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PARLIAMENTARY INSTITUTE OF CAMBODIA
STRENGTHENING PARLIAMENTARY CAPACITY

Briefing Note

Regional Fellowship Program

Status and Challenges of Rural Electrification in Cambodia and Renewable Energy Options

Author: Mr. Yi Marabona, Fellow from Cambodia
Direct Supervisor: Dr. Kem Sothorn, Senior Instructor
Associate Supervisor: Ms. Top Davy, Associate Instructor
Editor: Mr. John Christopher, Director of Parliamentary Research Capacity Development Department

September 2019

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Abbreviations

ADB	Asian Development Bank
ACE	ASEAN Centre for Energy
BAU	Business as Usual
EDC	Electricite du Cambodge
KEA	Korean Energy Agency
MOME	Ministry of Mine and Energy
MAFF	Ministry of Agriculture Forestry and Fisheries
RE	Renewable Energy
RGC	Royal Government of Cambodia
REF	Rural Electrification Funds
REMP	Rural Electrification Master Plan
SHS	Solar Home System
SNV	Netherlands Development Organization
NSDP	National Strategies Development Plan
NBP	National Biodigester Programme
P2P	Power to the Poor

Table of Contents

List of Tables.....	i
List of Figure.....	i
1. Introduction	1
2. Progress of Cambodia and Neighboring Countries.....	1
3. Trend in Energy Supply and Demand	2
4. Access to the National Grid and Off-Grid	4
5. Cost of Electricity	5
6. Potential of Renewable Energy for Electrification	6
7. Conclusion.....	7
References	8

List of Tables

Table 1: Tariffs for Electrical Power Categorize by Capacity of Supply in 2018.....	5
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List of Figure

Figure 1: Access to electricity, rural (% of urban population)	2
Figure 2: Access to electricity, urban (% of rural population)	2
Figure 3: Energy Supply by Type of Source in Percentage	3
Figure 4: Energy Available, Sold and Generation for Consumers from 2005 to 2017.	4

1. Introduction

Electrification is a key for economic growth [1, 2, 3]. One of the major impediments to Cambodia's economy is the limitation of the electricity coverage in rural areas. While by 2018, almost every household can access at least one source of electricity [4], one-third of rural household have to rely on off-grid sources [4, 5]. Issues also remain concerning unreliability and high costs [1, 6, 7, 8]. Sources of energy have been diversified from oil to hydropower and Renewable Energy (RE) such as solar and biomass [9, 10] and the government has also introduced RE to promote access to electricity for people in rural remote areas [11, 12, 13].

The Energy Sector Development Plan 2005-2024 and the Rural Electrification Master Plan (REMP) are embedded in the National Strategic Development Plan (NSDP) [14, 15]. The Framework of Strategic Planning for Reduction of the rate and gap of the tariff for sale of electricity (2015-2020) has been introduced to reduce the tariff and electricity costs in rural areas [6]. The government through REMP also encourages privately operated small-scale generating units to take part in the provision of electricity to rural areas [16]. The objective of this briefing note is to review the status of electrification in Cambodia, highlighting the potential for RE. The key research questions are as follows:

1. What is the current status of electrification in Cambodia? What are the challenges to expanding rural electrification?
2. What is the potential for RE as a means for energy sector development?

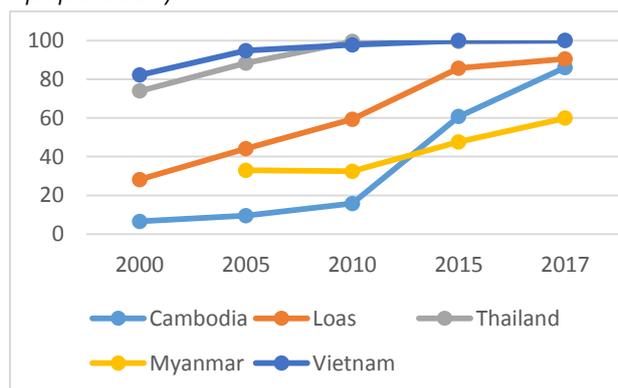
2. Progress of Cambodia and Neighboring Countries

Access to electricity among rural households in Cambodia increased from 6.56 percent to 86 percent from 2000 to 2017 (Figure 1). The country showed significant progress toward achieving more reliable and affordable electricity supplies by increasing its energy-producing capacity from hydropower plants and other sources of RE while reducing the dependency on the energy generated from oil. [17]. Over the same period of time, Lao experienced increases from 28 percent to 90 percent. The increase was the result of massive investments in hydropower that transformed the country from energy deficiency to an energy exporter. The country plans to export 7000MW (megawatt) to Thailand and 5000MW to Vietnam in 2020

[18]. Both Vietnam and Thailand, has 100 percent of rural households having access to electricity since 2010 (Figure 1). Myanmar experienced lesser progress in this regard (Figure 1).

