ICSESS2017
3rd International Conference of Science, Engineering and Social Sciences Universiti Teknologi Malaysia 17 -18 May

STAKEHOLDERS' PERSPECTIVES OF FUTURE DESIGN OPTIONS FOR A ROOFTOP SOLAR PV SELF-CONSUMPTION SCHEME IN THAILAND

K. Kokchang[1], S. Tongsopit[2], S. Junlakarn[2], W. Wibulpolprasert[3], M. Tossabanyad[2]
[1] Environment, Development, and Sustainability Program, Graduate School, Chulalongkorn University, Bangkok, THAILAND.
(E-mail: shizukawachi@gmail.com, tongsopit@gmail.com)
[2] Energy Research Institute, Chulalongkorn University, Bangkok, THAILAND.
(E-mail: siripha.j@gmail.com)
[3] Thailand Development Research Institute, Bangkok, THAILAND
(E-mail: wichsinee.w@gmail.com)

ABSTRACT

The growth in the adoption of solar photovoltaic (PV) power generation systems has been accelerating around the world, contributing to the debate about the future of policy and regulation in a high distributed energy resources future. Thailand is one of the leaders in solar investment in Southeast Asia. It has recently shifted its policy framework for the support of small scale, distributed solar PV systems from subsidizing power export through feed-in tariff toward a policy that is focused on self-consumption. This paper aims to investigate the perspectives of stakeholders on the detailed design options of self-consumption schemes for supporting rooftop solar PV systems installation. The research methodology employed questionnaires and in-depth interviews in order to understand all study related stakeholders' perspectives on each element of rooftop solar PV self-consumption schemes. The results show that most of stakeholder groups indicated a strong desire to compensate for excess generation from rooftop PV systems in order to encourage Thai consumers to invest rooftop PV systems and also to accelerate market expansion. This paper extensively discusses the various perspectives on scheme design elements which have implications on how to incorporate these stakeholders' viewpoints into the policy-making process the future.

KEYWORDS: Self-consumption scheme; Net metering; Net billing; Thailand's solar PV rooftop.

INTRODUCTION

Increasing popularity of distributed energy resources, particularly solar photovoltaic technology, has induced the transition of policy and regulatory schemes to encourage self-production and self-consumption by electricity users. During the past decades, the installed photovoltaic (PV) capacity has been growing due to the falling cost of solar PV panels and support schemes that promote the installation of solar PV worldwide [1]. The global total installed capacity in 2015 was 227 GW, a 25% increase over 2014 [2,3]. The majority of all PV installation worldwide is grid-connected systems, which have the advantage of more efficiently utilization of generated power [3, 4]

Several countries have been introducing self-consumption policies in order to promote the use of PV electricity by compensating for excess electricity using various forms of compensation mechanisms such as net metering and net billing. Since the cost of locally produced PV electricity is less than the retail electricity price of electricity nowadays in some countries, PV electricity production for self-consumption is increasingly more profitable without subsidy. However, there are challenges that a high penetration of distributed PV system for power generation might impact to ratepayers in terms of increasing distribution network charges or taxes [5].

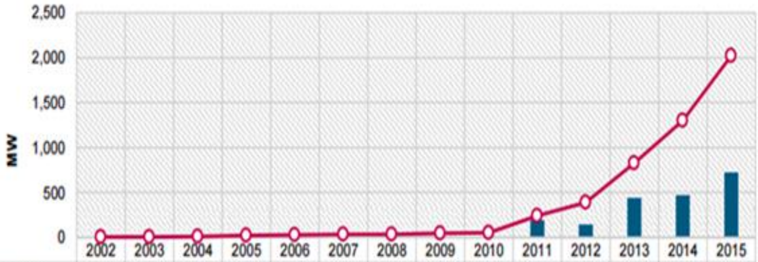
Among emerging economies, Thailand is the leader in solar PV investment. And though the majority of such investment has been for utility-scale systems, the government has recently shifted the support toward smaller-scale, distributed solar PV systems [6]. The Thai government began to promote the use of rooftop PV for exporting power between 2013 and 2015 and for self-consumption since 2016 onwards. In 2016, Thailand launched a Rooftop solar PV Pilot, designed for self-consumption in residential and commercial buildings. The pilot allowed consumers to produce electricity from their rooftop PV systems, and excess electricity that is not consumed will flow back to the power grid without any compensation by the utilities [7]. The government is currently designing a support scheme on how to support rooftop solar PV systems for self-consumption. The details of the support scheme will have an impact on how consumers produce and use distributed solar PV systems in the future.

