Energy for Life

COUNTRY PROFILE

CAMBODIA 2010

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Figure 1(Front cover): Administrative structure of Cambodia, Source: http://www.hoeckmann.de/karten/asien/kambodscha/index-en.htm

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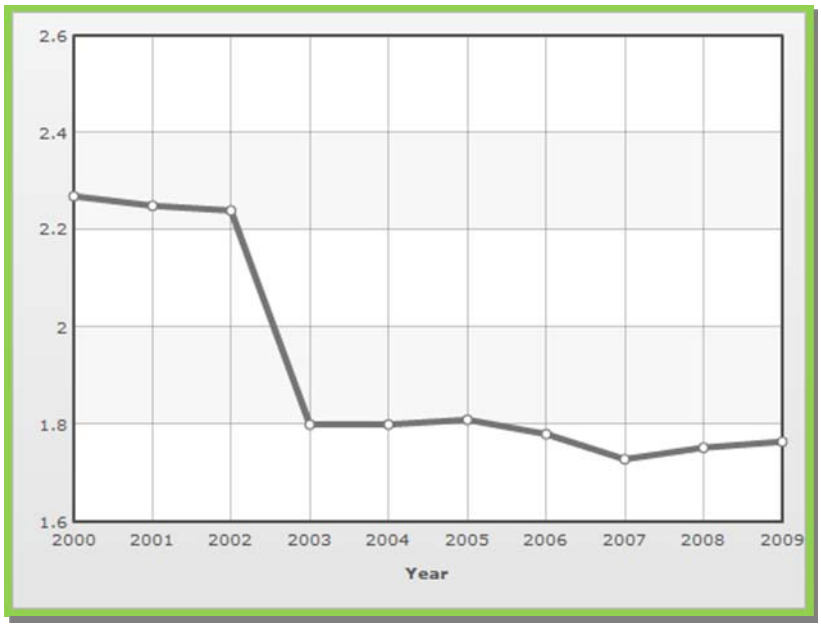
1. Background information

1.1. Country data[1]

Location of country:	Southeast Asia, bordering the Gulf of Thailand, between Vietnam, Laos and Thailand.
GPS:	13 00 N, 105 00 E
Land area:	181 035 sq. km
Capital:	Phnom Penh
Currency:	Cambodian Riel
Language:	Khmer (official), French, English
Religion:	Theravada Buddhist 95%, Muslim, Roman catholic
Population:	14.5 million (2010) 78% rural (2008).
Population density[2]:	81 persons per sq. km
Climate:	Tropical; rainy, monsoon season (May to November); dry season (December to April); little seasonal temperature variation
Temperature[3]:	Average 27.7 °C High 35 °C and low 21°C
Precipitation[4]:	1407 mm (55.4 in) rainfall per year, or 117 mm (4.6 in) per month
Terrain:	Mostly low, flat plains, mountains in south and north
Elevation:	Lowest: Gulf of Thailand 0 m. Highest: Phnum Aoral: 1,810 m.
GDP[5]:	USD 649 per capita per year (2007)

Figure 2: Population growth 2000 to 2009



Source: http://www.indexmundi.com/cambodia/population_growth_rate.html

[1] https://www.cia.gov/library/publications/the-world-factbook/geos/cb.html

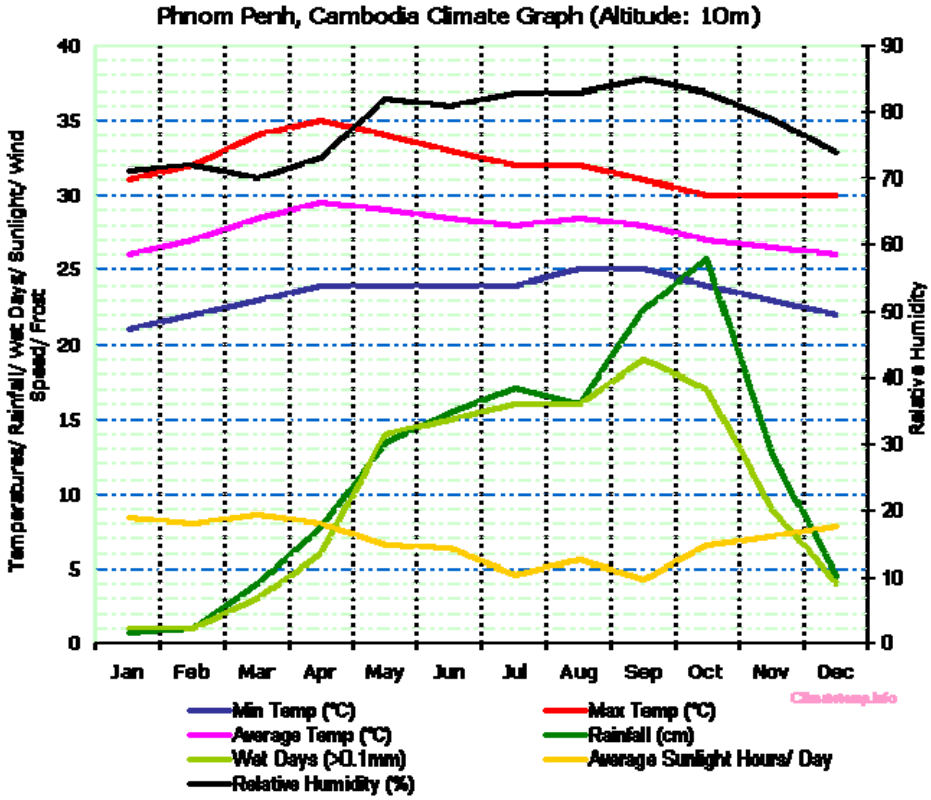
[2] http://www.internetworldstats.com/asia/kh.htm

[3] http://www.climatetemp.info/cambodia/

[4] http://www.climatetemp.info/cambodia/

[5] http://www.imf.org/external/pubs/ft/scr/2009/cr0948.pdf

Figure 3: Climate and weather in Cambodia



Source: http://www.climatetemp.info/cambodia/

1.2. RES targets[6]

The rural electrification strategy sets the goal: by year 2020 all villages will have access to electricity of at least one of different forms, including access to mini-grid and off-grid electricity.

