CHAPTER 3

RENEWABLE ENERGY

3.1 Current situation of renewable energy

Cambodia is blessed with substantial renewable energy sources such as hydro, solar, biomass (including biogas), and wind. However, these renewable energy resources, particularly non-hydro renewable energy, have not yet been tapped to fulfil energy demand in Cambodia. The total primary energy supply (TPES) in 2015 was 7 million tonnes of oil equivalent (Mtoe), supplied by renewable energy (mostly biomass) (62.4%), oil (27.4%), coal (8.3%), and electricity imports (1.9%). In terms of electricity, the total installed capacity in 2015 was 1,657.2 megawatts (MW), coming from hydro (56.1%), coal (24.3%), oil (18.4%), and biomass (1.2%).

(1) Hydropower

In 2006, the Ministry for Industry, Mines and Energy (now known as the Ministry of Mines and Energy) and the Cambodian National Mekong Committee (CNMC) reviewed hydropower and identified 60 possible sites for hydro development in Cambodia with the potential for approximately 10,000 MW of power generation, of which 50% was on the mainstream Mekong, 40% on its tributaries, and 10% in the southwest outside the Mekong Basin. There are about 63 possible sites for small and large hydropower projects throughout the country. However, currently only around 1,330 MW has been tapped, which is only 13% of the potential, and other projects are under development and feasibility studies. The production of electricity from hydropower dams has increased significantly in recent years. For example, hydropower electricity production in 2011 was just 51.5 gigawatt hours (GWh) and increased almost 50 times to 2567.9 GWh in 2016.

(2) Biomass (including biogas)

The potential of biomass mostly comes from a variety of agricultural residues, such as rice husks, cassava, coconuts, and animal waste. Biomass is commonly used in rural areas for cooking. Rural households still rely on traditional biomass energy, mainly fuelwood, as their primary cooking fuel. However, most households burn biomass in traditional ways, by using traditional and inefficient stoves, which produce toxic smoke that pollutes the air inside and outside homes. The toxic smoke can be a major health risk factor in Cambodia, such as for asthma and acute respiratory infections, particularly amongst children. A number of studies show that the use of solid fuels, especially amongst households in rural areas, is closely linked to a high incidence of respiratory diseases. To reduce or mitigate such household pollution, improved or advanced stoves that burn biomass in cleaner and more efficient ways should be promoted.

Biogas from animal waste for generating high-quality gas for lighting and cooking has been used by rural households. Around 25,383 biogas digesters with capacities varying from 2 m^3 to 15 m^3 were constructed in rural areas until 2016.

In terms of electricity, Cambodia has used biomass power plants since 2006 with an installed capacity of 4.50 MW, and this has gradually increased to around 22.64 MW in 2016.

(3) Solar

The average solar radiation in Cambodia is around 5 kWh/day, with an average sunshine duration of 6–9 hours per day, or around 1,400–1,800 kWh/m2. At present, one solar photovoltaic (PV) unit of 10 MW has been installed and connected to the grid, and another three solar PV units with a total capacity of 25 MW are under development. In addition, since 2012, around 48,980 units (5–50 W peak) of solar home systems with a total capacity of 625 kW have been installed in rural areas.

The 2016 Mekong Strategic Partners report projected the potential for solar PV in Cambodia to be 700 MW, which can be installed on 1,400 hectares of land. Solar PV projects are projected to increase. However, as land is a sensitive issue in Cambodia, the development of rooftop solar PV is potentially to be developed for residential buildings and also existing dam reservoirs instead of land.

(4) Wind

Cambodia's wind potential is located mostly in the southern part of the great lake Tonley Sap, the mountainous districts in the southwest and the coastal regions, such as Sihanoukville, Kampot, Kep, and Koh Kong, which have an annual average wind speed of 5 m/s.

3.2 Major issues

Electricity demand in Cambodia has grown at an average of nearly 20% per year since 2010. Electricity demand is mostly supplied by large-scale hydropower and coal-fired power plants. Although Cambodia has the potential for non-hydro renewable energy, such as biomass, wind, and solar, non-hydro renewable energy is not yet utilised optimally due to barriers such as higher up-front costs and no clear target for renewable energy in the energy mix.

