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# ASSESSING CAMBODIA'S POTENTIAL FOR BIO-ENERGY

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## Foreword

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# Contents

<b>LIST OF FIGURES</b> .....	<b>5</b>
<b>LIST OF TABLES</b> .....	<b>6</b>
<b>LIST OF TABLES</b> .....	<b>6</b>
<b>ABBREVIATIONS</b> .....	<b>7</b>
<b>ABBREVIATIONS</b> .....	<b>7</b>
<b>ABSTRACT</b> .....	<b>9</b>
<b>SECTION ONE: SUPPLY AND DEMAND OF ENERGY</b> .....	<b>10</b>
1.1 PRIMARY ENERGY CONSUMPTION .....	10
1.2 ELECTRICITY PRODUCTION.....	10
1.2.1 <i>Electricité du Cambodge (EDC)</i> .....	10
1.2.2 <i>Rural Electricity Enterprises (REE)</i> .....	14
1.3 DISTRIBUTION NETWORK.....	15
1.3.1 <i>Generation and Transmission Master Plan</i> .....	15
1.3.2 <i>Rural Electrification Strategy</i> .....	17
1.4 ENERGY POLICY AND PLANNING .....	19
<b>SECTION TWO: USES OF BIOMASS</b> .....	<b>21</b>
2.1 ASSESSMENT OF BIOMASS RESOURCES AVAILABLE .....	21
2.1.1 <i>Forest Resources</i> .....	21
2.1.2 <i>Agricultural Residues</i> .....	22
2.2 MAIN USES OF BIOMASS .....	22
2.3 RENEWABLE ENERGY POLICY.....	24
2.4 INITIATIVES PROMOTING BIO-ENERGY .....	25
2.5 POTENTIAL BIO-ENERGY PROJECTS .....	27
<b>SECTION THREE: BARRIERS TO THE IMPLEMENTATION OF BIO-ENERGY PROJECTS</b> .....	<b>29</b>
3.1 LIMITED INFORMATION AND LOW LEVEL OF AWARENESS .....	29
3.2 WEAK COORDINATION BETWEEN RELEVANT AGENCIES .....	29
3.3 LACK OF SKILLED PERSONNEL AND TRAINING FACILITIES .....	29
3.4 COMMERCIAL NON-VIABILITY .....	29
3.5 INADEQUATE FINANCING ARRANGEMENTS .....	30
3.6 UNFAVOURABLE IMPORT TAXES AND TARIFF SYSTEM.....	30
<b>SECTION FOUR: CLIMATE CHANGE AND THE CLEAN DEVELOPMENT MECHANISM (CDM)</b> .....	<b>31</b>
4.1 POLLUTION CONTROL LEGISLATION.....	31
4.2 CLIMATE CHANGE POLICY .....	31
4.3 INSTITUTIONAL ARRANGEMENTS FOR CDM PROJECTS.....	33
4.5 SUSTAINABLE DEVELOPMENT INDICATORS FOR CDM EVALUATION.....	33
4.6 CAPACITY BUILDING ACTIVITIES AND CDM.....	34
<b>CONCLUSION</b> .....	<b>36</b>
<b>REFERENCES</b> .....	<b>37</b>
<b>APPENDIX 1: MAIN SOURCE OF COOKING FUELS (NIS 1999)</b> .....	<b>39</b>
<b>APPENDIX 2: MAIN SOURCE OF LIGHT (NIS 1999)</b> .....	<b>40</b>
<b>APPENDIX 3: ELECTRICITY TARIFFS IN PHNOM PENH CHARGED BY ELECTRICITÉ DU CAMBODGE FOR THE PERIOD 1999 - 2003</b> .....	<b>41</b>

<b>APPENDIX 4: ELECTRICITY TARIFFS IN PROVINCIAL CAPITALS CHARGED BY ELECTRICITÉ DU CAMBODGE FOR THE PERIOD 1999 – 2003.....</b>	<b>42</b>
<b>APPENDIX 5: OUTCOME MATRIX – SECOND SOCIOECONOMIC DEVELOPMENT PLAN 2001- 2005 (ADAPTED FROM RGC 2002).....</b>	<b>43</b>

## List of Figures

FIGURE 1 STRUCTURE OF CAMBODIA'S POWER SECTOR (NISHIKAWA 2001).....	12
FIGURE 2 ENERGY CONSUMPTION BY SECTORS IN PHNOM PENH (EDC 2001).....	13
FIGURE 3 PROJECTED LAYOUT OF CAMBODIA'S DISTRIBUTION NETWORK (WORLD BANK AND HECEC 1998).....	17
FIGURE 4 JAPAN'S NEDO HYBRID SOLAR PHOTOVOLTAICS AND BIOGAS PROJECT .....	24
FIGURE 5 PROPOSED STRUCTURE FOR THE RURAL ELECTRIFICATION FUND (WORLD BANK 2002) .....	26
FIGURE 6 PROPOSED INSTRUMENTS FOR THE RURAL ELECTRIFICATION FUND (WORLD BANK 2002).....	27

## List of Tables

TABLE 1 NATIONAL ENERGY CONSUMPTION BY SECTOR.....	10
TABLE 2 AUTHORISED FUNCTIONS OF ELECTRICITÉ DU CAMBODGE (EDC 1999).....	11
TABLE 3 SUMMARY OF EDC'S COVERAGE AND OPERATIONS FOR YEARS 1998, 1999 AND 2000 (EDC 2001) .....	12
TABLE 4 CAMBODIA'S ACHIEVED (TO 2002) AND FORECASTED GENERATION OUTPUT AND ELECTRICAL ENERGY PRODUCTION (ADAPTED FROM WORLD BANK AND HECEC 1998 AND EDC 1999).....	15
TABLE 5 ECONOMIC IMPLICATIONS OF THREE POWER SECTOR DEVELOPMENT STRATEGIES (WORLD BANK AND HECEC 1998).....	16
TABLE 6 SELECTION CRITERIA FOR RURAL ELECTRIFICATION STRATEGY (ADAPTED FROM WORLD BANK AND HECEC 1998).....	18
TABLE 7 POWER AND TRANSMISSION DEVELOPMENT SCHEDULE (ADAPTED FROM MIME 2002).....	19
TABLE 8 NATIONAL ENERGY CONSUMPTION BY TYPE OF FUEL (MIME 1997).....	21
TABLE 9 RENEWABLE ELECTRIFICATION 10-YEAR TARGETS OF THE RENEWABLE ELECTRICITY ACTION PLAN (WORLD BANK 2002).....	25
TABLE 10 GUIDING PRINCIPLES OF THE RENEWABLE ELECTRICITY ACTION PLAN (WORLD BANK 2002).....	25
TABLE 11 ROLES OF THE RURAL AND RENEWABLE ELECTRIFICATION FUND (REF) (ADAPTED FROM WORLD BANK 2002) .....	26
TABLE 12 INVESTMENTS IN RENEWABLE ELECTRICITY SUPPORTED BY THE RENEWABLE ELECTRIFICATION FUND (REF) (ADAPTED FROM WORLD BANK 2002).....	26
TABLE 13 SUMMARY OF CAMBODIA'S 1994 GREENHOUSE GAS INVENTORY (Gg) (ADAPTED FROM MOE 2002). 32	
TABLE 14 PROJECTION OF GREENHOUSE GAS EMISSIONS AND REMOVALS BY SECTOR (Gg) (ADAPTED FROM MOE 2002) .....	32

## Abbreviations

### Technical terms

CCEAP	Climate Change Enabling Activity Project
CDM	Clean Development Mechanism
CHP	Combined Heat and Power
EIA	Environmental Impact Assessment
FSDP	Full Scale Demonstration Project
GDP	Gross Domestic Product
Gg	Gigagram
GAP	Governance Action Plan
GNP	Gross National Product
GWh	Gigawatt-hour
ha	Hectare
kg	Kilogram
km	Kilometre
km <sup>2</sup>	Square Kilometre
kWh	Kilowatt-hour
LEAP	Long-range Energy Alternatives Planning System
LULUCF	Land Use, Land Use Change and Forestry
m	Meter
m <sup>3</sup>	Cubic Meter
m/s	Meter per Second
MW	Megawatt
NEAP	National Environmental Action Plan
PV	Photovoltaic
REAP	Renewable Electricity Action Plan
W	Watt

### Institutions and Organisations

ADB	Asian Development Bank
CCCCO	Cambodian Climate Change Office
CDRI	Cambodia Development Research Institute
CEE	Compagnies des Eaux et d'Electricité
CFKE	Compagnie Franco-Khmer d'Electricité
CFSB	Cambodia Fuelwood Saving Project
CRCD	Cambodian Research Centre for Development
EAC	Electricity Authority of Cambodia
EDC	Electricité Du Cambodge
EDP	Electricité de Phnom Penh
FAO	Food and Agriculture Organization
IDA	International Development Association
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
JICA	Japanese International Cooperation Agency
KGC	Kompong Cham
MAFF	Ministry of Agriculture, Forestry and Fisheries
MIME	Ministry of Industry, Mines and Energy
MOE	Ministry of Environment
MOF	Ministry of Economy and Finance
MOP	Ministry of Planning
NEDO	New Energy and Industrial Technology Development Organization
PEU	Provincial Electricity Unit
PHN	Phnom Penh
NGO	Non Governmental Organisation
NIS	National Institute of Statistics
RGC	Royal Government of Cambodia

REE	Rural Electricity Enterprise
REB	Rural Electrification Board
RE	Rural Energy
REF	Rural and Renewable Electricity Fund
SEDP	Socio-Economic Development Plans
SHV	Sihanoukville
SME	Small and Medium Enterprise Cambodia
SSN	Southsouthnorth
UN	United Nations
UNDP	United Nations Development Program
UNFCC	United Nations Framework Convention on Climate Change
UNEDI	Union d'Electricité d'Indochine
WWF	Wildlife Fund for Nature
WB	World Bank



## **Abstract**

The present desk study aims to provide an overview of the potential for bio-energy projects in Cambodia. The first section discusses the supply and demand characteristics of the Cambodian energy sector, the generation and distribution of electricity, and the energy policy and planning framework. The second section reviews biomass resources and uses, available bio-energy technologies, and existing bio-energy projects. The third section discusses opportunities and barriers to the successful implementation of bio-energy projects in Cambodia. The fourth section discusses the latest developments with regards to the Clean Development Mechanism in Cambodia.