With regard to self-consumption schemes to support rooftop solar PV penetration, there are less existing studies on stakeholders' perspectives on the design options. It is important to take stakeholders' perspective into consideration in order to ensure successful implementation of the policy. This study thus aim to investigate the perspectives of stakeholders on the detailed design options of self-consumption schemes for supporting rooftop solar PV systems installation in Thailand. This paper is organized as follows. We define net metering and net billing schemes based on literature review and provide backgrounds on Thailand's rooftop solar PV development in the background of study section. Then, the results and discussion can be found together with the analysis of the pros and cons of net metering and net billing in main results section, followed by conclusions and recommendations.

BACKGROUND OF STUDY

Self-consumption schemes have been promoted in several developed countries and developing countries. Self-consumption scheme can be defined as the PV generated electricity that is firstly used for local consumption in a house or in a building in order to reduce electricity bills, and all this electricity should not be injected into distribution grid [8, 3]. Self-consumption schemes can be distinguished into two broad categories: Net metering and Net Billing. The terms "net-metering" and "net-billing" are sometimes used interchangeably. Net metering and net billing are electricity policies that assign compensation to excess electricity generated from the prosumers' sources, particular solar and wind [9, 10]. The term "prosumers' refers to the energy consumers who both consume the electricity from the grid and have the ability to produce their own power from a range of different onsite generators, such as rooftop solar photovoltaic system [11]. However, the main differences between net metering and net billing include the value of excess of electricity, the number of meters and the compensation terms (in kilowatt-hour (kWh) and in monetary unit).

To promote self-consumption of rooftop PV system for electric power generation, the self-consumed part of electricity could also be incentivized. The compensation of self-consumed PV electricity can be categorized into 2 types: no premium and with premium [3]. Self-consumption with no premium aims to mainly use PV electricity for reducing electricity bill without additional incentive such as Thailand rooftop PV's Pilot project [7]. Self-consumption with premium means that the self-consumption gets additional subsidy on top of the bill saving that the prosumer would usually get. The self-consumed electricity can be valued at below, equal, and above retail rate. In China, self-consumed electricity originally received an extra tariff on top of the saved retail price and later they reset the rate at wholesale price for self-consumed PV electricity [3].



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Annual Installed Capacity (MW)		1	7	13	7	2	1	10	6	193	145	441	470	722
Cumulative Installed Capacity (MW)	3	4	11	24	31	33	33	43	49	243	388	829	1,299	2,021

Figure 1: Thailand rooftop solar PV policy development (GIZ, 2017).

Figure 1 represents the growth of Thailand's grid-connected solar power capacity, which has been remarkable since 2011 and almost 99% comes from the large-scale solar installations with installed capacities over 1 MW [6]. This growth was incentivized by the adder scheme implemented since 2007. The adder scheme provides incentives to power producers that sell electricity produced by RE at a strong tariff for a specified period of time. However, the adder scheme was discontinued due to the concerns of the impacts to ratepayers and converted to a new Feed in Tariff (FiT). The rooftop FIT scheme assigns a fixed rate for each scale of rooftop PV systems in order to encourage customers to install solar PV systems to sell power to the grid. FiT is financed through the levy on the electricity bills (FT rate) for all electricity consumers and is valid for 25 years. The rooftop FiT program launched between 2013 and 2015 sets a quota of 200 MW of power purchase agreement (PPA) available, allocating 100 MW to commercial rooftops (10-1000 kW) and another 100 MW to residential (0-10 kW) rooftop solar systems. The result showed that the quota for commercial rooftop systems was reached quickly, while the residential quota was slowly subscribed. However, by the end of 2014, the residential rooftop sector resulted in small growth with an expected volume of less than 26 MW and lack of feasibility for residential-scale solar PV systems [6]. The FiT policy was discontinued in 2015.

