Distributed Photovoltaics: Trends and Policies in Southeast Asia

Global photovoltaic (PV) module prices dropped by more than 55% between 2014 and 2018 (see Figure 1). This decline in costs has rendered solar PV generation attractive not only to large-scale power producers, but also to the residential and commercial sectors.

> ***The cost of solar PV generation today is less than one percent of what it was in 1977, and they continue to fall.***
>
> (National Geographic, 2017)

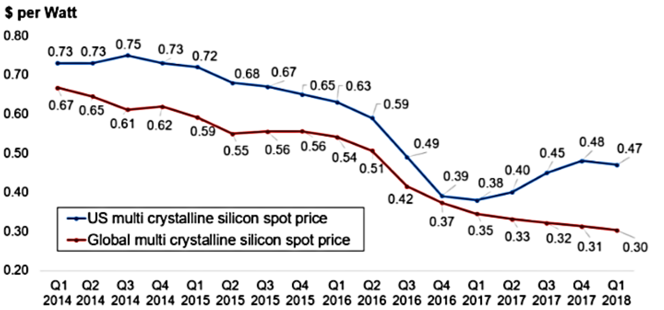

Figure 1: PV Module Spot Prices 2014-2018
Source: (NREL, 2018)

Households and businesses are increasingly installing small-scale PV systems (on rooftops or otherwise) as a means of meeting their own electricity demands and/or reducing their electricity bills. These small-scale systems are connected to the utility grid at the distribution level, and hence are categorized as distributed PV (DPV) systems.

The overall trend in the power sector of moving towards a more distributed model is driven by the economics of DPV, as well as of other distributed technologies (e.g., wind and biomass). While under the conventional central utility model, generation, transmission, and distribution were linearly structured, the distributed generation model has given rise to the 'prosumer': electricity consumers who can offset consumption with their own generation and send energy back to the grid (see Figure 2).

Deployment of DPV across Asia is rising. India has about 3.5 GW installed capacity of rooftop solar as of 2018 and recently launched the second phase of its grid-connected rooftop solar program, with an ambitious target to reach 40GW of rooftop solar by 2022 (SolarPower Europe, 2019). In China, according to the China PV Industry Association, 43.6GW of solar was deployed in 2018, 10GW of which was distributed (Bellini, 2019).

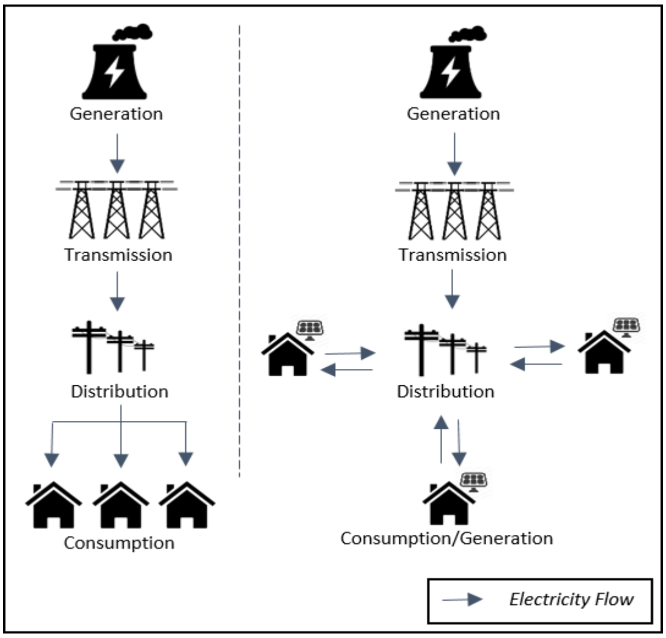

Figure 2: Central Utility Model (Left) vs. Distributed Generation Model (Right)
Source: (NREL, 2018)

In Southeast Asia specifically, the current level of deployment varies greatly. In countries where utility grid infrastructure is still lacking, such as Myanmar and Cambodia, DPV is being deployed mostly off-grid for rural electrification. In other countries, DPV is being employed on-grid for purposes such as electricity bill reduction. Thailand is leading ASEAN, with 354MW of DPV installed capacity as of 2017 (see Figure 3). This figure includes DPV systems enrolled in the 2013-2014 FIT programs, the 2016 DPV pilot program, as well as systems for self-consumption only, which make up about two-thirds of the total. Vietnam is second, with 186.37MW, followed by Singapore, Malaysia, the Philippines and Indonesia.

