cambodia has launched several initiatives to meet its global and national commitment to fight extreme poverty, including several institutional reforms. The

Rectangular Strategy and the *National Poverty Reduction Strategy* builds upon a policy stance of economic growth and poverty reduction. The reform agenda essentially focuses on a deepening of economic reforms and macroeconomic stability, including fiscal and monetary reforms, trade and investment promotion, administrative reforms, military demobilization, and improved fishery and forestry management.

Laos has a population of 6.135 million people with 2.5% growth per year. There is over 70% of population live in rural areas and are engaged in rice based agriculture. Its economy is one of the least developed in Asia with an approximate GDP per capita at 575 US$/y. Agriculture is the major sector contributing 47% of GDP and employing 80% of the labour force. The industry accounts for 27% and services for 26%.

The Lao economy continues to enjoy a sustainable growth around 6-7 percent during last years and is projected to grow at 7% in coming years. However, a large part of this growth comes from increased foreign investment flows in hydropower and mining. The macroeconomic situation remains stable and the inflation continues to decline. Since end of 1990s, the government has undertaken a broad range of reforms in several areas, including natural resources management, state-owned enterprises and the banking sector.

2. Legal and institutional framework in energy sector

2.1. Legal & regulatory framework

Cambodia

The basic law that governs the energy sector in Cambodia is *the electricity law* which was promulgate on 02 February 2001. The Electricity Law of the Kingdom of Cambodia governs and establishes a framework for the electric power supply and services throughout the Kingdom of Cambodia. This law covers all activities related to the supply, the provision of services and use of electricity and other associated activities of power sector. This law aims to establish

- the principles for operations in the electric power industry,
- the favourable condition for the investments in and the commercial operation of the electric power industry
- the principles for the protection of the rights of consumers,
- the principles for the promotion of private ownership of the facilities for providing electric power services and
- the principles for establishment of competition wherever feasible within the electric power sector.

Lao PDR

The national assembly of Laos has adopted *the electricity law* in April 1997. The purpose of Electricity Law is to establish systematic standards in (lie administration, production, transmission, distribution, and to manage tile exports arid imports through tile most effective use of natural resources in pursuit of improving tile national economy, society, and the living standards of the people :

- Promoting and Expanding the Production of Electricity
- Protecting the Rights and Interests of investors and Consumers of Electricity
- Protecting the environment

In 1999, *the Environmental protection law* has been promulgated. It specifies necessary principles, rules and measures for managing, monitoring, restoring and protecting the environment in order to

protect public, natural resources and bio-diversity, and to ensure the sustainable socio-economic development of the nation.

Comments and analysis

Both countries have established a legal framework for energy sector by promulgating the electricity law, with assistance from international experts. However, many studies review have pointed out to existing problems with actual legal and regulatory framework in these countries such as:

- *Lack of legal framework: basic laws were established but need further legal documents for managing and regulating the poser sector.*
- *Lack of data and information: regulatory process can not effective without transparent information and reliable information.*
- *Weak institutional capacity for planning, implementation and enforcement, particularly lack of human resources*
- *General lack of experience, particularly on regulations and enforcement*
- *The most important point is that despite the promulgation of the laws and establishment of the legal frameworks, the implementation and supporting measures are not yet followed.*

2.2. Institutional arrangement

Cambodia

Article 3 of electricity law defines the responsibility between two main institutions: Ministry of Industry, Mines and Energy (MIME) and Electricity Authority of Cambodia (EAC), in power sector. The roles of two organisations as well as other institutional arrangements are shown in the following picture.

EDC is a state owned corporation under MIME, which owns and operates the Phnom Penh main generation, transmission and distribution assets, as well as in several provincial towns and accounts for approximately 90% of total electricity consumption of the country (including IPP generation selling to EDC). The remaining electricity consumption is supplied through rural electrification enterprises (REE) and small generators.

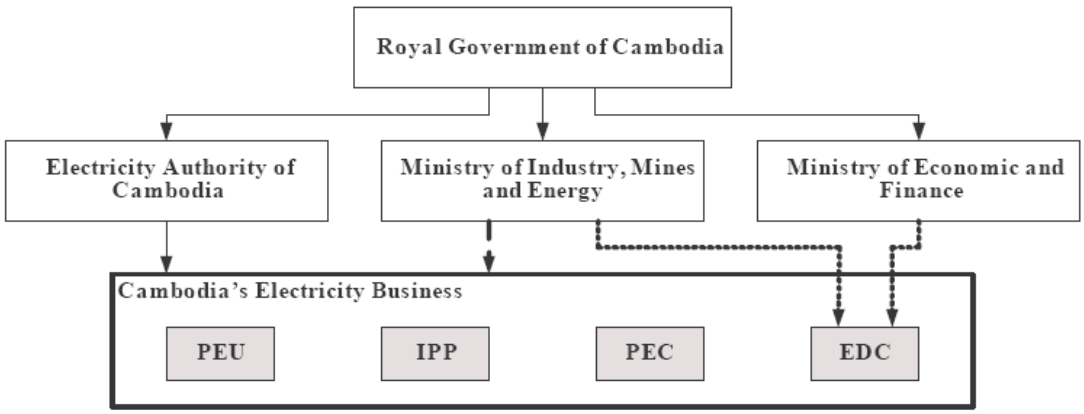


Figure 1 : Institutional structure of Cambodia energy sector

Note : PEU – public electricity utility; IPP – Independent power producer; PEC – Private electricity company; EDC – Electricité du Cambodge;

⋯⋯► Ownership control of EDC

– – ► Policy, strategies planning, development, technical, safety and environmental standards

——► Regulations, issue licences, review the planned investments, finance & performance, enforce regulation, rules and standards

At provincial level, the Departments of Industry, Mines and Energy (DIME) which depends on MIME and on Provincial authority, plays a key role in implementation of rural electrification programs, but not very actively participate in the formulation of policy and measures.

Lao PDR

There are four organisations responsible for power sector development:

- Ministry of Energy and Mines (MEM): Under the electricity law, MEM has the main duties of preparing strategic power sector plans; collect and process data about electricity generating potential; prepare regulations regarding generation and transmission development; prepare recommendations about tariff levels; administer and inspect electricity enterprises. Department of Electricity (DOE) in MEM has primary responsibility for strategic power planning, project identification and evaluation of IPP project proposal. Overall responsibility for power sector development is vested with the
- Department of Electricity (DOE) duties are divided between the Hydropower Office (HPO)/Hydro Power Development Division (HPD), the focal unit for generation and transmission planning and development, and the Rural Electrification Division (RED), the focal unit for on grid and off-grid electrification.
- RED co-ordinates and implements projects generally not intended for connection to the Main Grids. It does this in accordance with the jurisdiction of the Provincial and District offices. The work of the RED encompasses small-scale power systems including thermal, hydro, Biomass, etc. and dissemination of solar photovoltaic technology.
- Science, Technology and Environment Agency (STEA) is the main coordinating agency for environmental planning and management across all sector.
- National Committee for Energy (NCE) acts as a government's agency with power to manage the development and marketing of electricity for whole country to ensure effective implementation of strategic plans for energy and electric power development. It negotiates on behalf of the government and reports to it on matters concerning investment in power sector (generation and interconnection), exports sales and contracts with project developers
- Electricité du Laos (EDL) is a state-owned corporation under MEM, which owns and operates the country's main generation, transmission and distribution assets. EdL has also a project development role and has been the implementing agency for hydropower projects.

Apart of these central institutions, in each province there are Provincial Departments of Energy and Mines (PDEM) and EDL branch offices who are responsible for the local planning and implementation of the rural electrification programs from traditional top-down approach. However, the PDEM can play a active role in prioritize the objective and locality at local level.

