# THE WORLD WE WANT

## Cambodian Youth Perspectives


Edited by

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# Chapter 15 | Sustainable Electricity in Cambodia in 2050: A Study on Innovative Micro-Grid System

Vichet PRUM

## Future Scenario

In Preaek Tnoat Commune in Tuek Chhou District located in Kampot Province in Cambodia in 2050, Sok's family is one of families in the community that tends to use the most energy and electricity for their household business and daily usage. Most of Sok's family members own individual cars and drive to work every day. Sok's small business is a bakery shop in his area in which he produces bread to sell. It also requires a lot of electricity. Sok used to have electricity bills that were more expensive than other households in the community, but now that electricity in Cambodia is affordable and sufficient for usage, Sok has not had problems with high electrical bills. The government had planned for all rural areas to be connected to the national grid by 2030, which was achieved for his community. There is a micro-grid system locally generates electricity from renewable resource, which was established by a Chinese company.

Prior to these efforts to promote rural electrification, Cambodia was struggling to meet its electricity needs. Before 2030, Cambodia's electricity still depended on hydro dams and much of it was imported from other countries. However, hydro dams had many negative environmental impacts. Furthermore, due to overconsumption and overpopulation with the rise of globalization, Cambodia's sources of non-renewable energy such as oil, coal, natural gas were diminishing.

What made the electricity situation in Preaek Tnot Commune better and more sustainable is the connection that was built from new alternative energy resources to the installed micro-grid system, which can distribute sustainable electricity in local areas supported by a partnership between the government and foreign investment. These alternative energy resources such as solar and wind turbines are cheaper than traditional energy sources used to be. The solar projectors as well as solar batteries that can store electricity for use at night became cheaper after a subsidy from the government as well as the low tariff on energy efficiency products.

With these incentives in place, in Tuek Chhou District, a tidal energy system and a wind turbine were set up and connected to a micro-grid in Sok's community. This process involved a Chinese

company that worked with Électricité Du Cambodge (EDC) and rural electrification enterprises (REE) to assist in operating the micro-grid system.
In the northern and southern part of Cambodia, which are the windy areas, the government has installed some wind turbines along the mountain range and coastal area, which can generate electricity and connect to many micro-grids in rural areas as well as the national grid. Again, a Chinese company collaborated with EDC and REE to assist in operating the distribution line. In 2015, wind turbines are affordable to install and operate. Along with these alternative resources, the existing renewable energy sources such as hydro dams and solar systems also contribute electricity to the national grid. These are also supported by financial partnerships especially from banks that can share the burden with households in rural areas.
Rural electrification enterprises with Électricité Du Cambodge provide assistance in teaching communities members about generating electricity from their agricultural waste. The sustainability of electricity in the next few decades also comes from a regionally connected grid connected to other micro-grids near the borders and other partners such as China and Japan that are a driving force to reach energy security inside Cambodia.

Some policy recommendations have been implemented to make electricity in Cambodia more sustainable. The government has encouraged the development of alternative renewable energy resources such as biomass gas from agricultural waste for cooking in rural area, wave/tidal for areas that near the ocean, and wind turbines. As Sok's community is located in Tuek Chhou District, there is an innovative way to capture energy by building a grid under the ocean and generating electricity through waves. With alternative options such as solar energy, efficient hydro dams, affordable wind turbines, and the rise of biomass generators, in 2050, Cambodia will have capabilities to make these alternative sources more equitable and sustainable. In addition, Cambodia expected to have nuclear power plants by 2040, whose electricity will be available for domestic demand, connected to micro-grids in rural areas as well as the national grid.

Energy saving measures are also promoted. Carpooling to work is encouraged as well as the use of energy efficient products such as LEDs and, light control system that can save up to 50% of the electricity used by traditional products. Sok can also generate electricity in his household by using biomass from burning agricultural waste. Installing a micro-grid system in one respective area provides affordable and sustainable electricity for a whole area as in Sok's community.

The future of Cambodia's electricity is predicted to be affordable and sustainable by 2060. The country will have many alternative choices such as solar panels and wind turbines and generating power from nuclear energy and alternative sources will become cheaper and cheaper. Micro-grid systems in rural areas in the northern and western parts of Cambodia will provide reliable and sustainable energy for many more Cambodians.