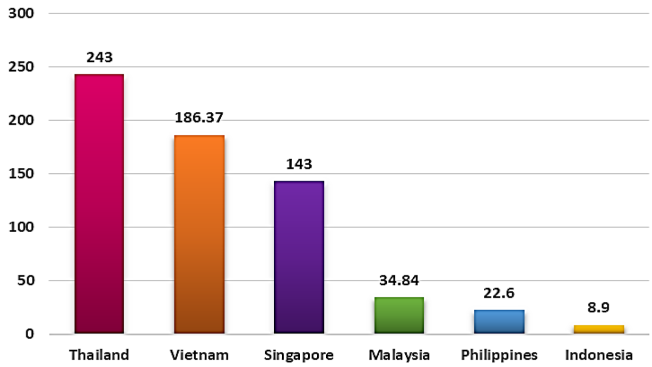

Figure 3: DPV Installed Capacity (MW) for select ASEAN countries
Note: Figures for Thailand and Singapore include self-consumption systems; for other countries, only net-metering enrolment figures were available. Source: Author compilation from various sources

Compensation Mechanisms for DPV

There are several policy tools for increasing DPV deployment, including financial incentives. One such tool to improve the economics of DPV investments for customers is a compensation mechanism for DPV, which clearly describes metering and billing arrangements, the sell rate for electricity generation exported to the grid, and the retail rate. There are three common compensation mechanisms for DPV: *Buy-All-Sell-All, Net-Energy Metering, and Net Billing* (Zinaman, et al., 2017).