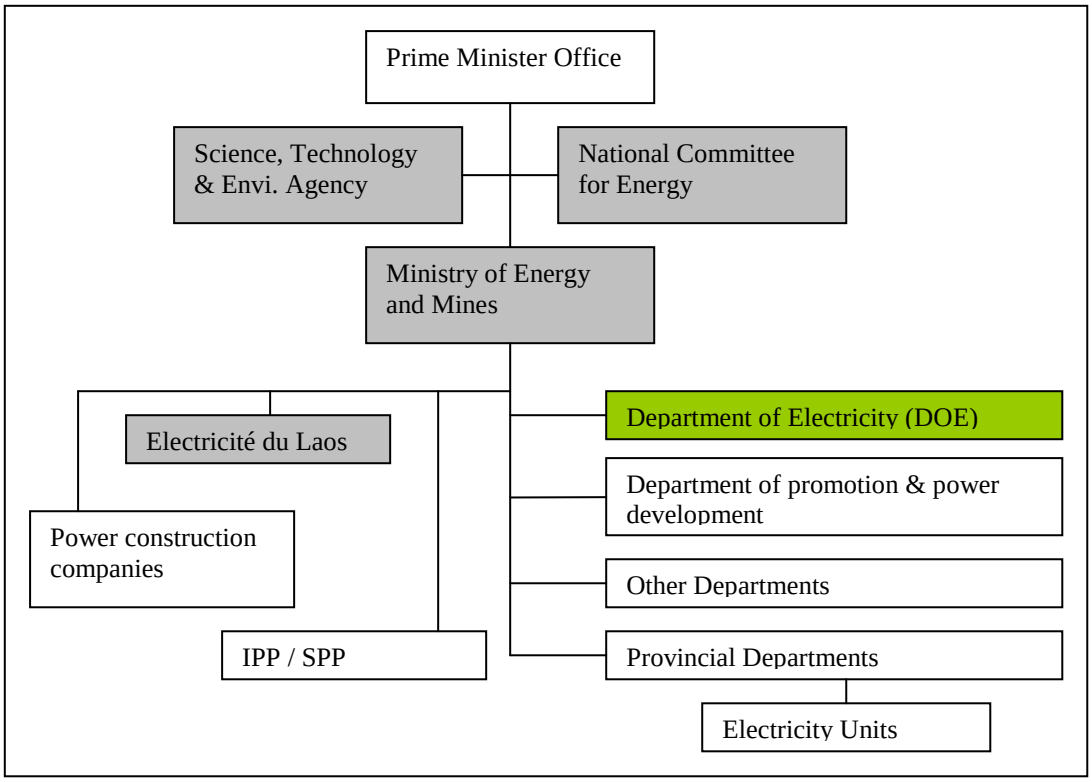


Figure 2 : Structure of Lao Energy sector organisation

Comments and analysis

- *Both countries emphasis objective to reform the institutional structure to clarify the responsibilities, strengthen commercial functions and streamline administration.*
- *Both countries have undertaken bold restructure recently, and it is expected that the role of regulators will be more independent and strengthened; the role of ministry will be concentrated on policy and strategies, macro level management; more autonomous responsibility on day-to-day management to the utilities and IPP. Also the vertical monopoly in power sector will be disintegrate into separated generation and transmission. The structures described above are those of 2006.*
- *Arrangement of institutional structure and share of responsibilities have undergone big changes since last 5 years in both countries. The roles of regulation and management have been split between different institutions. The role of rural electrification planning and implementation is clearly assigned for specialized structure. The institutional structures are in places, but they lack of human and financial resources to implement the assigned tasks.*

2.3. Energy Policy and rural electrification strategies

Cambodia

- provide access to reliable, safe and environmentally clean electricity services to rural areas
- act as a market enabler and encourage private sector participation in providing rural renewable electricity services;
- provide effective legal and regulatory framework for enabling access to reliable, safe and clean electricity services to rural areas
- encourage the most efficient systems for generation, transmission and distribution of electricity from clean and renewable energy sources

- promote renewable electricity systems for rural applications, provided they are the least-cost option for the national communities; and
- ensure adequate resources and appropriate institutional mechanisms to empower the poor, particularly those in rural areas.
- **Goals:** by *2020*, all villages will have access to electricity of different forms; The target of the government is to provide 24-hours services to 70% of rural households by 2030at acceptable price level and with minimum subsidy from the government.

Main components of the Rural Electrification Strategy in Cambodia:

1. Grid expansion from the existing network
2. Diesel stand-alone, Mini-Utility Systems
3. Cross-border Power Supply from neighboring countries (Thailand, Vietnam and Lao PDR)
4. Renewable Energy (Solar, Wind, Mini-micro hydro, Biomass, Biogas, Bio-fuel, etc…)

Lao PDR

- Maintain & expand an affordable reliable and sustainable electricity supply to promote economic and social development;
- Promote power generation for export to provide revenues to meet the development objectives
- Develop and enhance the legal and regulatory framework to effectively direct and facilitate energy sector development
- Reform institutions and institutional structure to clarify responsibilities.
- The target in 2010 is to have 70% of households having access to electricity and 90% by 2020.

Comments and analysis

- *The Cambodia and Lao PDR countries have recognized the importance of energy sector development, particularly of rural electrification in meeting their various energy and developmental goals, and each country has developed specific energy policy framework or have integrated renewable energy concerns in the overall energy and development policy framework*

- *In both countries, renewable energy development is pursued within the context of improving energy access (rural electrification) in rural communities to promote economic development. This relates to the low electrification levels in Cambodia and Lao PDR. They have also recognized the relevance of renewable energy resources development as a least-cost option to increase electricity access in remote and isolated regions of the country.*

- *The targets set by both governments are very high which require huge investments in the sector. However, the process of setting the targets and strategies are usually top-down approaches with big political willingness, and without clear assessment on impacts and linkages with country-wide economic development strategies*

3. Current situation in energy sector and rural electrification

3.1. National utilities and power systems

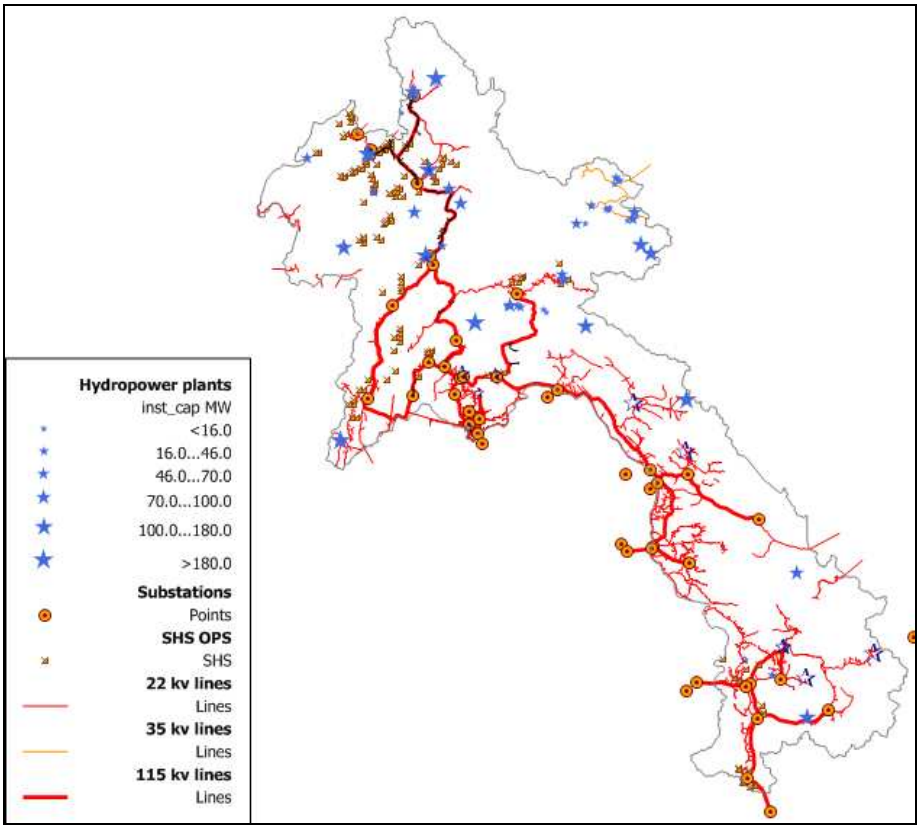
Lao PDR

Lao PDR relies heavily on indigenous fuel wood as a source of primary energy, which accounts for 80% of its total energy requirements. This reliance stems from the country's large forest reserves, covering 47% of total land area. It has coal resources but difficult to mine and high transport cost. The most abundant energy resource is hydropower, with the generating potential of 23 GW, of which 630 MW have been harnesses in 2005. The production of hydropower is mostly for export to Thailand.

Currently, Electricité du Laos (EdL) is only the national utility. It is a state-owned corporation under the MEM, which owns and operates the generation, transmission and distribution assets, and manages also import and export of electricity. EdL plays also project development role and implementing agency for government power projects and is the government shareholder in the case of IPP projects. In 2995, EdL has 3049 employees within 13 provincial agencies and 459000 customer meters.

The country has installed capacity of 671 MW, of which 308.3 MW is under EdL, 360 MW is IPP and the rest is under provincial authorities. The main hydropower plants are Nam Ngum (155 MW), Theun Hinboun (210 MW), Houy Ho (150 MW). In 2005, the country generated 1715 GWh, imported 325 GWh, and exported 728 GWh.

The present transmission and distribution are divided into four principal supply areas anda number of isolated small areas: Northern (EdL), Central 1 (EdL), Central 2 (EdL), Southern (EdL), Isolated supplies (EdL/Provinces), Off-grid electrification (Province/Private). These supply areas are not interconnected and use transmission and distribution systems consisting of 1498 km of 115 kV, 9800 km of 22 kV and 8855 km of LV circuit.



Map 1: Lao power system in 2006.
Source: DOE/EdL, elaborated by this study

Cambodia

Electric power system in Cambodia was reconstructed from the ruins since 80s years. It consists of isolated systems with the biggest systems in Phnom Penh capital (140 MW peak demand) and several