Despite the discontinuity of the FiT support scheme, another support scheme for rooftop PV systems was proposed to replace the FiT. In January 2015, the Thai cabinet announced the net metering scheme as the pilot project for the purpose of self-consumption. Later, in March 2016, National Energy Policy Council (NEPC) proposed a pilot project for the purpose of self-consumption. This pilot project aimed to support rooftop solar PV systems for on-site consumption only and any excess electricity injected back into the grid would not be compensated. The objective of this rooftop solar PV pilot project was first to study, monitor and then evaluate the impact of self-consumption on the utilities, the distribution systems, and the investors. Within a total 100 MW quota, 20 MW was allocated to residential roofs, which is divided equally into 10 MW (≤ 10 kWp) in Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA) areas and the remaining 80 MW was allocated to commercial roofs, which MEA and PEA each allow for 40 MW (10 kWp to 1 MWp). The application process was already closed for submission and all participants must install their rooftop solar PV by January 31, 2017. The current status of the uptake of Thailand rooftop solar PV pilot project was low, with less than 50% applied out of the quota of 100 MW [7].

METHODOLOGY

This study began with selecting the support schemes based on Background of Study, which pointed to popular schemes being net metering with buyback and net billing with real-time buyback. The study employed both qualitative and quantitative methodology by firstly inform stakeholder groups of the key design elements of PV self-consumption schemes and then sought their opinions through working group discussion, questionnaires, and in-depth interviews in order to confirm and enrich the findings. The following describes each group of stakeholders:
(i) Consumers: are the participants of Thailand's Rooftop Solar PV Pilot Project.
(ii) Private companies: include solar EPC contractors, Developers, Consultants, and representatives from the Federal of Thai industries, all of which have been involved in solar rooftop projects.
(iii) Policymakers: include government officials at executive and non-executive levels from the Bureau of Solar Energy Development of Department of Alternative Energy Development and Efficiency, Ministry of Energy, Ministry of Finance, and the Energy Regulatory Commission,
(iv) Utilities: there are two distribution electricity utilities in Thailand, namely MEA, which is responsible for providing service and electricity power in Bangkok, Nonthaburi and Samut Prakan and PEA, which is responsible for electricity distribution in 73 provinces. Most of these utility representatives are from Power System Planning Department, Power Economics Department, Business Development Planning, Research and Development Department.
(v) Others: include academic researchers, financial analysts, research consultants.

MAIN RESULTS AND DISCUSSION

Stakeholder Respondents Group

Table 1 shows the number of respondents and category by group. Most of stakeholders in this survey were directly involved in rooftop solar PV policy development or market development in Thailand. The surveys were conducted between September and December 2016. The gathered feedback are the basis of the results and discussions of this paper.

Table 1: Survey respondents

	Consumers	Private companies	Policymakers	Utility)MEA(	Utility)PEA(	Others	Total
Stakeholders engaged	13	21	9	16	13	10	72

Self-consumption Scheme Design

Figure 2 represents the result of self-consumed electricity scheme, which shows that the majority of respondents (58%) selected no compensation for the self-consumed part of PV electricity, whereas 42% of respondents preferred PV self-consumption to be compensated. Figure 3 shows that most of stakeholders preferred no compensation for the self-consumed part of electricity. This preference corresponds to the design of most self-consumption schemes worldwide, which do not compensate for the self-consumed part of electricity.

When classifying the types of stakeholders to understand the responses from each stakeholder groups, the study found that the most of respondents who represented the PEA and consumer groups preferred to give compensation to the self-consumed part of electricity. The majority of members from other groups preferred not to have compensation for excess electricity.