The study concludes that the technical potential for the use of bio-energy technologies in Cambodia is high. Some 80% of Cambodia's total energy consumption is covered by biomass sources. Yet, the use of bio-energy has been limited to pilot projects and other small-scale applications. Further research is needed to assess technical feasibility in the field, as well as the economic and social potentials for the adoption of bio-energy technologies. Cambodia's institutions are poised for the approval of projects eligible under the Clean Development Mechanism, which would provide an additional financial incentive for project developers.

Poverty reduction remains the principal objective of any adoption of bio-energy technology. Thus, applications and services that use energy productively to improve the livelihoods of people ought to be favoured. Bio-energy technologies will be adopted in Cambodia if they present direct benefits for the poor and contribute to national sustainable development objectives.

## Section One: Supply and Demand of Energy

### 1.1 Primary energy consumption

The 1998 national population census reported that less than 15% of the population had access to electricity (NIS 1999). Cambodia has the highest cost of electricity in Southeast Asia and the lowest level of consumption (ADB 2000a). It is estimated that some 80% of the national energy consumption is met by the use of biomass fuel, while the balance is covered by imported fossil fuels (MIME 2001). The share of biomass fuels has decreased from some 85% of total energy consumption in 1995, suggesting that fossil fuels have gradually taken up a larger place as an energy source in Cambodia. Households represent about 84% of the total energy consumption, followed by the transport sector with 14%. Services and industries only account for some 2% of Cambodia's energy consumption.

**Table 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	1,418	1.3
Industry	512	0.5	868	0.8
Transport	14,832	14.4	19,337	17.3
<b>Total</b>	<b>102,848</b>	<b>100</b>	<b>111,728</b>	<b>100</b>

Source: MIME (1997, 1999, 2001)

The main source of cooking fuel is firewood (90% of all households), followed by charcoal (5.3%), kerosene (1.8%) and liquefied petroleum gas (1.7%). The proportion of households using firewood for cooking is much lower in the capital city (40.5% for firewood and 34.4% for charcoal) than in the provinces. The main source of light for some 80% of households is kerosene. This proportion falls to 17.5% in Phnom Penh, where 43.1% of households have access to the city's grid. In some provinces, such as Prey Veng and Kandal, battery charging is also used to provide electricity with respectively 6.2% and 8.9% of households. Statistical tables for sources of cooking fuel and light are provided as appendices to this report (Appendices 1 and 2).

### 1.2 Electricity production

#### 1.2.1 Electricité du Cambodge (EDC)

Electricity was introduced in 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) operated in Battambang Province, the ricebowl of Cambodia; (3) Union d'Electricité d'Indochine (UNEDI) served 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. EDC's organisational culture and operating procedures closely reflected those of Electricité de France (EDF), the French national electric utility. The links between the two

companies persist to the present day through technical assistance and cooperation projects to help rebuild Cambodia's generation and transmission facilities.

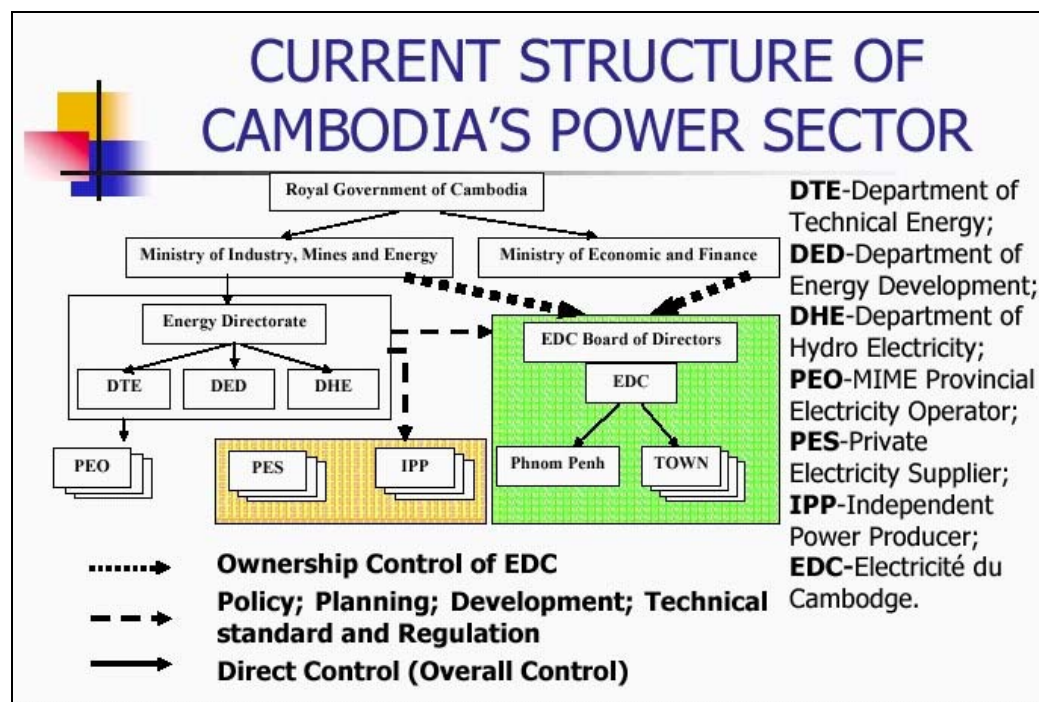
Most of EDC's infrastructures, like those of the rest of the country, were destroyed or severely damaged during the civil wars preceding and following the Khmer rouge years, and under the Khmer Rouge regime itself. Between 1991 and 1992, EDC was briefly renamed Electricité de Phnom Penh (EDP), and its 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 provincial authorities controlled production and transmission in the provinces with budgetary support from MIME.

In 1996, EDC came full circle, as the Royal Government of Cambodia (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. The seven members 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.

**Table 2** Authorised functions of Electricité du Cambodge (EDC 1999)

- |  |
|--|
| <ol style="list-style-type: none"><li>1. The generation of electricity for the purpose of satisfying the needs of consumers</li><li>2. The generation of electricity for purposes of export to neighbouring countries and the importation of electric power from such countries</li><li>3. The construction and operation of a national transmission network to ensure the reliable delivery of electric power</li><li>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</li><li>5. The sale of electricity and associated services</li><li>6. The acquisition, transfer and exchange of electric power</li><li>7. All legal acts necessary to achieve its commercial and corporate objectives</li><li>8. The rehabilitation of electricity in the provinces</li><li>9. Cooperation with neighbouring countries and ASEAN with respect to the ASEAN interconnection system</li><li>10. Respect of the Electricity Law promulgated by the Government of Cambodia and enforced by the Electricity Authority of Cambodia (EAC)</li></ol> |
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**Figure 1** Structure of Cambodia's power sector (Nishikawa 2001)

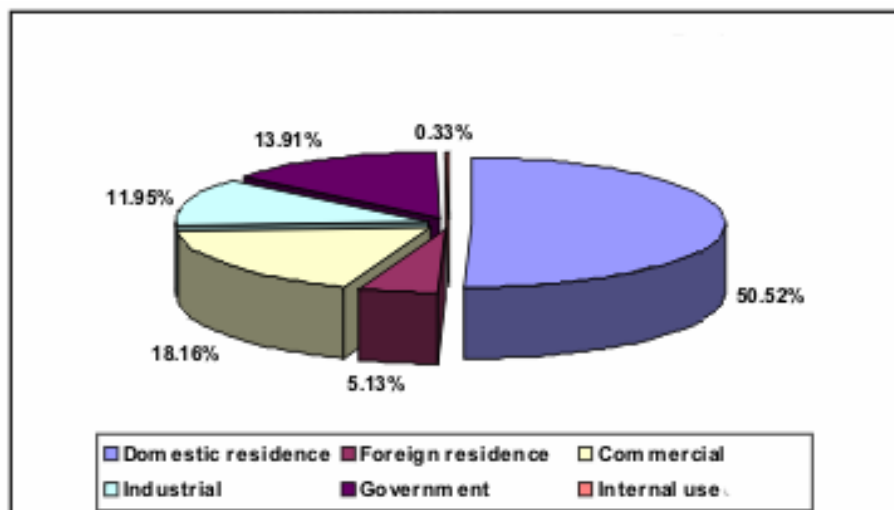


EDC currently operates in four separate locations: the capital city (PHN), and the three provincial capitals of Sihanoukville, Siem Reap and Kompong Cham. EDC's coverage is limited to the provincial capitals, and does not extend to the rest of the province itself. A point that may be matter for confusion is that provincial capitals usually bear the same names as provinces. Table 3 summarises EDC's characteristics with regards to installed capacity and energy generation. In Phnom Penh, EDC has some 100,000 customers.

**Table 3** Summary of EDC's coverage and operations for years 1998, 1999 and 2000 (EDC 2001)

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

**Figure 2** Energy consumption by sectors in Phnom Penh (EDC 2001)



EDC's operational capacity has been gradually upgraded over the past few years. At the same time, its management and corporate culture have undergone drastic changes since 1996 when it was re-established as a legal entity. Following a global pattern of liberalisation of energy markets and privatisation of public utilities, EDC is slowly making progress towards the longer term objective of becoming a competitively run electric utility. Corporate jargon and processes are being introduced, which is reflected in the company's mission statement:

“We are committed to providing an adequate quality and stable supply of electrical services to our current and future customers at competitive prices and operate our business with efficiency and excellence.”