By the year 2030, 70% of all rural households will have access to grid quality electricity.

The main components of the Rural Electrification Strategy are:

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

[6] Vuthy, Lieng, November 2007 Malaysia.

1.3. Status of the renewable energy market[7]

Levels of Rural Electrification

Three levels of electrification have been identified:

1. National Grid (grid electrification)
2. Mini-grids (off-grid)
3. Battery lighting (off-grid)

With the use of renewable energy:

1. Mini-grids: biomass and micro hydro
2. BCS: solar, (locally wind)

272,000 households awaiting RE by 2020 880,000 households using battery that have the ability to pay for mini-grids (USD 3-5 per h per month)

1.4. Supporting laws and policies

Short-term Policy Measures[8] (SP) (2006-2008)

SP1 Financial arrangements

SP1-1 Creation of tax exemption system on imports of renewable energy equipment

SP1-2 Creation of cross-subsidy system

SP2 Preparation for establishing non-profit SPC

SP2-1 Improvement of access to soft loans

SP2-2 Establishment of supporting system to CEC

SP3 Implementation of pilot projects (micro hydro, biomass, solar BCS)

The main tool to foster rural electrification is the "Rural Electrification Fund" (REF). REF targets to: (1) promote the equitable rural electrification coverage by facilitating the population's access to electricity at an affordable price for economic, social and household use, thus contributing to poverty reduction, and (2) to promote and encourage the private sector to participate in providing sustainable rural electrification services, in particular for the exploitation of the economic application of technically and commercially well proven, new and renewable energy technologies. REF provides grants for rural electricity enterprises in the implementation of new connections, for solar firms in the implementation of new solar home systems (100 USD per system) and for the development of new micro and pico hydropower plants[9].

[7] Vuthy, Lieng, November 2007 Malaysia.

[8] Vuthy, Lieng, November 2007 Malaysia

[9] http://www.ref.gov.kh/eng/text/Strategic%20Plan_Eg.pdf

1.5. Key supporting factors

Strategy for Promoting RE[10] - Electrification Strategy (ES)

ES1 Formulation of National Electrification Program

ES2 Grid electrification with government initiative and Off-grid electrification with private sector initiative

ES3 Establishment of implementation and supporting system

ES4 Financial arrangements for subsidy and soft loans

ES5 Supports to CEC/REEES2

Current Grant Program[11]

1. Provide grant assistance of USD 45 per new household connection to Rural Electricity Enterprises (REE);
2. Provide grant assistance of USD 100 per Solar Home System (SHS) with minimum capacity of 40Wp;
3. Provide grant assistance of USD 400 per kW for development of micro hydro & mini hydro, and grant assistance of USD 300 per kW for other renewable energy power plant (biomass).

1.6. Other issues

Insurance of a sustainable development in the power sector, The Royal Government of Cambodia worked out an electrification master plan (see website at the following link for more details http://www.ref.gov.kh/eng/text/Strategic%20Plan_Eg.pdf), which provides for (1) electricity generation development including hydropower resources development and development of coal or gas power plant, (2) electricity import to coordinate the development of the border zones of the Kingdom and (3) the development of transmission grid throughout the country in order to establish the electricity transmission system of Cambodia.

In general EAC recognizes the problem associated with the absence of affordable loans for large renewable energy projects, especially for biomass projects. Typical Cambodian loans have annual interest rates ranging from 10 to 25 %. Another problem is the high import tax the local companies have to pay, even for renewable energy equipment[12].