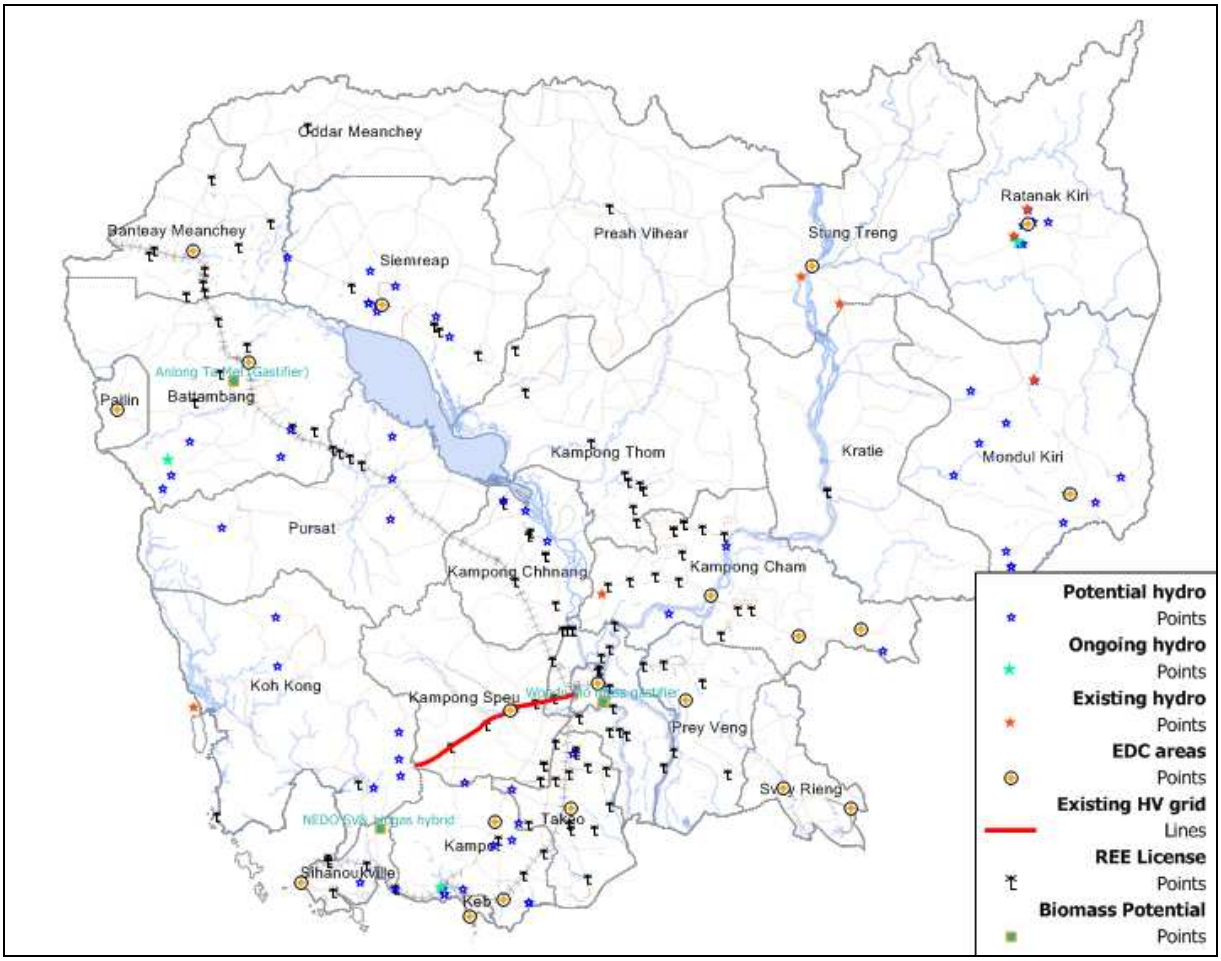
non-interconnected grid in provincial towns under EDC and many mini-grid systems provided by scattered rural electrification enterprises (REE, private energy providers). More than 90% of electric generation is from diesel power plants. Around 17% of household in Cambodia have access to electricity with average consumption of 48 kWh/y/hab.

With these small diesel systems operating on imported FO and diesel, the electricity prices in Cambodia are highest in ASEAN region (12-25 US cents/kWh).

Electricité du Cambodge (EdC) is a public sector utility, owned by MIME and Ministry of Economy and Finance, who is has non-exclusive responsibility for generation, transmission, distribution and retail of electricity throughout Cambodia.

At the end of 2005, the total installed capacity in Cambodia was 231.33 MW which distributed between EdC (83.86 MW), IPP (127.97) and small consolidated licensee (REE, 19.5 MW) and generated 879.37 GWh. The most generation capacity is Diesel (158.82 MW), one steam turbine (18 MW), two small hydropower plants and about 0.1 MW of wood & biomass power plants. There are two HV lines of 115 KV: a peripheral line around Phnom Penh of 22.71 km and Kirirom 1 – Phnom Penh of 111.24 km. The total distribution systems is about 1200 km of 22/15/10/6.6 kV.

In Cambodia, import of electricity from Vietnam and Thailand is considered an appropriated strategy for short and mid-term perspectives to meet surging demand and keep tariff at appropriated level as the most electricity is generated by small diesel groups.



Map 1 : Overall Cambodia power system,
Source: elaborated by this study, from MIME, EAC and EdC data.

Comments:

- *In both countries, fuel woods and hydro electricity are the energy domestic sources. All petroleum products are imported. Wood energy is the main source of energy and account for 80% of the total energy consumption.*
- *There are limits in the both power utilities to expand the grid networks to cover remaining population, although the problematic are quite different in these two countries: Laos PDR has many remote and difficult access (mountainous) villages and in Cambodia, there is lack of infrastructure (plant and networks) to provide electricity, even to urban population.*
- *Due to lack of capital investment, both countries start to promote IPP to invest in generation facility, although the transmission and distribution remain the monopoly of their utilities. IPP share in generation capacity has been increase rapidly since.*
- *The development of power sector is accelerated during the last decade both in term of supply and infrastructure, but mostly for urban area and easy access area. Further electrification development will become more difficult and costly which requires a more rational approach in planning.*
- *In both countries, the national utilities are responsible for grid- extension rural electrification, but not off-grid. But event with the grid-extension planning, they do not consider the social and development impacts and effects in the planning process. There is lack of coordination in energy planning between different line ministries and between different services of the MEM.*
- *Among those rural populations who have access to electricity, not all have good quality and reliable service.*

3.2. Renewable sources and development

3.2.1. Small hydropower

The hydropower potential in Lao PDR is amounted about 23 GW, but economic potential is estimated about 5300 MW over 20 identified projects. One of these identified hydropower projects is Nam Theum 2 which is expected to be commissioned by 2009 with 1070 MW installed capacity. However, regarding the small and minihydro potential, there is 40 small and minihydro power plants of total 5375 kW have been installed but no all of them are operational.

Potential of hydropower in Cambodia is very high (Technical potential is more than 10000 MW for large hydropower and 300MW for small, mini and micro hydropower) but the development of these sources has not been implemented due to lack of technical studies and investment capital.

Statistic of small hydro generation in Lao PDR

N°	Resource name	Location		Power (kW)	Number of Generators	Year	Remark
		District	Province				
1	Namphao	Khamkeuat	Oudomxai	1,600	1x1600 kW	1995	Not in used
2	Namkor	Xai	Oudomxai	1,500	3x500kW	1996	
3	Houaykasene	Pakbeng	Oudomxai	155	1x100kW	2003	
					1x55 kW	2003	
4	Namdong	LuangPrabang	Luangprabang	1,000	3x336 kW	1970	
5	Nampa	Luangprabang	Luangprabang	16	1x16 kW	1980	
6	Nammong	Nambak	Luangprabang	70	1x70 kW	2000	
7	Namboun-1	Bounneua	Phongsaly	110	2x55 kW	1996	
8	Namkhoun	Bounneua	Phongsaly	5	1x5 kW	1996	Not in used
9	Namkha	Bounneua	Phongsaly	5	1x5kW	1996	Not in used
10	Namgnay	Pongsaly	Phongsaly	1,200	2x600 kW	2002	

11	Namleu	Luangnamtha	Luangnamtha	46	1x46.2kW	1994	Not in used
12	Houaykibouan	Long	Luangnamtha	50	1x50kW	1998	Not in used
13	Namnoung	Nale	Luangnamtha	30	1x30kW	1999	
14	Nampoun-1	Viengxai	Houaphanh	96	2x48kW	1994	Not in used
15	Nampoun-2	Viengxai	Houaphanh	48	1x48kW	1998	Not in used
16	Namsoy	Viengxai	Houaphanh	12	1x12kW	1994	
17	Houaymenh	Samneua	Houaphanh	24	1x24kW	1994	Not in used
18	Namhung	Samneua	Houaphanh	6	1x6kW	1994	Not in used
19	Namsane	Samtai	Houaphanh	110	2x55kW	1995	
20	Nampeunh	Houamouang	Houaphanh	40	1x40kW	1986	
21	Nam at	Vienthong	Houaphanh	80	1x80kW	1988	
22	Namlong	Xiengkhor	Houaphanh	20	1x20kW	1989	
23	Soblong	Xienkhor	Houaphanh	24	1x24kW	1989	Not in used
24	Namsat	Vienthing	Houaphanh	250	2x125kW	1999	
25	Namla	Samtai	Houaphanh	104	2x52kW	2002	
26	Namham	Bortain	Xayabouly	180	2x90kW	1992	Not in used
27	Bansobma	Kham	Xienkhouang	55	1x55kW	1995	
28	Namtiane	Kham	Xiengkhouang	75	1x75kW	1995	
29	Bantanh-1	Khoune	Xiengkhoung	5	1x5kW	1994	Not in used
30	Bantanh-2	Khoune	Xiengkhouang	8	1x8kW	1995	Not in used
31	Banpoung	Khoune	Xiengkhouang	5	1x5kW	1995	Not in used
32	Bannong	Phaxai	Xiengkhouang	40	1x40kW	1995	Not in used
33	Namka-1	Phaxai	Xiengkhoung	12	1x12kW	1987	
34	Namka-2	Phaxai	Xiengkhounag	81	1x81kW	1995	
35	Namka-3	Phaxai	Xiengkouang	5	1x5kW	1995	Not in used
36	Horkang	Phaxai	Xiengkhouang	24	1x24kW	1986	Not in used
37	Namjat	Mork	Xienkouang	100	1x100kW	1992	Not in used
38	Houasloy	Nong	Savannaket	75	1x75kW	1996	
39	Houachampy	Paksong	Champasack	40	1x40kW	1985	Not in used
40	Mouangphoun	Mouangphoun	Xaisomboun	200	1x200kW	1999	Not in used
	Total			**5,375**			

Source: DOE/MEM (2004)

