Proven, Clean & Efficient Biomass, Coal, Gas Cogeneration

The EC - ASEAN Business Facilitator

National Energy Policy Review

Cambodia

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Proven, Clean & Efficient Biomass, Coal, Gas Cogeneration

The objective of COGEN 3 is to promote the use of proven, clean and efficient cogeneration using biomass, coal or gas as fuel. This is achieved through partnership between ASEAN industries and European equipment suppliers.

The programme is co-ordinated in ASEAN by the Asian Institute of Technology (AIT), Bangkok, Thailand and in Europe by Carl Bro International, Sweden. COGEN 3 started its operation in January 2002 and will continue until December 2004.

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List of Abbreviations

ADB	Asian Development Bank
APA	Angkor Prosperous Agriculture
APIP	Agriculture Productivity Improvement Project
AUSAID	Australian Aid
BOT	Build-Operate Transfer
CARERE	Cambodian Area Rehabilitation and Regeneration Project
CCGT	Combined Cycle Gas Turbine
CDC	Council for the Development of Cambodia
CISS	Comprehensive Import Supervision Scheme
DGHP	Direction Generale des Heveas
DO	Distillate Oil
EAC	Electricity Authority of Cambodia
EDC	Electricite du Cambodge
EDC/ SME	Small and Medium Enterprise
FCRMA	Federation of Cambodian Rice Millers Associations
FONDEM	Fondation Energies pour le Monde
GDP	Gross Domestic Product
GWh	Gigawatt-hour
HECEC	The Tasmanian Hydro-electric Commission Enterprise Corporation.
HFO	Heavy Fuel Oil
IFC	International Finance Corporation
IPP	Independent Power Producer
KHR	Cambodian Riel
KGC	Kampong Cham
LDO	Light Distillate Oil
LPG	Liquefied Petroleum Gas
MIME	Ministry of Industry, Mines and Energy
MEF	Ministry of Economy and Finance
MPDF	Mekong Project Development Facility
NEDO	New Energy and Industrial Technology Development Organisation
NGO	non-government organisations
PHN	Phnom Penh
PRV	Prey Veang
PSD	Private Sector Development
PSI	Pre-Shipment Inspection
RGC	Royal Government of Cambodia
REE	Rural Energy Enterprise

RET	Renewable Energy Technologies
REAP	Renewable Electricity Action Plan
SEDPII	The Second Socioeconomic Development Plan 2001-2005
SHS	Solar Home System
SEA	Solar Energy Application
SHV CC	Sihanoukville Combined Cycle
SIDA	Swedish International Development Cooperation Agency
SME	Small and Medium Enterprise
SPP	Small Power Producer
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund

List of Energy Units

BOE	Barrel of Oil Equivalent
kcal/kg	kilo Calories per Kilogram
MT	Mega tonnes
MW	Mega Watt
TSCF	trillion standard cubic feet
MWh	Megawatt-hour
kV	kilo Volt
kWh	kiloWatt-hour

Executive Summary

This report is a review of the energy policies and legislations of Cambodia. In retrospective of these policies, the Royal Government of Cambodia is making policies compliant to address energy conditions like adequate supply of energy throughout Cambodia at reasonable and affordable prices, to ensure reliable and secure electricity supply, to encourage exploration and development of energy resources and to promote energy efficiency programs.

The major sources of energy are biomass and petroleum products. There are no specific policies yet to promote cogeneration in Cambodia, though certain energy conservation programs and promotion of renewable energy resources especially biomass-based fuels are making an indirect contribution towards promoting cogeneration. Cogeneration is being recognised as one of the best Renewable Energy Technologies. Through reliance on external assistance like ADB, EC-ASEAN COGEN 3 Programme and SIDA, cogeneration and efficient generation of electricity utilising abundantly available biomass in Cambodia are being considered seriously now.

The energy situation in Cambodia constitutes very low conventional energy consumption as compared to other developing countries in the world. The per capita energy consumption is about 48kWh per annum which is one of the lowest in the Asian region. Only 12% of the households have access to electricity and more than 80% of the population use kerosene lanterns to provide the evening lights as most of the rural population of Cambodia do not have any form of electricity supply available to them. The total installed capacity of electricity is 150 MW, of this 100 MW are in Phnom Penh.

The energy office under the Department of Energy Development is responsible for making energy policy and planning. This department prepares the strategies to achieve the goal and mission of the Ministry. The Directorate of Energy is responsible for three departments, namely: Energy Development Department, Technical Energy Department and Hydropower Department. The Ministry of Industry, Mines and Energy is responsible for the Directorate of Energy, Directorate of Industry and Directorate of Mines and Geology.

Electricity was introduced into Cambodia at the beginning of last century under the French colonial administration. The present state owned electric utility, Electricité du Cambodge (EDC), was established in 1958, when the government purchased concession rights from the three private producers. Most of EDC’s infrastructure, like those of the rest of the country, were destroyed or severely damaged during the civil wars preceding and following the Khmer rouge years, and under the Khmer Rouge regime itself. In 1992, EDP was attached to the Ministry of Industry, Mines and Energy (MIME). Renamed EDC in 1993, the utility solely served the Phnom Penh area, while production and transmission in the provinces were controlled by provincial authorities with budgetary support from MIME. In 1996, EDC came into limelight again as the RGC re-established it as a state-owned limited liability company responsible for the generation, transmission and distribution of electric power throughout Cambodia. The Ministry of Mines and Energy, and the Ministry of Economy and Finance (MOF) are co-owners of EDC

1. Introduction

The Cambodian economy is growing at a steady rate of 5% over the last few years now (1999 - 2003). In the meantime, Cambodia remains one of the poorest countries in the world. With only 12% of households having access to electricity, Cambodia has one of the lowest energy consumption per capita in the world. Cambodia has no exploited fossil fuel resources. Cambodia is a net importer of fuels. The existing domestic markets for electricity are extremely small and mainly concentrated in Phnom Penh and a few other provincial towns.