## Introduction

Electricity is one of the basic needs for households, business places, small and medium enterprises, companies and any light or heavy industries. In this modern world, people cannot live without electricity, as simple activities such as turning on the light, opening a refrigerator to get some food, charging your phone, and especially using fans or an air conditioner at night, all consume quite an amount of electricity and are necessary to enhance our quality of life. However, life in rural areas is not the same as in the city where the majority of people enjoy regular access to electricity. In rural areas, the level of accessibility and affordability of electricity is still limited (Marabona, 2019).

Electricity demand is increasing significantly from decade to decade (Energypedia, 2018). Domestically demand exceeds the electricity supply that is generated in the country from coal, fuel, oil and, hydro leaving Cambodia to import electricity from its neighboring countries (Poch, 2013). In the first half of 2020, power consumption dropped from 1,900 megawatts to 1,700 megawatts because the COVID-19 pandemic forced the closure of many factories and tourism-related facilities (Chea, 2020). However, the global pandemic cannot be a driving force to decrease the demand of energy consumption in the long term. The impact of generating electricity from non-renewable sources has harmed environment severely, which could pose a threat to energy security in the region. Therefore, it is imperative for Cambodia to achieve sustainability of electricity for the whole nation.

## Context Analysis

The Royal Government of Cambodia expects to provide electricity to all rural areas in Cambodia by 2030 (ADB, 2018). By 2050, rural areas in Cambodia will achieve the sustainability of electricity, meaning the transition to a system using 100 percent renewable energy that meets today's demand without depletion in the future (Burger et al., 2012). Current electricity supply for the country comes from coal (35 percent), hydroelectricity (48 percent), fuel oil (2 percent), and other renewable sources like solar (less than 1 percent) and imports from Thailand, Vietnam and Laos (14 percent) (Electricity Authority of Cambodia, 2018). The Royal Government of Cambodia has tried to seek financial support from international development partners, other Cambodian private, and public sector investors to take part in grid expansion projects (De Ferranti et al., 2016). Recently, ADB has approved a US$127.8 million loan to support Électricité du Cambodge (EDC) to strengthen its transmission infrastructure by financing the construction of four 115–230 kilovolt transmission lines and 10 substations in Phnom Penh and Kampong Chhang, Kampong Cham, and Takeo provinces (ADB, 2020).

According to the Electricity Authority of Cambodia (EAC) annual report in 2019, there were nine hydropower dams operating in Cambodia that connected to the national grid and to other

provincial grids, as well as three coal-fired power plants, four biomass companies that generate electricity from biomass and other waste, and only one 90 MW solar farm in Kompong Speu province (EAC, 2019). The Ministry of Mines and Energy has said that there will be no further hydropower dams built on the Mekong River and the focus for future electricity generation will be on renewable energies, but they will also construct two coal-fired electricity plants with a total output of 900 MW (Kijewski, 2020). Five solar parks that account for 160 MW a year are under construction and will be connected to the national grid (Chhut, 2020). Moreover, Électricité du Cambodge negotiated with The Blue Circle Company to construct an 80 MW wind power farm in Kampot province and plans to build more wind turbines in Sihanoukville and Mondulkiri province (Hin, 2020). Non-renewable energy sources will eventually face exhaustion in the future while some renewable energy especially hydro dam can have negative environmental impacts such as restricting the movement of fish to the lower Mekong, increasing flood risk potential and causing pollution to the river during construction. As such, the government needs to consider promoting other types of renewable energies such as more solar farms and wind turbines.

Figure 1: Rural household benefit from solar home system program of rural electrification enterprise
Source: Department of Rural Electrification, 2021

Some households in rural areas still cannot access the national grid and only have access to small rural electrification enterprises, who are private power producers that operate micro grids supplied by diesel generators; these micro-grids are more pollution-intensive and more expensive than electricity provided by the grid (De Ferranti et al., 2016).