The challenges ahead can be summed up by the fact that EDC's financial losses exceed \$2 million per year for its Phnom Penh operations alone. The electricity tariff differs between cities and between types of customers. It is cheapest in Phnom Penh where equipment is relatively more modern, system loss is limited, spare parts are available and fuel can be easily 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. Appendices 3 and 4 provide a complete schedule of EDC's tariffs nationwide.

The main reason explaining the losses 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. To make matters worse, all government agencies, including EDC may purchase their fuel from Sokimex, the only local private oil company that grants EDC supplies on loan at 10% interest rate. All other companies, because of uncertainties regarding EDC's ability to pay for its supplies, usually require stricter

financing conditions, such as cash payment. EDC is in a weak position when confronting other government agencies and its primary supplier of fuel.

These observations suggest that institutional reforms in the power sector may be required if this sector is to provide support to the broader social and economic development of the country. The World Bank's Cambodia power sector strategy recommends that EDC be granted a consolidated license for generation, transmission and distribution only for a clearly defined period (World Bank 1999). Options to improve sector efficiency include allowing new Independent Power Producers to sign contract directly with large consumers. The World Bank further argues that the poor performance of EDC stems from the government's political interference in its operations:

“A complex issue is the Government's inability to separate its role as policy maker, owner and customer of EDC. This problem is manifested in eventual political interference on EDC's operations, and most important, in the blurring of lines between the finances of EDC and the Government budget which tends to distort EDC's incentives and accountability.”

### **1.2.2 Rural Electricity Enterprises (REE)**

One of the few studies 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. It appears that the main concern of these REEs are:

“real and perceived threats from government agencies, foreign competitors, and multilateral organizations that have not included the REEs in their rural electrification planning.”

Exclusion from the government's Power Transmission Master Plan and Rural Electrification Strategy (World Bank and HECEC 1998) is a theme recurring 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.

SME has argued for a model electrification of Cambodia:

“that offers a broad set of participants, including communities themselves, a louder voice in the decision-making process and a model that encourages rapid, dynamic and organic growth of the industry.”

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.

The Asian Development Bank has more broadly appraised the existing methods for supplying electricity in eight Cambodian provinces (ADB & NRECA 2002). The appraisal concludes that electricity within the provinces is restricted to small independent power generators who haphazardly provide electric services “ranging from somewhat reliable to totally inadequate”. Local private power suppliers share a common set of problems, which

include: little or no safety, lack of discipline in construction and maintenance, high system losses, and poor billing and collection practises. The report further criticises “the prevailing viewpoint that electricity is a commodity to be sold to create wealth for the owners”, which limits electric service to a few highly profitable areas at the expense of more economically depressed areas.

### 1.3 Distribution Network

#### 1.3.1 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 document is widely quoted in the literature and in presentations by government officials (EDC 1999; MIME 1999). 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 Table 4. These correspond to an annual increase of 12.0% and 9.4%, for respectively peak demand and electrical energy production forecast.

**Table 4** Cambodia’s achieved (to 2002) and forecasted generation output and electrical energy production (Adapted from World Bank and HECEC 1998 and EDC 1999)

Year	1999	2000	2001	2002	2003	2004	2006	2008	2010	2012	2014	2016
<b>Generation output (MW)</b>												
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
<b>Electrical energy production (GWh)</b>												
Total	387	415	478	956	947	1035	1215	1454	1700	1968	2292	2634
PHN only	358	380	427	658	632	695	820	994	1168	1355	1584	1829

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* 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. These plants, for which feasibility studies have yet to be undertaken, are scheduled to enter service from 2008 onwards in the *trade* scenario. The net present value of the *trade* scenario appears substantially larger than that of other scenarios.

**Table 5** Economic implications of three power sector development strategies (World Bank and HECEC 1998)

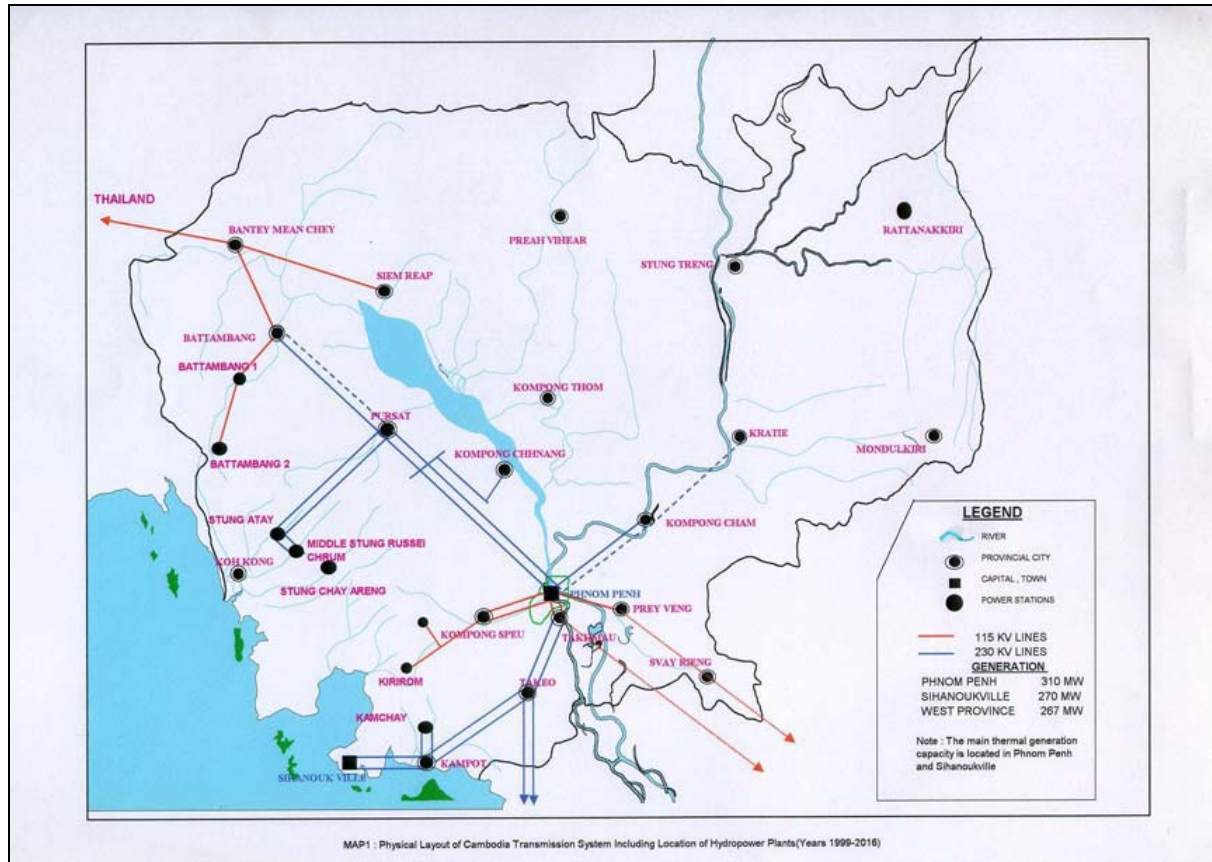
Strategy	Net Present Value (US \$million)	Economic Internal Rate of Return (percent)
Isolated	-131	-3.7
Transmission	59	15.0
Trade	85	16.4

The plan assumes that large hydroelectricity stations from 76 MW to 350 MW may be constructed, despite the fact that there exists much uncertainty as to whether these schemes are environmentally and socially acceptable. An additional critique of the construction of a national grid was expressed by the Association of Rural Electricity Enterprises, underlined the lack of concern for the economic and social repercussions of the plan on small entrepreneurs and existing local grids (SME 2001).

Despite these reservations, the master plan seems to have been accepted by the government with relatively little public debate. The Cambodia power sector strategy for the period 1999 to 2016 is by and large a face value adoption of the recommendations made by the World Bank funded consultancy firm (MIME 1999). In the first phase, a transmission line from the Vietnamese border to Phnom Penh will be built, while the second phase will consist of the construction of a transmission line from Thailand to Siem Ream (Angkor Wat), through the agriculturally rich northern provinces of Cambodia. The southern grid is expected to become operational by 2007. However, the current political deadlock in Cambodia, may prevent the disbursement of loans from multilateral agencies, further delaying the projects.



**Figure 3** Projected layout of Cambodia's distribution network (World Bank and HECEC 1998)



### 1.3.2 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 Ministry of Industry is convinced that:

“Electricity is very important for the improvement of living standards, and an important infrastructure requirement for agricultural and small-scale industrial development in rural areas.”

As has been discussed earlier, one of the recurrent themes in the government's power sector strategy is a neo-classical approach to public utilities which essentially focuses on “private sector participation”, “private sector led development”, and “partnership with the private sector”. This parallels current efforts to turn EDC into a profitable entity with a customer oriented corporate culture. The argument is that growth in power supply and infrastructure requirements is “not affordable” by the government. As for the matter of rural electrification, however, the government acknowledges that the rates of return are too low to be attractive to private participation. The RGC will therefore attempt to seek soft loans and grants to meet the estimated US \$10 million per year required for rural electrification over a ten-year period. The rural electrification strategy recommended by the master plan is based on a number of criteria which are presented in Table 6.

