THE ECONOMICS OF RESIDENTIAL SOLAR PV DEPLOYMENT IN SOUTHEAST ASIA: FROM FEED-IN TARIFF TO INCENTIVIZED SELF-CONSUMPTION POLICY FRAMEWORKS

Romeo Pacudan PhD, Associate Professor, Universiti Brunei Darussalam (UBD)/Chief Researcher, Brunei National Energy Research Institute (BNERI), +673-7256850, romeo.pacudan@ubd.edu.bn, romeo.pacudan@bneri.org.bn, romeo.pacudan@gmail.com

Overview

As one of the dynamic regions in the world, Southeast Asia strives to balance rapid economic growth with long-term sustainability goals. Transitioning towards low carbon economic development has been slowly gaining momentum in the regional and national political agenda. In the energy sector, several countries have pursued aggressively to increase the share of renewable energies in their national energy mix in the medium to long-terms. With diverse national policy objectives to promote renewable energies, the initial focus in the past was on increasing deployment of utility scale renewable energy technologies. More recently however the focus is broadened to cover deployment of small-scale renewable energy systems targeting the commercial and residential sectors.

Among Southeast Asian countries, Malaysia, the Philippines, Singapore and Thailand have introduced policy frameworks that incentivize residential households to invest in rooftop solar PV systems. The choice of policy measures however has been disparate. Malaysia had introduced a feed-in tariff scheme; the Philippines and Singapore, net metering arrangement (for non-contestable consumers); and Thailand, feed-in tariff policy and more recently self-consumption scheme. The continued decline of solar PV system costs, and with high financial obligations associated with feed-in tariff schemes, Malaysia and Thailand have recently announced to introduce net metering policies. With these, policies to promote residential households' deployment of solar PV systems in the region converge towards incentivized self-consumption schemes. Incentivized self-consumption schemes cover net metering and net billing arrangements. In both cases, energy generated by solar PV systems is consumed first by residential households and excess generation is exported to the grid. Under a net metering arrangement, excess electricity receives energy compensation while a net billing scheme offers monetary compensation (IEA PVPS, 2016).

Based on these definitions, the schemes introduced in Malaysia and the Philippines and proposed in Thailand are therefore not net metering but net billing frameworks. In these countries, surplus generation are compensated based on the generation cost rather than energetic compensation. This paper evaluates the economic attractiveness of installing solar PV systems under different incentive frameworks in Southeast Asia.

Methods

To assess the economic attractiveness of residential solar PV systems in Southeast Asia, the methods adopted by the study are the following:

- The study considered 3 solar PV system sizes: 3.0 kW_p, 5.5 kW_p, and 12.0 kW_p. The energy yield of the rooftop solar PV power systems used in the analysis was estimated following the methodology employed by Pacudan (2016, 2018) which takes into account the regional climatic data and plant configuration. The study used the climatological database and program Meteonorm to derive the radiation data (www.meteonorm.com). In estimating the solar PV power system energy production, the study used typical polycrystalline solar PV modules and string inverter available in the market. The energy production software used in simulating plant energy yield is PVsyst. The PVsyst model estimates: i) annual energy yield, ii) specific energy yield or yield factor (YF), and iii) performance ratio (PR) (www.pvsyst.com).
- To estimate the electricity consumption and export by residential households, a typical middle income household with daily electricity consumption amounting to 50 kWh (1,500 kWh per month) was used in the analysis. This load profile is based from Pacudan (2018). The average daily energy production curves of the solar PV systems derived from PVsyst simulation were superimposed with this demand profile. If a household uses a smaller 3 kW_p system, between 89%-98% of the electricity generation would be self-consumed in these 4 countries. If the household installs bigger systems, 5.5 kW_p and 12.0 kW_p between 69%-78% and 39%-42% of the energy generated would be self-consumed, respectively.
- The levelized cost of electricity (LCOE) for solar PV systems were estimated following IEA/NEA (2010) using three alternative installed costs: i) US$ 1.5 per W_p (low value), ii) US$ 1.75 per W_p (most likely value), and iii) US$ 2.0 per W_p (high value). This range of installed costs for small-scale systems is consistent with those in the ASEAN (ACE, 2016; Pacudan, 2018) and in IEA reporting countries (IEA PVPS, 2017). The study considered only the capital and O&M costs. The latter is taken to be 1% of the system installed cost. Decommissioning and other costs were not considered in the analysis. The debt share used in the study was 70% and the project lifespan was 20 years.

