

RENEWABLE ENERGIES MADE IN CAMBODIA

APPROPRIATE CONCEPTS FOR RURAL ELECTRICITY SUPPLY



Figure 1: Angkor Wat, Siem Riep, Kambodscha

If one thinks on Cambodia the first themes springing in the mind are Ankor Wat and the Khmer Rouge. Two very important thinks in the history of the country. Whereby, Ankor Wat is a cultural heritage of which the Cambodian are very proud of, the terror regime of the Khmer Rouge was the darkest point in the history of the country. The country still struggles with the targeted killing of the intelligence of the country during the Pol-Pot regime from 1975 to 1979. Cambodia, which was before known as the Swiss of South-East-Asia is now one of the 10 poorest countries of the world. Today, one out of three Cambodians live on less than 0,5 USD a day, 27% of the population older than 15 years are illiterates and even 20% of the children are not going to the primary school. The median age is 20,6 years, with more than 50% of the population younger than 25. And this young generation, which is not

influenced from the Khmer Rouge, supported from the older Khmers, educated in foreign countries, may bring the country back to sustainable development.

The Kingdom of Cambodia, a member country of the Association of South East Asian Nations (ASEAN), with an area of 181,035 square Kilometres and a population of 14,5 million, is situated in the Lower Mekong region. Its neighbouring countries are Thailand in the West, Vietnam in the East and Laos in the North. In Cambodia 84% of population live in rural areas where many public services are not available, especially electricity service.

Electricity supply in Cambodia

The Pol Pot regime even not spared the electric power supply facilities, which was seriously demanded during their power. Until now the government was not able to build up a national grid with a stable electricity provision to the Cambodi-

an population. The country's electricity supply consists of 24 isolated grids centred at major cities, provincial and small towns, with the exception of the electricity supply system of Kampong Speu which has been connected to the Phnom Penh system through a 115 kV single circuit transmission line since 2002.

The overall electricity consumption per year was 1.349 GWh in 2007. Considering the population of Cambodia to be 13,4 million, the per capita consumption of electricity supplied by licensees comes to 100,68 kWh per year during 2007. But the electricity is not consumed by the 13,4 Cambodians, but only by the 16,41% of the households, which have access to electricity. Alone 73 % of those households are situated in Phnom Penh and areas around it, where the largest electric power system of the countries works. The rest of the electricity supplied by the licensees was consumed in the border zones (10,48 %) getting supply from neighbouring countries, in other provincial towns (14,37 %) and other zones (1,74 %).

There are 3 electricity providers in the country:

- Electricité du Cambodge (EDC),
- Licensed electricity providers and
- Rural electricity enterprises.

The main electricity supplier is Electricité du Cambodge (EDC) a state-owned utility with a consolidated license from Electricity Authority of Cambodia (EAC) to generate, transmit and distribute electricity throughout the country. Licensed electricity providers are entities with li-

Table 1: Information on energy generated and purchased, energy sold, losses and number of consumers classified by area of supply (EAC, 2008)

Area of Service	Energy generated and purchased, GWh	Energy sold, GWh	Losses in %	Number of customers
Phnom Pneh system	1.115,548	990,474	10,41	204.212
Areas served by Vietnam	78,868	70,361	10,79	24.601
Areas served by Thailand	76,487	70,973	7,21	18.907
Other provincial towns	224,469	193,904	7,21	87.146
Other areas and rural areas	31,358	23,410	25,34	80.275
Total	1.516,730	1.349,122	11,05	415.141

cense to supply electricity services granted by EAC. Most service providers with consolidated licenses have small-scale operations. Around 73% have capacities with less than 100 kW while the remaining 27% have unit generators ranging between 100 kW to 800 kW. The rural electricity enterprises work outside provincial capitals and small towns. These enterprises operate small diesel generators and produce electricity for their own use and for neighbouring customers. Their supply operation ranges from 20 to few hundred customers. Almost all of these rural electricity enterprises are not licensed since the travel costs in obtaining a license from Phnom Penh are substantial. Rural electricity enterprises all over the country were estimated to number around 500.