**Table 6** Selection criteria for rural electrification strategy (Adapted from World Bank and HECEC 1998)

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

An interesting initiative recommended by the master plan would warrant further investigation by government agencies. This calls for the establishment of self-managed rural electrification cooperatives at the village level, which would in theory be able to complement the general top down approach of the master plan. MIME and EDC are to provide technical and management support to these cooperatives, and to facilitate their access to investment credit. The Asian Development Bank has similarly suggested a strategy for management of provincial power supplies for Cambodia based on local, cooperatively-owned, electric systems or Electric Membership Corporations (EMCs) (ADB & NRECA 2002). Experience shows that cooperatives provide better electric service to rural areas than private operators do. EMCs are democratically controlled and owned by consumers. Their goal is to provide electricity as a social service rather than as a commodity. Thus, the study argues that an effective approach to rural electrification is “to view electric service as a means to affluence and development of the entire community”.

**Table 7** Power and transmission development schedule (Adapted from MIME 2002)

<b>Project</b>	<b>Status and Financing</b>
<b>2001</b> 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) From 2000 to 2003, Jupiter, a private Canadian IPP has operated a 15 MW station with private financing in temporary replacement of this project From 2004, Eclipse Energy, an Australian IPP will operate a 15 MW stations with private financing in temporary replacement of this project
<b>2002</b> Rehabilitation and construction of Kirirom (12 MW)	Kirirom currently operating under Build Transfer Operate (BOOT) agreement for 30 years. Financing by CETIC, private company from China
<b>2003-2004</b> Initial development of the western section of the planned national grid with connection from Thailand.	Joint venture between EGCO (Electricity Generation Public Company Ltd) and EDC (67% & 33%), PPA Signed on 2 July 2002 Co-financing loan from WB/ADB, Signed MOU with MIME on 27 October 2002
<b>2003</b> Initial development of the eastern section of the planned national grid with connection from Vietnam.	Delayed to 2005 / 2006. Financing from World Bank and Asian Development Bank
<b>2008</b> Develop a 90MW x 2 units plant in Sihanoukville	Feasibility study completed in early 2002, expected generation in 2008 Looking for investors
<b>2010</b> Commissioning of 24 MW Battambang 1 hydro station	Preliminary study stage Looking for investors
<b>2011</b> Commissioning of 36 MW Battambang 2 hydro station	Preliminary study stage Looking for investors
<b>2012</b> Commissioning of 110 MW Stung Atay hydro station	Desk study Looking for investors

## 1.4 Energy policy and planning

The Electricity Law of the Kingdom of Cambodia was promulgated by Royal Decree on 2 February 2001. It set forth the principles that govern the operations of the electric power industry and the activities of licensees that provide electric power services, including:

“ The principles for: (i) the protection of the rights of consumers to receive the reliable and adequate supply of electric power services at reasonable cost, (ii) the promotion of private ownership on the facilities for providing electric power services, and (iii) the establishment of competition wherever feasible within the electric power sector.” (Article 2)

The Electricity Law also establishes a regulating body for electric power services, the Electricity Authority of Cambodia (EAC). Under Article 5 of the law, each power service supplier is required to have a license issued by EAC. The Electricity Authority of Cambodia is:

“The Electricity Authority of Cambodia is a legal public entity, being granted the right from the Royal Government to be an autonomous agency to regulate the electricity

services and to govern the relation between the delivery, receiving and use of electricity.”  
(Article 6)

The duties of EAC include the issuance, revision, suspension, revocation or denial of licenses for the supply of electricity services. EAC approves tariff rates, except where those rates are “established pursuant to a competitive market-based process.” The law also gives EAC the duty of ensuring that the provision of services is performed in a “transparent manner” and that the public be informed about affairs within its duties.

Article 29 lists eight different types of licenses: (1) generation license, (2) transmission license, (3) dispatch license, (4) distribution license, (5) bulk sale license, (6) retail license, (7) subcontract license, (8) consolidate license. A subcontract licensee operates according to the subcontract agreement with an existing licensee. A consolidate license is a combination of some or all of the licenses stated in the Electricity Law.

To enforce the law, EAC is declared competent to file complaints in the courts of the Kingdom of Cambodia. EAC may also impose monetary penalties, sanctions and fines as stipulated under the Electricity Law (Articles 64 to 70).

In summary, the Electricity Law consists of a broad regulatory framework for electric power services and supply throughout the country. The law establishes an independent enforcement agency, the Electricity Authority of Cambodia. The letter of the law is clear: EAC must promote competition in the power services sector in order to protect the interest of the public against monopolistic suppliers. Thus, the law describes a broad range of power service licenses where private sector participation may be encouraged.

## Section Two: Uses of Biomass

### 2.1 Assessment of biomass resources available

#### 2.1.1 Forest Resources

Wood accounts for more than 80% of total national energy consumption (MIME 1997). Fuelwood is by far the main source of energy available to the general population, but plays an even greater role for the poor and rural people. Yet, the main source of fuelwood in Cambodia, natural forests, has been severely degraded under the pressure of uncontrolled logging over the past twenty years.

**Table 8** National energy consumption by type of fuel (MIME 1997)

Type of Fuel	1996	
	Tons	Percent
Wood	5,621,035	85.51
Other biomass	113,300	1.72
Petroleum Product	419,475	6.38
Fuel oil	50,553	0.77
Diesel oil	183,431	2.79
Kerosene	25,015	0.38
Kerosene Jet fuel	10,748	0.16
Motor Gasoline	145,983	2.22
LPG	3,745	0.06
<b>Total</b>	<b>6,573,285</b>	<b>100</b>

The most reliable assessment of Cambodia's forests was produced with satellite imagery in 1993. The forest cover was then estimated at 9.1 million ha or 62% of the total land area. Between 1973 and 1993, the country had lost 1.4 million ha of forests (Thung, 1994). Currently available forest cover estimates are at best misleading. In 1994, the newly elected Royal Government of Cambodia (RGC) decided to institute a system of private concessions that granted logging rights to private companies. Cambodia was facing mounting international pressure to control deforestation and to exploit its forests resources in a sustainable manner. However, the process through which concessions were granted was largely opaque and consisted in direct negotiations between senior officials and private companies (IDA 1998). Graft pervades the system of concessions and trade controls and has drawn criticism from the international community (Asian Development Bank 2000b, Global Witness 2002, World Bank 1996). Actual levels of harvesting have been up to 5 times higher than the suggested annual allowable cut of 500,000 m<sup>3</sup>. A log monitoring project funded by the International Development Association (IDA) reports actual harvest at 4 million m<sup>3</sup> of timber in 1997 (IDA 1998). The Asian Development Bank has performed the latest sector-wide assessment of forestry in Cambodia. Half of the concession area has no commercial timber value left. The report criticizes concessionaires for "the appalling quality of the current managing plans". Unless a major reorganisation of the concession system is undertaken, Cambodia forest resources will be totally mined within the next three years (ADB 2000).

Rural communities' consumption of forests products, timber in particular, is significant. The rapid growth of the population will add to the already excessive demands put on Cambodia's forests. The era of commercially profitable logging is with little doubt coming to an end. Foreign timber concessionaires are gradually moving out of Cambodia, following a trend well studied in other Asia Pacific countries (Dauvergne 2001, Ross 2001). Were the

RGC to bring about a successful reform of the forestry sector, the sustainable exploitation of remaining forest resources would be uncertain, even for the sole purpose of gathering fuelwood and other non-timber forest products. Degraded forest ecosystems in Cambodia may be far less productive in environmental products and services, and under threat from increased population pressure.

### **2.1.2 Agricultural Residues**

Japan's New Energy and Industrial Technology Development Organization (NEDO) has conducted an assessment of the potential for using biomass as an energy source in Cambodia. The analysis starts with an examination of crops currently produced in different provinces of the Kingdom. Rice, sugar cane and maize are the only three crops that are grown nationally and of which residues can be used to produce energy. The annual production for year 2001 was 4.04 million tons for rice, 0.16 million tons for sugar cane and 0.10 for white maize (0.34 when red maize is included, however growing red maize for livestock feed is a more recent phenomenon) (MAFF 2002). These figures mask large disparities among production regions. Out of 24 provinces, only three exceed an annual rice production of 400,000 tons. For sugar cane, three provinces produce more than 20,000 tons per year. These figures imply that rice and sugar cane production is broadly dispersed among different provinces. In contrast, the production of maize is more concentrated, with most of the crop harvested in Battambang Province. The problem of transporting biomass residues to energy production facilities would be further compounded by the generally poor condition of the provincial road network. Thus a barrier to the use of biomass to produce energy is the availability of sufficient quantities of crop residues at specific locations.

The NEDO report identifies Kompong Cham province as the region with the highest potential for biomass energy resources. The annual production for rice, sugar cane and maize were for year 2000 respectively 465,733 tons, 25,310 tons and 15,649. Proximity to the capital and the existence of adequate roads and waterways makes the area "ideal for the construction of a power generating facility fuelled by biomass energy" (NEDO 2002).

A parallel initiative, funded by the European Commission, is the COGEN 3 project for the promotion of cogeneration or combined heat and power (CHP) technologies among ASEAN member countries. COGEN 3 acts as a business facilitator and aims to develop Full Scale Demonstration Projects (FSDP) through the provision of a grant of 15% of the cost of purchase of cogeneration equipment from EU-based suppliers (COGEN 2002). Although several provinces have been identified as having potential for using rice husk for power production, the main obstacle is the availability of residues in sufficient quantities to allow for economies of scale and the construction of a financially viable facility. Existing rice-mills, operated by independent rural entrepreneurs, use rudimentary technology and have limited processing capacity, e.g. 2 to 3 tons of rice per hour (SME 2000). This implies that rice husk will generally need to be collected from different mills to a central heat and power production plant. A study funded by COGEN 3 and conducted by CRCDC (De Lopez and others 2003) has identified clusters of rice mills in Battambang and Banteay Meanchey provinces where risk husk might be available in sufficient quantities for cogeneration plants of 1 MW capacity and less. However, the authors of the study cautioned that more research was needed to identify competing uses of rice husk, in particular for household cooking, and for cottage industries.