[10] Vuthy, Lieng, November 2007 Malaysia

[11] http://www.ref.gov.kh/eng/text/Strategic%20Plan_Eg.pdf

[12] Klauß-Vorreiter, Antje Dipl.-Ing., November-Dezember 2009

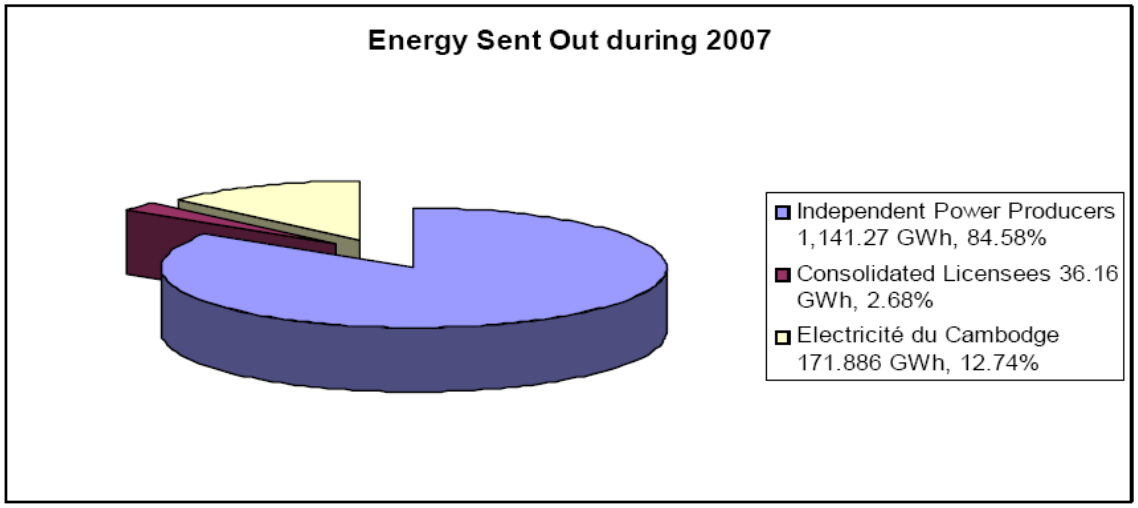
2. Current status of RES

2.1. Energy related data

Electrification rate[13]	16.41% of the household (approx. 2,350,542.47 persons) in Cambodia have access to electricity, of which 73% are located in Phnom Penh area.
Energy consumption[14]	94 kWh per capita (2007)
Actual electricity consumed	574 kWh per capita (2007)
Electricity cost[15]	Ranging from about USD 0.14/kWh in EDC's grid to USD 0.30 – USD 0.92 per kWh in rural areas served by REE*
Electricity generation in 2007	314.41 MW and 1,349 GWh
Electricity projection in 2020[16]	3,502 MW and 18,597 GWh
Main power generation sources[17]	Diesel Oil & Heavy Fuel Oil (96 % of the Cambodian electricity is generated from diesel (1,294.4 GWh).

** Note. In remote areas served by small- scale IPPs, prices can be even higher i.e. USD0.75 to USD1.25 per KWh in some districts outside Battambang town[18].*

Figure 4: Energy sent out of Cambodia during 2007



Source: Electricity Authority of Cambodia Report on Power Sector of the Kingdom of Cambodia 2009 edition.

[13] Electricity authority of Cambodia, September, 2008
[14] http://databank.worldbank.org
[15] Institute of Technology of Cambodia Renewable Energy Development in Cambodia, 2009
[16] http://www.eac.gov.kh/pdf/reports/Annual%20report%202008.en.pdf
[17] Institute of Technology of Cambodia Renewable Energy Development in Cambodia, 2009
[18] Vuthy, Lieng, November 2007 Malaysia

Table 1: Expected Generation Output for Cambodia (GWh) - Base Case

YEAR	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016
Banteay Meanchey	24.8	24.8	28.1	32.7	37.6	43.8	51.2	59.9	70.1	77.8
Battambang	22.5	28.8	36	43.5	50.6	59.6	69.8	81.5	95.1	102
Kampong Cham	28.8	34	39.3	44.8	50.3	58.1	65.3	73.1	82.9	92.9
Kampong Chnang	5.1	6.1	7.3	8.3	9.5	11	12.6	14.4	16.4	18.2
Kampong Speu	8	9.4	11	12.7	14.3	16.8	19.6	23.4	29.6	38.8
Kampong Thom	7.4	9.1	11.1	13.3	15.1	17.5	20.3	23.5	27	30.9
Kampot	13.7	16.9	22.7	26.3	34.3	39.2	45.2	52.1	59.5	68.4
Kandal	16	21	27.5	34	41.1	49.6	60	69.9	82.1	95.6
Koh Kong	4.6	5.5	6.5	7.5	8.8	10.1	11.5	13.1	14.9	17.3
Kratie	8.7	11.2	14.3	17.6	20.7	24.3	28.4	33.1	38.4	44.6
Mondul Kiri	0.6	0.7	1	1.3	1.4	1.7	1.9	2.1	2.8	3.1
Phnom Penh	321	438	566	695	820	994	1168	1355	1584	1829
Preah Vihear	1.5	1.9	2.4	2.8	3.2	3.9	4.4	5	6	6.6
Prey Veng	10.6	12.4	14.5	16.3	18.2	20.8	23.7	26.7	30	33.5
Pursat	7.2	8.9	11	13.2	15.4	17.9	20.7	23.9	27.6	31.8
Ratanak Kiri	3.5	3.6	4.2	4.4	4.8	5.6	6	7	7.7	8.9
Siem Reap	12.5	15.2	18.2	21.1	23.9	27.5	31.4	36.2	41.4	47.3
Sihanoukville	10.2	11.9	14	16.2	18.3	20.8	23.7	27	30.8	35.4
Stung Treng	1.2	1.4	1.7	2	2.6	3	3.4	3.9	4.5	5.6
Svay Rieng	5.6	6.3	7.3	8.1	8.8	10.1	11.1	12.3	14	15.4
Takeo	8.6	10.4	12.3	14.2	16.2	18.4	21.6	24.6	27.4	31.6
Pailin	0.5	0.6	0.9	1.2	1.3	1.6	1.8	2	2.7	3
Oddar Meanchey	?									
Kep	0.4	0.5	0.7	1	1.1	1.5	1.6	1.8	2	3
TOTAL	**523**	**678.6**	**858**	**1037.5**	**1217.5**	**1456.8**	**1703.2**	**1971.5**	**2296.9**	**2640.7**

Source: The Royal Government of Cambodia, Ministry of Industry, Mines and Energy Cambodia Power Sector Strategy EGY 1999-2016

Table 2: Expected Generation installed capacity Output for Cambodia (MW) - Base Case