The Rural Electrification Fund under the EDC has implemented two essential programs, which are Power 2 Poor (P2P) and Solar Home System. The Power 2 Poor program has helped poor households in rural areas to access electricity from the grid supply by providing interest free loans to meet the costs for connection fees, deposit, equipment and the installation of wires from the

connection point to houses as well as the costs to cover the purchase of materials and labor for the installation of in-house wiring. The Solar Home System program helps install solar panels for poor households in rural areas that cannot connect to the national grid. After the purchaser has paid the remaining cost in full, the Solar Home System will become the property of the purchaser. During 2020, 9,834 rural families equivalent to 45,236 individuals have directly benefited from this program as show in Figure 1, rural households received each solar home panel and other solar-related equipment from the program (Department of Rural Electrification, 2021, p.27). However, the programs from the Rural Electrification Fund have some challenges such as a lack of coordination among the parties involved, a lack of financial support, and some projects have been put on hold. At the end of 2020, the electricity supply by the national grid to rural areas reached 97.13% of total villages and the remaining are non-electrified due to the delay of the expansion plan amid of the outbreak of the COVID-19 pandemic (Electricity Authority of Cambodia, 2021). What concerns those using solar panels in rural areas the most is the price of equipment which continues to rise due to import tariffs. The regulation from authorities needs to be improved to ease these problems so that households in rural areas can access electricity via renewable sources more easily.

In order to give rural areas in Cambodia sustainable access to electricity, Cambodia must introduce more alternative renewable energy resources and install micro-grid systems in hard-to-reach areas. Micro-grids are small, privately owned and operated systems with a generation capacity of up to 10 megawatts and which can distribute power to multiple customers (Castalia, 2017). A micro-grid can be supplied by distributed generators, batteries, and/or renewable energies like solar panels and it can disconnect from the main grid and operate autonomously (Lantero, 2014). Better access to micro-grids in rural areas would make the future of electricity in Cambodia more sustainable

## Policy Recommendations

To make electricity in rural areas in Cambodia more sustainable by 2050, several actions should be considered by the Ministry of Mines and Energy, the Electricity Authority of Cambodia and other public-private partnerships especially foreign investors in the electricity sector. These include promoting more renewable energy sources that could connect to micro-grids as well as improving regulations.

**Accessibility, affordability and sustainability of renewable energies**

Cambodia should consider expanding opportunities for more types of renewable energy. Currently, the price of solar panels might be a barrier for Cambodia to promote more solar farms at the community level, but prices may come down as the demand for solar equipment increases, as is expected over the next decade, according to the International Energy Agency's annual report

(Calma, 2020). In Cambodia, the price of a solar panel is based on the type of power that panel can generate. Solar farms constructed by private partnerships such as Schneitec Infinite, have set a small tariff to EDC of only USD 0.076 per kWh, but for solar rooftop installations, the current market price is around USD 800-1000 per kWp (kilowatt peak). However, over the next two decades, it has been predicted that the price might fall to USD 10 per kWh (Sevea, 2020).

Since the price is still high, rural electrification enterprises should take action to install solar rooftop systems that can be shared within communities for low-income people to access electricity. Rural electrification enterprises might face difficulty with the price when solar photovoltaic (PV) systems are not connected to the national grid, but if all rural areas are connected to the national grid, enterprises can reduce their operating costs by assisting in financial incentives for households that are using micro-grids with renewable energies and providing a reliable supply of energy in the area.

Moreover, the power per unit area that is received from the Sun in Cambodia of five $kWh/m^2$ is considered very good for investing in solar energy (UNDP, 2019).

Similarly, wind turbines also have high upfront costs, but wind energy will be applicable for the future of Cambodia's electricity as well. Strong winds in the northeast and southern part of Cambodia make those the most promising locations for wind energy in the future. The government should promote more small scale solar panels and wind turbines by rural enterprises or independent producers to install in rural areas, so people can access electricity with the help of funds from rural enterprises and enjoy having electricity before national grid connected to their areas.