Table 1.1: Economic Figures – compared to other ASEAN countries

Countries	Purchasing power parity (PPP) $	Real GDP Growth %		Per Capita PPP $	GDP per Sector		
		2003	2004		Agriculture %	Industry %	Services %
Cambodia	**18 billion**	**5.0**	**5.5**	**1500**	**50**	**15**	**35**
Indonesia	663 billion	3.5	4.0	3100	17	41	42
Malaysia	210 billion	4.2	5.1	9300	12	40	48
Philippines	356 billion	4.0	4.5	4200	15	31	54
Singapore	105 billion	2.2	4.2	24000	Negl	33	67
Thailand	429 billion	5.2	5.5	6900	11	40	49
Vietnam	168 billion	6.9	7.1	2100	25	35	40

Source: Asian Development Bank and World Bank Yearly Report for Year 2002

Only about 7-10 percent of the rural population (85% of the total people) has access to lighting services through diesel generators and batteries. Small sized generation units, dependence on oil-based generation and large distribution losses render the unit cost of electricity in Cambodia very high, 25 to 50 cents per kWh (US $). Further, these operations are conducted in unregulated highly unsafe conditions. Kerosene is extensively used for lighting in rural areas.

The power sector was severely damaged by war and neglected in the period from 1975 until 1995. It is in a process of recovery supported by multilateral and bilateral agencies[1]. The energy sector development policy adopted in 1994 by the Royal Government of Cambodia has the following objectives (MIME 1999):

- to provide an adequate supply of energy throughout Cambodia at a reasonable and affordable price
- to ensure a reliable, secure electricity supply at prices that facilitate investment in Cambodia and development of the national economy
- to encourage exploration and environmentally and socially acceptable development of energy resources needed for supply to all sectors of the economy and
- to encourage efficient use of energy and to minimise detrimental environmental effects resulting from energy supply and use.

[1] Cambodia Royal Government's "Second Five Year Socioeconomic Development Plan (SEDPII), 2001-2005, July 2002"

2. General Overview of the Energy Sector[2]

According to the World Development Index (World Bank, 1998), Cambodia uses relatively little commercial energy per person: 44 kg of oil equivalent per capita for 1994. Cambodia imports 100% of the required petroleum products from countries in the region. Petroleum products are the main source of commercial energy for power generation, industry, transport, and the residential and commercial sectors. Petroleum products imported into Cambodia for 1994 were estimated to be 415.67 kt, of which 2.5% was lubricant. The main petroleum products used in the country are LPG, gasoline, diesel oil, fuel oil, kerosene and jet fuel. The consumption of petroleum products for each sector are: 107.6 kt for power generation (27%), 2.12 kt for industry, 262.25 kt for transport (65%), 26.2 kt for residential sector, 8.56 kt for commercial sector, and 8.89 kt for other non-energy use.

The Primary Energy Consumption:

The 1998 national population census reported that, 80% of the national energy consumption is met by the use of biomass fuels, while the balance is covered by imported fossil fuels (MIME 2001).

Table 2.1: National Energy Consumption by Sector

Type of Fuel	1995		2000	
	Terajoules (TJ)	Percent	Terajoules (TJ)	Percent
Households	86,224	83.8	90,106	80.6
Service Sector	1,625	1.6	1,414	1.3
Industry	512	0.5	868	0.8
Transport	14,832	14.4	19,337	17.3
Total	102,848	100	111,728	100

2.1 Energy Statistics and Data

The potential supply volume and the latent demand for electricity for Phnom Penh and Cambodia are shown in the table below. The potential supply volume is based on EDC's plan.

Table 2.2: The Latent Demand (Total Sales) for Electrical Power in Cambodia, MW[3]

	2000	2001	2002	2003	2004	2005	2010	2015
City Power	429.79	481.26	534.06	592.23	656.31	724.61	1,159.11	1,737.66
Private Power Generation	161.66	175.35	188.83	203.39	219.15	236.18	336.68	466.22
Batteries (Pattern 1)	59.12	59.94	60.70	61.42	62.09	62.71	64.96	65.44
Batteries (Pattern 2)	15.17	21.44	27.96	34.73	41.75	49.01	88.83	136.80
Total	665.74	738.00	811.55	891.76	979.30	1,072.52	1,649.59	2,406.13
Latent Demand	**803.50**	**873.4**	**943.7**	**1,019.9**	**1102.7**	**1,190.0**	**1,719.4**	**2,406.1**
Potential Supply	**412**	**589**	**679**	**679**	**959**	**1,239**	**1,239**	**2,036**

[2] Figures based on available recorded statistics, Asia-Pacific in Figures, 2002, UNESCAP and Cambodia Energy Use Survey Report Summary by Meritec Ltd, http://www.recambodia.org/reportsreap.htm

[3] New and Industrial Technology Development Organisation (NEDO), "Assistance Project for the Establishment of an Energy Master Plan for the Kingdom of Cambodia", July 2002, page 112

2.2 Electricity Supply Industry

2.2.1 Current electricity situation:

Only 12% of Cambodian households have access to electricity. There is no national grid, except 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, which was put into operation in late May 2002. Power supply is available through small isolated systems using diesel generators with medium and low voltage distribution systems, and, as a result, the price of power is the highest in the region. The total installed capacity of the country is about 150 MW, of this 100 MW are in Phnom Penh. Per capita consumption is only about 48 kWh per annum. Annual growth of power demand is forecasted at 12%.

Breakdown of the installed capacity on the basis of fuel used

The country is served by 22 small isolated power systems. These systems can be divided into two parts:

1) Phnom Penh and six big provincial towns served by Electricité du Cambodge (EDC), a state-owned limited liability company, and
2) The remainder of the country is under the responsibility of the Ministry of Industry, Mines and Energy (MIME) or served by private companies under contract with MIME.

Table 2.3: Generation of Electricity by Type of Power Plant and Their Efficiencies

Name of Plant	Fuel	Number x P_{inst} MW	$P_{available,}$ MW	Efficiency	Status
CUPL	HFO	7 x 5	3	37.87%	IPP
Jupiter	Diesel	10 x 1.5	15	38.65%	IPP
C2	HFO	3 x 6	10	22.01%	EDC
C3	HFO	3 x 6	3.6	31.95%	EDC
C5	Diesel	2 x 5	10	39.01%	EDC
C6	HFO	3 x 6.2	17	37.64%	EDC
Kirirom	Hydro	2 x 6	12	100%	IPP
Total		**124**	**110**		

There is one small hydropower plant, O Chum II, in Ratanakiri province with a capacity of 1 MW. The generation data were given as 1,145 MWh in 1994 and 1,450 MWh in 1995.