YEAR	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016
Banteay Meanchey	4	5.9	8	10	12	14.5	17.3	20	24	26
Battamban g	3.5	5.7	8.6	12	15	18.5	22.4	27	31	33
Kampong Cham	4.9	7.8	10.5	13	15.2	17.9	20.5	23	26	29
Kampong Chnang	1.1	1.6	2.2	2.8	3.4	4	4.7	5	6	7
Kampong Speu	1	2	2.9	3.8	4.7	5.9	7.2	9	12	16
Kampong Thom	1.5	2.4	3.4	4.5	5.3	6.4	7.5	9	10	11
Kampot	2.7	4.8	8.1	10.1	13.9	16.3	18.9	25	28	33
Kandal	2.2	3.9	5.5	6.7	7.9	9.2	10.6	12	13	15
Koh Kong	0.7	0.9	1.2	1.4	1.7	2	2.3	3	3	4
Kratie	1.9	3.2	4.4	5.7	6.8	8	9.4	11	12	14
Mondul Kiri	0.1	0.2	0.3	0.4	0.5	0.6	0.7	1	1	1
Phnom Penh	60	93	131	170	207	256	304	356	418	484
Preah Vihear	0.3	0.5	0.7	1	1.1	1.4	1.6	2	2	2
Prey Veng	1.7	3	4.4	5.5	6.6	7.8	9	10	11	13
Pursat	1.3	2.3	3.2	4.2	5	5.9	6.9	8	9	11
Ratanak Kiri	0.9	1.1	1.3	1.5	1.7	1.9	2.2	2	3	3
Siem Reap	3	4.2	5.6	7.1	8.4	10	11.5	13	15	17
Sihanoukvil le	2.9	3.4	4.1	4.8	5.5	6.3	7.3	8	10	11
Stung Treng	0.2	0.5	0.7	0.9	1.1	1.3	1.5	2	2	2
Svay Rieng	1	1.6	2.2	2.8	3.2	3.9	4.4	5	6	6
Takeo	1.5	2.4	3.4	4.2	4.9	5.8	6.7	8	8	9
Pailin	0.1	0.2	0.3	0.4	0.5	0.6	0.7	1	1	1
Oddar Meanchey	0.1	0.1	-	-	-	-	-	-	-	-
Kep	0.1	0.2	0.3	0.4	0.5	0.6	0.7	1	1	1
TOTAL	**96.7**	**150.9**	**212.3**	**273.2**	**331.9**	**404.8**	**478**	**561**	**652**	**749**

Source: The Royal Government of Cambodia, Ministry of Industry, Mines and Energy Cambodia Power Sector Strategy EGY 1999-2016

2.2. Current situation

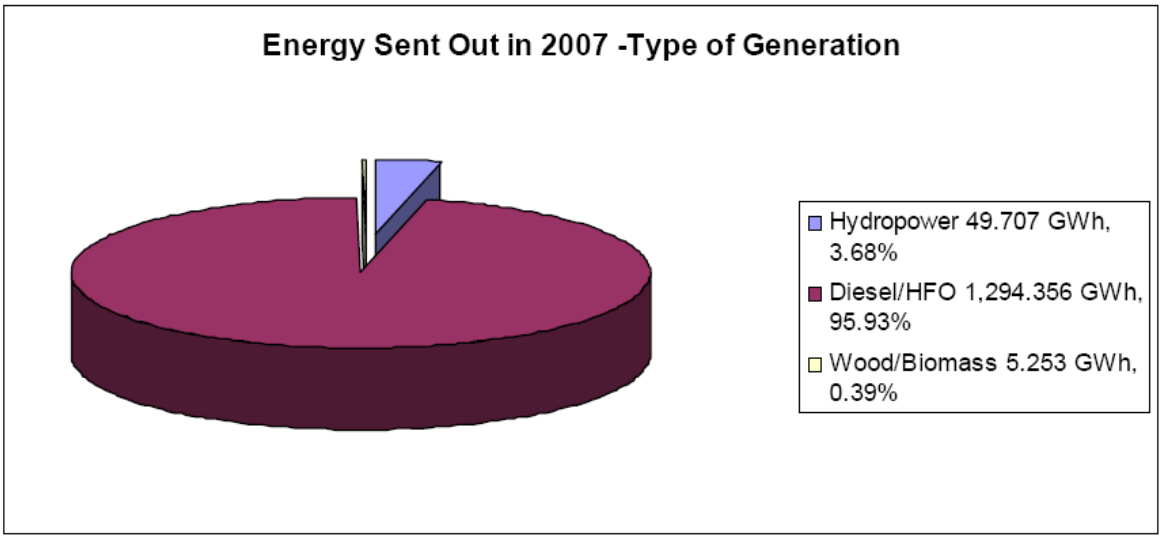
Electricity generation facilities (2008) in the Kingdom of Cambodia can be divided into 4 types[19]:

1. Hydropower Plants
2. Diesel power Plants
3. Thermal Power Plants using coal and
4. Plants using wood and other biomass.

The two EDC Hydropower Plants (49.7 GWh), one at Kirirom connected to Phnom Penh power system and the other one at Ratanakiri connected to Ratanakiri power system, produce 3.6 % of the energy and the 3 biomass gasifiers (5.3 GWh) in Battambang and Phnom Penh produce the remaining 0.4%. 84.58% of the electricity is sent out by independent power producers, 12.74% by EDC and the remaining 2.68% by consolidated licensees[20].

Electricity production and transmission licenses are in the private sector except for three. The three licensees in the Government sector are (i) Electricité Du Cambodge – having Consolidate License No. 001L consisting of Generation, National Transmission and Distribution License, (ii) Electricity of Kratie Province – having Consolidate License No. 059L consisting of Generation and Distribution License, and (iii) Electricity Unit of Mondulkiri Province – having Consolidate License No. 158L consisting of Generation and Distribution License[21].

Figure 5: Energy sent out during 2007 by type of Generation



Source: Electricity Authority of Cambodia Report on Power Sector of the Kingdom of Cambodia 2009 edition.