- To evaluate the competitiveness of rooftop solar PV, the LCOE of the small scale solar PV unit is being compared with the average retail electricity price. When the LCOE of a given technology equals the average price the consumer is paying to the distribution utility, the said technology is known to reach 'grid parity' (IEA PVPS, 2017). If the LCOE equals the average cost of generation, the 'fuel parity' is said to have been achieved.
- With the above financial parameters, financial cash flows were established for each project case. The annual calculated cash flows are then used to compute investment appraisal indicators. The study used the internal rate of return (IRR) and simple payback period as key indicators.

Results

Among Southeast Asian countries and for households with monthly consumption of 1,500 kWh per month, the Philippines has the highest electricity tariff with more than US$0.21 per kWh and followed by Singapore with more than US$0.15 per kWh. Thailand and Malaysia have tariff rates below US$ 0.15 per kWh. At solar PV system installed cost scenario below USD 1.5 per Wp, households with monthly consumption of 1,500 kWh and above have achieved past the grid parity (around US$ 10.7 per kWh in Thailand and the Philippines and around US$ 12.0 in Singapore and Malaysia). The results indicate that with the existing electricity retail tariffs and solar PV system prices, these households have strong financial incentives to invest in rooftop solar PV technologies.

Feed-in tariff schemes are, in the past, the main policies to address the cost gap between the cost of residential rooftop solar PV generation and retail electricity tariffs and responsible for increasing deployment of residential solar PV technologies in Malaysia and Thailand. Due to premium tariff rates, investments under feed-in tariff schemes have higher financial returns than those of incentivized self-consumption schemes. On the other hand, net metering schemes generate higher financial returns than net billing schemes. The latter has reasonable rate of return and not as excessive as those under the former schemes.

Smaller solar PV systems have the same financial returns with larger systems under feed-in tariff and net metering arrangements. This implies that these schemes provide an incentive for households to install larger systems and maximize exports. On the other hand, bigger systems have lower returns than smaller systems under the net billing scheme. This is due to the fact that the export tariff rate is much lower than the opportunity cost of self-consumption. The net billing policy design therefore has established a built-in disincentive to households to oversize their solar PV system installations.

Conclusions

The achievement of grid parity have drawn interest from policy makers in Southeast Asia on incentivized self-consumption policies as an alternative option for feed-in tariff scheme in stimulating investments from residential consumers. The increased competitiveness and the decentralized nature of solar PV systems enable residential households to invest on rooftop PV systems to reduce their electricity bills.

Given the same technical and economic parameters, net metering schemes generate relatively higher economic benefit than those under net billing arrangements. In addition, net metering incentivizes households to install larger systems while net billing incentivizes households to install smaller systems that cater their own daytime needs rather than for exports. Since residential solar PV deployment programs are utility customer-funded programs, net billing arrangements would yield lower financial burden to electricity customers than net metering schemes.

References

1. ACE, 2016. Levelized Cost of Electricity of Selected Renewable Technologies in the ASEAN Member States. ASEAN Centre for Energy. Jakarta, Indonesia.
2. IEA/NEA, 2010. Project Costs of Generating Electricity 2010. International Energy Agency and Nuclear Energy Agency of the Organization for Economic Cooperation and Development. Paris, France.
3. IEA PVPS, 2017. Trends 2017 in Photovoltaic Applications. International Energy Agency. Paris, France.
4. IEA PVPS, 2016. A Methodology for the Analysis of PV Self-Consumption Policies. International Energy Agency. Paris, France.
5. Pacudan, R., 2016. Implications of applying solar industry best practice resource estimation on project financing. *Energy Policy 95* (2016), 489-497.
6. Pacudan, R., 2018. Feed-in Tariff vs Incentivized Self-Consumption: Options for Residential Solar PV Policy in Brunei Darussalam. *Renewable Energy 122*, 2018, pp.362-374.
7. Pacudan, R., 2018. The Economics of Net Metering Policy in the Philippines. Working Paper Series, Institute of Policy Studies (IPS),Universiti Brunei Darussalam.
8. http://www.meteonorm.com, accessed December 2017.
9. http://www.pvsyst.com/en/, accessed December 2017.