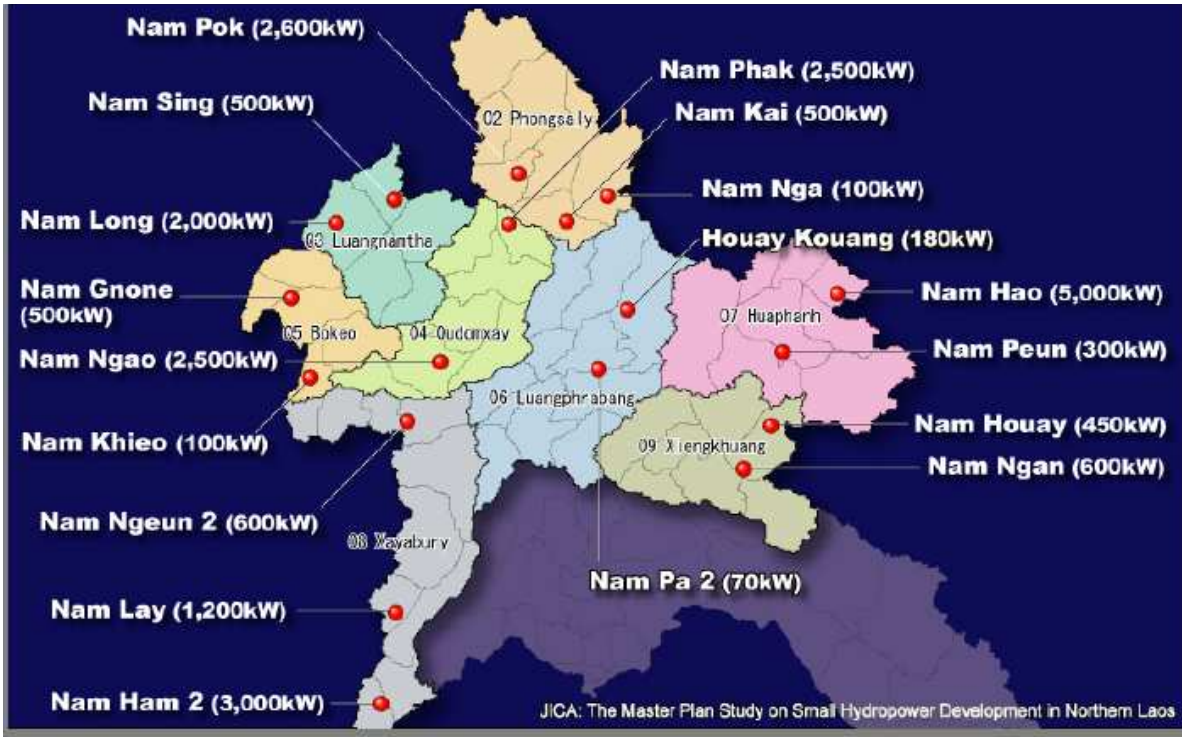


Figure 3 : Candidates of minihydro development in 7 nothern provinces of Laos,
Source: JICA/DOE, 2006

As of 2006, there are 10 hydropower plants in operation in Cambodia with total capacity of 13189 kW, 4 hydropower plants with a total capacity of 180.44 MW are under study and/or construction, and about 65 small and minihydro sites have been identified (see the map above)

The study “Master plan on rural electrification by renewable energy in the kingdom of Cambodia” by JICA, have identified 30 sites with more detailed parameters as shown in the table.

Table: Survey results of potential MHP site in Cambodia (source: JICA study)

	Name of MHP Scheme	Province	District	River name	Q obs. site (UTM Indian-Thai)		C.A. (km²)	Obs. discharge	Specific discha.	date	time of Q obs.	Gross Head (m)	Potential Gen Pow	No of HH	Peak demand	Villages (target area)	remark
					GPS X (E)	GPS Y (N)		m3/s	m3/s/km²				kW		kW *		
1	Slung Sva Slab	Kampong Speu	Phnum Snoch	Sva Slab	03 95 710	12 61 360	205	0.096	0.0005	2004/12/4	13:52	85.0	56	665	69	Chambak, Kreng Chek, Beng, Thmei	Meritec study (2001) 3.80MW
2	Preak Kaoh Touch	Kampot	Kampot	Kaoh Touch	03 99 035	11 71 179	21.65	0.000	-	06/12/2004	15:17	60.0	0	546	57	Kilou Dabpir, Kaou touch (Preak Chek)	MIME List [317kW] River dried up
3	Srae Cheng (Srat Cheng)	Kampot	Chum Kiri	Srae Cheng (Srat Cheng)	04 31 151	12 18 070	36.0	0.017	0.0005	2004/12/7	14:55	55	6.4	284	30	Pong tuek village	Height measurement by Altimeter
4	O Traou Trao	Kampot	Kampot	O Traou Trao	04 01 427	11 80 460	20.0	0.052	0.0026	2004/12/S	10:30	154.3	55	352	37	Mortpeam, Bat Kbal damrei	Meritec Study (2001) 1.12 kW
5	O Samrel	Battambang	Samlot	O Samrel	02 68 856	13 81 692	12.0	0.036	0.0030	2005/1/5	16:25	28.0	6.9	110	11	O Kroch (samrel)	Meritec study (2003) [33kW]
6	TaTaok	Battambang	Samlot	O Chum	02 65 898	13 76 917	14.0	0.060	0.0043	2005/1/6	14:22	71.4	29	50	5	Veal roling (ta taok commune)	Meritec Study (2003) |37.5kW]
7	Kampong Lpov	Battambang	Samlot	Ou Daem Chek	02 71 928	13 83 174	8.0	0.026	0.0033	2005/1/7	14:15	78.7	14	127	13	Ou Dam Chek [Kampong Lpov commune)	Meritec Study (2001) [31 kW]
8	O Chum I (existing dam)	Ratanak Kiri	O Chum	O Chum	07 16 437	15 24 726	22.7	1.50	0.0661	2005/1/18	16:00	9.0	92	274	28	Ta Long (Thrarang Chong) Ou Chum, Svey	Meritec study (2001) [74kW]
9	O Kachan	Ratanak Kiri	Lumphat	O Kachan	07 15 659	15 14 518	31.2	0.35	0.0112	2005/1/19	9:40	13.2	32	98	10	Phum Pir	MME List 82kW
10	O Kalieng	Ratanak Kiri	Lumphat	O Katieng	07 14 128	15 11 427	42.9	0.410	0.0096	2005/1/19	12:00	14.1	40	295	31	Katieng I & II (KaTueng, Banlung town?)	Meritec study (2001) 1076kW, MIME List 224kW
11	O Kalieng (D/S)	Ratanak Kiri	Lumphat	O Katieng (D/S)	07 14 12S	15 11 427	42.9	0.410	0.0096	2005/1/19	12:00	44.7	126	368	38	Katieng I & II, Kam Pleng, Kateng	New scheme proposed by JICA team
12	Bay Srok (O Sien ler)	Ratanak Kiri	Lumphat	O Sien Ler (O Paling Thorn)	07 26 215	15 03 449	115.0	1.070	0.0093	2005/1/20	13:00	23.2	170	560	58	Bay Srok, New Kalaeng, New Sayos	Meritec Study (2003) 78kW
12	Bay Srok (O Sien ler)	Ratanak Kiri	Lumphat	O Sien Ler (O Paling Thorn)	07 26 215	15 03 449	115.0	0.410	0.0036	2005/5/20		23.3	65	560	58	Ditto	Ditto
13	O Pyol	Ratanak Kiri	Andoung Meas	O Pyol	07 52 917	153S 257	14.0	0.130	0.0093	2005/1/21	13:45	12.57	11	91	9	Ka Chut	
14	Ta Ang	Ratanak Kiri	Koum Mom	O Cheng	07 09 708	15 11 423	19.0	0.070	0.0037	2005/1/22	10:00	25.0	12	98	10	Sek	Meritec Study (2003) 10kW
15	O Chrolong	Stung Treng	Sienbok	O Chrolong	06 19 514	14 76 863	128.0	0.450	0.0035	2005/1/23	16:20	4.8	15	103	11	O Resey Kadal	Proposed by DIME, Survey by JST(2005)
15	O Chrolong	Stung Treng	Sienbok	O Chrolong	06 19 514	14 76 863	128.0	0.320	0.0025	22/05/2005	-	4.8	10.4	103	11	Ditto	Ditto
16	O Chrop	Stung Treng	Se San	0 Chrop	06 42 492	14 76 053	16.0	0.030	0.0019	24/01/2005	13:00	5.0	1	116	12	O Crop	Proposed by DIME, survey by JICA, low potential
17	O Baingkla (D/S)	Stung Treng	Siem Bouk	0 Baign Kla	06 07 817	14 75 073	35.0	0.210	0,006	24/01/2005	14:00	5.0	7	270	28	Srae Krasan (Phnom Dei Krahom)	Proposed by DIME, Survey by JST (2005)
18	O Dambal	Kratie	Chhnong	0 Dambal	06 19 706	13 52 202	115.0	0.050	0.0004	2005/1/26	17:15	3.6	1.2	175	18	Pralay Trick, Kroch	JST (2005) x 6 time available if peak
19	0 Chrei mieng	Kratie	Sunoul	O Chrei Meing	06 64 149	13 35 908	180.0	0.719	0.0040	2005/1/27	11:45	5.0	25	114	12	Cheung Khle	JST(2005), Dam(H=10m, DCL=400m)
20	Prek Prey	Kratie	Sunoul	Prek Proy	06 68 328	13 37 375	165.0	0.007	0.0000	2005/1/27	15:30	5.0	0.2	4	0	Prek Prey (4 Army camp' families only)	JST(2005) Low posibility
21	O Dak Dam	Mondul Kiri	Ou Reang	O Dak Dam	07 51 659	13 72 642	4.0	0.020	0.0050	26/01/2005	11:00	17.0	2.3	117	12		-
22	Busra	Mondul Kiri	Pechr Chenda	Prek Por	07 64 312	13 90 088	197.0	0.150	0.0008	27/01/2005	11:00	65.0	67	899	93	Busra Comnmne	Meritec (2003) 54kW
22	Bursa	Mondul Kiri	Pechr Chenda	Prek Por	07 64 312	14 90 088	197.0	2.050	0.0104	2005/5/20	11:30	68.2	959	899	93	Ditto	
23	OPhlai	Mondul Kiri	Pechr Chenda	0 Phlai	07 53 300	13 87 700	302.0	0.330	0.0011	27/01/2005	16:00	40.0	91	899	93	Busia Commune & surrounding areas	
23	0 Phlai	Mondul Kiri	Pechr Chenda	0 Phlai	07 58 300	13 87 700	302.0	0.470	0.0016	2005/5/21	11:45	23.5	76	899	93	Ditto	
24	Sangke(D/S)	Battambang	Samlot	Stung Sangke	02 68 875	14 11 162	696.0	1.150	0.0017	2005/2/5	11:00	15.0	118	6786	706	Ratanak Mondul district, Samlout District	Mine clearing is required for further survey
24	Sangke(D/S)	Battambang	Samlot	Stung Sangke	02 63 875	14 11 162	696.0	2.830	0.0041	2005/5/14	10:30	7.5	145	6786	706	Ditto	Ditto
24	Sangke (D/S)	Battambang	Samlot	Stung Sangke	02 63 875	14 11 162	696.0	2.880	0.0041	2005/5/15	12:15	7.5	147	6786	706	Ditto	Ditto
25	Sangke (U/S)	Battambang	Samlot	Stung Sangke	02 55 200	14 02 400	499.0	0.824	0.0017	2005/2/5	-	15.0	85	6786	706	Ditto	Ditto
26	Tatai (D/S)	Koh Kong	Thmabang	Stung Tatai	03 25 927	12 89 335	423.0	0.284	0.0007	2005/2/11	11:00	32.0	62	155	16	Kokir Chrum, Trapeang Chuetav Viliage	
26	Tatai (D/S)	Koh Kong	Thmabang	Stung Tatai	03 25 927	12 89 335	423.0			2005/6/1		30.2	62	155	16	Ditto	Ditto
27	Tatai (U/S)	Koh Kong	Thmabang	Stung Tatai	03 40 963	13 07 608	158	0.031	0.0002	2005/2/12	11:40	28	6	92	10	Ksidal, Trapeang Kkna, Spean Kdar Villages	
*) peak demand = total household x 0.8 x 0.1 kw/hh x 1.3 loss																	