Cambodia has a high hydropower potential for electricity generation and/or for irrigation. As of this date, due to decades of war, electricity from hydropower sources is still very insignificant.

Power is generated by using Diesel 47%, and Heavy Fuel Oil (HFO) 53%. There is one hydropower plant (Kirirom) with an installed capacity of 12 MW. In EDC, there are 4 existing IPPs, 2 in Phnom Penh, 1 in Kampong Cham using diesel and 1 in Battambang using diesel. There are several SPPs under the control of MIME.

If the 90 MW Sihanoukville CCGT starts up in 2004 or 2005 as planned, Phnom Penh's electricity needs will be met. However, although the feasibility study has been completed, it is unlikely that the plant will be commissioned until 2007.

Solar energy for decentralised utilisation in remote rural zones has been developing over the last few years. However, its development remains limited due to high investment costs.

2.2.2 Electricité du Cambodge

Electricity was introduced into Cambodia at the beginning of last century under the French colonial administration (EDC, 1999). Power generation was divided between three different electric utilities:

(1) Compagnie des Eaux et d'Electricité (CEE) covered the Phnom Penh area;
(2) Compagnie Franco-Khmer d'Electricité (CFKE) operating in Battambang Province, ricebowl of Cambodia and then largest province (Battambang was divided into smaller provinces by the present government);
(3) Union d'Electricité d'Indochine (UNEDI) serving all other provinces of Cambodia.

The present state owned electric utility, Electricité du Cambodge (EDC), was established in 1958, when the government purchased concession rights from the three private producers. At this stage, it is important to note the influence of the colonial legacy on the culture and operating procedures of EDC, which closely reflects those of Electricité de France (EDF), the French national electric utility. The links between the two companies continue to the present day through technical assistance and cooperation projects to help rebuild Cambodia's generation and transmission facilities (De Lopez, Praing & Toch, 2003).

Most of EDC's infrastructure, like those of the rest of the country, were destroyed or severely damaged during the civil wars preceding and following the Khmer rouge years, and under the Khmer Rouge regime itself. Between 1991 and 1992, EDC was briefly renamed Electricité de Phnom Penh (EDP), and its control transferred to the capital's municipality. In 1992, EDP was attached to the Ministry of Industry, Mines and Energy (MIME). Renamed EDC in 1993, the utility solely served the Phnom Penh area, while production and transmission in the provinces were controlled by provincial authorities with budgetary support from MIME.

In 1996, EDC came into limelight again as the RGC re-established it as a state-owned limited liability company responsible for the generation, transmission and distribution of electric power throughout Cambodia. The Ministry of Mines and Energy, and the Ministry of Economy and Finance (MEF) are co-owners of EDC. The seven members of the board of EDC's board of directors comprise: a chairperson representing MIME, a representative of MEF, a representative of the Ministry of Justice, the managing director of EDC, a representative of EDC's workforce, and two representatives of the business community.

Authorised functions of Electricité du Cambodge (EDC, 1999)

1. The generation of electricity for the purpose of satisfying the needs of consumers
2. The generation of electricity for purposes of export to neighbouring countries and to important electric power from such countries
3. The construction and operation of a national transmission network to ensure the reliable delivery of electric power
4. The construction and operation of subsidiary networks for the distribution of electric power and the coordination of connections and operation of EDC and other distribution networks
5. The sale of electricity and associated services
6. The acquisition, transfer and exchange of electric power
7. All legal acts necessary to achieve its commercial and corporate objectives

EDC currently operates in four separate locations: the capital city (PHN), and the three provincial capitals of Sihanoukville, Siem Reap and Kompong Cham. EDC's coverage is limited to the provincial capitals, and does not extend to the rest of the province itself. (Please note: In Cambodia, the provinces and their capitals usually have the same names.)

The following table summarises EDC's characteristics with regards to installed capacity and energy generation. In Phnom Penh, EDC has some 100,000 customers.

Table 2.4: Summary of EDC's Coverage and Operations 1998-2000.

1998					
Coverage Area*	**PHN**	**SHV**	**SRP**	**KGC**	**Total**
Installed Capacity (MW)	77.80	10.56	2.96	3.30	94.62
Yearly Energy Generation (GWh)	341.53	11.50	10.02	4.40	367.45
1999					
Coverage Area	**PHN**	**SHV**	**SRP**	**KGC**	**Total**
Installed Capacity (MW)	98.20	10.00	4.40	2.03	212.84
Yearly Energy Generation (GWh)	358.22	13.96	9.46	5.13	386.77
2000					
Coverage Area	**PHN**	**SHV**	**SRP**	**KGC**	**Total**
Installed Capacity (MW)	112.00	10.00	4.40	2.03	128.43
Yearly Energy Generation (GWh)	379.99	15.90	12.18	5.39	413.46

Source: 2000 Corporate Planning and Project Department Planning, MIS and Tariff Office, Electricite du Cambodge

2.3 Power Sector Priorities

2.3.1 Rural Electricity Enterprises (REE)

The only study available on Rural Electric Enterprises (REE) in Cambodia was conducted by Small and Medium Enterprise Cambodia (SME), a local NGO which received funding from the World Bank (SME, 2001). A group of 67 REEs in two provinces were surveyed as part of SME's efforts to form a business association. There is currently an estimated 600 REEs in Cambodia, serving 60,000 customers. The group surveyed represents an installed capacity of 8 MW for some 13,000 customers.

Exclusion from the government's Power Transmission Master Plan and Rural Electrification Strategy (World Bank and HECEC, 1998) is a recurring theme in discussions with rural electricity entrepreneurs. In October 2001, MIME sent through its provincial department branches a letter to the REEs interviewed warning that: (1) REEs should not expand their businesses beyond the service territory limit of their licenses, and (2) MIME and its provincial departments will not be responsible for losses from the extension of the national grid. Furthermore, REEs report that MIME is discouraging equipment upgrades and has imposed restrictions on electrical production and distribution equipment. In essence, this is a call for market liberalisation where REEs and EDC can compete on a level playing field, and which would allow consumers to choose their electricity suppliers.