[19] http://www.eac.gov.kh/pdf/reports/Annual%20report%202008.en.pdf

[20] Klauß-Vorreiter, Antje Dipl.-Ing., November-Dezember 2009

[21] Electricity Authority of Cambodia, November, 2009

Table 3: Types and Number of Electricity production/transmission licenses

No	Type of License Issued	Licenses valid end of 2007	Issued during 2008	Revoked during 2008	Change of type during 2008	Valid end of 2008
1	Consolidated License consisting of Generation, Distribution and National Transmission Licenses	1				1
2	Generation License	14	6			20
3	Special Purpose Transmission License	1				1
4	Consolidated License consisting of Special Purpose Transmission and Distribution Licenses		2			2
5	Distribution License	16	4		+2-1	21
6	Retail License	1				1
7	Consolidated License consisting of Generation and Distribution Licenses	147	30	4	+2-1	172
	Total	**180**	**42**	**4**	**+3-3**	**218**

Source: Electricity Authority of Cambodia report on Power Sector of the Kingdom of Cambodia 2009 edition, Compiled by EAC from the information received till end of 2008 November, 2009.

Table 4: Electricity/Heat energy system registered in Cambodia in 2007

Production from:	Electricity Unit: GWh	Heat Unit: TJ
- coal	0	0
- oil	1,294	0
- gas	0	0
- biomass	5	0
- waste	0	0
- nuclear	0	0
- hydro*	50	
- geothermal	0	0
- solar PV	0	
- solar thermal	0	0
- wind	0	0
- tide	0	0
- other sources	0	0
Total Production	**1,349**	**0**

**Note: Includes production from pumped storage plants.*

Source: http://www.iea.org/stats/electricitydata.asp?COUNTRY_CODE=KH

Table 5: Energy balance of Cambodia

No	Type of fuel	Tera Joule	Percent
1	Fuel wood	77,721	82.16%
2	Agricultural residues	1,624	1.72%
3	Dung	18	0.02%
4	Charcoal	1,097	1.16%
5	Electricity	827	0.87%
6	LPG	170	0.18%
7	Gasoline	6,089	6.44%
8	Jet Fuel	468	0.49%
9	Kerosene	1,112	1.18%
10	Diesel fuel	5,401	5.71%
11	Fuel oil	65	0.07%
	TOTAL	**94,592**	**100%**

Source: National Biodigester Programme Cambodia, Information Folder, 2009

2.3. Biomass installed and identified systems

Biomass sources in Cambodia

With few exploitable energy sources available in Cambodia, wood is the main biomass utilized, accounting for more than 80% of the total national energy consumption[22]. As such, natural forests are being depleted being the main source of fuel wood.

Biomass sources for electricity generation[23]

- Agricultural Waste
- Rice husk –One million t/year rice husk; 60-100 MW capacity
- Cashew nuts shell, sugarcane bagasse, cassava stems etc.
- Old Rubber Trees
- 40,000 ha plantation, 25-30 year replanting cycle, 180 t/ha
- 250,000 t/year; 20-50 MW capacity
- Forest Resource
- Plantation, tree farming

[22] http://www.recambodia.org/nationaldata.htm#Key Indicators

[23] Vuthy, Lieng, November 2007 Malaysia

Table 6: Number of biogas systems installed from 2006 till May 2009

Province	The result accomplishment				Total
	2006	2007	2008	May 2009	
Kampong Cham	113	250	400	219	**982**
Kandal	85	81	100	69	**335**
Svay Rieng	61	136	332	274	**803**
Takeo	31	450	686	179	**1,346**
Kampong Speu	4	232	289	87	**612**
Kampong Chhnang	0	0	155	102	**257**
Kampot	0	1	357	102	**460**
Prey Veng	0	0	21	93	**114**
Total	**294**	**1,150**	**2,340**	**1,125**	**4,909**

Source: National Biodigester Programme Cambodia, Information Folder, 2009

This number of biogas systems is increasing daily. Further information on the developments of biodigestión in Cambodia and on the National Biodigester Programme can be found on the organization's webpage www. www.nbp.org.kh

2.4. Hydroelectric installed and identified systems

Table 7: Hydroelectric projects installed and identified

Hydropower Project Type	Number of Projects	Total Installed Capacity (MW)	Annual Generating Potential (GWh/year)	Potential Annual Greenhouse Gas Abatement (ton CO2 equiv)
Installed Projects				
Large (5 MW to 465 MW)	1	12.00	53.00	36,941.00
Mini-hydro (500 kW to 5 MW)	1	1.00	2.50	2,250.00
Micro-hydro (10 kW to 500 kW)	1	0.04	0.14	126.00
Identified Projects				
Large (5 MW to 465 MW)	20	1,788.30	8,839.97	6,161,462.00
Mini-hydro (500 kW to 5 MW)	9	23.05	108.50	97,650.00
Micro-hydro (10 kW to 500 kW)	10	0.68	1.78	1,605.60
Total	**42**	**1,825.07**	**9,005.90**	**6,300,035.00**

Source: http://www.recambodia.org/nationaldata.htm#Key Indicators

2.5. Solar installed and identified systems

Table 8: Total installed PV capacity from 1999 to 2004

Applications	Capacity (kWp)
Lighting	55.9
Pumping	13.3
Refrigerator	7.8
Computers	6.9
Radio repeater	1.9
Telecommunication equipments	1,050.0
Total	**1,135.8**

Source:www.recambodia.org/nationaldata.htm#Key Indicators

Table 9: Total installed PV capacity (Cambodia country report for RETs project)

Applications	Capacity (kWp)
Lighting	55.9
Pumping	13.3
Refrigerator	7.8
Computers	6.9
Radio repeater	1.9
Telecommunication equipments	1,050.0
Total	**1,135.8**