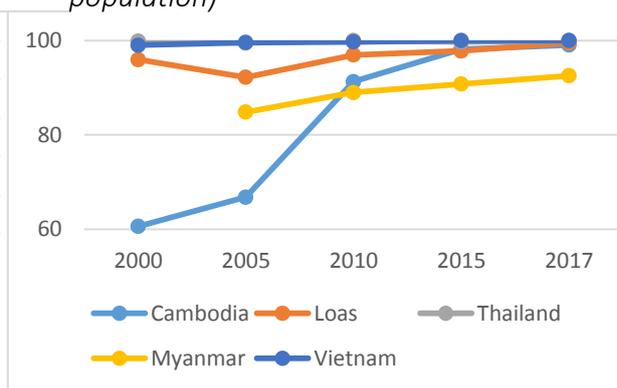
Cambodia also experienced an increase in urban electricity access from less than 60 to 99 percent from 1990 to 2016, marking significant progress in energy sector development that overtook Myanmar in 2010 and was able to catch up with Lao, Thailand, and Vietnam (Figure 2). Thailand and Vietnam share a similar pattern of access to electricity where rural electricity access is almost 100 percent since the 1990s. However, a large proportion of their electricity is still generated from thermal sources [18]. These two countries have started to increase their RE share to reduce GHG emissions by 20 and 25 percent, respectively, by 2030 [18].

Figure 1: Access to electricity, (% of rural population)



Source: [19]

Figure 2: Access to electricity, (% of urban population)



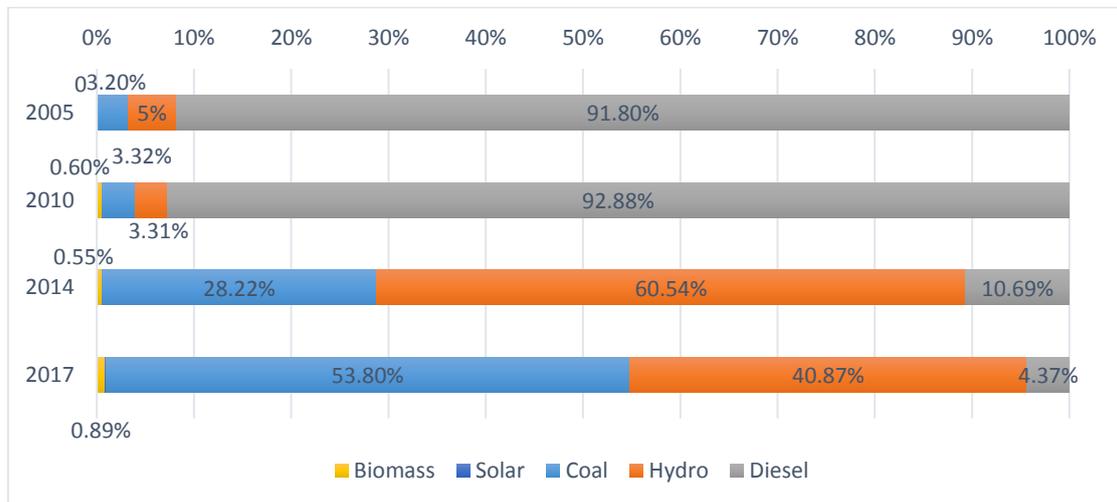
Source: [19]

3. Trend in Energy Supply and Demand

There has been a significant change in the sources of energy in Cambodia. From 2005 to 2010, more than 90 percent of the energy came from diesel-powered generators (Figure 3). The first hydropower facility—Kirirom 1—was built in 2002 with only 12MW of installed capacity. From 2010 to 2014, five hydropower facilities and two coal energy plants were built with a total of 915MW of install capacity electricity [20]. The share of electricity generated from hydropower increased from 3.31percent to 60.54 percent while share of coal increased from 3.32 percent in 2005 to 28.22 percent in 2014 (Figure 3). Energy from coal power plants keeps increasing to 53.8 percent, followed by 40.8 percent from hydropower. Other sources

of RE such as solar and biomass remain at an early stage of development, sharing less than one percent.