2.3.2 Rural Electrification Strategy

Parallel to the development of a national grid, the government has adopted a rural electrification strategy, based in large parts on the World Bank funded transmission and electrification master plan (EDC, 1999; MIME, 1999).
The rural electrification strategy recommended by the master plan is based on a number of factors which are presented as below:

Selection Criteria for Rural Electrification Strategy

- Population, population density and population growth
- Income distribution (consumers ability to pay)
- Consumers willingness to pay
- Remoteness from nearest available source
- Closeness of other rural villages (average separation between villages)
- Present arrangement of supply

* Please note: PHN, SHV, SRP and KGC represent Phonm Penh, Sihanoukville, Siem Reap and Kompong Cham.

- Load density and growth
- Special considerations, such as indigenous resources or existing industry
- Preferred policy selected according to least cost development

2.3.3 Second Five Year Socioeconomic Development Plan (SEDPII), 2001-2005:

The primary strategic requirement in the power sector during the "Second Five Year Socioeconomic Development Plan (SEDPII), 2001-2005" is to identify and develop alternative, lower-cost sources of energy. The Electricite du Cambodge (EDC), the state-owned electric utility, will undertake the following initiatives:

- conversion where feasible of the Phnom Penh diesel plants to heavy fuel oil
- rehabilitation of the 12 MW hydropower plant in Kampong Speu province and of the 115 kV transmission line to supply Kampong Speu and Phnom Penh
- implementation of the agreement to establish the High Voltage 220 kV interconnection with Vietnam to supply Phnom Penh
- investigation of lower voltage cross-border transmission lines to supply towns close to the Thai and Vietnam borders
- and investigation of a 115 kV transmission line from Thailand to supply Serey Sophon in Banteay Meanchey province, with possible later extension to Siem Reap and Battambang.

2.3.4 The Cambodian Power Sector Strategy

The specific objectives as identified by the Cambodian Government for the power sector are:

- to re-establish an adequate supply of electricity nationwide through direct support of donors and private participation in generation
- to strengthen sector managerial and implementation capability
- to create the environment required for sustained and efficient development of the power sector, open to competition and private participation and
- to extend power sector objectives to rural areas.

Under Sector Reform measures

- Electricité Du Cambodge (EDC) a wholly state-owned limited liability utility generates transmits and distributes electricity throughout Cambodia.
- The newly created, "Electricity Authority of Cambodia" has responsibilities for the issue of licenses to electrical utilities for generation, transmission and distribution and to create favourable, conditions for capital investments in and the commercial operation of the electric power industry.

Objectives of the Cambodian Power Sector Strategy

Cambodia faces a major challenge to develop an adequate and reliable source of electric power in the years ahead. Based on intensive studies of the best means of providing a national electricity supply network, the Royal Government has developed a long-term power sector strategy for Cambodia to meet the growing demand for electric power over the next 20 years. The strategy establishes the sector's policy and action plans for:

- Investment in the power sector,
- Priorities for generation and transmission,
- Establishment of the power sector's Regulatory Framework,
- Commercialisation of EDC,
- Private sector participation,
- Provincial and Rural Electrification.

Investment Strategy in the Power Sector

The huge growth in power supply and infrastructure requirements is not affordable by the Cambodian Government. Hence the Royal Government has decided to encourage and create the conditions to attract private sector investment in the power industry. The objectives of private sector investment are:

- to speed-up the rehabilitation of power sector,
- to mobilise capital that may not be available from multilateral lending agencies.
- to reduce the public sector debt,
- to increase the efficiency of existing power utilities through increased competition and transfer of technology and skill.

The Cambodian Government will also continue to seek financial assistance from multilateral and bilateral lending agencies for energy infrastructure development to be undertaken by state-owned corporations. Such borrowings will most likely be for electricity transmission and distribution, hydro-electricity generation, and also provincial and rural electrification.

2.4 Tax structure and Fuel Tariff / Prices

The tax structure:

The Cambodian government has eliminated most non-tariff barriers to trade. Customs duties range from 7 to 35%. Value Added Tax (VAT) is 10%.On Customs valuation, Cambodia signed an agreement in August 2000 with the Societe Generale de Surveillance (SGS) to resume pre-shipment inspection starting from October 2000 under a Comprehensive Import Supervision Scheme (CISS) program. Under the scheme, importers will have to pay an intervention fee for PSI service prior to application for bulk petroleum products. The charge schedule for petroleum products is a fee of 30 US cents per metric ton, or as declared in the exporter's final or proforma invoice and indicated in the report of findings. A minimum fee of US$210 per intervention will be applied if the *ad-valorem* rate or the tonnage rate would produce a lesser amount.

A number of tax measures were implemented by the Ministry of Economy and Finance (MEF) from 1999 to 2000 to enhance revenue collection and strengthen fiscal governance, including broadening the revenue base by introducing the VAT and extending the VAT coverage; expanding the coverage of the real regime to five provinces (Sihanoukville, Battambang, Siem Reap, Kompong Cham, and Koh Kong); and an excise tax on gasoline and diesel.

The Electricity Tariff:

Electricity tariff is the cheapest in Phnom Penh where equipment is relatively modern, system loss is limited, spare parts are available and fuel can easily be supplied. The residential sector represents the bulk of customers, with more than 60% of sales, including sales to wholesalers that re-sell electricity to residential customers. Sales to government agencies and ministries represent about 15% of total sales, which approximates sales to the industrial, commercial and hotel sectors (14%). A large number of businesses, such as hotels and textile plants operate their own diesel generators to ensure the continuity of their operations.

In Phnom Penh, the usual tariff is 350 Riel per kilowatt-hour (or less than 9 cents) for residential customers, and up to 12 cents for the commercial, industrial and service sectors.

The tariff is fixed in Riel which means that a rise in the value of the US dollar, currency in which fuel supplies are purchased, has a direct impact on EDC's finances. The main reason explaining the loss made by EDC is the accumulation of unpaid receivables and debts incurred by government customers. These receivables represent more than four months of the company's revenues.

2.5 The energy forecast - Generation and Transmission Master Plan

Under a World Bank financed technical assistance project, a power transmission master plan and rural electrification strategy was developed by a private sector consultancy firm for the Ministry of Industry, Mines and Energy (World Bank and HECEC, 1998). The master plan covers load forecast, transmission development, and argues strongly in favour of hydropower schemes. The main findings of the project are summarised hereafter.