(1) No clear target

Renewable energy targets are defined as numerical goals established by governments to achieve a specific amount of renewable energy production or consumption in the entire energy mix (TPES or total final energy consumption [TFES]). They can apply to electricity or heating/cooling or to the energy sector as a whole. For example, Indonesia has set a renewable energy target of 23% by 2025 and Thailand of 40% by 2036, while ASEAN's renewable energy target is 23% by 2025. A renewable energy target sends an important signal to stakeholders, and it plays a significant role in informing investment decisions. Renewable energy targets contribute to developing a clearer vision for the development of the sector and enable stakeholders to allocate funding more effectively. Specific design issues for policymakers to consider include whether the target should be established in absolute terms (a specific quantity of energy to be supplied) or relative to a moving baseline (i.e., in percentage terms) and whether electricity targets should be set in capacity (megawatts) or in output (megawatt-hour) terms. Renewable energy targets need to be accompanied by a clear strategy and backed by specific policies and measures.

Although the Government of Cambodia has issued policies and regulations in the energy sector, some of which are linked to renewable energy utilisation, the government has not yet set a national target for renewable energy utilisation. This means there is no clear signal to stakeholders, particularly to the private sector, to convince them or to guarantee that their investments in renewable energy projects will give them benefits and profit, especially for the national energy supply security.

(2) Lack of policy and regulations to support the promotion of renewable energy utilisation

The Government of Cambodia is committed to implementing sustainable energy security. The government has set up the Cambodia Energy Policy, which aims to provide an adequate supply of energy throughout Cambodia at a reasonable and affordable price; to ensure a reliable and secure electricity supply at a reasonable price, which facilitates investment in Cambodia and the development of the national economy; to encourage exploration and the environmentally and socially acceptable development of energy sources needed for supply to all sectors of the Cambodian economy; and to encourage the efficient use of energy and to minimise the detrimental environmental effects resulting from energy supply and consumption.

The government has also set up policy targets: by 2020, 100% of villages in the country should have access to electricity, and by 2030, at least 70% of the total households in the country should have access to quality grid-supplied electricity. Achieving these targets will depend on the utilisation of all types of electricity sources and the participation of the relevant stakeholders.

The Electricity Law (2001) provides the governing framework for the electricity power supply and services throughout the Kingdom of Cambodia. The law covers all activities related to the supply of electricity, provision of services, and use of electricity and other associated activities in the power sector.

The National Policy on Rural Electrification by renewable energy has the objectives of providing clean, reliable, safe, and reasonably priced electricity in rural areas based on primarily renewable energy in a fair and equitable way.

The Development Plan 2008–2021 projects that 2,770 MW will be constructed in 2020, of which 2,241 MW will be supplied by hydropower.

The National Climate Change Strategic Plan 2014–2023 is a comprehensive national policy that promotes the use of renewable energy to mitigate greenhouse gas emissions. The Government of Cambodia has made a major commitment to reducing the carbon intensity of its energy sector as part of its Intended Nationally Determined Contribution (INDC). Under its INDC, Cambodia proposed a contribution to mitigating greenhouse gases, conditional upon the availability of support from the international community, of a 16% reduction from the 2030 energy sector business-as-usual scenario. The priorities of the INDC actions are the following:

- national grid-connected renewable energy generation (solar energy, hydro, biomass, and biogas);
- connecting decentralised renewable generation to the grid;
- off-grid electricity, such as solar home systems, hydro (pico, micro, and mini); and
- promoting energy efficiency by end users.

In 2013, Prime Minister Hun Sen launched the Cambodian Climate Change Strategic Plan 2014–2023, the National Policy for Green Growth 2013–2030, and the National Strategic Plan for Green Growth 2013–2030, all of which propose policy actions in the energy sector that can support greener, more inclusive growth, including increasing renewable energy deployment, facilitating loans for sustainable projects, and improving the energy efficiency of industries and households.