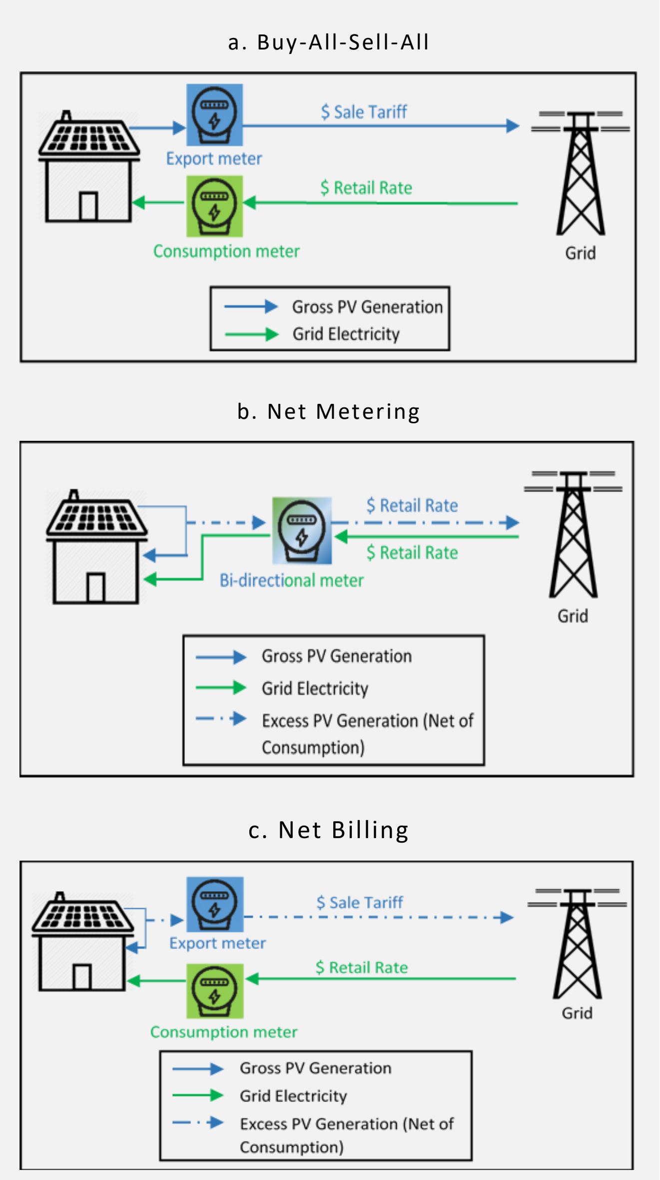

Figure 4: Three DPV compensation mechanisms

Buy-All-Sell-All arrangement: all DPV generation is exported to the grid and compensated at the export rate, while all consumption is drawn from the grid and charged at the retail rate (usually higher than the export rate).

Net Metering: Allows for self-consumption, and credits customers for kilowatt-hours exported to the grid. Consumers can therefore offset grid electricity, one-for-one, with self-generated DPV. At the end of the billing period, customers are billed for the *net units* of electricity consumed.

Net Billing: Also allows consumers to offset consumption with self-generation but compensates exported units at a different (usually lower) rate than the retail tariff. Net Billing incentivizes self-consumption, as generation is best utilized replacing the more expensive grid electricity, as opposed to exporting.

The relative customer economics for DPV investment under these compensation schemes for each customer group (e.g., residential, commercial, industrial sectors) can differ depending on many factors such as load demand. At the system level, potential benefits of exploiting DPV generation include reduction in losses and peak load, as DPV near the point of consumption reduces the need for upstream generation and transmission. This could also potentially defer investment in expanding the distribution system.

However, the introduction of DPV to the power system calls for additional technical requirements, such as the need to manage voltage and current fluctuations. When DPV is not being generated (i.e., at night or on cloudy days), utilities and grid operators may struggle to ramp up other sources of generation to meet demand. Conversely, when there is excess DPV generation, it may threaten to overwhelm the grid and cause over-voltages and current overload.

As mentioned above, DPV can potentially reduce transmission line losses; but at high DPV penetration levels, a lot of DPV generation can lead to reverse power flow and excessively high distribution line current, resulting in increased line losses. Thus, the amount of DPV that can be connected to the grid is subject to how much the distribution feeder can accommodate (determined by conducting hosting capacity analysis) and how DPV systems interact with the grid. In addition to feeder-specific hosting limits, technical concerns can also be addressed through the right grid codes and interconnection standards to ensure safe and reliable connection of a DPV system to the distribution system.

In addition to technical issues, there are myriad other concerns for electric utilities, including the impact of DPV on their revenues. As customers replace their consumption of grid electricity with self-generation, utility revenues are likely to drop. This can lead to cross subsidization as revenue losses are passed on to customers in the form of higher electricity prices, impacting non-DPV customers the most, as they have no alternative to grid electricity. A well-designed DPV compensation mechanism should successfully promote DPV deployment while minimizing negative impacts on the grid and other stakeholders such as utilities and non-DPV customers.

DPV Policies and Trends in Southeast Asia

Where DPV policies are in place, compensation mechanisms remain relatively conservative. Governments and state-owned utilities are wary of over stimulating DPV development that may have adverse effects on utility revenues and the grid. In many cases, capacity caps, stringent permitting rules, and low tariffs on exported electricity present a hurdle for DPV growth.

While many countries have net-metering programs, in practice most of them are net-billing schemes. For instance, in ***Indonesia***, excess DPV generation exported to the grid is credited to the user's next electricity bill at 65% of the retail value. According to the Indonesia Rooftop Photovoltaic Users Association, this rate is not attractive enough to incentivize customer adoption of DPV. Additionally, there are limitations on system sizes and onerous local content requirements, as well as a rule that only registered companies can install DPV systems.