Table 2.5: Energy Demand in Million Gigajoules

Sector	1994	%	2000	%	2010	%	2020	%	2030	%
Household	79.475	86.4	90.106	80.6	113.979	71.7	142.118	61.4	166.287	48.0
Industry	0.522	0.6	0.868	0.8	2.254	1.4	4.866	2.1	14.711	4.2
Service	0.918	1.0	1.418	1.3	3.183	2.0	7.816	3.4	20.056	5.8
Transport	11.072	12.0	19.337	17.3	39.453	24.8	76.694	33.1	145.288	41.9
Sum	**91.987**	**100.0**	**111.728**	**100.0**	**158.869**	**100.0**	**231.494**	**100.0**	**346.342**	**100.0**

Source: adapted from World Bank and HECEC, 1998 and EDC, 1999 by De Lopez, Praing & Toch 2003

The load forecast (1998 to 2016) is based on market segmentation of end users and essentially relies on the World Bank's GDP forecast for Cambodia. Other key drivers include population growth, electrification ratio, income elasticity and price elasticity. The forecasts are presented in the following table. These correspond to an annual increase of 12.0% and 9.4%, for respectively peak demand and electrical energy production forecast.

Table 2.6: Energy Generation and Forecast up to 2016.

Year	1999	2000	2001	2002	2003	2004	2006	2008	2010	2012	2014	2016
Generation output (MW)												
Total	114	129	142	152	243	273	331	404	477	558	651	746
PHN only	98	112	112	122	151	170	207	256	304	356	418	484
Electrical energy production (GWh)												
Total	387	415	478	956	947	1,035	1,215	1,454	1,700	1,968	2,292	2,634
PHN only	358	380	427	658	632	695	820	994	1,168	1,355	1,584	1,829

Source: Adapted from World Bank and HECEC, 1998 and EDC, 1999 by De Lopez, Praing & Toch 2003

The master plan further examines three main strategies to meet forecasted demand of electricity: (1) isolated option, (2) transmission option and (3) trade option. The three options are defined as follows:

- The isolated option: Development of Phnom Penh and provincial generating capacity with no tie capacity between load centres or with neighbouring countries.
- The Transmission option: Enhancement of Phnom Penh capacity and strategic development of generating capacity in regional areas couple with the development of a national grid.
- The Trade option: As above but with the development of a transmission capability between Cambodia and adjoining countries (Vietnam and Thailand), to allow a development of large size hydro-power stations."

In the *isolated option case*, load increase is met through the construction of combined cycle gas turbines alone, while in the other two scenarios combined gas turbines only provide early additional capacity, while hydroelectric stations provide capacity increases in subsequent years. In the trade option, Electricité du Cambodge is assumed to be able to earn revenues from the export of electricity generated by Cambodian hydroelectric plants. The net present value of the trade scenario appears substantially larger than that of other scenarios.

Table 2.7: Economic Implications of Three Power Sector Development Strategies

Strategy	Net Present Value (US $million)	Economic Internal Rate of Return (percent)
Isolated	-131	-3.7
Transmission	59	15.0
Trade	85	16.4

Source: World Bank and HECEC, 1998

Table 2.8: Power and Transmission Development Schedule

Project	Status and Financing
2001 Private developers to establish a 60 MW generating plant in Phnom Penh with a commissioning date of May 2001	Financial constraints, Financing by Cambodian Power Company (Private Sector from USA)
2002 Rehabilitation and construction of Kirirom (12 MW)	Kirirom currently operating under Build Operate and Transfer (BOT) agreement for 30 years. Financing by CETIC, private company from China
2004-2005 Initial development of the western grid with connection from Thailand and Vietnam.	Joint venture between EGCO and EDC (67% & 33%), PPA Signed on 2 July 2002 Co-financing loan from WB/ADB, Signed MOU with MIME on 27 October 2002
2008 Develop a 90MW x 2 units plant in Sihanoukville	Feasibility study completed in early 2002, expected generation in 2008 Looking for investors
2010 Commissioning of 24 MW Battambang 1 hydro station	Preliminary study stage Looking for investors
2011 Commissioning of 36 MW Battambang 2 hydro station	Preliminary study stage Looking for investors
2012 Commissioning of 110 MW Stung Atay hydro station	Desk study Looking for investors

Sources: Asian Development Bank TA 2241-CAM, October 1996, *Strengthening the Institutional and Legal Framework for the Energy and Minerals Sectors Project*. Final Report.

Table 2.9: National Energy Demand from 1994 to 2010 (TJ)

Type of Fuel	1994	2000	2005	2010
Wood	77,721	89,616	103,552	106,344
Charcoal	1,097	1,213	1,367	1,357
Other biomass	1,754	1,600	1,559	1,351
LPG	103	421	729	1,050
Gasoline	6,006	10,765	15,288	20,284
Kerosene	1,323	1,678	2,081	2,430
Jet fuel	725	881	1,125	1,435
Diesel oil	4,580	7,521	10,539	14,783
Fuel oil	65	102	158	249
Electricity	777	1,308	2,066	2,962
Total	**94,151**	**115,105**	**138,464**	**152,245**

Source: Adapted from World Bank and HECEC, 1998 by De Lopez, Praing & Toch 2003

2.6 Key Players in the Cogeneration Market

Cogeneration is a new concept in Cambodia, and presently there are no existing national strategy and policies governing cogeneration. The EC-ASEAN COGEN 3 Programme is co-ordinating activities related to business identification, cogeneration potential assessment especially using biomass as fuel and also facilitating matchmaking between Cambodian industries and European equipment suppliers.

Model power purchase contract

Licenses/permits are required for implementing biomass, coal and natural gas-based cogeneration plants. The Ministry of Industry, Mines & Energy (MIME), particularly its Directorate of Energy-MIME, is responsible for **Concession Licensing**, which sets up territorial limits for the project. For small projects below and up to 125 kVA, MIME provincial/municipality authority can deliver this concession license. For projects above 125 kVA, developers must submit their request to MIME at Phnom Penh.

The ***Standard and Efficiency Office*** of the Technical Energy Department, Ministry of Industry, Mines, and Energy (MIME,) is responsible for promoting practice of energy efficiency in factories, enterprises, buildings and households.