Source: Phol, Norith, Bun, Long, ITC 2007

2.6. Wind energy installed and identified systems

Table 10: Wind energy projects installed and identified

Wind Power Projects	Number of Projects	Total Installed Capacity (kW)	Annual Generating Potential (MWh/year)	Potential Annual Greenhouse Gas Abatement (ton CO2 equiv)
Installed Projects				
NEDO Village Demonstration	1	2.8	0	0
Identified Projects				
Sihanoukville Port Wind Turbine	1	660.0	1,700	1,561
Totals	**2**	**662.8**	**1,700**	**1,561**

Source: http://www.recambodia.org/nationaldata.htm#Key Indicators

Table 11: Wind energy projects installed and identified

Wind Power Projects	Number of Projects	Total Installed Capacity (kW)	Annual Generating Potential (MWh/year)	Potential Annual Greenhouse Gas Abatement (ton CO2 equiv)
Installed Projects				
NEDO Village Demonstration	1	2.8	0	0
Identified Projects				
Sihanoukville Port Wind Turbine	1	660.0	1,700	1,561
Totals	**2**	**662.8**	**1,700**	**1,561**

Source: http://www.recambodia.org/nationaldata.htm#Key Indicators

3. Potentials of RES in Cambodia

Cambodia has a very high potential of renewable energies, especially in solar, wind and hydropower. The average sunshine per day ranges from 6 to 9 hours, allowing the production of an average of 5 kWh of electricity per day. Nevertheless, the total installed capacity is only around 3,000 kWp, mainly installed as Solar Home Systems with a capacity of 15, 20 or 40 Wp (as of 2007 not registered). The southern part of the great lake Tonle Sap, the mountainous districts in the southwest and the coastal regions, such as Sihanoukville, Kampot, Kep and Koh Kong have an annual average wind speed of 5m/s or more which would allow the installation of wind powered systems. Nevertheless, so far the wind energy potential is not used. The hydropower potential accounts for up to 10,000 MW, but currently less the 20 MW are installed with the plants above mentioned and some micro and pico hydro power plants[24].

3.1. Biomass Energy Resource potential

A conservative estimate of the technical potential for domestic biodigesters was conducted by the National Biodigestor Programme in the 6 selected provinces (Kampong Cham, Svay Rieng, Prey Veng, Kampong-Speu, Takeo and Kandal) showing a potential of 224,000 units[25].

Biomass generation potential estimate[26]: **18,852 GWh/yr** (approx. 35 times EDC generation 2002) Based on existing crop and livestock residues Based on existing crop and livestock residues Assumes 35% conversion efficiency

Issues: Existing uses, costs of collection + transport, impacts of land use change

Table 12: Implementation of biogas systems in planning 2006-2012

Province	Implementation of Planning 2006-2012							Total
	2006	2007	2008	2009	2010	2011	2012	
Kampong Cham	113	250	400	600	600	700	750	**3,413**
Kandal	85	81	100	220	200	250	300	**1,236**
Svay Rieng	61	136	332	400	450	500	600	**2,479**
Takeo	31	450	686	660	500	550	600	**3,477**
Kampong Speu	4	232	289	420	400	450	500	**2,295**
Kampong Chhnang	0	0	155	250	300	350	400	**1,455**
Kampot	0	1	357	500	500	550	600	**2,508**
Prey Veng	0	0	21	300	450	500	550	**1,821**
Total	**294**	**1,150**	**2,340**	**3,350**	**3,400**	**3,850**	**4,300**	***18,684**

**Note: The implementation planning for SNV donated.*

Source: National Biodigester Programme Cambodia, Information Folder, 2009

[24] Klauß-Vorreiter, November-Dezember 2009

[25] National Biodigester Programme Cambodia, Information Folder, 2009

[26] http://www.recambodia.org/nationaldata.htm#Key Indicators

Table 13: Payback Period of 4 cum capacity biodigester in Cambodia

Type of Fuel Sources	Quantity saved	Cost per unit	Total cost saved per day	Total cost saved per year	Payback period without subsidy	Payback period with subsidy (USD 100)
Firewood	6 kg	USD 0.07	USD 0.42	USD 153	2.6 years	1.6 years
Charcoal	2 kg	USD 0.20	USD 0.42	USD 153	2.6 years	1.6 years
Kerosene	0.7 litre	USD 0.65	USD 0.46	USD 166	2.4 years	1.5 years
LPG	0.5 kg	USD 1.00	USD 0.50	USD 183	2.2 years	1.3 years

Source: National Biodigester Programme Cambodia, Information Folder, 2009

3.2. Hydro Energy Resource potential

Total hydropower resource[27]: **8,600 MW** (up to 10,000 MW[28])
- 50% on Mekong
- 40% on Mekong tributaries
- 10% in SW Coastal Area
- Over 70 potential hydropower sites have been identified

Issues[29]
Environmental impacts, livelihood impacts, feasibility of small projects, seasonal flows

3.3. Solar Energy Resource potential

Sunlight hours[30]:
- 4.3 hours average per day in September
- 8.6 hours average per day in March
- 2,490 hours average per year
- 6.8 hours average sunlight per day.