To realise sustainable energy security, particularly in the field of the power sector, the government set up strategies for developing generation through increasing the diversification of the power supply, such as through hydro, coal power, importing electricity, and other renewable energy sources (biomass, solar, and wind), to meet the electricity demand and reduce oil for power generation. However, since there is no specific target for the renewable energy share in the national energy mix and no clear regulation or policy, the renewable energy business in Cambodia is relatively low, particularly for non-hydro.

The Government of Cambodia ratified the Paris Agreement in 2016 and has agreed to reduce greenhouse gas emissions, but the reduction of greenhouse gas emissions, particularly in the energy sector, cannot be achieved without increasing the utilisation of renewable energy significantly. Therefore, sustainable energy security, environmental protection, and climate change mitigation in Cambodia are major drivers for scaling up renewable energy deployment. The government should take action to develop strong policies, regulations, and incentives for investors to make them more interested in investing in the renewable energy industry. Cambodia has some good experience in implementing renewable energy projects, but it needs to develop policy instruments based on the lessons learned in other countries that have already successfully implemented renewable energy projects. The Ministry of Mines and Energy of Cambodia, together with related institutions, such as the Ministry of Environment, Ministry of Finance, and the Electricity Authority of Cambodia, will start drafting regulations and incentives for renewable energy, such as feed-in tariffs (FITs), reducing import taxes on renewable energy technology/ equipment, financing support mechanisms, the simplification of permit procedures, and grid system and renewable energy standards.

3.3 Assessment of the voluntary renewable energy target

Electricity demand in Cambodia has been increasing significantly by around 18% annually from 2010 to 2016. Coal (29%) and hydro (52%) are two primary sources of power, together accounting for 81% of the total installed capacity in 2017, while other renewable power plants using wood and other biomass comprised only 5%. The total installed capacity was 1,867 MW. Cambodia does not have fossil energy resources, so for its coal and diesel power generation, the country imports coal and fuel oil from other countries. To strengthen the national energy security of supply as well as to achieve the national target of emission reduction as already stated in the INDC, the Government of Cambodia should increase the use of renewable energy, which is locally available. The government should reduce the use of coal and diesel power plants. Based on the Cambodia Energy Outlook, the most possible energy mix in the year 2030 comprises hydro at 55% and non-hydro renewable energy at 10% (biomass, solar PV, and wind) of the projected total electricity output of 26.2 TWh.

3.4 Necessary renewable energy policies

To achieve the target as mentioned, there needs to be strong regulation.

(1) Hydro

The average production cost of electricity from hydropower is less than US$0.07/kWh, which is less than the national electricity tariff of US$0.20/kWh. So, from the economical point of view, there is no need for the government to issue new regulation, since hydropower can be developed on a commercial basis. However, hydropower projects are always subject to environmental issues. Most hydropower project developments are strongly opposed by environmentalists and local people. Even a common study by the Mekong River Commission shows that dam construction has negative impacts on the riparian ecosystem, sustainability, and food security associated with fish production in Cambodia. In order to maximise the use of hydropower but minimise its negative impacts, the government needs to have strategies on how to mitigate the predicted negative impacts. For such purposes, the government should issue regulations that guarantee that hydropower project developments comply with all steps to achieve a high-quality environmental impact assessment and also a transparent decision-making process.