## **2.2 Main uses of biomass**

There is little or no quantitative data available as to the main uses of biomass. As discussed earlier fuelwood is used essentially for household cooking, in combination with all

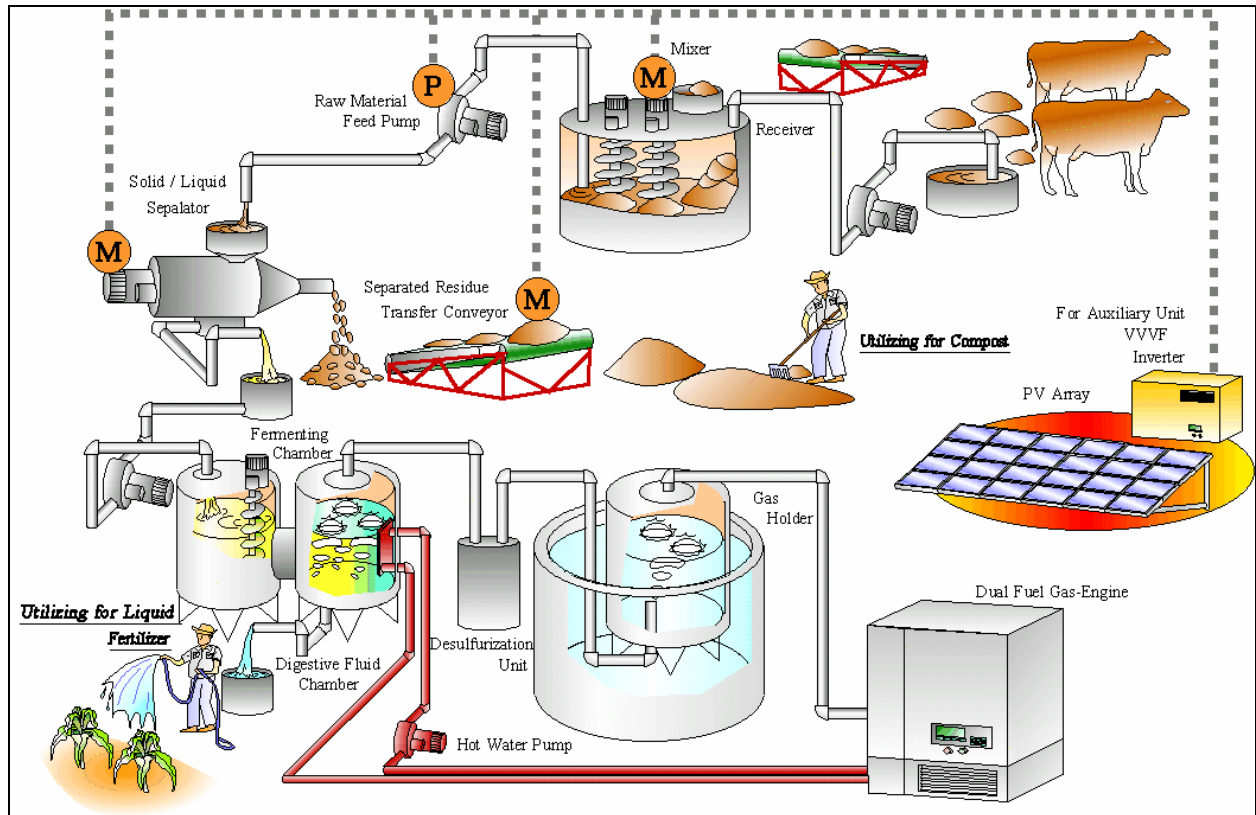
available bio-residues. Cottage industries operate primitive furnaces to burn rice husk mixed with wood and other bio-residues, incurring high energy losses. These include brick and tile manufacturing, wine distillation, and palm sugar production.

Evidence from specific study sites suggest that most cooking stoves currently used in Cambodia are of basic technology and of poor conversion efficiency, such as three-stone stoves and bucket stoves (Burgess 2000, De Lopez 2001, FAO 1998). The Cambodia Fuelwood Saving Project (CFSB), an NGO funded by international donors, has developed locally a more efficient cooking stove. The introduction of the stove has been limited to a few rural areas because of budgetary constraints. Cottage industries similarly use rudimentary furnaces and ovens to burn biomass residues as fuel.

The EC Cogen 3 project has identified the Angkor Prosperous Rice Mill, located some 30 km from Phnom Penh, as a potential full scale demonstration site. According to the pre-feasibility study, the mill has enough residues for rice husk fired cogeneration for a capacity of at least 0.5 MW (Cogen 3 2002). Electricity production using rice husk would replace diesel generation, while heat would be used for drying rice. It is expected that ashes from burning husk would be marketed as fertilisers. Despite a forecasted internal rate of return of some 30%, the project is facing steep financing constraints due to the limited availability of funds in the Cambodian banking sector.

In December 2003, Japan's NEDO completed the construction of a hybrid pilot scheme combining solar photovoltaics (50 kW) and electricity generation using biogas (60kW). Biogas is produced using cattle excrements from a farm. The project is expected to become operational in March 2004. Although the financial details remain sketchy, the project is considered to be mainly a demonstration and research venture and would not be economically viable without donor subsidies. Figure 4 details the different components of this hybrid photovoltaic-biogas system.

**Figure 4** Japan's NEDO hybrid solar photovoltaics and biogas project



### 2.3 Renewable energy policy

The Renewable Electricity Action Plan (REAP) is an initiative of the World Bank to assist, in the adoption of renewable energy technologies, the government of Cambodia, through its Ministry of Industry, Mines and Energy. The REAP began activities in 2001, and is expected to extend over a decade (REAP 2001). The stated ambition of the REAP of Cambodia is to become “the model used for the development of renewable energy projects worldwide” (World Bank 2002). The Cambodia Renewable Electricity Action Plan Mission is:

“to improve the living standards of Cambodian people, especially the rural communities, by working together and sharing knowledge and information to formulate effective strategies and a work plan for the development of affordable and reliable electricity from renewable electricity.”

The REAP envisions an active partnership between public and private sectors to create a favourable environment for investment opportunities in renewable electricity, in particular in hydroelectricity and solar installations. Although the vision and mission statements still occasionally, and maybe involuntarily, make use of the term *energy*, the focus of the REAP is without doubt on *electricity* and electrification. The vision describes an ideal world where electrification of rural areas fulfils the needs of communities, raising their standards of living,



while simultaneously “improving and sustaining the integrity of the natural world”. More specifically, the REAP has set a list of targets to be reached over the coming decade (Table 9).

**Table 9** Renewable electrification 10-year targets of the Renewable Electricity Action Plan (World Bank 2002)

- 6 Megawatts from renewables
- 100,000 households served
- 10,000 solar home systems
- Profitable, demand-driven renewable electricity markets

The guiding principles of the REAP (Table 10) broadly follow a neo-classical approach to the introduction of renewable electricity into Cambodia. Government serves as “market enabler”, while the private sector is to lead the way as “market developer and supplier”. At the same time, the invisible hand of the market is expected to favour pro-poor development.

**Table 10** Guiding principles of the Renewable Electricity Action Plan (World Bank 2002)

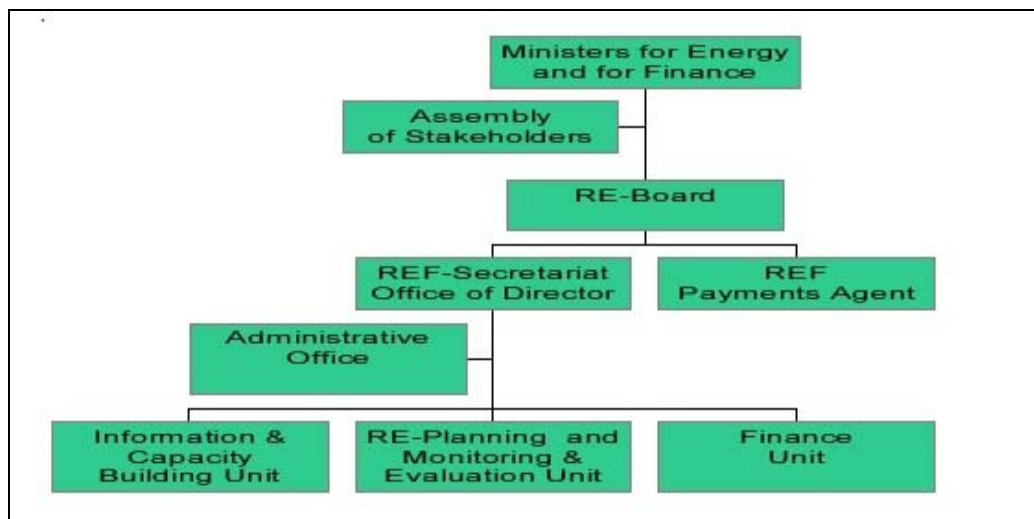
- Renewables used where least cost
- Government serves as market enabler
- Private sector serves as market developer and supplier
- Pro-poor development
- Subsidies used conscientiously

## 2.4 Initiatives promoting bio-energy

To achieve its stated objectives, the REAP will establish a Rural and Renewable Electrification Fund. Significantly, the acronym of the fund is REF, which in turn stands for either Rural *or* Renewable Electrification Fund. Originally designed as Rural *Energy* Fund, the emphasis has switched to *electrification*. This reflects a shift from energy to a more limited electricity focus.

The REF is to be established as an independent entity with legal autonomy. There are three layers in the REF’s “governance / management structure”: (i) the Minister for Industry, Mines and Energy, and the Minister of Finance, “assisted by the general Assembly of stakeholders as advisors”; (ii) a board of directors called the Rural Electrification Board (REB); (iii) the Executive Director and the REF Secretariat. The assembly of stakeholders include donors, finance institutions, renewable energy enterprises, suppliers of renewable energy goods and services, ministries and agencies involved in rural development and NGOs. As currently designed, the REF will be essentially controlled by donors and government.

