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Bill saving analysis of rooftop PV customers and policy implications for Thailand

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ABSTRACT

Since a new policy supporting rooftop photovoltaics (PV) will be launched in Thailand, this study investigates the economics of utility customers' investments in rooftop PV (values of bill savings) for four customer groups (residential scale, small general service, medium general service and large general service) across electricity tariffs, PV-to-load ratios and compensation schemes (net metering and net billing). The values of the bill savings of all groups are higher under the conditions of higher buyback rates/credit, lower PV-to-load ratios, and higher retail rates. Under the current retail rate design, the values of the bill savings of residential and small general service groups are slightly higher than those of medium and large general service groups, since there are demand charges for the latter two groups that cannot be completely avoided using rooftop PV. Load shapes do not significantly impact the values of the bill savings for all customer groups. Additionally, net metering causes a smaller variation in bill savings as compared to net billing, implying more flexibility for the customers to size their PV systems over a broader range. In contrast, net billing would encourage customers to limit their PV sizes, thereby mitigating the concerns of the utilities.

1. Introduction

Among the emerging economies,[1] Thailand is the leading market for renewable power and investments in solar power [1]. The building blocks, especially the long-term Alternative Energy Development Plan 2015–2036 (AEDP 2015) and various incentive programs, for solar PV development in Thailand are already in place. Thailand's AEDP includes targets to achieve a 30% share of the renewable energy in the final energy consumption of the year 2036. In Q3 of 2017, the cumulative installed capacity of solar PV plants connected to the grid was approximately 3211 MW, which is an increase of more than 200% from 2013, as shown in Fig. 1. Of the total installed capacity, 95% is solar farms (ground-mounted solar systems) while the rooftop PV capacity share is approximately 5%[2] [2].

Focusing on rooftop PV, incentive schemes are one of the key building blocks that can help increase the deployment of this technology. Since 2013, the Thai government has begun to promote rooftop PV through a fixed Feed-in Tariff (FiT) scheme and in 2015, revised the incentive scheme by which all electricity generated from rooftop PV is purchased at fixed rates (6.01–6.85 THB/kWh or 0.18–0.21 USD/kWh,[3] depending on installed capacity). With a policy environment that is friendlier to rooftop solar power, many rooftop PV business models, such as roof rentals, power purchase agreements (PPA) and leasing services, have emerged in the country [3].

In 2016, a new rooftop PV scheme was announced, representing a shift from the feed-in tariff scheme toward a self-consumption scheme. While the feed-in tariff scheme compensates for all units

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[1] Nations whose economies are rapidly growing and industrializing.

[2] The range of rooftop PV installed capacity is usually at 0–1,000 kW while the installed capacity of solar farms usually starts at 1,000 kW.

[3] The exchange rate is 32.75 THB/USD as of February 2015.

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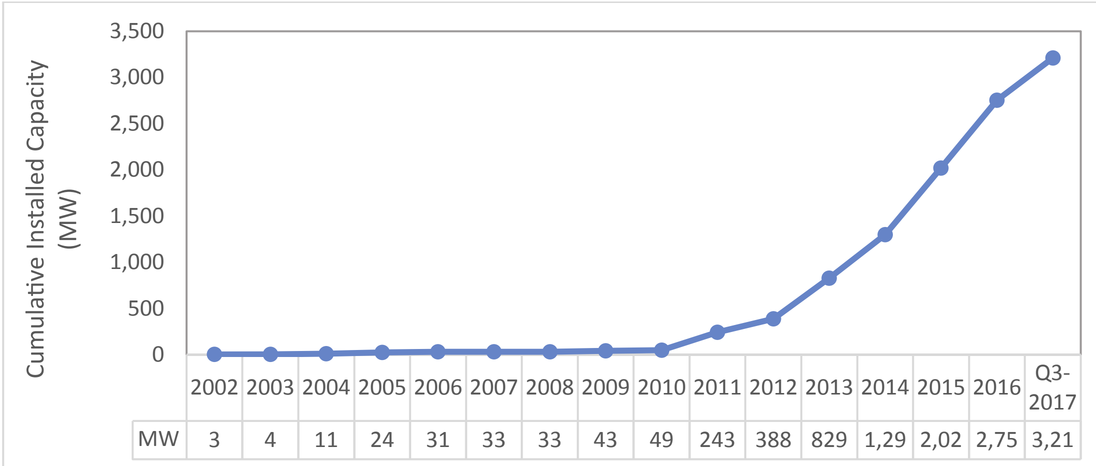