(2) Wiser use of biomass through efficient cooking stoves

As mentioned, many rural households rely on biomass, particularly for cooking, by using simple traditional cooking stoves (three big stones). Unaware of the harmful effects of household air pollution, the users of firewood stoves expose themselves daily to toxic smoke, increasing the risk of asthma, lung tuberculosis, and acute respiratory infections, particularly amongst children. A World Health Organization publication (2018) estimates that over 4 million people around the globe die each year from using traditional cooking stoves. Realising the importance of biomass in rural areas, the Government of Cambodia has taken action since some years ago to examine how to use biomass/fuelwood in efficient ways as well as tackle indoor pollution. There are several improved cookstoves that have already been introduced to rural households, such as the New Lao Stove introduced by the Group for the Environment, Renewable Energy and Solidarity in 2003. The New Lao Stove is more resistant and consumes less biomass fuel, using 22% less fuelwood, and each stove saves 0.4 tonnes of CO_2-equivalent per year. In 10 years until 2013, 2 million New Lao Stove units have been distributed by the Group for the Environment, Renewable Energy and Solidarity. Promoting the wide use of efficient biomass cookstoves, particularly in rural areas, requires strong policies and regulations that emphasise improving energy access for remote and poor populations. The policies and regulations should be able to create an enabling environment for developing the biomass cookstove business and markets by providing incentives.

The Ministry of Energy and Mining of Cambodia should take the lead in developing a road map or a master plan to scale up access to clean biomass cooking stoves and developing national standards, testing, and certifications for biomass cookstoves.

(3) Gradual increase of solar PV and wind

At present, the use of solar PV and wind power generation in Cambodia is small compared to other countries, both in the ASEAN region and internationally. The development of solar PV generation is expected to improve the overall energy sector in Cambodia. With the relatively high potential of solar PV and wind power in Cambodia, it is projected that solar PV and wind power will gradually increase, both to strengthen the security of the energy supply and to tackle climate change. The projection is also supported by the decline in cost. The International Renewable Energy Agency states that from 2010 to 2017, the cost of solar fell by 60% and wind by 40%. The predicted cost will continue to fall because of more efficient designs and advances in materials and manufacturing. Solar rooftops will also increase because of the price of land. However, to scale up solar PV and wind power projects will require huge investment. Therefore, cooperation and collaboration with international financing are strongly needed, such as from the Asian Development Bank, World Bank, USAID, Japan International Cooperation Agency, European countries, KfW of Germany, and Agence Française de Développement of France.

(4) Introduction of existing renewable energy policies

In general, renewable energy is mostly claimed to have a high cost of production, which results in a cost per kilowatt-hour of electricity that is relatively expensive compared with that of conventional power plants. On the contrary, renewable energy is clean energy, which means the emissions from renewable energy are very low compared to fossil energy. However, there are still some barriers facing the development of renewable energy projects. To increase renewable energy utilisation, the barriers should be removed by creating an enabling policy environment that can encourage the private sector to participate in investment in the renewable energy projects. Countries with a low level of renewable energy development and small-scale projects, such as Cambodia, need regulations to scale up renewable energy deployment.

In many countries around the world, such as in Europe, the United States, Japan, India, and ASEAN countries such as Thailand, the Philippines, Indonesia, and Malaysia, governments have issued various policies and regulations to scale up renewable energy deployment. Various regulations have been implemented in many countries, such as FITs, Renewable Portfolio Standards (RPS), net metering systems, and other incentives to encourage and scale up renewable energy business.

1) Renewable Portfolio Standards

RPS mandate that certain percentages of all electricity in the country come from renewable energy sources. The RPS mechanism commonly places an obligation on electricity supply companies to produce a specified fraction of their electricity from renewable energy sources. The RPS can be achieved through three mechanisms: (1) by producing renewable energy itself, (2) by purchasing renewable energy produced by another supplier, or (3) by buying renewable energy credit certificates. These certificates are issued to renewable energy producers based on the amount of energy they feed into the grid. Selling the certificates is another way for renewable energy producers to supplement their revenue. The RPS encourages the development of renewable energy markets by ensuring that some specified minimum amount of renewable energy is included in the supplier's portfolio of generating fuels. The RPS can play an integral role in a country's efforts to diversify its energy mix, promote domestic energy production, and reduce emissions. However, the RPS can cause electricity price increases because, in many cases, the cost of electricity from renewable energy is higher than that of conventional energy. This means that consumers will spend more for electricity. In addition, the RPS need transmission and integration system upgrades to enable the absorption of more electricity from renewable energy. Because of the intermittent nature of renewable energy, in terms of planning reserves, as the amount of variable generation gets added to the electricity system, it is possible that more fossil peak-power generation will be needed in order to maintain reserve requirements.