DPV policies in Thailand and Malaysia have undergone recent changes. Malaysia introduced net-metering in 2016. Initially, like Indonesia, exported electricity was credited at below retail rates; i.e. the average cost of generating and supplying one kilowatt hour of electricity from non-renewable resources up to the point of interconnection (SEDA, 2019). However, in January 2019, Malaysia switched to true net-metering. As of May 2019, the approved capacity in the net-metering program totalled 16.6MW, compared to 18.24MW in all of 2018 (SEDA, 2019). Thailand, too, experienced recent developments in DPV policy. A long anticipated net-billing program was finally launched in May 2019, for systems no larger than 10kW; however, the low sell-back tariff of only 5.5 cents/kWh (compared to the average retail rate of 12 cents/kWh) has resulted in lower enrolment than expected.

Both Thailand and Malaysia are also exploring ***peer-to-peer (P2P) electricity trading***, which would enable consumers to trade electricity directly with one another without the state-utilities as an intermediary. Thailand's utility has been implementing pilot projects that combine P2P trading, blockchain technology, and energy storage (see Figure 5), while Malaysia is planning to include P2P in its upcoming Renewable Energy Transition Roadmap 2035 (MalayMail, 2019).

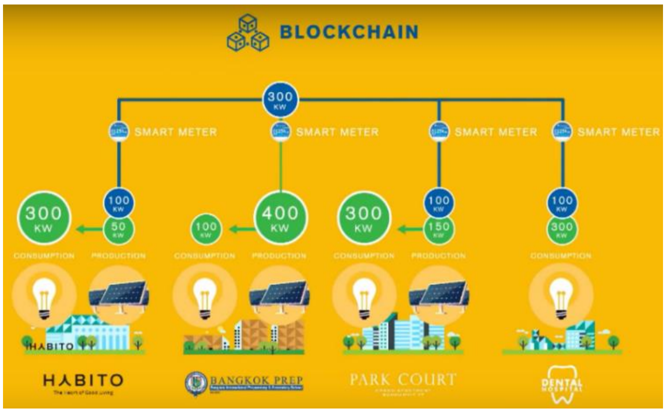

Figure 5: Peer-to-Peer Energy Trading Pilot in Thailand
Source: (Power Ledger, 2018)

The Philippines and Vietnam are in the process of revising their DPV policies. The Vietnamese government's Decision 11, which allowed for the sale of solar generation to the state utility, expired at the end of June 2019 and is expected to be replaced by a new Decision involving geographically differentiated tariffs. The Philippines, on the other hand, is revising its net-metering rules and policies to enhance customer participation in the net-metering program, including reconsidering an existing size cap, modifying the compensation mechanism, and improving the permitting and interconnection processes.

In the midst of policy changes and expected higher DPV penetration, the analysis of DPV impacts are therefore key to the successful implementation of compensation mechanisms to achieve greater DPV adoption, while minimizing potential negative impacts on stakeholders and the grid. Case studies on DPV policies, the impacts of DPV, and prevailing barriers for the Philippines, Thailand, and Vietnam are provided below.

Philippines

The Philippines electricity sector is one of the most liberalized in the region. Whereas most power markets in Southeast Asia follow a single-buyer model, the Philippines' power distribution sector is quite competitive. After the Electric Power Industry Reform Act was passed in 2001, power generation and distribution in the Philippines became widely privatized, with about 150 distribution utilities currently serving the vast archipelago.

The Philippines introduced a net metering program in 2013, although in practice it resembles a net billing scheme, with exported units compensated at the distribution utilities' blended generation rate (ADB, 2018). The program, nevertheless, has not met expectations in terms of boosting DPV deployment; there is currently only around 10MW of DPV installed capacity from 1,400 customers that have joined this program.

One of the major reasons for this is a 100kW cap on the size of DPV systems that can enroll in the net metering program, which excludes larger commercial/industrial customers. Other barriers include onerous regulatory requirements, such as requirements for conducting Distribution Impact and Distribution Asset Studies, which are costly and time consuming (Ahmed, 2018). The permitting and interconnection processes are lengthy, complicated and non-standardized. Finally, there is limited financing for small-scale DPV systems.