Fig. 1. Cumulative installed capacity of solar PV in Thailand during 2002 to Q3 of 2017.

generated by rooftop PV, a self-consumption scheme encourages the use of PV electricity by the consumers first while the excess generation injected into the grid may be compensated, depending on each country's policy [4]. The policy was launched as a pilot project to encourage the on-site consumption of the electricity generated from rooftop PV systems while any excess electricity fed back to the grid would not be compensated. The Thai government would use the results of the evaluation of this pilot project to launch a new support scheme for rooftop PV with the intention of compensating for the excess electricity injected into the grid. However, the details of the compensation schemes are not yet confirmed at the time of writing.

To support the self-consumption of PV electricity, there are two main compensation schemes for excess PV generation: net metering and net billing. With net metering, the compensation is calculated on an energy-credit basis with one bi-directional meter. For net billing, the compensation is calculated as a monetary credit, using two different meters or one digital meter to measure the imported and exported electricity separately [5,6]. Normally, self-consumed PV electricity is valued at the retail rate to which the utility customers subscribe. There are also options for crediting self-consumed PV at a premium rate [7]. In the case of excess electricity sent back to the grid, the excess will be compensated differently depending on the features, such as the number of meters, compensation type, banking options, banking periods, buyback options and buyback rates, of the compensation scheme in each country.

For each type of compensation scheme, the value of the consumers' bill savings depends on the customers' characteristics, the designs of the PV systems, retail rate structures and the applied compensation scheme. Each type of compensation scheme may have different levels of benefits for different groups of customers. This study raises the following question: “For a particular self-consumption scheme, how do the bill savings vary across individual load profiles and electricity tariffs and how can the findings help inform policy development?”

This study analyzed the bill savings of rooftop PV under different compensation schemes (net metering and net billing), focusing on 4 customer classes sampled from 224 individual load profiles of the customers of the Metropolitan Electricity Authority (MEA), which is the distribution utility that supplies electricity to 3,632,722 customers as of 2016 in Bangkok and two neighboring provinces (Nonthaburi and Samut Prakarn). We also conducted sensitivity analyses by varying the PV sizes using the various PV-to-load ratios of each customer group to provide detailed analyses that would help inform upcoming rooftop PV policy development in the country.

This paper is structured as follows. Section 2 summarizes the existing literature related to the topic. Section 3 describes the data used in the research, assumptions and detailed methodology of this research. Section 4 discusses the bill saving results of each customer group/retail tariff under different compensation schemes and PV-to-load ratios. Finally, Section 5 summarizes the key findings and policy implications.

2. Literature review

Bill savings have been a topic of interest, particularly from the standpoint of policymakers who seek to understand the costs and benefits of solar policies. For example, in Refs. [8–10], bill savings were mentioned as one of the financial incentives for encouraging consumers to generate electricity on-site. In the case of the UK, as shown in Ref. [8], the annual profits of rooftop PV installation is a factor of the FiT rate for all PV generation, the export rate for the electricity supplied to the grid, the retail electricity price, and the ratio of self-consumption to export. The bill saving component could help the UK government to improve the efficiency of their FiT scheme in order to achieve £40 million worth of savings during the 2014–15 financial year.

Moreover, bill savings was one of the components in the Cost-Benefit analysis of net metering based on a utility's point of view in California and conducted by Energy and Environmental Economics (E3) [11] for the California Public Utilities Commission. Focusing on bill savings due to rooftop PV, there were two main inputs into the E3 study: load and PV production profiles. Load profiles came mainly from real net metered users in California while PV production profiles came from both simulation and metered data. After grouping the load profiles based on load/PV shapes and rate classes, as well as calculating the value of the bill savings according to the representatives of each group, the results were aggregated to represent the penetration-level scenarios of the net metering system in California. The study conducted a sensitivity analysis based on retail rate escalation and found that greater retail rate escalations lead to a higher value of bill savings from the consumer's standpoint.

Darghouth et al. [12] studied the impact of rate design and net metering on the bill savings of residential-scale distributed PV systems in California. The authors found that the values of bill