The RPS mechanism has been adopted in many countries. For example, Germany set the RPS at 18%, 30%, and 60%, respectively, in 2020, 2030, and 2050.

2) Feed-in tariffs

FITs are an instrument for encouraging large-scale renewable energy projects since they provide a stable income to developers. A FIT is a fixed price or standard purchasing price that is paid to renewable energy producers for each unit of electricity produced and injected into the electricity grid. A FIT is intended to encourage the adoption of renewable energy by overcoming the high upfront costs of renewable energy projects. FITs offer an effective way of achieving the RPS. FITs are usually differentiated from renewable energy technology due to the differences in generation costs between the renewable energy technology. FITs are also used for the size of the renewable energy project, such as for small and medium capacity.

The payment of the FIT is guaranteed for a certain period of time, which is often related to the economic lifetime of the respective renewable energy project. A FIT is usually paid by the electricity grid system or market operators in the long-term contract of the power purchase agreement.

The level of a FIT is determined on the basis of a calculation of the levelised cost of electricity produced from renewable energy. This allows the renewable energy investor to recover the different costs (capital, operation and maintenance, fuel, and finances) while realising a return on the investment that depends on the assumed financing cost. It is also possible to determine the FIT level by means of a tendering mechanism. As a FIT is a cost-based price, the price for a renewable energy-based power plant will be higher than for a conventional-based power plant or national electricity tariff. As a consequence, the government should allocate budget to cover the gap; or the FIT can be passed through to consumers, and it is possible to increase the electricity tariff.

When introducing a FIT, some key components must be considered:

- Determining a good tariff rate. If the tariff rate is too high, producers will benefit more, but the government will bear or provide more subsidies, or consumers will pay a higher electricity tariff. If the tariff rate is too low, there will be little or no investment.
- Imposing a priority purchase obligation for renewable energy. Grid operators should prioritise connecting and transmitting electricity from renewable resources before energy from other sources.

- Guaranteed tariff rates for a specific time period/length of contract. This ensures the security of investment for producers, investors, and suppliers.
- Determining the renewable energy technologies to be covered.
- The size of the eligible project.

The advantages of FITs include the following:
- Guaranteed long-term contracts (usually 15–20 years).
- Increased drive for technology innovation. Good FIT rates for renewable energy encourage investment in renewable energy business.
- Secure domestic energy supply. Countries will become less dependent on imported fossil fuels when the domestic renewable energy supply market expands.
- Creation of jobs. The growth of the renewable energy market will increase job opportunities. Analysis by the International Renewable Energy Agency has shown that the renewable energy sector is already creating jobs across Southeast Asia, estimated at 611,000 jobs in 2016, of which 362 jobs were in bioenergy, while the rest were in hydropower, solar, wind, and geothermal energy.
- Reduction of CO_2 emissions because renewable energy is from clean energy sources.
- Enables renewable energy technologies to compete with conventional energy sources.
- Easier for developers to get project financing.

The disadvantages of FITs include the following:
- Likely to cause an increase in the cost of electricity for customers unless subsidies or incentives are available.
- Utilities need to improve their grid system to enable absorbing more renewable energy.

REN 21 (2014) states that 73 countries have adopted FITs. The lessons learned from many countries, such as Germany, Denmark, Spain, Japan, India, Thailand, Indonesia, the Philippines, and Malaysia show that FITs have proven to be very effective in speeding the transitions to the use of renewable energy for producing electricity and also for helping society to effectively address climate change. The example of Japan's FIT is shown in Table 3.1.

Table 3.1 **Feed-in Tariff for Renewable Energy in Japan, 2012**

Resource	JPY/kWh	US$/kWh	Period of contract (years)
Wind			
< 20 kW	55.75	0.735	20
> 20 kW	23.1	0.294	20
Geothermal			
< 15 MW	42	0.534	15
> 15 MW	27.3	0.347	15
Hydro			
>200 KW	35.7	0.454	20
>200 KW < 1 MW	30.45	0.387	20
> 1 MW < 30 MW	25.2	0.321	20
Photovoltaics			
< 10 KW	42	0.534	10
> 10 KW	42	0.534	20

JPY = Japanese yen, kWh = kilowatt-hour, US$ = United States dollar.