3.2.2. Biomass

Lao PDR

Laos has plenty source of renewable energy, biomass (mainly fuelwood) supply of around 46 million tons per year. It could generate about 3.9 million tons of agricultural residues per year. Of this volume, about 2.9 million tons would be in the form of rice straw, 0.44 million tons as rice husk, and 0.15 million tons as maize stalks. An estimate shows that about 264 million cubic meters of gas per year could be generated from the manure of buffalo, cows and pigs.

Table Energy potential of some agriculture and forestry residues in Lao PDR

Biomass sources	Type of fuel / energy	Equivalent energy (MWh/y)	Equivalent diesel fuel (litters/y)
Rice husk	Combustive	2 108 000	214 000 000
Rice straw	Biogas	1 030 000	105 000 000
Husbandry	Biogas	3 269 000	332 000 000
Forests residues	Combustive	12 500 000	1 271 000 000
Total		**18 907 000**	**1 922 000 000**

Source: DGS

Rice industry in Lao PDR and rice husk generation

Paddy farming is by far the single most important national economic activity in the country. Rice is the dominant crop and occupies 68% of total cultivated area. Annual rice production in Lao PDR ranges between 2.2 – 2.4 million tonnes (According to the National Statistics, rice production was 2.41 million tonnes in 2002, and 2.37 million ton in 2003). Rice husk in paddy constitutes about 22% by weight. Huge quantities of rice husk are thus generated during rice milling, and are considered as waste. Most of the rice husk produced is not being put to any productive use. Rice husk could thus be the main potential biomass fuel in Lao PDR. The rice industry in Lao PDR is producing large quantities of rice husk after de-husking the paddy. Rice husk can be used as an excellent fuel for power generation/cogeneration. While used as a fuel, the benefit it offers to the rice milling industry is significant. According to the National Statistics, the rice husk generation was about 556 380 tonnes in 2004, which are mostly concentrated in southern provinces (Khammuon, Champasak, Saravane & Vientiane).

Sugar industry in Lao and bagasse generation

Sugarcane is one of Laos' main industrial crops, the sugarcane plantation is scattered throughout the country, with plantation in the northern region covering Luangnamtha and Phongsaly provinces, plantation in central Laos covering Vientiane Capital, Vientiane Province, and Bolykhansay provinces, and in the southern region, covering Savannakhet province. The production of sugarcane in Lao PDR is about 223,300 tonnes, in a plantation area of about 7 030 ha and produce about 70 000 tonnes of bagasse[1]. Luangnamtha province, located in the northern part of Laos, is the largest producer of sugarcane, producing about 68,100 tonnes in 2004. Most of the sugarcane produced in Luangnamtha is exported to China, while the production in central Laos is supplied to Vangthap Sugar Factory located in Vientiane Capital. Vangthap Sugar Factory produces about 600-700 tonnes of red sugar per annum, and generates large quantities of bagasse in the process, as waste. Bagasse is the fibrous residue delivered after the extraction of the juice from the sugar cane in mills. Over the 10 years of operation, the bagasse generated has not been consumed for any useful purpose, although there exists an opportunity to utilise it for energy purpose.

[1] based on a bagasse-to-sugarcane conservative ratio of 30%

Sugarcane bagasse is one important option for producing biomass energy in Lao PDR. Bagasse has traditionally been used as a fuel in the sugar mill itself, to produce steam for the process and electricity for internal use.

Wood industry in and wood waste resource Lao PDR

Lao PDR still has high forest coverage. Most of the remaining forest in Indochina lies along the shared borders of Vietnam, Lao PDR and Cambodia. Forest covers up to 25% of land in some northern provinces of Lao PDR and up to 70 % in the south. This resource is rapidly declining as the estimated national forest cover in 1970 was 70%. At present, forests occupy an estimated 10.7 million ha or 45% of the total land area of the country. In addition, there are about 10 million ha of potential forest including degraded forest, bamboo areas etc.

There are over 1,400 wood industry establishments in the country, including sawmills, plywood, and furniture. The exports of forest products constitute nearly 30 % (86.8 million USD in 2001) of the total country exports. Forestry and wood industry represent 20% of the total contribution of agriculture to GDP. The rural population relies on the forests to provide some 40% of the rural income in the form of food firewood.

Sawmills and plymills generate large amounts of waste (up to 50%) which constitute bark, shavings, off-cuts and sawdust. These wood wastes are partly used by the mills as fuel for their steam requirements in the drying processes. There are about 173 sawmills in the country, mainly in the central and southern parts of the country. The biggest sawmill in Vientiane municipality is the First May Wood Processing Co. Ltd., located at about 10 km south of Vientiane. This sawmill produces about 2.000 m^3 of wood per year, while the waste wood and sawdust produced during wood processing are about 4.000 tonnes /year. The waste wood is used as fuel in the plant boiler, for stream generation. Steam is used on the plant for wood production. The sawdust produced is compressed and converted to charcoal.

Other smaller saw mills however do not use their saw dust and wood waste to meet their own energy requirements. These are mostly used for domestic cooking and heating purposes.

Lao PDR is exporting considerable amount of timber, lumber and plywood. The export figures in recent years are:

Year	Timber Export in 1000 (m^3)	Lumber Export in 1000 (m^3)	Plywood Export in 1000 (sheets)
2002	11	293	693
2003	21	80	1196
2004	19	21	2839

Source: Committee for Planning and Investment, National Statistics Center.

Cambodia

- **Rice husk:** In 2003, rice was cultivated in 2.3 million ha of the field and 4.7 million ton was produced. Rice husks account for 20% of the paddy production, on a weight basis . This means that nearly 1 million ton of rice husk was produced ,
- **Cashew nuts trees** have been planted 37,140 ha in Cambodia and the number of grower is increasing. Cashew is mainly planted in Kampong Cham province (17,136 ha, 46%), Rotanakiri province (6,505 ha, 18%) and Kampong Thom province (6,371 ha, 17%),
- **The production of cassava** in 2003 was 330,649 t
- **The area of coconut** plantations was 27,054 ha .

- **Peanut** production in 2003 was 18,483 t. Peanuts shells represent approximately 30% of the total weight of the peanuts**.**

Old Rubber Trees

There are about 40,000 ha of rubber plantations in Cambodia and 40,000 tons of rubber block, also known

Natural Forest

Although more than a half of Cambodia is still covered by forest, there has been serious deforestation over the last several decades. In 1960, forests covered 73% of the total land area of the country but this had decreased to 58% in 1998. Forest cover is expected to further decrease to 50–56% by 2010.