**Figure 5** Proposed Structure for the Rural Electrification Fund (World Bank 2002)



**Table 11** Roles of the Rural and Renewable Electrification Fund (REF) (Adapted from World Bank 2002)

- To provide cost effective electricity supply to rural consumers
- Through channelling cost effective grants and Technical Assistance (TA). Such as grants for TA and soft investments for REEs, consultants, financial intermediaries, and construction companies involved in Rural Energy (RE)
- Subsidies for hard investments to all project developers, including EDC
- Solar Home Systems (SHS): grant support to jump-start the market

The REF will use subsidies for promotional and technical assistance activities, as well as for “hard investments” in renewable electricity projects. Table 12 presents REF supported types of investments. The proposal is for subsidies of US \$70 for a stand-alone home solar system of 20 to 55 Wp and US \$400 per kW for generation using renewable sources. Rural power distribution will also benefit from subsidies currently set at: US \$1000 per km of high voltage lines and US \$150 per connected customer of low voltage lines.

**Table 12** Investments in Renewable Electricity supported by the Renewable Electrification Fund (REF) (Adapted from World Bank 2002)

- Grid-connected generation using renewable energy
- Stand-alone PV systems
- Isolated mini-grids
- Isolated regional grids
- Expansion of distribution from transmission grid
- Expansion of transmission grid
- Grid-connected generation using renewable energy

The policy of the fund for providing grants to renewable energy technology are articulated in the World Bank concept paper as follows (World Bank 2002):

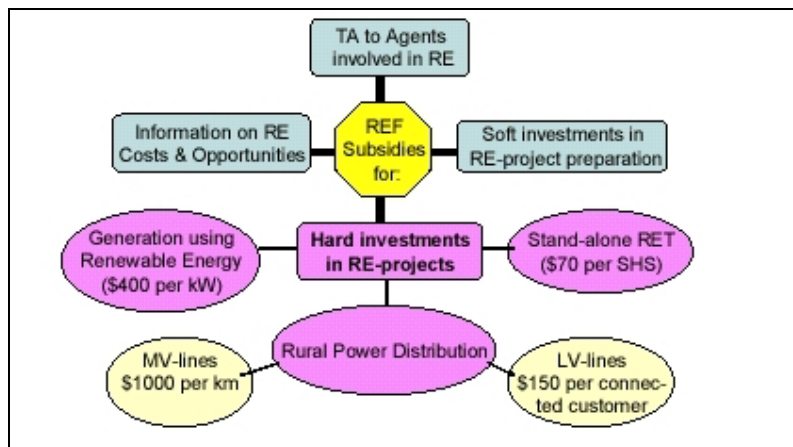
“The REF promotes investments in renewable energy technology, RET, as long as they are the least cost solutions for satisfying the power demand of individual consumers or, for grid-connected electricity generation using RET, can supply power at least as cheap as competing conventional generators. SHS for isolated households living too far from the grid to make grid connection an economically feasible option within a five-year horizon or beyond are one example. Another are grid-connected mini-hydros and generators using biomass resources.”

The funding of the REF will initially come from donor grants and concession loans. In the longer term, however, it is envisaged that funds will be replenished through a fee from electricity consumption and transmission. The proposal is that the Ministry of Finance levy an REF fee as a special purpose tax on urban electricity consumption per kWh:

“The fee generates little revenue in the beginning, but establishes the important principal of using cross-subsidies from urban electricity consumers to co-finance rural electrification.”

The idea is to have urban electricity consumers, who currently benefit from lower electricity tariffs than rural users, subsidise the electrification of rural areas with renewable energy sources (World Bank 2002). The REF, at this stage, is heavily skewed in favour of solar photovoltaics and hydroelectricity, although in theory bio-energy projects could benefit from the fund’s subsidies as well.

**Figure 6** Proposed Instruments for the Rural Electrification Fund (World Bank 2002)



## 2.5 Potential bio-energy projects

The highest potential for bio-energy projects in Cambodia consist of the implementation of small-scale technologies adapted to the needs of cottage industries and rural households. Much remains to be undertaken to promote bio-energy in a systematic and rigorous manner, and with appropriate consideration for end-user requirements and technical feasibility. Attempts at promoting bio-energy have been carried out in an ad-hoc and piece-

meal fashion, and usually remain unsustainable beyond the timeframe of specific projects. Energy efficiency for existing stoves, ovens, furnaces and kilns remain low as these have yet to benefit from efficiency improvement programmes. Potential projects also include the introduction of technologies well-proven in other countries, such as briquetting machines, biogas digesters, and bio-diesels. Large-scale bio-energy operations have much lower potential in Cambodia due to the relative dispersion of end-users and bio-residues, and the inadequacies of the financial sector.

## **Section Three: Barriers to the Implementation of Bio-energy Projects**

### **3.1 Limited information and low level of awareness**

The level of awareness of renewable energy and bio-energy is low among policy makers, private sector firms, and in society at large. For instance, solar panels are only exceptionally considered for water supply applications and off-grid lighting. The potential for using renewable energy is not systematically explored due to a lack of knowledge and understanding of such technologies.

Without any clear action plan, adequate manpower and budget for information and promotion, government agencies involved in renewable energy are unable to provide support to a broad audience of stakeholders that would include end-users, energy supply companies and policy makers. In short, bio-energy knowledge in Cambodia is available only to those who can access the Internet and other international sources of information.

### **3.2 Weak coordination between relevant agencies**

Energy development in Cambodia is not addressed as a cross-sector issue with link to climate change, environment, and human and economic development. This lack of an integrated approach in energy planning and development may lead to adverse social and environmental impacts. A number of ministries and agencies operate in the energy sector. Thus, there is a need for better inter and intra-agency coordination and cooperation to ensure that renewable energy be developed in a cross-sectoral manner.

### **3.3 Lack of skilled personnel and training facilities**

Most government institutions responsible for renewable energy development and energy efficiency were recently established. As such, the technical capacity and work experience of their staff are still limited. There is neither specialised training programme nor training facility for human resources development. Companies commercialising renewable energy and energy efficiency equipment number less than a handful in Cambodia. These enterprises often employ a limited number of local staff, with one or two expatriate technicians. On the job in-house training provides basic practical skills as there is currently no curriculum in renewable energy and energy efficiency available in Cambodia, either at the university level or at the vocational level. The dearth of skilled personnel both in the private and public sectors constitute major obstacles to the successful implementation of bio-energy technologies in Cambodia.

### **3.4 Commercial non-viability**

Cambodia has an estimated population of some 11 million inhabitants. Since some 36% of Cambodians live on less than a dollar per day, large sections of the population cannot afford the initial investment required for even the smallest renewable energy home systems. Lower costs of renewable energy rely on economies of scale and large sales volume. Because of the small size of the Cambodian market, these may not be achievable. Limited sales volumes combined with low purchasing power also imply low profitability for distributors and manufacturers of renewable energy equipment.

### **3.5 Inadequate financing arrangements**

The implementation of renewable energy technologies requires high initial investment costs. Yet, the Cambodian financial sector remains weak and unable to perform efficiently basic savings and loans operations (ADB 2000a, World Bank 2000). Limited credit extension in rural areas is essentially provided by Non Governmental Organisations (NGOs).

The total assets held by commercial banks in Cambodia represent less than 20% of the Gross Domestic Product (GDP). Because of this shortage of capital, interest rates on personal loans may range from 17% to 45% per annum for personal loans and from 12% to 35% per annum for private sector loans. Interest rates from rural credit institutions range from 25% to 30% per annum. Such high interest rates and unfavourable terms of payment represent major obstacles even for investments with high returns. In addition, it may be near impossible to obtain financing, as Cambodian financial institutions are unfamiliar with bio-energy technologies. Cambodian end-users of bio-energy equipment essentially have to pay for their initial investments in cash. High initial capital costs represent an obstacle for both private sector firms and individual households.

### **3.6 Unfavourable import taxes and tariff system**

Cambodia has to import most of its renewable energy and energy efficiency equipment from foreign countries. Local distributors sell solar panels and small wind turbines manufactured in the European Union, Japan and the USA. Compact Fluorescent Lamps (CFL) are imported from neighbouring Asian countries, mostly China and Thailand. While a few local entrepreneurs have set up workshops to produce lighting equipment, charge controllers, and efficient stoves, these remain small-scale operations with prototypes rather than finished products. A tariff of 35% is currently levied on renewable energy and energy efficiency equipment imported into Cambodia, making such technologies a luxury product that the majority of consumers cannot afford.

## **Section Four: Climate Change and The Clean Development Mechanism (CDM)**

### **4.1 Pollution control legislation**

The Sub-decree on Environmental Impact Assessment (EIA) and associated Guidelines for Conducting Environmental Impact Assessment stipulate that energy projects with installed capacity exceeding 1 MW must undergo an EIA carried out by an independent party. Thus, developers are required to disclose all the foreseeable negative social and environmental impacts of their projects and to submit an environmental management plan to mitigate these impacts. Pollution control legislation consists of the Sub-Decree on Solid Waste Management, the Sub-Decree on Air Pollution Control and Noise Disturbance, and the Sub-decree on Water Pollution Control, which set environmental standards in conformity with internationally approved principles. The Law on Environmental Protection and Natural Resource Management further confines development activities to sustainable development. A particularity of Cambodia is that most environmental legal texts expressly forbid any negative impact on the Kingdom's archaeological and cultural heritage.

### **4.2 Climate change policy**

Cambodia signed the United Nations Framework Convention on Climate Change (UNFCCC) on 18 December 1995, within a few years of the creation of the country's Ministry of Environment (MOE) and of the first national elections held after the Paris accord. The convention entered force on 16 March 1996. As a developing country, or non-Annex I member, Cambodia does not have any reduction obligations with regards to its emissions of greenhouse gases. Cambodia signed the Kyoto Protocol on 4 July 2002, which entered force for the Kingdom on 22 August 2002. Cambodia is thus eligible for the financing of emission reduction activities under the Clean Development Mechanism (CDM).