The key license for eligible projects is the investment license issued by the **Council for the Development of Cambodia (CDC).** The Electricity Authority of Cambodia (EAC) issues the regulations and licenses to electric power services and to review the cost and approve the tariff.

3. Energy Sector Legislation Framework

Table 3.1: The Policy Making Institutions Responsible For Energy Related Activities In Cambodia.

<table>
<tr><th colspan="4">THE ENERGY SECTOR</th></tr>
<tr><th colspan="2">The Policy Maker</th><th colspan="2">The economic and technical regulatory functions related activities.</th></tr>
<tr><td>Institution</td><td>Area of Jurisdiction</td><td>Institution</td><td>Area of Jurisdiction</td></tr>
<tr><td>Ministry of Industry, Mines and Energy (MIME)</td><td>The MIME was established in 1993. The Ministry has the duty to set and administer: Energy Policies, Electric Power Strategies, Power Development Plan, technical, safety and environmental standard and other duties in the power sector.</td><td>Electricity Authority of Cambodia (EAC).</td><td>The EAC was established by the “Electricity Law of the Kingdom of Cambodia”, which was promulgated on February 2, 2001. The EAC’s role is to: a) issue the regulations and licenses to electric power services; b) review the cost and approve the tariff; c) resolve disputes; d) control and impose penalty.</td></tr>
<tr><th colspan="4">THE ENVIRONMENT SECTOR</th></tr>
<tr><th colspan="4">The Policy Maker</th></tr>
<tr><td colspan="2">Institution</td><td colspan="2">Area of Jurisdiction</td></tr>
<tr><td colspan="2">Ministry of Environment (MOE)</td><td colspan="2">The MOE is responsible for the Law on Environmental Impact Assessment (EIA). EIAs must be performed by independent third parties for all existing industrial activities, including energy projects.</td></tr>
<tr><th colspan="4">THE INDUSTRY SECTOR</th></tr>
<tr><th colspan="4">The Policy Maker</th></tr>
<tr><td colspan="2">Institution</td><td colspan="2">Area of Jurisdiction</td></tr>
<tr><td colspan="2">Ministry of Industry, Mines and Energy</td><td colspan="2">The MIME was established in 1993. The Ministry has the duty to set and administer: Energy Policies, Electric Power Strategies, Power Development Plan, technical, safety and environmental standard and other duties in the power sector.</td></tr>
</table>

3.1 Liberalisation of the Electricity and Gas Market

Due to the current on-going activities still at a nascent stage in the electricity and gas market of Cambodia, there is no official plan for liberalisation and market reforms.

3.2 Legislation and Programs Promoting Cogeneration

The fact that the cogeneration systems are not present in Cambodia, not much of policy framework has been here. Legislations and policies applicable to Cogeneration come within the scope of legislations and policies as applicable to Energy Efficiency and Renewable Energy.

3.3 Legislation and Programs Promoting Energy Efficiency, Biomass and Renewable Energy (RE)

The Ministry of Industry, Mines and Energy has received support from a variety of donors in the areas of renewable energy and energy efficiency. The Energy Efficiency Office (EEO) was formed in 1997 to establish energy efficiency standards and to disseminate information about energy efficiency. Finally, the Renewable Energy Office (REO) was created in 1999 to prepare development plans on renewable energy, to manage renewable energy projects and to promote the use of renewable energy technologies (De Lopez, Praing & Toch, 2003).

The main donor-funded projects in renewable energy and energy efficiency that have been carried out in cooperation with MIME include the following:

(1) a research and dissemination project in Renewable Energy Technologies (RETs) funded by the Swedish International Cooperation Agency (SIDA)
(2) renewable energy initiatives undertaken by Japan's NEDO,
(3) an energy efficiency project supported by France's Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME).

NEDO has supported several pilot projects to promote renewable energy in Cambodia, including the use of photovoltaic panels for battery charging and water pumping. A total capacity of 3,276 Wp of solar panels and 2,800 Wp of wind turbines have been installed under this project. More significantly, NEDO completed an energy master plan which included an assessment of renewable energy potential in Cambodia (NEDO, 2002).

Promotion of Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement (PREGA) project

PREGA is funded by the Dutch Ministry of Foreign Affairs through the Asian Development Bank. The output of this project is a pre-feasibility study of the rehabilitation of a 30 year old heavy fuel oil power plant, an opportunity and barriers to renewable energy report, and a Cambodian energy sector review. As a result of poor management by the ADB, Cambodia has unilaterally decided to withdraw from PREGA pending a full review of the project by the Dutch Ministry of Foreign Affairs.

COGEN 3

COGEN 3 started its activities in Cambodia in August 2002. COGEN 3 with the assistance of the working team of Cambodia Research Centre for Development has been working on:

- initiation and dissemination of capacity building activities,
- identification of potential cogeneration possibilities,
- assessment of potential cogeneration capacity based on biomass availability in Cambodia,
- facilitation of technical assistance and
- matchmaking between European Equipment suppliers and Cambodian Industries.

SIDA

A total capacity of 1,240 Wp of solar panels was installed in rural areas. However, technical adaptation of photovoltaic systems could not be achieved due to the lack of qualified manpower in Cambodia.

Solar Energy

A Solar Energy Application (SEA) working group was created in 1995 to undertake basic research, identification and dissemination of pilot projects, training of local users and promotion of the wider use of the technology

As of yet, the Renewable Electricity Action Plan (REAP) designed by the World Bank, provides the only development framework for the broader adoption of renewable electricity technologies in Cambodia. The formulation of a national policy for renewable energy is still in its embryonic stage, as most of the efforts of MIME are directed towards the establishment of the Rural Electrification Fund (REF).

SIDA's technical assistance in RETs was part of a two-year regional research and dissemination project. The goal was to promote mature or nearly mature renewable energy technologies in six Asian countries through adaptation to local requirements and conditions. Adaptive research aimed to develop low-cost accessories to meet local needs. The project covered photovoltaic energy, solar drying, biomass briquettes and briquette stoves.