From the perspective of policymakers, the existing net metering policy needs updating. Some of their major concerns are the cross-subsidization of DPV by non-DPV customers and grid stability. As a result, the Philippines Department of Energy and Energy Regulatory Commission is currently in the process of revising the net metering policy. USAID Clean Power Asia, the National Renewable Energy Laboratory (NREL), the Lawrence Berkeley National Laboratory (LBNL), and Chulalongkorn University supported this by addressing the economic and technical implications of DPV deployment with three main analyses: the technical impacts of DPV, the economic impacts on utility rates and revenues, and the customer economics of investing in DPV systems.

Comparing different compensation schemes, the results of the customer economics analysis, which looked at the returns of DPV investment, indicate that net metering yields the shortest payback period and highest returns as it offers the highest prices for exported power.

The technical analysis shows that the hosting capacity of the feeder depends on the location of DPV. The closer DPV is to the transformer, the higher the penetration level that can be accommodated. Furthermore, individual capacity limits like the 100kW cap are unnecessary as long as the aggregate capacity can be supported without negative impacts. DPV was also shown to potentially relieve peak demand for medium-voltage consumers but not low-voltage consumers, as the latter's demand (residential systems) peaks in the evening.

Utility revenues are not significantly impacted by DPV, at least in the short term, as the forward-looking ratemaking process allows for full cost recovery. Utilities are able to forecast sales and revenue changes ahead of time and incorporate them into the rates. Finally, the impact of DPV on electricity rates varies with the level of penetration—the higher the penetration level, the larger the impact on rates, due to the decreasing value of solar. Figure 6 shows the decreasing value of DPV in Luzon, calculated as the ratio of the average value of DPV to the average wholesale price of electricity.

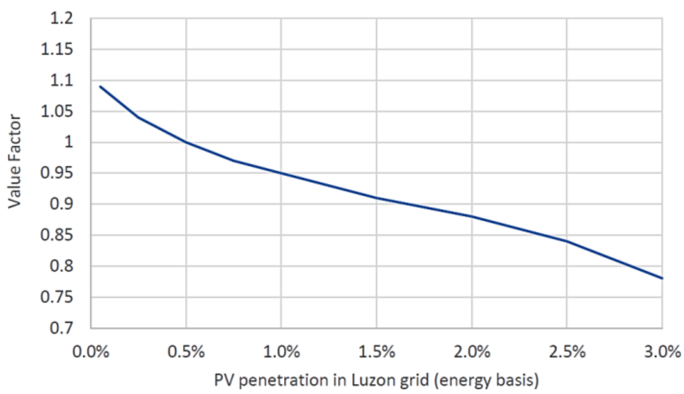

Figure 6: Value Factor Curve for Luzon Grid
Source: (Tongsopit, et al., 2019)

The main barrier for DPV adoption currently seems to be the regulatory one: the costly and onerous licensing requirements and the size cap that prohibits DPV systems larger than 100kW to enrol in the net metering program. Consequently, the Philippines Department of Energy is currently reviewing its net-metering program to consider revision of the system size cap.

Thailand

Thailand's power sector, like most of the region, follows a single-buyer model. While there is some private participation in generation, transmission and distribution are controlled by state-owned utilities. Thailand first began supporting DPV in 2013, under Phase 1 of the Solar PV Rooftop program, when it introduced an attractive Feed-in-Tariff (FIT); i.e., a buy-all-sell-all arrangement. Phase 2 followed in 2014 with a slightly lower FIT. In 2016, however, policy objectives shifted from grid export to self-consumption, targeting commercial and residential customers. A pilot program for 100MW was launched, allowing customers to connect DPV systems to the grid but offering no compensation for exports. The program was severely undersubscribed, resulting in only 3.9MW.

Plans for revising the DPV program were repeatedly delayed pending the announcement of a new Power Development Plan. A new self-consumption scheme was finally unveiled in May 2019, but as of July 2019, only 8.74MW have enrolled in the program (Bangkok Post, 2019). One reason for this is the low tariff of 5.5 cents/kWh, which makes DPV investment only attractive to heavy consumers of electricity. Another barrier is the size cap of 10kW, which limits participation to the residential sector. Policy awareness and knowledge of DPV systems among this target group may be limited.