**Promoting innovative micro-grid system with renewable energy sources in remoted areas**

In order to achieve a sustainable and efficient electricity system in the whole nation, an innovative micro-grid system should be promoted and installed in off-grid areas. According to EAC, there are approximately 300 mini-grids operating in Cambodia, but those mini-grids are mostly connected to non-renewable energy resources such as coal and oil. Given the immense potential in Cambodia for renewable energy such as solar and wind energy, micro-grid systems that draw from renewable energy sources and connect from the main grid to remote areas offer an excellent alternative. For example, a Singaporean company has introduced an innovative micro-grid on Koh Rong Sanloem Island, transforming the island from diesel power to solar-battery power that can provide clean and sustainable electricity for the whole island (Thou, 2020). Cambodia is expected to construct more solar farms as well as wind turbines in the northern and eastern parts of the country, where plenty of rural households are off-grid. Therefore, there is very high potential for installing micro-grids in those remote areas by connecting a distribution line from the main renewable energy resource to the micro-grid. However, the process of installing micro-grids and connections from renewable energy sources might face potential barriers. It requires last-longing storage devices or batteries, an inverter that

converts DC power generated by solar PV systems into an AC power supply, and a suitable area for installing the grid near to the renewable energy source, solar farm or wind farm (Murali et al., 2012). While micro-grids with renewable energy sources will make the electricity sector in Cambodia more sustainable and reliable, there are still many challenges to be addressed and the next section will look at improvements needed in regulations toward micro-grid systems.

**Policies and regulations toward innovative micro-grids**

There are a number of regulations that need to be improved in order to ensure sustainable and reliable energy access for rural areas. The Ministry of Mines and Energy (MME) is in charge of providing policies or strategies for the power sector, while the Electricity Authority of Cambodia is in charge of setting tariffs, enforcing regulations and reviewing of policies. Moreover, Électricité du Cambodge is responsible for generator transmission and distribution of power and working with independent power producers, rural electricity enterprises, and provincial electricity companies (Sevea, 2020). The relations between each stakeholder needs to improve by lessening the authority of Électricité du Cambodge and giving more authority and power to the sub-sectors, especially in rural areas to initiate micro-grids with renewable energies more easily. Moreover, these actions need to be overseen by the Electricity Authority of Cambodia to ensure the sustainability of policies working in the rural areas. The Ministry of Mines and Energy and the Electricity Authority of Cambodia should provide financial incentives for rural electricity enterprises and provincial electricity companies to distribute their electricity generators such as solar home systems and biomass generators in rural areas, which would allow people to access them efficiently. Financial incentives could also be offered to other private sector actors that want to invest in an innovative micro-grid system to increase their productivity (Poch, 2013).

In order to operate a micro-grid, operators, either private sector or independent power producers need to apply for many licenses from MME; otherwise, their operations are against Electricity Law (Castalia, 2017). The process of granting all the licenses is very complicated and can take up to 25 years; a process which needs to be improved or shortened (Castalia, 2017).

The setting of tariffs, financing and subsidies of micro-grids should be reviewed as well. Some micro-grids are charging up to USD 1 dollar per kWh according to the EAC (2019). This rate is prohibitively expensive for many rural areas. The Electricity Authority of Cambodia needs to provide subsidies or a financial incentive to reduce tariffs on innovative micro-grids with renewable energy. Households in rural areas would enjoy stable and affordable electricity from those independent power producers. However, besides providing financial incentives, EDC should open the market to local and foreign investors to invest in and operate renewable energy companies to conduct and install innovative micro-grids in off-grid areas. This can provide affordability, accessibility and efficiency of electricity supply in rural areas before the completion of full access to the national grid.

## Conclusion

Demand for electricity is continually increasing, but the supply chain for electricity is raising concerns. People in rural areas have been suffering due to unequal access to electricity, but the proposed solutions about innovative micro-grid systems and improvement to regulations will be able to solve this problem and provide efficiency, affordability, and sustainability to the electricity sector in all rural areas. The future scenario in 2050 sees all rural areas in Cambodia that are not connected to the national grid, installing innovative micro-grids with connections from the nearest renewable energy resources. Alongside new regulations to facilitate those micro-grid operations, we believe this intervention will ensure that Cambodia will have electricity independence and fulfill the demands of households in rural areas by 2050.

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