3.4 Legislation and Programs Promoting Natural Gas

Following the conclusion of the 1991 Paris Peace Accord, full-scale surveys of petroleum and natural gas began. As a result, major western industries began geological surveys and as of now at least 3 major oil and gas fields have been unearthed. The existence of a major gas field offshore close to the Thai border has also been ascertained.[4]

Cambodian National Petroleum Authority (CNPA) is to announce a new licensing program is expected before the end of the year 2003 (Cambodian Business Review, March 2003). The final draft was expected to be finalised by the end of 2003.Exploration activities off-shore Cambodia has raised the hopes of commercial production of oil and gas within the next two years. This is because of oil and gas exploration off-shore Cambodia has taken off to a good start with Chevron Texaco completing the drilling process on two exploratory wells.

3.5 Legislation and Programs Promoting Coal

A countrywide survey of coal resource is yet to be conducted. According to the Industrial Production Energy Department (MIME), Stueng Traeng and Preah Vihear in the northern region and Kampong Thum in the central region have a total of 7 million tons of unmined coal. In the offshore of southern Kampot and Koh Kong there is an availability of reserves of bituminous coal.

[4] New and Industrial Technology Development Organisation (NEDO), "Assistance Project for the Establishment of an Energy Master Plan for the Kingdom of Cambodia", July 2002, page 13.

4. Conclusions

Presently, there is no cogeneration plant in Cambodia.

No direct policy and legislation has been in force to promote cogeneration. Cogeneration has only been indirectly supported in the energy efficiency and biomass power measures initiated in connection with the SEDP II.

Regulatory and market barriers to cogeneration

The main hurdles to cogeneration are:

- No national policies for cogeneration to date.
- Current regulations do not recognise the overall energy efficiency of cogeneration (this is no longer true, as Cambodia has ratified the Kyoto Protocol and participating in several CDM initiatives funded by UNEP, the Dutch and Japanese Governments)
- Many facility managers are unaware of technology developments that have expanded the potential for cost-effective cogeneration.

Potential of cogeneration

There are cost-effective opportunities for CHP capacity in Cambodia.

- There are available biomass supplies from the agriculture sector. This needs to be assessed as sources of biomass may be widely dispersed.
- Drilling for natural gas (and petroleum) is ongoing. Once gas is available, there is potential for cogeneration in hotels, hospitals, and buildings, since most of these establishments are presently generating their own electricity.

Recommended next steps

- The EAC should promulgate a national interconnection standard. EAC should also develop guidelines for the purchase of backup and supplemental power service for cogeneration facilities at fair and reasonable terms.
- Incentives should be adopted that enact tax credits to encourage efficient, low-emissions cogeneration systems.
- The EAC should implement interconnection to have access to rules favourable to cogeneration, facilitate sitting and permitting, cost-share cogeneration feasibility studies, and review industrial and commercial as well as residential facilities for cogeneration opportunities.
- The MIME and EAC should support educational and technical assistance efforts by state and regional initiatives to identify and implement cogeneration at appropriate sites.

5. Links and Other Sources of Information

1. www.RECambodia.org - Renewable Energy Action Plan (REAP)

2. ww.cambodiainvestment.gov.kh - Council for Development, provides investment information, forms and access to the Cambodian Investment Board (CIB)

3. www.embassyofcambodia.org.ns/au.htm - a wide variety of economic and cultural information is available from the website of the Cambodian embassy of New Sealand

4. www.nis.gov.kh - The National Institute of Statistics official website provides national economic and statistical data

5. www.eac.gov.kh - Electricity Authority of Cambodia contains licensing information, copies of issued licenses, and up-to-date procedures

6. www.camnet.com.kh/moe -Ministry of Environment

7. www.moc.gov.kh – Ministry of Commerce

8. www.cdc-crdb.gov.kh - Council for the Development of Cambodia

9. Assessing Cambodia's potential for bio-energy – De Lopez, Praing & Toch, 2003.

Annexes

Annex 1: General information

Official Name	Kingdom of Cambodia
Population	12,200,000 (2000)
Territory	181,035 km²
GDP (USD billions)	3 (1999)
GDP Growth	5% (2002)
GDP per capita	295 (2002)
Inflation	3.7 (CPI, 2002)
Unemployment	2.6% (2000)
Currency	Riel (pegged to $US at KR 3,924:US $1)2001
Official Reserves	$US 602 million (2002)
Prime Minister	Hun Sen

Sources: Published in the SEDPII, Data provided by Cambodian authorities and IMF staff projections in "ADB's Third Review Under the Poverty Reduction and Growth Facility" Staff Report, July 2001

Annex 2: Existing and future IPP's in Cambodia

Name of Plant	Fuel	Number x P $_{inst}$ MW	P $_{available,}$ MW	Consum. MBTU/MWh	Efficiency	Status
CUPL	HFO	7 x 5	33	9.01	37.87%	IPP
Jupiter	Diesel	10 x 1.5	15	8.83	38.65%	IPP
C2	HFO	3 x 6	10	15.24	22.01%	EDC
C3 old	Diesel	2 x 2.1	3.6	10.67	31.95%	EDC
C3 new	Diesel	4 x 2.8	10	8.83	38.65%	EDC
5	Diesel	2 x 5	10	8.75	39.01%	EDC
C6	HFO	3 x 6.2	17	9.06	37.64%	EDC
Kirirom	Hydro	2 x 6	12		100%	IPP
Total		**124**	**110**			

The EAC has issued 13 consolidated licenses, 7 generation licenses and 4 distribution licenses.

ANNEX 3: Cogeneration Plant Potential in the Sectors

Biomass

The energy produced per biomass source per state is calculated. Each harvest per season is in the following table. For palm bunch, the figure obtained from the oil palm plantation expansion plan proposal of 10,000 tons per year is used.