Forest Plantations

Cambodia currently has around 11,125 ha of forest plantations, mainly with *Acacia* and *Eucalyptus*

	Quantity		Usage
Rubber Trees	Total Plantation	40,000ha	Boiler, Brick Kilns and Households
	Life	25-30 years	
	Output	250,000ton/year (180 ton/ ha)	
Rice Husk	Rice	2,300,000ha 4,7000,000ton	Households Brick factory
	Rice Husk	10,000 ton/year	
Bagasse	Sugar Cane Waste	About 100,000 ton/year	
Palm Tree			
Cashew Nut Shell	Total Plantation	37,000ha	
	Cashew nut Yield	14,000 ton/year 800-1,000kg/ha	
	Shell	10,000 ton/year	

Source: MIME 2007

Agricultural residues are already well utilized as domestic energy sources and natural forests are not recommended as a fuel source for electricity generation. By contrast, energy tree farming would be highly suitable for biomass fuel supply for rural mini-grid electrification

There are three biomass fuelled electricity generation in Cambodia:

- Centre for livestock and agriculture development with installed capacity of 9 kW, for research purpose.
- NEDO PV and biogas hybrid power generation project which consists of PV (50 kW) and 2x35 kW duel fuel biogas engine near Sihanouk ville. The biogas is extracted from cattle excrements from farms. The system is operating but for demonstration and research purpose and would not economically viable
- Along Tamei community energy project – Battambong : This is only biomass gasification electricity generation project on commercial basic in Cambodia, with main characteristics presented below.

Biomass Gasification Electricity Generation by Community/SME Cambodia in Battambong province	
Installed Capacity:	14 kW
Biomass used:	Leucaena
Capacity output	7kW
Tariff	R 1,200 /kWh
Cost: Investment	US$24,000

3.2.3. Solar

Lao PDR

Annual solar radiation in Laos is 1600 – 1800 kWh/m² in the southern part of the country, and possible less in mountain northern areas, with annual sun-shine about 2.000 – 2.600. The solar energy was started to be introduced to rural villages in 5 districts in 1997 in framework of rural electrification initiated by the Lao government and currently several programs have been implemented and under implementation to introduce SHS to provide electricity to remote area in the south and north of country.

Two main categories of PV systems users in Lao PDR are telecommunication systems and off-grid electrification programs. In 2005, there is 296.9 kW of installed capacity of PV systems in 194 villages under ownership of the MEM + JICA, STEA (Science Technology and Environment Agency), MCTPC (Ministry of Communication, Transport, Post and Construction), EDL and NGO.

Cambodia

The data from JICA master study of rural electrification by Renewable energy in 2006 have show an average radiation of 5.1 kWh/m²/day or equivalent of 1860 kWh/m²/y over the country.

According to MIME, as of 2004, more than 204 kWp of PV modules has been installed in the country which are used to supply power for household lighting and small electric equipment of public and telecommunication facilities. These installations were mostly donation and/or demonstration research projects

3.2.4. Wind

Laos wind speeds of around 1 m/s have been observed at Luan Prabang and Vientiane, and mountain areas would likely have higher wind speeds. There is a limited potential due to low average speeds and high unit costs.

There are few reliable records of wind speed data for Cambodia. Observations and extrapolation from neighbouring Thailand and Vietnam tend to indicate that mean wind speeds are low, in the order of 2m/s for much of the country.

The southern part of the great lake Tonle Sap, the mountainous districts in the southwest and the coastal regions, such as Sihanoukville, Kampot, Kep and Koh Kong have the annual average wind speed of 5m/s or greater; thus the introduction of wind power generation system in these areas is promising.

Table : Wind Energy Potential of Cambodia and Lao PDR at 65 m*

Country	Characteristic	Poor (<6 m/s)	Fair(6-7 m/s)	Good(7-8 m/s)	Very Good(8-9 m/s)	Excellent (>9 m/s)
Cambodia	Land Area (Sq. Km)	175468	6155	315	30	0
	% of Total Land area	96.4%	3.4%	0.2%	0.0%	0.0%
	MW Potential	NA	24620	1260	120	0
Laos	Land Area	184511	38787	6070	671	35

	(Sq. Km)					
	% of Total Land area	80.2%	16.9%	2.6%	0.3%	0.0%
	MW Potential	NA	155148	24280	2684	140

*For large wind turbines only. Potential MW assumes an average wind turbine density of 4 MW per square kilometre and no exclusions for parks, urban, or inaccessible areas. Wind speeds are for 65 m height in the predominant land cover with no obstructions.
Source: Wind energy resource atlas of Southeast Asia, the World Bank 2001

Comments and analysis:

General issues for renewable energy development in Cambodia and Lao PDR are:

- *Lack of reliable data and resources assessments for all renewable energies. There are urgent needs for country-wide assessment of renewable energy resources, particularly for small scale power development.*
- *For minihydro development, significant drop in the dry season flow and power output make them not very attractive option for rural electrification.*
- *Very small demand in the area with rich potential development so there is no incentive for development of small generation for local consumption.*
- *No concrete incentive for RE have been applied, although the governments have announced several policies for RE development.*

3.3. Rural electrification situation and programs

Currently, the provision of rural electricity service in Cambodia and Laos is largely left to small private entrepreneurs with no formal training in power generation, distribution or business. Consequently the rural consumers face some of the highest electricity prices in the world. This situation is a significant barrier to development because households are spending limited income on energy costs, rather than food, shelter or education; and many potential income generating opportunities are not feasible due to the high power prices.

Rural electricity services play a key role in rural development because the access to affordable, reliable and safe electricity can greatly improve food, education and health services, as well as improving opportunities for income generation. This is particularly true for Cambodia and Lao PDR, after decades of destructive war.

Lao PDR

Much of the country lies beyond the economic expansion of grid, so off-grid decentralized development is only the option for many isolated rural communities. The Rural electrification Division of DOE is responsible for development, coordination of off-grid at village and household level. There is a Rural Electrification Fund established to coordinated and channel financing.

In 2005, there are 441 800 household spreading over 4000 villages were electrified, covering 46% of total households in the country.

Table: Electrification status in Lao PDR

Year	**Total**			**Electrified**					
	District	Villages	Households	District	%	villages	%	Hh	%
2000	142	11263	818 668	119	83.8	2651	23.5	293 495	35.9
2001	142	11231	866 277	116	81.7	2811	25.0	303 690	35.1

2002	142	11118	876 774	125	88.0	3245	29.2	340 550	38.8
2003	142	10566	883 366	128	90.1	3776	35.7	379 109	42.9
2004	141	10781	930 982	127	90.1	4229	39.2	437 649	47.0
2005	141	10552	959 595	129	91.5	4229	40.1	441 827	46.0
2006	141	10567	935 019	125	89	4256	40	504 000	54
	Of which - EDL - Provincial authorities			 103 22		 3897 359		 465 988 38 012	

Source: DOE/MEM & EDL

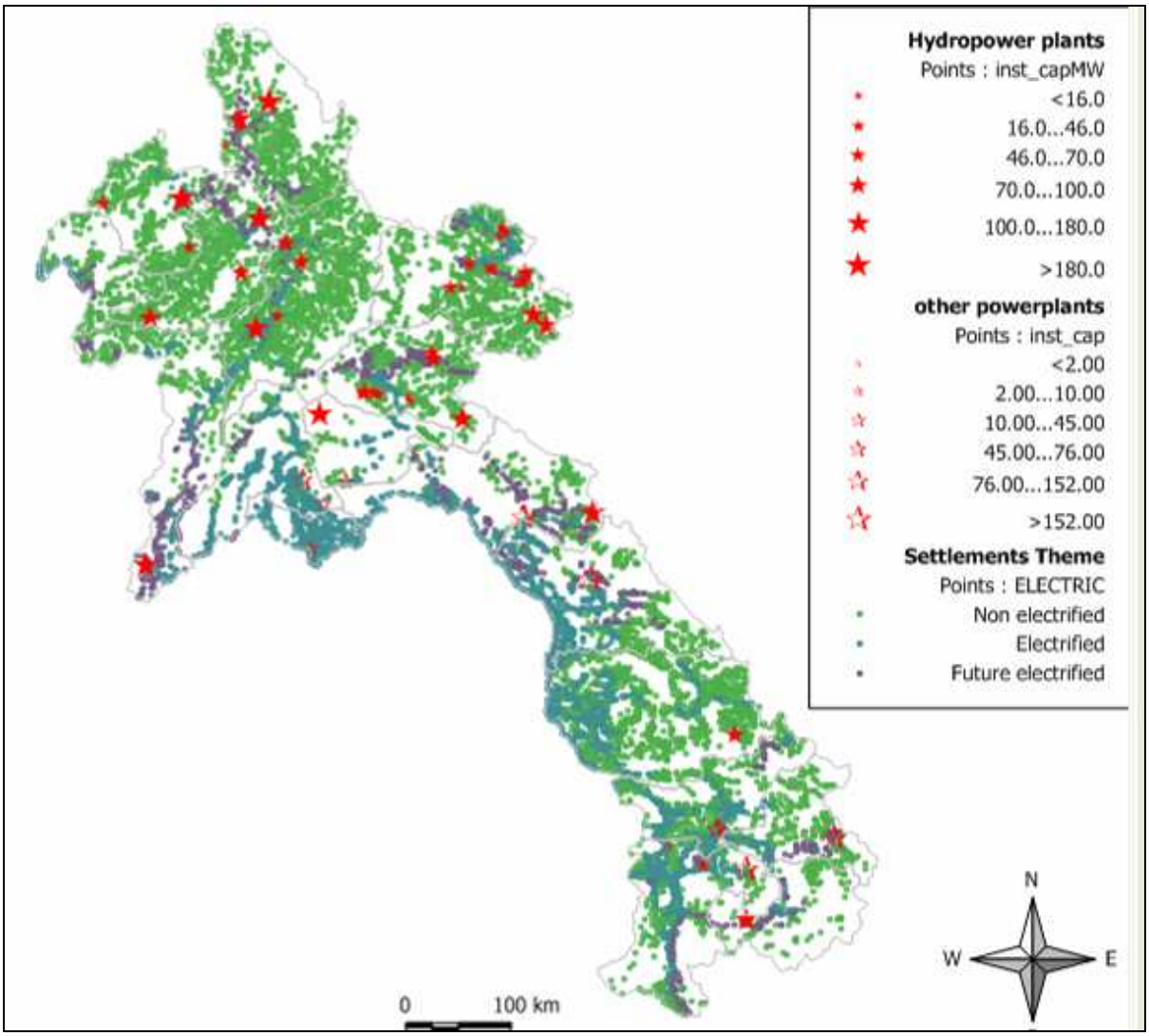


Figure 4 : Spatial electrification situation in Lao PDR in 2006,
Source : EDL, MEM & elaborated by this study

The figure 3 shows the current spatial electrification location and status at village level for Lao PDR at 2006. The electrified areas are mostly concentrated along Mekong River, easy accessible areas and closed to the hydropower generation. The future electrification plan will cover mostly the extension of the existing grid network. The remaining non electrified area will be difficult to be electrified by conventional grid extension and will be costly to be electrified.