Source: IEA, 2017.

3) Net metering

Net metering is a billing mechanism that credits solar energy system owners for the electricity they add to the grid. If residential customers have a PV system on their house rooftops, they may generate more electricity than the home uses during daylight hours. If the home is net-metered, the electricity meter will run backward to provide a credit against what electricity is consumed at night or other periods where the home's electricity use exceeds the system's output. Customers are only billed for their 'net' energy use.

Net metering allows utility consumers to generate their own electricity cleanly and efficiently. Net metering is more suitable for small-scale renewable-based distributed generation. During the day, most solar consumers produce more electricity than they consume, which allows them to export that power to the grid and reduce their future bills. As such, solar PV enables local self-consumption that can deliver savings to the grid. This can result in a significant reduction in the monthly electricity consumption of the owner of a solar PV system. It can complement the grid and provide benefits and potential cost reductions for both the end consumers and the grid system. A net metering system is easy and inexpensive. With the net metering system, the installed solar PV does not need a battery backup to store power, meaning that the investment for the solar PV system can be reduced. Net metering increases demand for solar energy systems, which in turn creates jobs for the installers, electricians, and manufacturers who work in the solar supply chain. However, for utility companies, the net metering system means shrinking profits because consumers buy less power from the utility.

4) Financial and fiscal incentives

Financial and fiscal incentives are aimed at decreasing the production cost of renewable energy projects and increasing their affordability and bankability. Financial and fiscal incentives are needed to improve access to capital, lower financing costs, and reduce the burden of the high upfront costs of large-scale renewable energy projects. They can be in the form of tax incentives, rebates, or grants. Tax incentives are typically offered in the form of a reduction in value-added, tax allowance/accelerated depreciation, or investment tax credit. Tax incentives can reduce the cost of renewable energy systems for the developer and can increase their affordability and profitability. Many countries have adopted tax incentives to increase renewable energy deployment.

Table 3.2 Summary of Advantages and Disadvantages of Renewable Portfolio Standards, Feed-in Tariffs, and Net Metering

	Renewable portfolio standards	Feed-in tariffs	Net metering
Advantages	• RPS can play an integral role in countries' efforts to diversify their energy mix, promote domestic energy production, and reduce emissions. • RPS encourage the development of renewable energy markets by ensuring that some specified minimum amount of renewable energy is included in the supplier's portfolio of generating fuels.	• Guaranteed long-term contracts (usually 15–20 years) • Increased drive for technology innovation. Good FIT rates for renewable energy encourage investment in renewable energy business. • Secure domestic energy supply. Countries will become less dependent on imported fossil fuels when the domestic renewable energy supply market expands. • Creation of jobs. The growth of the renewable energy market will increase job opportunities. Analysis by the International Renewable Energy Agency has shown that the renewable energy sector is already creating jobs across Southeast Asia, estimated at 611,000 jobs in 2016, of which 362 jobs were in bioenergy while the rest were in hydropower, solar, wind, and geothermal energy. • Reduction of CO_2 emissions because renewable energy is from clean energy sources. • Enables renewable energy technologies to compete with conventional energy sources. Easier for developers to get project financing.	• Net metering allows utility consumers to generate their own electricity cleanly and efficiently. • Net metering allows consumers to export power to the grid and reduce their future bills. • It can complement the grid and provide potential cost reductions to both the end consumers and the grid system. • The net metering system is easy and inexpensive. • With the net metering system, the installed solar PV does not need a battery backup to store power. This means that the investment for solar PV system can be reduced. • Net metering increases demand for solar energy systems, which in turn creates jobs for the installers, electricians, and manufacturers who work in the solar supply chain.
Disadvantages	• RPS can cause the electricity prices because the cost of electricity from renewable energy is higher than conventional energy. • RPS needs transmission and integration system upgrades to enable the absorption of more electricity from renewable energy. • Because of the intermittent nature of renewable energy, it is possible that more fossil peak-power generation will be needed in order to maintain reserve requirements.	• Likely to cause an increase in the cost of electricity to customers unless subsidies or incentives are available. • The utility needs to improve its grid system to enable it to absorb more renewable energy.	• The utility companies may have shrinking profits because consumers buy less power from the utility.