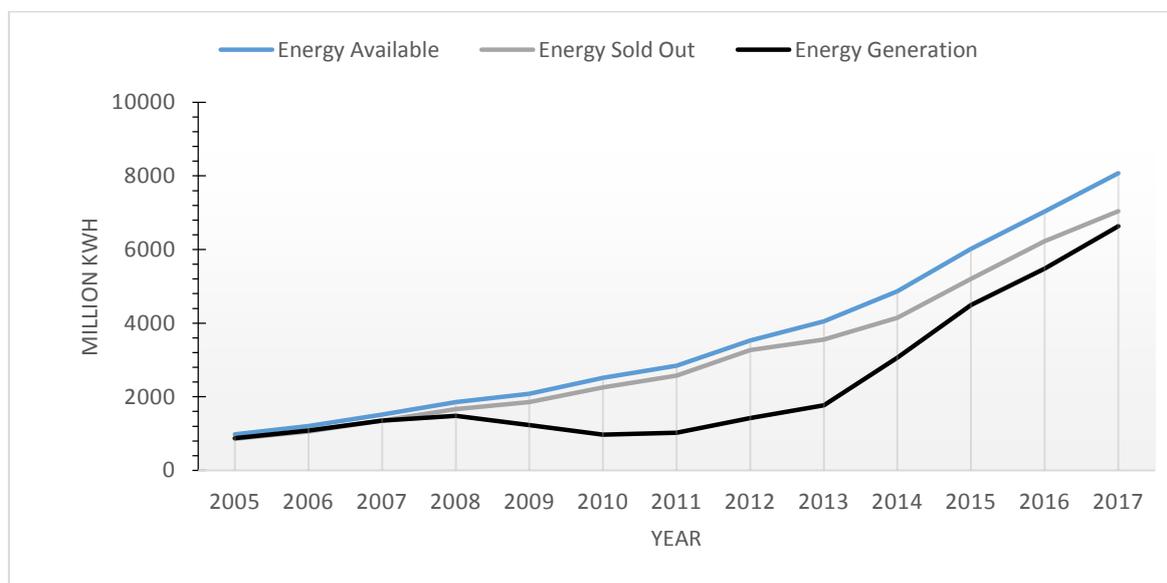
Figure 3: Energy Supply by Type of Source in Percentage



Source: EAC Annual Report 2015-2017

Energy demand is growing on average, eighteen percent per year due to economic and population growth, driving the diversification of energy supply sources [18]. The amount of energy sold from 2005 to 2017 increased from 858 million kilowatt-hours (kWh) to 7,038 million kWh (Figure 4). The amount of domestic energy produced was not enough even though the country has scaled up its energy supplies, necessitating the purchase of energy from neighboring countries. The increased imports of energy from neighboring countries from 2008-2013 contributed to the reduction of energy generated from oil. Since 2012, the energy available appears to exceed the rate of energy sold. But this tends to be temporary and the country will continue to have a mismatch between supply and demand at different times of the year [4].

Figure 4: Energy Available, Sold and Generation for Consumers from 2005 to 2017.



Source: EAC Annual Report 2005-2017

4. Access to the National Grid and Off-Grid

Data in 2018 shows that 97.6 percent of households in the country have access to at least a source of electricity (71.5 percent from grid and 26.1 percent from off-grid) [4, 10, 21]. Grid electricity is available for almost every urban household while one-third of rural households still rely on off-grid sources particularly solar home systems and rechargeable batteries [4]. On average, approximately 13,000 new solar home systems have been installed every year since 2008 [4, 22, 23]. The issue with grid-electricity is reliability since some 69 percent of users reported unpredictable power shortages and 32.6 percent experience appliance damage due to unstable voltage [4]. Mondolkiri, Ratanakiri, Steung Treng, Preah Vihear, Svay Rieng, and Kratie have the lowest electricity coverage (about 60 percent of their villages) [21]. Almost half of the rural households in these provinces cannot afford grid-electricity due to distance from the grid [4].

The government plans to build a high voltage grid system to cover all provinces and build at least one substation in each city and region by 2020 [24, 25]. The country has 2,141kms of transmission lines, and 33 sub-stations but needs another 1639.32kms of transmission lines and 14 substations to cover all the entire country [5].

5. Cost of Electricity

Data from 2015 showed that Cambodia’s electricity cost is KHR680 (USD 0.17) per kWh the highest among neighboring countries while it was USD 0.13, USD 0.08 and USD 0.12 cents respectively in Thailand, Laos, and Vietnam, which lowers the competitive advantage of the country [5]. The government has implemented an inclusive tariff policy under the multi-Tier Framework (MTF) for access to electricity. In 2018, the price of electricity in Phnom Penh for low-income consumers was KHR610/kWh (USD 0.15/kWh). Medium and high-income consumers need to pay 15 and 19 percent more per kWh. To boost the rate of rural electricity connectivity, the price of electricity for low-income consumer groups in the provinces is about 27 percent lower compared to the amount charged for the same group in the capital (Table 1).