Back in 2017, when it was anticipated that the Thai government planned to launch a policy on DPV, USAID Clean Power Asia conducted an impact analysis of DPV on utility revenues and rates in the medium term (i.e., targeted scenario of 3000MW of DPV deployed by 2020). The simulations yielded that, given the forward-looking nature of Thailand's ratemaking process, the deployment of DPV would have no impact on utility revenues in the medium to long term. The analysis looked at five scenarios: three base scenarios of net billing with tariffs of 1, 2, and 3 baht, (3, 6, and 9 cents) respectively; a low-impact scenario of self-consumption only; and a high-impact scenario of net energy metering.

The analysis results showed that in all five scenarios, the simulated impact on retail rates was smaller than the median change in F_t—an automatic adjustment mechanism that recovers utility costs through retail rates. Figure 7 compares the retail rate impacts for the two Thai distribution utilities: the Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA). The impact study findings help put into perspective how Thailand still has considerable leeway in boosting DPV deployment without adversely affecting utilities and non-DPV ratepayers.

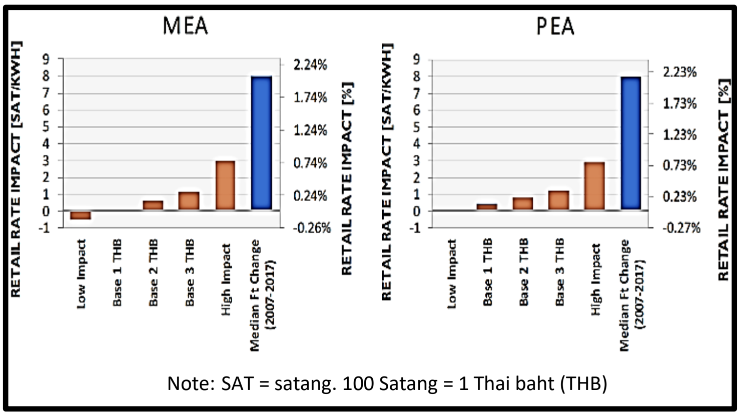

Figure 7: Impact of 3000MW DPV by 2020 on Retail Rates

Source: (Tongsopit, Zinaman, & Darghouth, Understanding the Impact of Distributed Photovoltaic Adoption on Utility Revenues and Retail Electrivity Tariffs in Thailand, 2017)

Vietnam

In April 2017, the Vietnamese government promulgated Decision No. 11/2017/QD-TTg, allowing for the sale of solar generation—both from solar farms and DPV—to the state-owned utility, EVN, at a rate of 9.35 cents/kWh. Decision 11 established a deadline for commercial operation of June 2019 in order to qualify for the FIT. This spurred rapid development of solar farm projects but not as many rooftop projects, as industrial customers who are most likely to have available roof space for DPV already enjoy low retail tariffs[1].

A study, conducted under the collaboration between USAID Clean Power Asia, USAID Vietnam Low Energy Emissions Program and NREL, found that the current tariff renders self-consumption the most beneficial to high-consumption residential and commercial customers who face high retail tariffs. Industrial customers, on the other hand, have the longest payback periods and lowest internal rates of return, under current and other potential compensation schemes as they face lower retail tariffs than other customer groups.

[1] The retail tariff for industrial customers was increased in April, 2019 (CEIA, 2019).

Since the beginning of 2019, the government has released two drafts of an updated policy to replace Decision 11. The anticipated new Draft Decision will introduce the Direct Corporate Power Purchase Agreement (DPPA), allowing for direct sale of power between two private parties. It also will establish new FITs differentiated by geographical zones (Figure 8), with the highest incentives for areas with lower solar irradiation, and technology, categorized as floating solar, ground-mounted solar, solar projects with integrated storage, and rooftop solar. The proposed FITs vary from 6.67 cents/kWh to 10.87 cents/kWh (GlobalData Energy, 2019).

Under the original Decision 11, owners of DPV systems were required to install bi-directional meters; exports in excess of consumption were credited to the next billing cycle and payments were settled at the end of the year. In January 2019, an amendment to the payment system was issued to separate the accounting of exported and imported units and settling payments on a monthly basis[2].