Harvest per Season

State	Rice (Ton)			Sugar Cane (Ton)			Maize (Ton)		
	Total	Season		Total	Season		Total	Season	
		Wet	Dry		Wet	Dry		Wet	Dry
Kampong Cham	460,935	367,935	93,000	49,185	37,200	11,985	31,774	30,190	1,584
	464,733	314,230	151,503	25,310	16,080	9,230	15,649	15,304	345
Kampot	308,795	300,820	7,975	23,280	22,000	1,280	2,033	1,970	63
	287,722	272,096	15,626	29,669	26,550	3,119	2,521	2,500	21
Battambang	357,860	355,700	2,160	6,200	5,800	400	47,077	47,000	77
	313,850	308,035	5,815	4,280	3,860	420	193,490	193,306	184

Type of Biomass	LHVw(kJ/kg)(kcal/kg)	MCw(%)	ACd(%)
Bagasse (Sugar cane)	7,700-8,000(1840-1910)	40-60	1.7-3.8
Maize (Cobs,stalks)	13,000-15,000(3100-3580)	10-20	2(cobs), 3-7(stalks)
Rice Husks	14,000 (3340)	9	19
Palm Oil residues			
Fruit stems	5,000(1200)	63	5
Fibers	11,000(2630)	40	
Shells	15,000(3580)	15	

Source: World Bank Technical Paper No. 422, Energy from Biomass
LHV: low heating value
MC: moisture content
w: on a wet basis
AC: ash content
d: on a dry basis
1 kcal = 4.186kJ

It is estimated that, 50% of the total harvest can be used for fuel. The usability per crop is defined as follows:

- rice husks 20% of rice harvest volume
- Bagasse 30% of sugar cane harvest
- Maize Cobs 200% of corn harvest (The material refers to the actual part; the combustible parts are the ears and the stalk, or 2 times the harvest volume)
- Palm fibers 20% of palm harvest (Kampot, Ta Ney Village: 10,000 tons was used as the basis for these figures)

The following is the result of the calculation on the possible calories generated, (gcal)

	Kampong Cham	Kampot	Battambang
Rice Husks	154,137	96,214	104,951
Bagasse	6,982	6,422	1,181
Maize	48,606	7,830	600,980
Palm Fibres		2,628	

1999 and 2000 Crop Production Figures for Rice, Sugar Cane, and Maize

Source: Ministry of Agriculture, Forestry and Fisheries (as published in "Assistance Project for the Establishment of an Energy Master Plan for the Kingdom of Cambodia: NEDO-MIME")

No.	Name of State or City	Population (1998)	RICE Crop Yield Tons		SUGAR CANE Crop Yield Tons		MAIZE Crop Yield Tons	
			1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001
1.	*Phnom Penh	999,804	12,110	12,584	0	0	574	455
2.	Kandal	1,075,125	246,331	239,780	31,695	38,000	38,901	19,311
3.	Kampong Cham	1,608,914	460,935	465,733	49,185	25,310	31,774	15,649
4.	Svay Reng	478,252	266,877	255,307	1,000	900	22	125
5.	PreyVeng	946,042	577,380	461,315	2,205	2,769	3,827	4,085
6.	Ta Keo	790,168	554,890	466,360	3,558	5,484	377	290
7.	Kompong Thom	569,060	153,070	176,547	1,555	1,155	810	587
8.	Siem Reap	696,164	260,404	327,565	7,080	12,063	1,103	1,295
9.	Battambang	793,129	357,860	313,850	6,200	4,280	47,077	193,490
10.	Banteay Meanchey	577,772	243,446	244,391	2,970	2935	12,203	28,545
11.	Pursat	360,445	132,650	154,055	5,500	8,510	870	560
12.	Kampong Chhnang	417,693	154,300	208,529	3,842	4,630	1,561	766
13.	*Suhanoukville	155,690	16,940	16,230	500	0	18	25
14.	*Kep	28,660	4,500	4,669	0	1,150	0	30
15.	Kampot	528,405	308,795	287,722	23,280	29,669	2,033	2,521
16.	Koh Kong	132,106	9,460	10,021	1,800	3,750	0	250
17.	Kompong Speu	598,882	155,388	157,180	1,500	3,370	700	626
18.	Preah Vihear	119,261	21,986	25,226	1,600	258	970	730
19.	Stung Treng	81,074	18,852	27,837	13,252	6,840	1,290	709
20.	Rattanakiri	94,243	22,905	26,195	1,100	4,388	840	663
21.	Mondulkiri	32,407	8,960	11,616	1,080	1,320	230	280
22.	Kratie	263,175	52,861	46,383	957	5,406	4,774	3,705
23.	Oddor Meanchey	68,279	-	84,041	-	1,990	-	320
24.	Pailin	22,906	-	2,956	-	0	-	3,696
25.	Total	11,437,656	4,040,900	4,026,092	159,859	164,177	149,954	278,713

(* City)

ANNEX 4: GMS – Summary of Energy and Demand Forecast (2000 – 2020, base case)

FY	Energy Requirements(GWh)						Total	Annual Growth
	Thailand	Laos	Cambodia	Vietnam	Yunnan	Myanmar		
2000	96,781	865	**586**	26,722	31,635	4,401	160,990	---
2001	103,496	980	**632**	29,813	33,742	4,629	173,292	7.60%
2002	110,945	1,098	**703**	32,911	35,969	4,871	186,497	7.60%
2003	118,540	1,263	**1,007**	36,382	38,343	5,129	200,664	7.60%
2004	126,449	1,392	**1,165**	40,140	40,873	5,403	215,422	7.40%
2005	134,794	1,528	**1,329**	44,230	43,571	5,695	231,147	7.30%
2006	143,748	1,690	**1,521**	48,439	45,923	6,072	247,393	7.00%
2007	152,743	1,869	**1,753**	53,139	48,678	6,478	264,660	7.00%
2008	162,438	2,049	**2,011**	58,772	51,599	6,913	283,782	7.20%
2009	173,532	2,248	**2,244**	65,043	54,695	7,381	305,143	7.50%
2010	184,213	2,468	**2,502**	72,014	57,976	7,883	327,056	7.20%
2011	194,930	2,670	**2,777**	78,800	60,875	8,470	348,522	6.60%
2012	206,660	2,874	**3,033**	85,660	63,919	9,130	371,276	6.50%
2013	219,134	3,075	**3,284**	93,555	67,115	9,787	395,950	6.70%
2014	232,106	3,274	**3,556**	102,064	70,471	10,525	421,996	6.60%
2015	245,948	3,472	**3,848**	111,333	73,994	11,322	449,917	6.60%
2016	260,262	3,668	**4,168**	121,431	76,887	12,184	478,600	6.40%
2017	275,595	3,862	**4,509**	132,508	80,347	13,114	509,935	6.50%
1018	292,180	4,055	**4,880**	143,233	83,962	14,119	542,429	6.40%
2019	309,771	4,247	**5,282**	155,791	87,741	15,204	578,036	6.60%
2020	328,429	4,437	**5,720**	169,428	91,689	16,378	616,081	6.60%