The government's strategy on rural electrification is to obtain an electrification rate of 70% by the year 2010 and 90% by 2020. The target will be met by implementing several projects with supports from WB, ADB, and JICA: REP1, Southern provincial rural electrification phase II – SPRE 2, SPRE 3, Power transmission and distribution PTD 2 & PTD 3.

REP1 (Rural Electrification Program 1) Project for the 2006-2009:

- Off Grid by SHS, VS/GS: 10.000 households in isolated villages; Rural Electrification Fund is being operated by DOE
- Grid Extension by EdL : REP1 for 7 Provinces in central and Southern part; PTD2 Project for Northern provinces

Other programmes:

- Promotion of Rural Electrification.
- Pilot Hybrid System (PV+S/Hydro + Biomass);
- Promotion of SHP for SIPP
- Village Off-Grid Promotion and Support (VOPS) 2005-2008:
  - Spread out over the country in 17 Provinces in isolated villages;
  - Target number of about 10,000 HHs, about 0.37 MWs during the REP1;
- Small Hydro Power Projects
  - Pre-Feasibility Study the best 11 Sites
  - 2 SHP have been signed PPA with EdL and some SHP have signed MOU with GOL by private investors.

Future Planning Projects

Table 3.5-2: Rural Electrification Plan

	Actual 2006	2010	2016	2020
Government Target				
Total Villages	10,567	10,567	10,567	10,567
Total Households	935,019	1,019,900	1,147,033	1,231,788
No.of Villages with electrified	4,266	5,284	7,185	8,453
Elect. rate(%)	40%	50%	68%	80%
No.of Households with electrified	504,000	713,930	950,737	1,108,609
Elect. rate(%)	54%	70%	83%	90%
	2006	2010	2016	2020
EDL Target				
No.of Villages with electrified	3,897	4,838	6,579	7,740
Elect. rate(%)	37%	46%	62%	73%
No.of Households with electrified	465,988	660,085	879,032	1,024,997
Elect. rate(%)	50%	65%	77%	83%
	2006	**2010**	**2016**	**2020**
Other Contribution				
No.of Villages with electrified	369	446	606	713
Elect. rate(%)	3%	4%	6%	7%
No.of Households with electrified	38,012	53,845	71,705	83,612
Elect. rate(%)	4%	5%	6%	7%

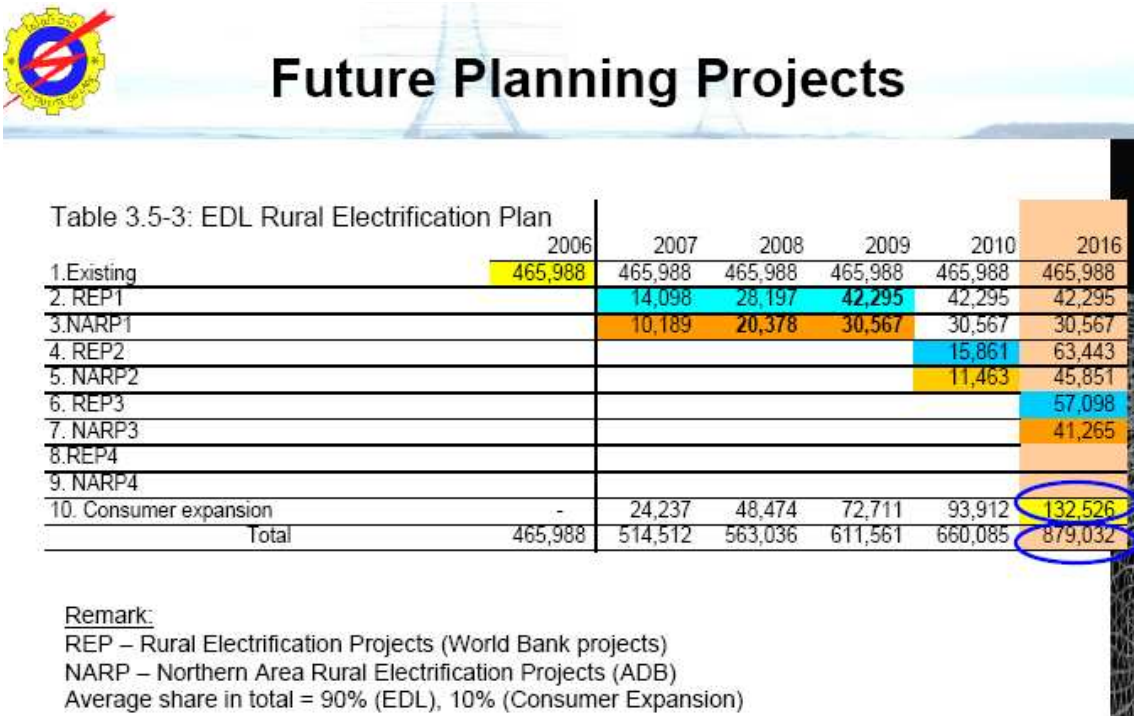


Figure 5 : future planning project for rural electrification under EDL planning.
Source: EDL, 2007

Cambodia

The electric power systems in Cambodia are isolated and fragmented systems, which can be regroup into three categories : a) EDL supply systems (18 not interconnected supply areas in Phnom Penh and provinces); b) Licensed REE power supply systems (around 142 generation, distribution and/or retail REE, mostly mini-grid with diesel systems); Non-licensed REE power supply system (estimated number between 400 – 600). About 18% of household have access to electricity, mostly concentrated in Phnom Penh and big citites (Sihanouk ville, Xiem riep, Battambong). Per capita consumption is about 78 kWh/y. Also rechargeable automotive batteries are commonly used in rural areas where are without existing grid for basic lighting and powering radio.

In this context, MIME is formulating a Rural Electrification Strategy. The main objectives of this strategy will be:

- 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.

Challenge and Resources for Rural Electrification
The challenge of Rural Electrification (RE) in Cambodia is substantial, requiring a private and public up scaling in investments, implementation rate and human resource development. To achieve the RE's target of 70% in 2030, it is estimated that an investment of more than US$ 1 billion would be required.

In addition, the present electrification rate is about 14,000 new services per year (urban and rural). To reach the above set target, the electrification rate will have to be increased by at least a factor 5 over the next 10 years. The current electrification rate is delivered by a human capacity base of about 2,700

people, 1300 employed by EDC (urban and rural) and about 1500 working for Rural Electricity Enterprises. To achieve the said targets, an estimated 200-300 of these rural electricity employees will require some kind of training, as well as the additions of hundreds of new employees. To meet this great challenge, joint private and public efforts will be required.

Rural electrification is much more expensive than urban electrification and rural households are poorer, which leads to a severe affordability problem for consumers but also for the potential investors. It makes it difficult to get RE projects organized and financed, and even where a project is established, the connection rate to grid is low.