PV = photovoltaic, RPS = Renewable Portfolio Standards.

Source: Summary taken from section 3.4.

5) Rural electrification

Cambodia as a developing country has many rural areas that have not yet been reached by the national grid. To increase access to electricity, using locally available renewable energy may be a solution. However, the development of renewable energy-based power plants in rural areas may not be commercially viable because people's ability to pay is low.

The Government of Cambodia has set an electrification target of increasing the level of villages' access to grid-quality electricity to 100% by 2020; and at least 70% of all households in Cambodia are to have access to grid-quality electricity by 2030. This means that in 2030, it is projected that around 30% of households will not have access to the grid, and these households will mostly be in rural areas that face difficulty or high costs of being reached by the grid system. For such areas, the implementation of standalone or decentralised systems using renewable energy is an appropriate option. Solar home systems, for example, are standalone systems, and micro hydropower and solar PV decentralised systems may be economical for remote rural households that do not have access to the grid for long periods.

Since the production cost of renewable energy-based power plants is high, and the electricity price from renewable energy is higher, the high cost of providing services to remote areas and the low consumption mean that rural electrification schemes are usually more costly than urban schemes. However, it seems there is a strong correlation between rural poverty and access to electricity because electricity is a pre-requisite for productive activities. Rural electricity programmes seem to be crucial for implementing improved living conditions and promoting production and better health and education for households. However, the electricity tariffs in rural areas do not need to be the same as in urban areas. Rural electricity tariffs should be set at a level that is affordable for the majority of customers. Therefore, to increase the access of rural people to electricity, the government should support rural electrification programmes through collaboration with international banks. For such purposes, the Government of Cambodia, supported by the World Bank, established the Rural Electrification Fund (REF) in 2004. The REF is intended to provide grants for promoting rural electrification by renewable energy technologies. The REF has facilitated access by rural people to electricity through solar home systems by providing subsidies of US$100 per solar home system unit. With the subsidy, solar home systems have become more competitive in rural areas.

Since the government's funding for rural electrification is limited, to accelerate the implementation of rural electrification programmes, the Ministry of Mines and Energy should actively seek international support such as from the Asian Development Bank, the Japan International Cooperation Agency, USAID, Global Environment Facility, the Carbon Fund of the World Bank, and from European countries, such as Germany's GIZ, Denmark, the Netherlands, France, Finland, and Norway, which provide some assistance to developing countries to develop rural electrification. In addition, the government should take into consideration the open access of rural people to microfinance.

3.5 Recommendations

Based on Cambodia's energy situation, in order to speed up the deployment of renewable energy, the government needs to take action, particularly in setting up policy and regulations. For such purposes, we recommended the following measures:

- **In the short and medium terms**
  - → Set up a target for renewable energy in the energy mix for 2030.
  - → Set up regulations on environmental issues for hydropower development.
  - → Set up regulations for using biomass-efficient cooking stoves and developing national standards, testing, and certifications for biomass cookstoves. The government, through the Ministry of Mines and Energy, should actively seek international funding resources (grants and soft loans).

- **In the medium and long terms**
  - → Study to apply FITs (up to a certain capacity, for example a capacity up to 10 MW) for biomass, solar, and wind power generation.
  - → Study to apply a net metering system to encourage the use of solar rooftops.
  - → Study to apply renewable portfolio standards and financing and fiscal incentives.

Reference

International Energy Agency [IEA] (2017] Feed-in Tariff for Renewable Electricity and Solar PV Auction. Access at [https://www.iea.org/policiesandmeasures/pams/japan/name-30660-en.php]. Access date [27 January 2019].