In 1999, the country started the implementation of the Climate Change Enabling Activity Project (CCEAP), funded by the United Nations Development Program (UNDP) and the Global Environment Facility (GEF). The project is considered the first step taken by the Kingdom towards the implementation of the UNFCCC. The main objectives are as follows:

“To build capacity and facilitate the process of taking climate change related issues increasingly into account in Cambodia thus facilitating the country's capacity to deal with climate change and its adverse impacts.”

The achievements of the project culminated with the production of *Cambodia's Initial National Communication under the United Nations Framework Convention on Climate Change* (MOE 2002). The document presents the findings of the national greenhouse gas inventory for year 1994, greenhouse gas projections from 1994 to 2020, mitigation options and a vulnerability and adaptation assessment.

Cambodia's 1994 greenhouse gas inventory quantifies anthropogenic emissions by sources and removals by sinks of carbon dioxide, methane and nitrous oxide. The inventory covers five sectors: (1) energy, (2) industrial processes, (3) agriculture, (4) waste and (5) land use, land use change and forestry (LULUCF). In 1994, Cambodia emitted some 59,708 Gg and removed some 64,850 Gg of CO<sub>2</sub>-equivalent. Thus Cambodia was a net carbon sink country with a net total carbon removal of 5,142 Gg of CO<sub>2</sub>-equivalent. Land use change and forestry accounted for most of the emissions and removals of greenhouse gases in 1994.

LULUCF represented 81.2% of greenhouse gases emissions, followed by agriculture with 15.5% and energy with 2.8%.

**Table 13** Summary of Cambodia's 1994 Greenhouse Gas Inventory (Gg) (Adapted from MOE 2002)

<i>Source/Sink</i>	1994 Inventory (Gg)	Percent of Total Emissions (%)
<b>Emissions</b>		
Energy	1881	2.8
Industrial Processes	50	0.1
Agriculture	10560	15.5
Waste	273	0.4
LULUCF	55216	81.2
<b>Total Emissions</b>	67980	100
<b>Removals by LULUCF</b>	-73122	
<b>Net Emissions</b>	-5142	

The projection of greenhouse gas emissions to the year 2020 was carried out using the Long-range Energy Alternatives Planning system (LEAP) developed by the Stockholm Environment Institute. Industry was excluded from projections under the assumption that mainly light industries, such as garment and food processing would be developed. Emissions from wood used as fuel by households were not included and were assumed to be absorbed by the forestry sector. This assumption is matter for debate, in particular given present deforestation trends. Table 14 shows that by year 2000, Cambodia will have become a net emitter. However, these emission forecasts may vary substantially with a different set of assumptions, such as increased rates of deforestation, adoption of renewable energy technologies or rapid industrialisation of the Kingdom.

**Table 14** Projection of greenhouse gas emissions and removals by sector (Gg) (Adapted from MOE 2002)

<i>Source/Sink</i>	2000		2010		2020	
<b>Emissions</b>	(Gg)	Percent of Total Emissions (%)	(Gg)	Percent of Total Emissions (%)	(Gg)	Percent of Total Emissions (%)
Energy	2622	3.6	4780	5.9	8761	9.0
Industrial Processes						
Agriculture	12030	16.4	17789	22.1	26821	27.5
Waste	331	0.4	425	0.5	523	0.5
LUCF	58379	79.6	57627	71.5	61512	63.0
<b>Total Emissions</b>	73362	100	80621	100	97617	100
Removals by LUCF	-67118		61090		53769	
<b>Net Emissions</b>	6244		19531		43848	



The national communication also examines mitigation options such as improved cook stoves, energy efficiency building codes, tax relief for renewable energy and mass transit. Since land use change and forestry account for the largest share in emissions and removals of greenhouse gases, the national communication also recommends that the government focus on reforestation and forest protection as mitigation measures. Under changing climate, the frequency and the severity of floods may increase, thus negatively affecting rice production. Over the past five years, 70% of rice production losses were attributed to flooding.

On-going efforts at the Ministry of Environment aim to integrate climate change concerns into the broader economic and social development framework of Cambodia. The first national action plan on climate change has identified existing or proposed government policies in agriculture, forestry, energy and transport in which climate change objectives could be integrated. Thus a priority for MOE is to promote increased climate change awareness among decision makers whilst building its own technical capacity, notably in the area of Clean Development Mechanism. On 23 June 2003, the Ministry of Environment, underlining growing awareness in Cambodia of global warming issues, formally established the Cambodian Climate Change Office (CCCCO).

### **4.3 Institutional arrangements for CDM projects**

On 15 July 2003, the Ministry of Environment was nominated as the interim Designated National Authority for CDM projects in Cambodia. The Cambodian Climate Change Office carries out the technical assessment of CDM projects, while the Minister of Environment issues letters of approval for CDM projects. These temporary institutional arrangements allow developers to seek national approval for their projects immediately, while policy-makers finalise the structure of the Designated National Authority over the next year. The final Cambodian DNA may take the shape of a newly created national authority, however, it is likely that the Climate Change Office will remain central to the technical evaluation process.

### **4.5 Sustainable development indicators for CDM evaluation**

The previous government's "development vision" (RGC 2002) rests on a "triangle strategy" which consisted in:

- (1) restoring peace and stability, and maintaining peace for the nation
- (2) integrating Cambodia into the region and normalising relations with the international community
- (3) promoting economic and social development through the implementation of an extensive reform program.

The "three main pillars" of national development are:

- Economic growth that is broad enough to include sectors where the poor derive a livelihood
- Social and cultural development
- Sustainable use of natural resources and sound environmental management.

The Second Socioeconomic Development Plan (SEDP II) draws heavily on the experience of the first plan and its overall disappointing performance. The main presumption is that "economic growth is a prerequisite for poverty reduction". Weak governance,

including absence of stable institutional framework, inadequate public service delivery and lack of institutional capacity, are considered major obstacles to economic growth, and thus to poverty reduction. Private sector development is presented as the key to economic growth, which itself depends on the successful implementation of the Governance Action Plan. This intended reform of the civil service will be broad based and cover decentralisation, military demobilisation, reforms of the legal and judiciary system, improvement of public financial management, sustainable natural resources management, as well as generalised anti-corruption measures. By and large, the GAP follows policy recommendations set out by the Asian Development Bank and the Cambodian Development Research Institute (CDRI) in a joint study on governance for sustainable development in Cambodia (ADB & CDRI 2000). Governance is defined as the manner in which power is exercised in the management of the country's economic and social resources for development. The attributes of good governance are accountability, transparency, predictability and participation, all of which are crucially lacking in Cambodia's legislative, executive and judiciary structures. The objectives of the SEDP II are given in Appendix 5.

"Sustainable use of natural resources and the environment" is presented as the third axis of the government's development strategy. This contrasts with the SEDP I and reflects concerns on the part of donors and conservation organisations for the rapid depletion of Cambodia's timber and fish stock, and their associated environmental and social consequences, including the higher occurrence of flooding, widespread soil erosion, siltation of major waterways and lakes, and exclusion of rural people from common pool resources to the benefits of private interests. Poverty reduction remains the overarching goal of the development vision. Thus, sustainable use of the country's environmental resources, including fisheries, forests, arable land and water, is presented as a strategy to ensure that local communities have access to these valuable benefits.

The Cambodia Climate Change Office has recently completed with the Ministry of Energy, Mines and Industry a draft of sustainable development indicators for CDM projects assessment. These indicators reflect national sustainable development objectives in four areas: economic development, social development, environmental sustainability, and technological self-reliance. The indicators are in the process of being approved, and are thus not yet publishable. The Cambodian DNA will use a methodology combining the Gold Standard of the Worldwide Fund for Nature (WWF 2003), and the ranking system of the SouthSouthNorth project (SSN 2003). Thus proposed CDM projects will be graded for each sustainable development indicator on a scale of -3 to +3. A negative score on any individual indicator would make the proposed project ineligible under national sustainable development objectives.

#### **4.6 Capacity building activities and CDM**

Cambodia is currently benefiting from the support of two capacity building projects for the Clean Development Mechanism: (1) Capacity Development for the Clean Development Mechanism (CD4CDM) and (2) Integrated Capacity Strengthening (ICS). The Ministry of Environment is the national counterpart agency for both projects. CD4CDM, managed by the UNEP Risoe Centre (URC) began in May 2003, aims to generate a broad understanding of the opportunities offered by CDM in Cambodia, and to develop the necessary institutional and human capabilities to implement CDM projects. CD4CDM essentially assists the Cambodian government in establishing and building capacity for a CDM Designated National Authority. The ICS project, managed by Japan's Institute for Global Environmental Studies (IGES) started in December 2003, and aims to complement the activities of CD4CDM by providing in-depth technical training for DNA staff and project

developers in CDM methodologies. ICS is also expected to produce a pipeline of CDM eligible projects for Cambodia.

## **Conclusion**

Some 80% of the Cambodia's total energy consumption is covered by biomass sources, the balance by imported fossil fuels. The technical potential for bio-energy in Cambodia is high. The kingdom has ample sources of bio-residues. To date, the use of bio-energy has been limited to pilot projects and other small-scale applications. Further research is urgently needed to assess the technical feasibility, as well as the economic and social potentials for the adoption of bio-energy technologies.

Cambodia's commitments to the Climate Change Convention and the Kyoto Protocol provide a favourable environment for funding under the Clean Development Mechanism. The Ministry of Environment remains the lead institution in Cambodia, with in-depth understanding of climate change issues. International assistance has already enabled the establishment of the Designated National Authority for the assessment of CDM projects. Such projects may allow Cambodia to contribute to reducing greenhouse gases emissions, while meeting its own social and economic development needs.