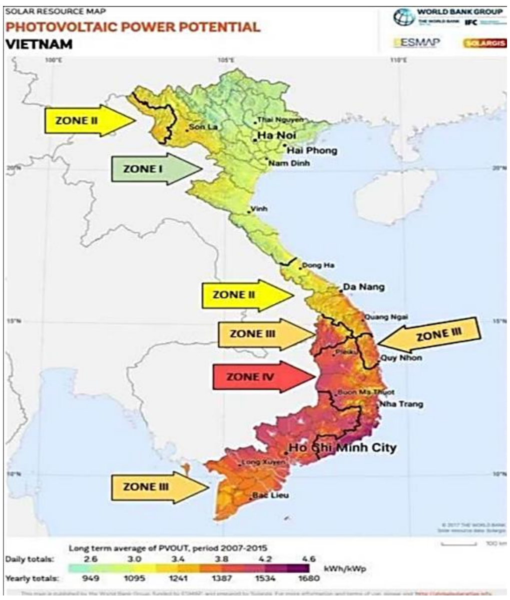

Figure 8: Geographic zones for applying new FITs under the Draft Decision

Source: (CEIA, 2019)

In practice, however, it is unclear whether any sale of excess DPV has taken place, as the Ministry of Industry and Trade (MOIT) and the Ministry of Finance (MOF) claim that they have not received guidance on implementing payment systems for DPV (Massmann, January). MOIT issued Circular No. 05 in March 2019, providing guidelines on the payment mechanism for electricity exported from rooftop solar projects. Circular No. 05 may begin to address some of the payment issues that previously marred the net-metering program. Nevertheless, at present, the June 2019 deadline of Decision 11 has expired, while the Draft Decision and new FITs have yet to be finalized.

Conclusion

The growth in DPV deployment in Southeast Asia can be attributed to a number of factors, including the ASEAN-wide goal of achieving 23% RE in the energy mix by 2025 and the cost of solar approaching grid parity.

While governments have initially been restrictive of DPV, citing concerns over the impacts on the grid and utility bottom lines, they are gradually becoming more supportive of its deployment and grid interconnection. Most countries now allow for self-consumption and some allow injections of excess generation to the grid with varying rates of compensation. What governments have to grapple with is calibrating a compensation mechanism and rate that incentivize the target level of deployment, improving the economics of DPV investment for customers, and minimizing negative impacts on utilities, ratepayers and the distribution system. While this is highly context specific, as it depends on the existing retail tariff structure, the composition of customer classes (i.e. industrial, commercial, residential), and the financing infrastructure, there is much value in cross-country knowledge exchange.

There are additional common prevailing barriers to DPV across countries, such as onerous permitting and interconnection processes, unattractive sale tariffs for exported DPV, and system size restrictions. As Southeast Asian power sectors and economies share many similarities, case studies from the region are likely to hold the most applicable lessons.

[2] Under Decision No. 02/2019/QD-TTg

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Zinaman, O., Aznar, A., Linvill, C., Darghouth, N., Dubbeling, T., & Bianco, E. (2017). *Grid-Connected Distributed Generation: Compensation Mechanism Basics.* Denver: NREL.

Additional Resources:

An Overview of International Compensation Mechanisms for DPV:
http://usaidcleanpowerasia.aseanenergy.org/resource/an-overview-of-international-compensation-mechanisms-for-dpv-2/

DPV Economic and Technical Impact Analysis in the Philippines:
http://usaidcleanpowerasia.aseanenergy.org/resource/distributed-photovoltaic-economic-and-technical-impact-analysis-in-the-philippines/

DPV Utility Revenues and Rates Impact Analysis in Thailand:
http://usaidcleanpowerasia.aseanenergy.org/resource/understanding-impact-distributed-photovoltaic-adoption-utility-revenues-retail-electricity-tariffs-thailand/

NREL DPV Toolkit:
https://greeningthegrid.org/Distributed-photovoltaics

For more, go to the USAID Clean Power Asia website:
www.usaidcleanpowerasia.org