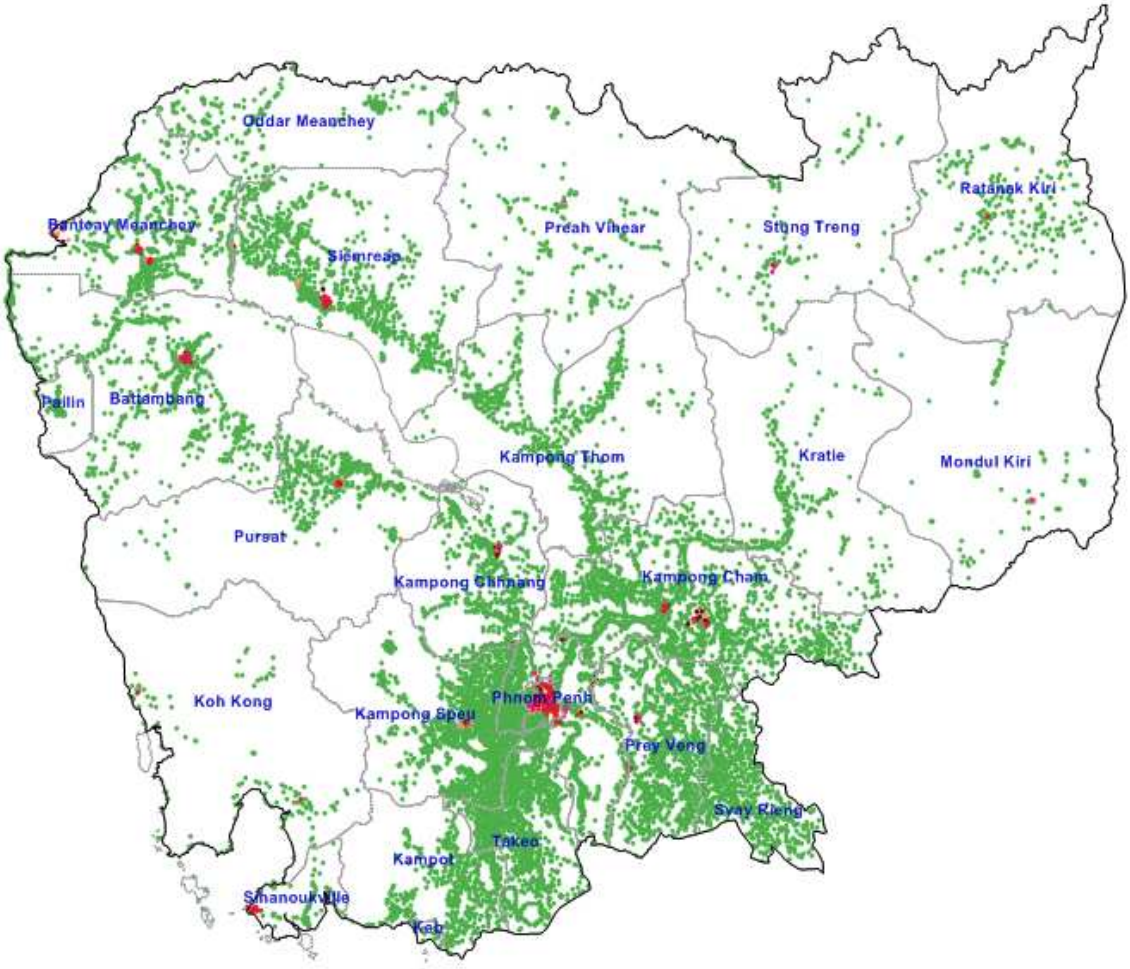


Figure 6 : Spatial distribution of electrified situation by villages in Cambodia 2005 (green are villages without electricity, red and orange are villages with total or partial access to electricity)
Source: Seila, elaborated by this study.

The RGC recognizes that private sector can play a key role in achieving the rural electrification target of 70% in 2030. With the enactment of Electricity Law and establishment of regulator in power sector, the RGC has laid the path for the expansion of private provision of rural electricity services in Cambodia. The RGC will continue with its ongoing reforms to remove impediments to the private sector and establish a legal environment that is friendly to entrepreneurs. The RGC will take further number of steps to strengthen the private sector and the environment that it works in. These include:

- to strengthen political stability, peace, security and social order through out the country;
- to create a Rural Electrification Fund to provide subsidies in support of rural electrification;

- to make the Electricity Authority of Cambodia(EAC) fully operational (already in operation since September 2001);
- to develop the legal and regulatory framework;
- to improve tax administration; and
- commercial reforms.

The implementation of Cambodia Rural Electrification Strategy i.e. achieving the overall rural electrification goal of 70% by 2030 will be a very major undertaking. The Royal Government of Cambodia would like to seek the support of French Government, ADB and other donors both in technical and financial terms for the successful implementation of the RE strategy. The government of Cambodia encourages the Private Sector Participation with concrete policies such as:

- The Rural Electrification Fund (REF) is to be the principle instrument to facilitate financial support and technical assistance to expand electricity supplies in rural and remote communities and ensure the poor benefit from rural electrification programs
- Strong public and private partnerships shall be developed to implement rural programs/projects
- Rural Entrepreneurs, NGOs and woman's groups shall be encouraged to participate in the management at the local level

REF program main features:

- Credit from the World Bank to RGC with Low Interest Rate
- Grant from Global Environmental Facility (a World Bank source)
- Counterpart money from RGC
- Future funding may include funds from other sources and/or countries.
- For the 1st year the subsidies are as follows:
  - Diesel REEs – US$ 45 per new Household Connected
  - Solar Home System: US$ 100/set of 40 Wp
  - Mini and Micro Hydro – US$ 400/kW Capacity

Type of Electrification	No. of Candidate Villages	No. of h.h. to be electrified by year 2020	Total Cost	Total Cost per h.h.	Fund Source of Capital Costs		
			($1,000)	($/h.h.)	Subsidy	Equity	Loan
Electrified as of 2005	2,062	(350,345)	-	-	-	-	-
Newly Electrified by Grid	6,411	**600,000**	**280,140**	467	70,035	42,021	168,084
MHP/Hybrid	137	9,000	11,064	1,229	5,532	1,106	4,426
Biomass	3,071	168,000	99,498	592	24,875	14,925	59,699
Diesel	392	23,000	9,760	424	2,440	2,440	4,880
Sub-total of Mini-grid	**3,600**	**200,000**	**120,322**	**602**	**32,847**	**18,471**	**69,004**
Solar BCS	1,720	60,000	21,045	351	19,993	1,052	0
SHS(World Bank)		12,000	5,520	460	1,380	1,380	2,760
Sub-total of off-grid area	5,320	**272,000**	**146,887**	540	54,219	20,903	71,764
Village data unknown	121	-	-	-	-	-	-
Total	13,914	**872,000**	**427,027**	490	124,254	62,924	239,848

Figure 7 : Rural electrification plan and financing requirements

Comments

- *Rural electrification options for Lao PDR and Cambodia consist of grid extension, isolated mall grid, off-grid. They have to be in good coordination in order to avoid overlap planning, particularly in mid-terms. It happen some time that the off-grid PV systems in remote villages are replaced by a grid extension after only one or two years of installation;*
- *They need to develop a detailed master plan of rural electrification which should be realistic, suitable with financing recourses and supported by concerned stakeholders (local population and authorities). Current practice in power development planning can be summarized as follows:*
    - *Set objective and target in top-down approach (on the basis of a vision)*
    - *Develop programmes of action*
    - *Implement the programmes at national and local levels*
    - *Monitor, evaluate and reports.*

  It should be emphasized that the process of review and readjustment of the objectives and targets as necessary is not well integrated into the planning process;
- *At present, the private sector participation is very limited in rural electrification development, due to uncertainty over mid and long terms planning of the grid and lack of financial incentives.*
- *There is a planning barrier for rural electrification, particularly for decentralized energy options :*
    - *Continuing preoccupation with oil substitutions & fuel substitutions, so the TOP-DOWN approach is prevailed*
    - *Lack of attention to socio-environment costs leads to weakens attractiveness of DEO in cost comparison with other options*
    - *Low quality and unavailability of data which leads to tendency to sideline rural energy system from bottom-up models*
    - *Poor coordination within energy & with other sectors (infrastructure, education, health…)*

Table : Comparative features of energy sector between two countries

Features	***Cambodia***	***Lao PDR***
Power systems	*Many isolated diesel-generation, Mostly Diesel generation*	*4 Supply areas, few isolate, off-grids Only Hydro generation*
HH Access to electricity	*17% has access to electricity*	*54% has access to electricity*
Main actors	*MIME, EAC, EDC, REF, REE*	*MEM (DOE/RED), EDL, LNCE, Donors*
Rural electrification activities	*Many activities, projects Strong commitments of the government to rural electrification by off-grid*	*Few big activities (off-grid) Strong commitment of the government to the rural electrification by off-grid and grid.*
Components of rural electrification programme	*1. Diesels, 2. Grid extension, 3. Mini-grid*	*1. Grid extention 2. PV, 3. Minihydro,*
Principal donors	*WB, ADB, JICA*	*WB, ADB, JICA, GTZ*
Private Energy Service structure in rural areas	*600-800 REEs (most are non-licensed, some have license)*	*6 PESCOs There will be 0-15 in next few year*
Electricity tariff	*0,5$-1,2$/kWh*	*0,1-0,3$/kWh*
Off-grid components	*Widely use battery*	*Widely use PV kits*

- *Poverty and rural impacts: The positive impacts of rural electrification have been presented many times in other deliverables. However, few aspects have to be considered:*

- *Electrification provides the potential and necessary basis for the development, but not automatically generates them. Having electricity gives the opportunity of developing the alternative economic activities, but is not sufficient for developing it.*
- *The poorest of the population is the one which is least likely to benefit fully from such a development.*
- *Consequently, rural electrification planning should be integrated in a more comprehensive rural development program, and should be targeted at the poorest segment of the population.*

In planning practice, the rural electrification options are being considered as follows:

- *Main grid extension for rural electrification is being done by utilities (EDL or EDC) to supply electricity to the most of provincial, district and village centers.*
- *Diesel generation, mini or small hydropower plants have been used to supply electricity to provincial and district town level through isolated mini grids, owned by Utilities and/or local authorities, rural electrification enterprises.*
- *Small villages or small clusters of villages are powered by micro or small diesel units*
- *Few PV systems have been installed to supply electricity to remote clinics, local center, schools, and individual households. It is more developed in Lao PDR*
- *Few pico hydro systems have been used in Northern provinces.*

The planning approach to rural electrification has following features:

- *Utilities continue planning the main grid extension for rural electrification.*
- *Utilities have priority for electrification at villages that the households have higher potential in terms of willingness to pay and connect to the grid.*
- *Small grid and off-grid have to be done by local authorities (provincial & district) with the assistance from Rural electrification division (MEM) or EAC.*
- *Off-grid electrification will be done directly to villages that could not be covered under national grid or under isolated grid of local authorities*

4. Local stakeholder involvement

(Waiting for ETC report from local stakeholder interviews to complete this part. It should be very short 2-3 pages)