Poverty reduction must ultimately be, for Cambodia, the principal objective of any adoption of bio-energy technology. What matters for people, is not energy itself, but rather the satisfaction of basic needs in food security, healthcare and education that more energy may help achieve. Thus, relevant applications and services that use energy productively ought to be favoured. Bio-energy technologies will be adopted in Cambodia if they present direct benefits for the poor and are relevant to national development strategies.

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## APPENDIX 1: Main Source of Cooking Fuels (NIS 1999)

<i>Code</i>	<i>Province</i>	<i>Firewood</i>	<i>Charcoal</i>	<i>Kerosene</i>	<i>Liquefied Petroleum Gas (LPG)</i>	<i>Other</i>
	<b>Cambodia</b>	<b>90.0</b>	<b>5.3</b>	<b>1.8</b>	<b>1.7</b>	<b>1.2</b>
01	Banteay Mean Chey	90.6	7.6	1.0	0.5	0.3
02	Bat Dambang	92.4	4.4	1.6	0.6	1.0
03	Kampong Cham	96.7	1.0	1.6	0.6	0.1
04	Kampong Chhnang	95.8	1.9	1.8	0.4	0.1
05	Kampong Spueu	96.7	1.1	1.8	0.3	0.1
06	Kampong Thum	95.6	1.7	2.4	0.3	N
07	Kampot	93.5	4.0	1.9	0.3	0.3
08	Kandal	96.5	1.7	1.0	0.7	0.1
09	Kaoh Kong	71.8	24.2	1.4	2.3	0.3
10	Kracheh	95.3	3.1	1.2	0.4	N
11	Mondol Kiri	97.6	0.5	1.5	0.2	0.2
12	Phnom Penh	43.1	34.4	5.0	16.3	1.2
13	Preah Vihear	98.4	1.0	0.3	0.2	0.1
14	Prey Veang	92.0	1.2	1.1	0.4	5.3
15	Pousat	94.9	1.9	2.5	0.6	0.1
16	Rotanak Kiri	96.2	1.6	0.9	0.3	1.0
17	Siem Reab	96.1	1.4	2.1	0.4	N
18	Krong Preah Sihanouk	68.7	27.3	1.7	2.1	0.2
19	Stueng Traeng	94.1	4.4	0.3	0.5	0.2
20	Svay Rieng	89.4	0.6	1.4	0.5	8.1
21	Takaev	96.2	1.0	1.7	0.4	0.7
22	Otdar Mean Chey	97.4	1.6	0.8	0.2	N
23	Krong Kaeb	96.3	1.4	2.0	0.3	N
24	Krong Pailin	40.5	56.5	1.6	1.3	0.1

## APPENDIX 2: Main Source of Light (NIS 1999)

<i>Code</i>	<i>Province</i>	<i>City Power</i>	<i>Generator</i>	<i>City Power and Generator</i>	<i>Kerosene</i>	<i>Battery</i>	<i>Other</i>
	<b>Cambodia</b>	<b>12.5</b>	<b>1.0</b>	<b>1.6</b>	<b>79.9</b>	<b>3.5</b>	<b>1.5</b>
01	Banteay Mean Chey	8.2	1.1	2.7	84.6	2.9	0.5
02	Bat Dambang	10.0	1.4	2.5	83.2	2.7	0.2
03	Kampong Cham	9.2	1.0	1.5	82.7	5.3	0.3
04	Kampong Chhnang	4.6	0.7	0.7	89.9	3.9	0.2
05	Kampong Spueu	2.6	0.7	0.7	94.9	1.0	0.1
06	Kampong Thum	5.3	0.5	1.0	89.4	1.4	2.4
07	Kampot	4.9	0.8	1.1	92.5	0.7	N
08	Kandal	9.4	1.0	2.4	78.1	8.9	0.2
09	Kaoh Kong	26.6	4.5	7.8	59.1	0.8	1.2
10	Kracheh	9.5	1.7	2.3	80.8	4.1	1.6
11	Mondol Kiri	2.8	2.1	3.7	47.9	1.5	42.0
12	Phnom Penh	75.5	1.9	2.8	17.5	1.5	0.8
13	Preah Vihear	1.7	1.2	0.8	45.8	0.4	50.1
14	Prey Veang	3.0	0.4	0.5	89.8	6.2	0.1
15	Pousat	8.0	0.8	0.8	88.1	2.0	0.3
16	Rotanak Kiri	12.8	0.8	1.3	42.1	0.3	42.7
17	Siem Reab	7.6	0.8	1.1	88.8	1.6	0.1
18	Krong Preah Sihanouk	37.3	2.4	1.8	57.3	0.5	0.7
19	Stueng Traeng	11.7	1.5	0.9	60.5	1.7	23.7
20	Svay Rieng	3.5	0.5	0.7	91.3	3.8	0.2
21	Takaev	3.4	0.5	0.7	92.7	2.7	N
22	Otdar Mean Chey	1.8	0.6	0.2	96.2	1.0	0.2
23	Krong Kaeb	4.9	1.9	2.4	89.7	1.1	N
24	Krong Pailin	11.1	8.2	3.8	69.8	2.4	4.7



## APPENDIX 3: Electricity Tariffs in Phnom Penh Charged by Electricité du Cambodge for the Period 1999 - 2003

Exchange Rate (year 2003) 1 USD =

4000 Riels

Phnom Penh	Riels/kWh	USD/kWh
<b>Residential</b>		
0-50 kWh	350	0.09
51-100 kWh	550	0.14
>100 kWh	650	0.17
<b>Industrial and Handicraft Sectors</b>		
<45,000 kWh	600	0.15
45,000-80,000 kWh	550	0.14
80,000-130,00 kWh	550	0.14
>130,000 kWh	500	0.13
Medium Voltage	480	0.12
<b>Commercial &amp; Service Sectors</b>		
<45,000 kWh	650	0.17
45,000-80,000 kWh	600	0.15
80,000-130,00 kWh	600	0.15
>130,000 kWh	500	0.13
Medium Voltage	480	0.12
<b>Hotels &amp; Guest Houses</b>		
<45,000 kWh	650	0.17
45,000-80,000 kWh	600	0.15
80,000-130,00 kWh	600	0.15
>130,000 kWh	500	0.13
Medium Voltage	480	0.12
<b>Embassies, Foreigners' residences, NGOs, International Organisations</b>	800	0.20
<b>Government Institutions</b>	700	0.18
<b>Siem Reap</b>		
<b>All Sectors</b>		
<20 000 kWh	850	0.217
20 000-50 000 kWh	757	0.193
50 000-110 000 kWh	690	0.176
>110 000 kWh	635	0.162

## APPENDIX 4: Electricity Tariffs in Provincial Capitals Charged by Electricité du Cambodge for the Period 1999 – 2003

<b>Sihanoukville</b>	Riels/kWh	USD/kWh
<b>Residential</b>	500	0.13
<b>Industrial &amp; Handicraft</b>		
<20 000 kWh	686	0.175
20 000-50 000 kWh	690	0.176
50 000-110 000 kWh	568	0.145
>130 000 kWh	529	0.135
<b>Commercial</b>		
<20 000 kWh	764	0.195
20 000-50 000 kWh	706	0.18
50 000-110 000 kWh	643	0.164
>130 000 kWh	588	0.15
<b>Hotels, Houses for Foreigners</b>		
<20 000 kWh	784	0.20
20 000-50 000 kWh	721	0.18
50 000-110 000 kWh	666	0.17
>130 000 kWh	627	0.16
<b>Embassies, Government Institutions</b>	760	0.19
<b>Kompong Chnang</b>		
<b>All Sectors</b>	850	0.22
<b>Takeo</b>		
<b>All Sectors</b>	900	0.23
<b>Battambang</b>		
<b>All Sectors</b>	960	0.245

## APPENDIX 5: Outcome Matrix – Second Socioeconomic Development Plan 2001-2005 (Adapted from RGC 2002)

Goal/Objective	Target
Poverty Reduction	<ul style="list-style-type: none"> <li>▪ 31% headcount index (plus falling poverty gap and poverty severity indices)</li> </ul>
Sustained Economic Growth with Equity	<ul style="list-style-type: none"> <li>▪ Real DBP (factor cost) average annual growth rate of 6.1%</li> <li>▪ Agriculture sector growth rate of 3.5%</li> <li>▪ Industry sector growth rate of 7.0%</li> <li>▪ Services sector growth rate of 8.0%</li> <li>▪ Gini coefficient falls from 1997 level of 0.42</li> </ul>
Social Development	<ul style="list-style-type: none"> <li>▪ Infant mortality rate falls to 65 per 1000 live births</li> <li>▪ Maternal mortality rate falls to 200 per 100,000 live births</li> <li>▪ Reduction in the under 5 stunting rate by at least 1.5% per year</li> <li>▪ Percentage of rural population with access to safe water rises from 29% to 40%</li> <li>▪ Percentage of urban population with access to safe water rises from 69.5% to 87%</li> <li>▪ Percentage of rural population with access to improved sanitation facilities rises from 8.6% to 20% and from 49% to 90% for the urban population</li> <li>▪ 90% of 12 year olds completing Grade 6 and functionally literate and numerate</li> <li>▪ Enrolments of 2.4 million in primary, 0.4 million in lower secondary, 0.3 million in upper secondary</li> </ul>
Sustainable Management and Use of Natural Resources and the Environment	<ul style="list-style-type: none"> <li>▪ Draft implementing regulations for the new land law, including accelerating land registration and building a land administration system to enhance land tenure security, in full consultation with donors, NGOs and civil society</li> <li>▪ Draft and submit a new forestry law after full consultation with stakeholders</li> <li>▪ Implement the Fisheries Master Plan, including establishment of the Inland Fisheries Institute</li> </ul>