96 % of the Cambodian electricity is generated from diesel (1.294,4 GWh). 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 % 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.

Due to the present system and the strong reliance on diesel the electricity prices in Cambodia is with about 0,25 USD in Phnom Penh to up to 1,0 USD in the provinces the highest in the region.

Use and potential of Renewable energy in Cambodia

Cambodia as a very big potential of renewable energies, especially on Solar, wind and hydropower. The average sunshine duration per day is 6-9 hours, giving an average of 5kWh/day. Nevertheless, the total installed capacity is only around 3.000 kWp, mainly installed as Solar Home systems with 15, 20 or 40 Wp. The southern part of the great lake Tonle Sap, the mountainous districts in the southwest and the coastal regions, such as Sihanoukville, Kampot, Kep and Koh Kong have the annual average wind speed of 5m/s or greater. But so far the wind energy potential is not used. The hydropower potential account to up to 10.000 MW, but currently only less the 20 MW are installed with the 2 before mentioned and some micro and pico hydropower plants.

To overcome the present situation and to bring electricity to the Cambodians, the Royal Government of Cambodia has made rural electrification as one of its key energy sector priorities. The rural electri-

fication strategy of the country sets the goal: by year 2020 all villages have access to electricity of at least one of different forms, including access to mini-grid and off-grid electricity. The main tool to foster rural electrification is the "Rural Electrification Fund" (REF). REF targets (I) to promote the equitable rural electrification coverage by facilitating the population's access to electricity at affordable price for economic, social and household uses, thus contributing to poverty reduction, and (II) to promote and encourage the private sector to participate in providing the 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 for the implementation of new connections, for solar firm for the implementation of new solar home systems (100 USD per system) and for the development of new micro and pico hydropower plants. Mr. Theng Marith, Electricity Authority of Cambodia, said within the "REF programm most of the applications come for distribution lines and not for renewable energy projects and that most of the licensed biomass projects failed or delayed their start." He also said that "In case the decentralised renewable energy projects will not improve the Government probable will change its policy from decentralised to grid-connected projects." In general EAC recognized the problem of missing affordable loans for big renewable energy projects, especially biomass projects. Typical Cambodian loans have interest rates from 10 to 25 % per year. Another problem is the high import tax the local companies have to pay, even for the renewable energy equipment. 1 Wp PV module from Sharp Thailand costs 2009 between 3,5 to 4 USD in Cambodia. Which is already less than 2008 when it costs 5 to 7 USD per Wp, put still much more than on the world market. And it is not only the price put also the quality of the available modules, which some time make the observer think that the Cambodian market only gets the second quality ware. To overcome the present problems the country need a better import regulation for renewable energy equipment, quality controls and a special loans for renewable energy projects.

Anyway, their already exist some technical and financial viable projects, like the village grid of Anlong Tamey in the province Battambang, which is fed by a biomass gasifier (29 kWel) and a network of solar battery charging stations in the province of Kampong Chhnag. Both projects were funded partly by UNDP and



Figure 2: Hybrid 50 kWp PV and B35 kWel Biogas system, Sihanoukville Province

demonstrate how renewable energy projects could work in Cambodia. Both projects involve both, the private sector and the community, which is for Cambodia the most beneficial way. Other technically and financially good projects failed as they not considered involving these groups. Like the hybrid PV and Biogas system (50 kWp of PV combined with a 35 kWel biogas plant) which fed the village grid of Prey No in the province of Sihanouk Ville, which is since the beginning of 2009 out of operation as the villagers not accept to pay the increased electricity tariff, as they do not understand why the tariff rose due to higher operation costs as the investment of the plant was donated.