Radiation intensity[31]:
- 4.7 kWh/m^2/day in the lowest area
- 5.3 kWh/m^2/day in the highest area and
- 5.1 kWh/m^2/day is an average over the country

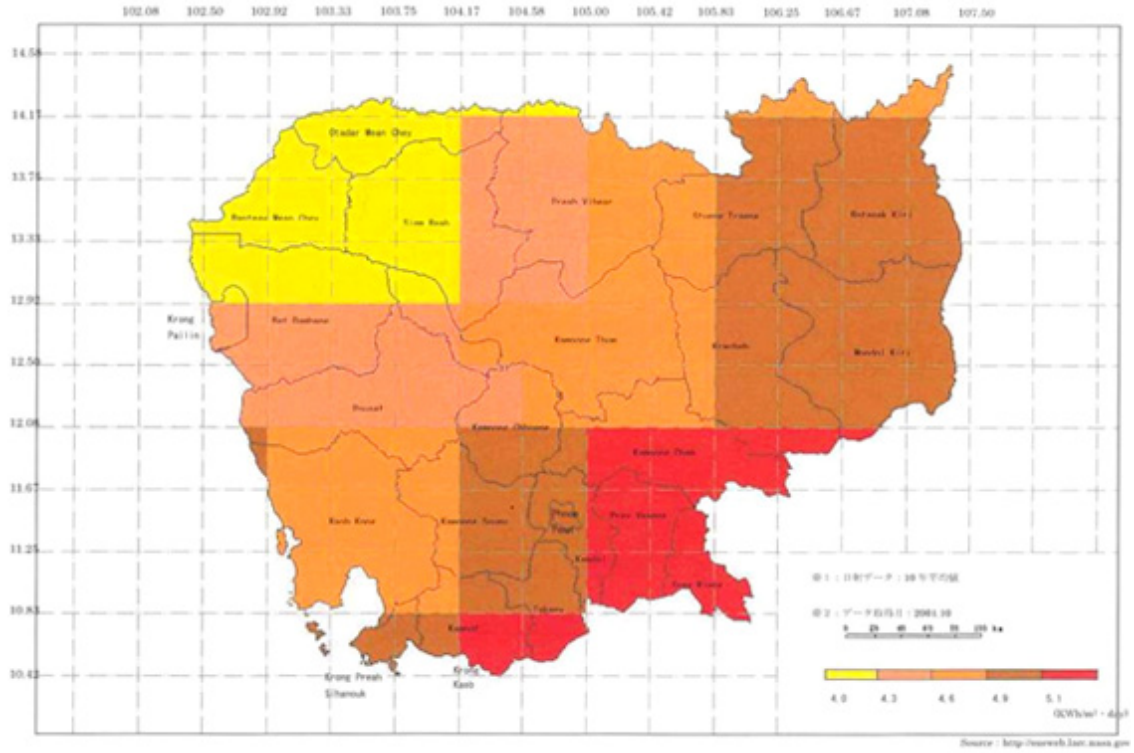
Solar power generation potential estimate[32]: **7,665 GWh/yr** (approx. 14 times EDC generation 2002)

Solar hot water potential estimate: **17,995** GWh/yr
Every household could boil 240 litres of water every day. Based on insolation of 5.10 kWh/sq.m, and 0.02% of Cambodia's land area.

Issues: Cost, storage

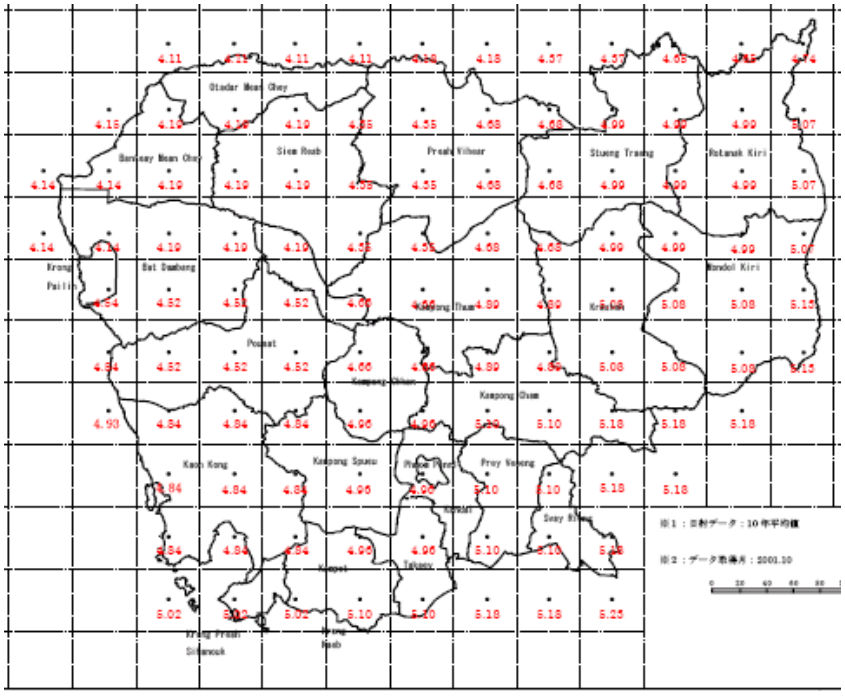
[27] http://www.recambodia.org/nationaldata.htm#Key Indicators
[28] Sovanna, Toch, Cambodia 2nd March 2006
[29] http://www.recambodia.org/nationaldata.htm#Key Indicators
[30] http://www.climatetemp.info/cambodia/
[31] van Diessen, Tom, Delft University of Technology, 2008
[32] http://www.recambodia.org/nationaldata.htm#Key Indicators

Figure 6: Solar radiation map



Source: http://eosweb.larc.nasa.gov/

Figure 7: Solar energy resource map (Energy master plan of MIME)



Source: Phol, Norith, Bun, Long ITC Promotion of the Efficient Use of Renewable Energies in Developing Countries Report on WP 2.05 Appropriate technologies scan in Cambodia Authors Norith Phol, ITC Long Bun, ITC 2007