Table 1: Tariffs for Electrical Power Categorize by Capacity of Supply in 2018

Phnom Penh and Takmao	Low Consumer (0-50) kWh	Medium Consumer (51-200)kWh	High Consumer >=201
Amount of Household in %	51.23%	25.81%	22.94%
Electrical Power Tariff per kWh	610riel	720riel	750riel
Province and Rural Area	Low Consumer (0-10) kWh	Medium Consumer (11-50)kWh	High Consumer >=51 kWh
Amount of Household in %	13.85%	52.68%	33.47%
Electrical Power Tariff per kWh	480riel	620riel	750riel for EDC and 770riel for Private Sector

Source: [5]

In 2018, the government and development partners deployed a number of mechanisms under the Rural Electrification Fund (REF) for more inclusive electrical coverage for the rural poor. Programs for the transfer of benefits to the rural population included interest-free loans to cover the cost of connection, a subsidy for the use of electricity for pumping water for agriculture and a low tariff during night time [23]. The program also encourages the use of RE particularly, solar devices, in order to improve access to electricity [17].

6. Potential of Renewable Energy for Electrification

The biggest source of RE used in Cambodia is hydropower with the first project beginning in 2002. The latest data shows that there are nine hydropower dams across the country with 979MW of installed capacity [21]. Since 2016, the investment in construction of dams from China reached USD 1.6 billion [26]. The government has approved the construction of more hydropower facilities to meet the 4,000MW of installed capacity needed by 2040 [12, 18]. Despite its economic benefit, the development of hydropower is usually associated with some environmental concerns such as land use, natural habitat, deforestation and the impact on local livelihood in terms of relocation and lost income for the people concerned [27, 28]. Apart from hydropower, the country has huge potential for more power generation from its abundant agriculture biomass. A study by ADB estimated that the country could produce about 15000GWh (gigawat-hours) of electricity from biomass [29]. In 2017, Cambodia produced 54.29 million kWh from biomass or 0.89 percent of total energy generation. In 2016, Cambodia had only five biomass generation plants with 18MW capacity and an additional two plants with 21MW capacity that were completed in 2017 [29]. With support from SNV (Stichting Nederlandse Vrijwilligers – Netherlands Development Organization), some 15,000 bio-digester plants were installed across the country since 2005 [30].

Another source of RE that has also not been fully developed is wind energy. With about 5km/s wind speed recorded at the southern part of Tonle Sap Lake and the coastal provinces (Kep, Sihanoukville, Kampot, Koh Kong), the country can potentially generate about 500MW of wind power depending on weather conditions [27]. While the first wind project was developed in Sihanoukville Province in 2010 that can produce up to 300,000 kWh/year, the country still does not have the regulatory framework to support private sector investment in this field [11, 30].

Solar energy appears to be the cleanest and workable energy source that is easy to install with long term benefits. The country has solar irradiance measuring on average 1,400–1,800kWh per square meter per year throughout the country and an average of 6-9hours of daytime [27]. Again, the development of solar energy is still at an early stage. Several projects had been already underway since 2016. For example, the 10MW grid-tied solar farm in Bavet that can produce 4.64 million kWh of energy generation in 2017, and the solar farm

developed in 2017 in Siem Reap that has 10kW installed capacity or approximately 32,85kWh per year. The government aims to scale up the share of electricity generated from solar farms to 3.5 percent of total energy in Cambodia by 2030 [27].

7. Conclusion

There has been significant progress made in the Cambodian energy sector. This is evidenced by: (1) the significant increase in urban as well as rural electricity coverage, (2) the increase in electricity supply capacity and (3) the diversification of electrical supply sources from oil generators to hydropower and other RE sources. The country still lags behind its neighbors in terms of cost, reliability and electricity coverage in rural areas, hampering its economic competitiveness. Distance from the grid, connection costs, and low-income consumers prevent some rural households from accessing electricity. Nonetheless, the country has a well-formulated energy policy with a clear plan for future expansion and a mechanism to make electricity affordable for the poor. The vision of the National Grid Development Plan 2020 is to have electricity coverage across the country. That aim, set in the policy, is likely to be achieved in the future given: (1) the current pace of electrical expansion, (2) the plan to build more hydropower dams, solar farms, and other means of electrical generation using biomass or wind energy and (3) the continued implementation of the tariffs and subsidies policies program.

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