Solar battery charging with home made tracking systems

The Cambodian NGO LOCAP introduced 4 hybrid solar charging stations, a combination of PV modules with a back up 28 VDC diesel generator, in the Kampong Chhnag province. The 1,56 kWp PV systems use each twelve 130 Wp Sharp modules installed on a locally developed tracking system.

The 12 PV modules are installed on a metal substructure, which is movable connected with a pole, which elevates the modules to about 3 m. 4 cords below the modules in the edges enable the operator to move this tracker manually biaxial. This system was developed by the LOCAP team in the frame of the UNDP project and increases the solar energy yield by about 30%. But, even with this manual tracking system, the battery charging station can not only be operated with solar energy as on cloudy days and during the raining season the energy from the solar system is not sufficient to charge the batteries of the clients. Here the diesel engine serves as back up for the solar system. Another home-made solution LOCAP developed for charge controlling. They do not use typical charge controller but simple diodes. Those diodes bring the

electricity from the modules in the batteries but prevent the return flow of the electricity. Through this the PV modules and its bypass diodes are secured and the batteries are charged duly.

The 4 hybrid solar charging stations are the first solar charging station in Cambodia. The other about 2500 battery charging stations are fueled with diesel.

Community based approach for the operation of the battery charging station

LOCAP implemented the 4 battery charging stations 2009 together with 4 local entrepreneurs (battery charging stations operators) and the respective community. "LOCAP as NGO did not wanted to compete with the local entrepreneurs and spoil their business, but to cooperate with them to offer clean cheap energy charging" said Mr. Kong Pharith, LOCAP President. The community was involved by the establishment of a village committee which controls the operation of the battery charging station and is responsible for a saving fund fed by a part of the earnings of the solar battery charging.

In the frame of the LOCAP UNDP Solar Battery Charging Stations Project the 4 entrepreneurs, who already operated a battery charging station got the described PV system donated. In return they are obligated to give 50 % of their daily earnings to a saving fund, whereby the other 50% are their income. Additionally, they are obligated to sell their services 40 % cheaper than diesel battery chargers (see Figure 5). The 50 % which go to the saving fund are used equally for saving, maintenance of the PV system and the work of the committee supervised by



Figure 3: Cambodian mechanical operated solar tracking system



Figure 4: Home made charge controller and diesel engine

LOCAP. The so created saving fund can be used for infrastructure measurements in the community. But also secures the technical support from LOCAP to the community and the battery charging entrepreneurs even after the 12 month UNDP project phase. LOCAP developed a participatory concept which brings a win-win situation to both the entrepreneurs and the communities and additionally saves the environment.

Cost Structure

The investment of each of the 4 PV systems was 8000 USD, whereby the daily income is about 8 USD. The charging costs range from 0,20 to 0,30 USD per battery as listed below:

The battery charging entrepreneurs have to document their business. Every charged battery including the earning for the service is listed by the entrepreneur. Every day representatives of the village committee check the daily earning from battery charging sign the documentation, see Figure 5, and take 50 % of the daily earning for the village fund. This daily control by not only one person secures a corruption free reliable basis for the operation of the charging station and the village fund, which avoids jealousy of the villager not directly involved in the system explained Mr. Kong Pharith.

The described system only could be implemented by LOCAP due to the fact that LOCAP accompanied the technical work with an extensive training programme, which enables all stakeholders to participate properly. LOCAP even will support the further operation of the charging stations for minimum 3 years more.

Locally adapted concepts like the described one are strongly needed to increase the use of renewable energies in Cambodia.



Figure 5: Battery charging and daily earning list

Electrical capacity	Voltage	Solar charging price in USD	Normal charging price in USD
50 Ah	12	0,20	0,33
70 Ah	12	0,25	0,38
100 Ah	12	0,30	0,50

AUTHOR:

► *Dipl.-Ing. Antje Klauß-Vorreiter*
 Vice-President (Treasurer)
 Deutsche Gesellschaft für Sonnenenergie e.V.,
 International Solar Energy Society /
 German Section

www.dgs.de
 vorreiter@dgs.de