3.4. Wind Energy Resource potential

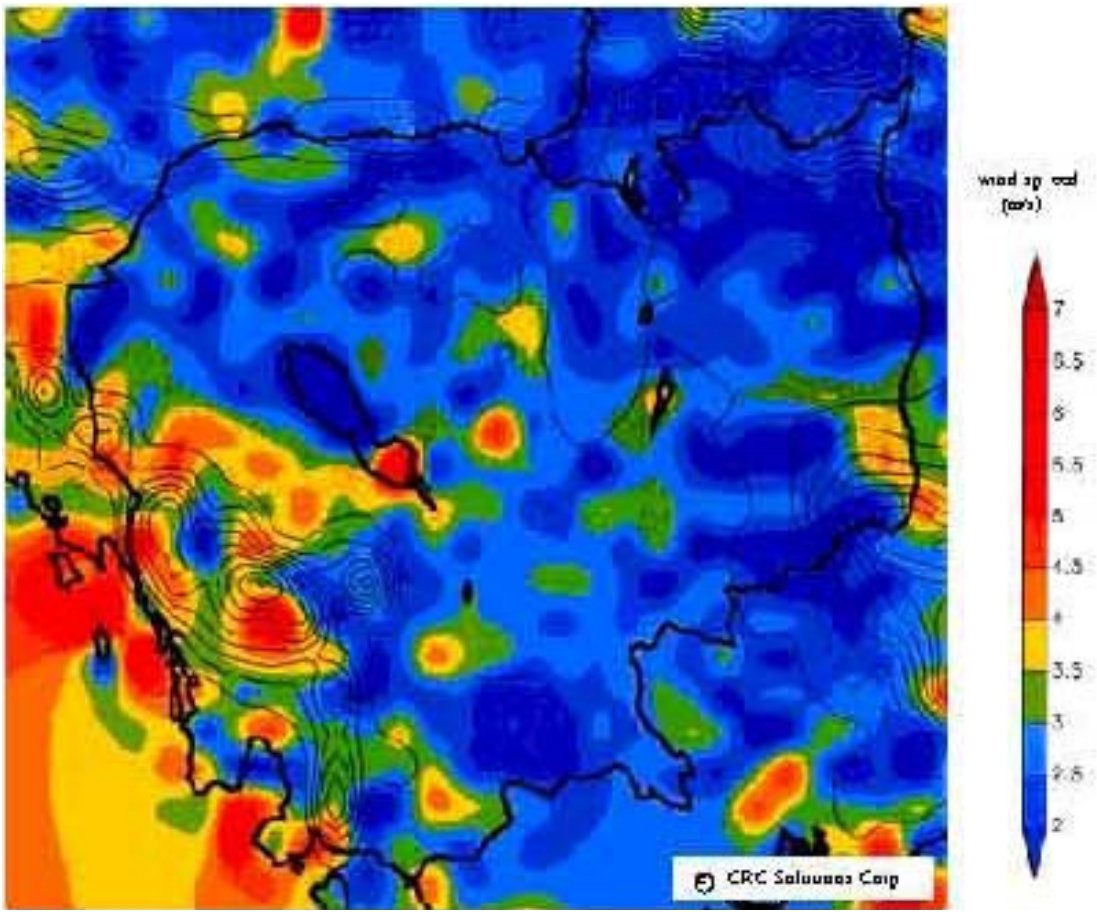
Wind speed[33]:
3.5 m/sec country annual average wind speed at 50 m
2.6 m/sec at 20 m.
4.6 m/sec maximum towards the eastern and southern regions on annual average.

Wind generation potential estimate[34]: **3,666 GWh/yr** (approx. 7 times EDC generation 2002)
Commercial farms and village scale

Issues
Sensitive environmental areas, visual impact, grid and road access, seasonal resource

As shown in the following map, the southern part of the great lake Tonle Sap, the mountainous districts in the southwest and the coastal regions, such as Sihanoukville, have an annual average wind speed of 5m/s or greater; thus the introduction of wind power generation system in these areas is promising[35].

Figure 8: Wind energy resource map



Source: Sovanna, TOCH, Cambodia 2 March 2006

[33] Phol, Norith, Bun, Long, 2007
[34] http://www.recambodia.org/nationaldata.htm#Key Indicators
[35] Sovanna, TOCH, 2 March 2006

3.5. Other renewable energy sources potentials

3.5.1. Geothermal[36]

Current situation
- No assessments available
- Some thermal springs, but appear low-grade
- No known projects

3.5.2. Wave or Tidal[37]

Current situation
- No assessments available
- Low apparent potential
- No known projects

[36] http://www.recambodia.org/nationaldata.htm#Key Indicators

[37] http://www.recambodia.org/nationaldata.htm#Key Indicators

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Related links

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Royal Government Website	www.cambodiva.gov.kh
Rural Electrification Fund	www.ref.gov.kh
Ministry of Industry, Mines & Energy	www.mime.gov.kh
Ministry of Economy & Finance	www.mef.gov.kh
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Ministry of Environment	/www.camnet.com.kh/moe
Ministry of Planning	www.mop.gov.kh
Electricité du Cambodge (EDC)	http://edc.com.kh
Department of Energy Technique (DET), Ministry of Industry, Mines and Energy (MIME)	www.recambodia.org
Cambodian organizations	
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National Biodigester Programme (NBP)	www.nbp.org.kh
Local Capacity Builder (LOCAB)	www.locab.org
Cambodian Education and Waste Management Organization (COMPED)	www.comped-cam.org
Asian organizations	
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International Affairs Department, National Institute of Advanced Industrial Science and Technology (AIST)	www.biomass-asia-workshop.jp
International organizations	
World Bank	www.worldbank.org
International Monetary Fund	www.imf.org
United Nations Development Programme	www.undp.org
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Asian Development Bank	www.adb.org/carm or http://www.adb.org
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