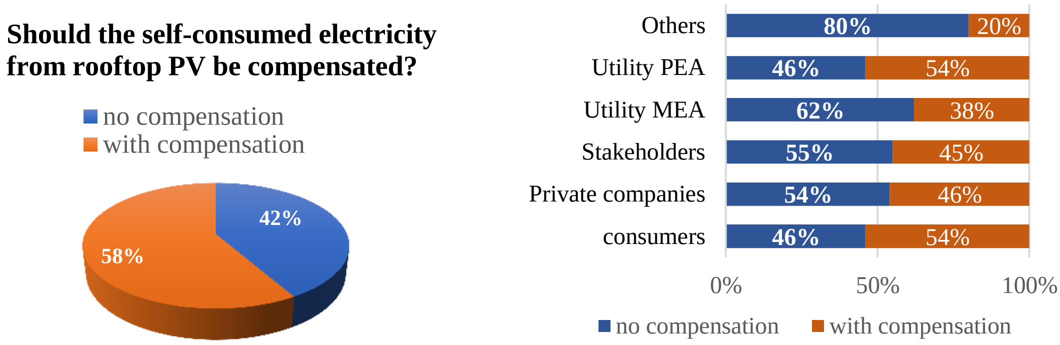
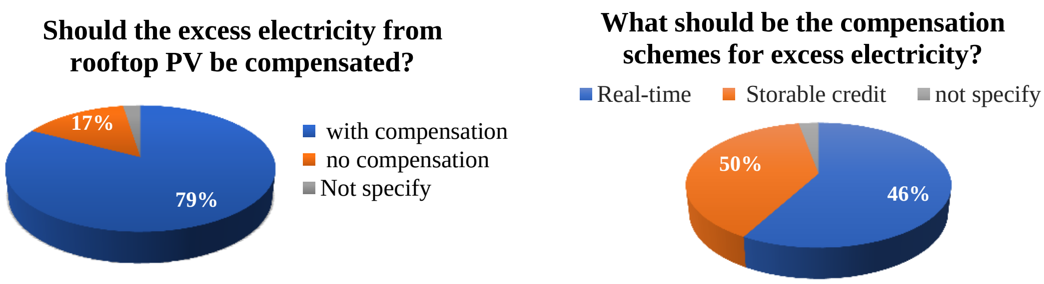


Figure 2. The result of self-consumption scheme design from all stakeholders.

Excess Generation Scheme Design

Figure 4 showed that the majority of respondents (79%) preferred to gain compensation for the excess part of electricity from rooftop PV systems. For those that chose to have compensation for excess electricity, the study asked whether the compensation should be in the form of collected credits or whether the compensation should occur as real-time payment. Most of respondents were split equally between these two types of the compensation schemes for excess part of PV electricity. Among those who chose to have excess generation compensated in the form of credits, 63% of them specified that the value of credits should be equal to retail rate. For real-time compensation, the study asked what the real-time buy-back rate should be. Most of the respondents were split equally between below retail rate and equal to retail rate, which is very interesting. The study also asked regarding the cap for compensation per year and most of respondent agreed to define a capacity cap per kWh/person/year.



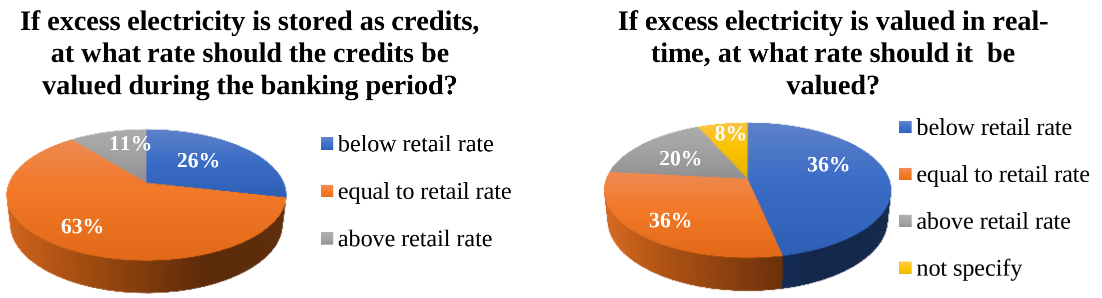


Figure 4. The result of excess generation scheme design from all stakeholders

Based on the overall result from all stakeholders, the findings identified difference in opinions and preferences among consumers, private sectors, stakeholders and utilities (as shown in Figure 5).it is clearly indicated that the majority of utilities preferred real-time payment as compensation method

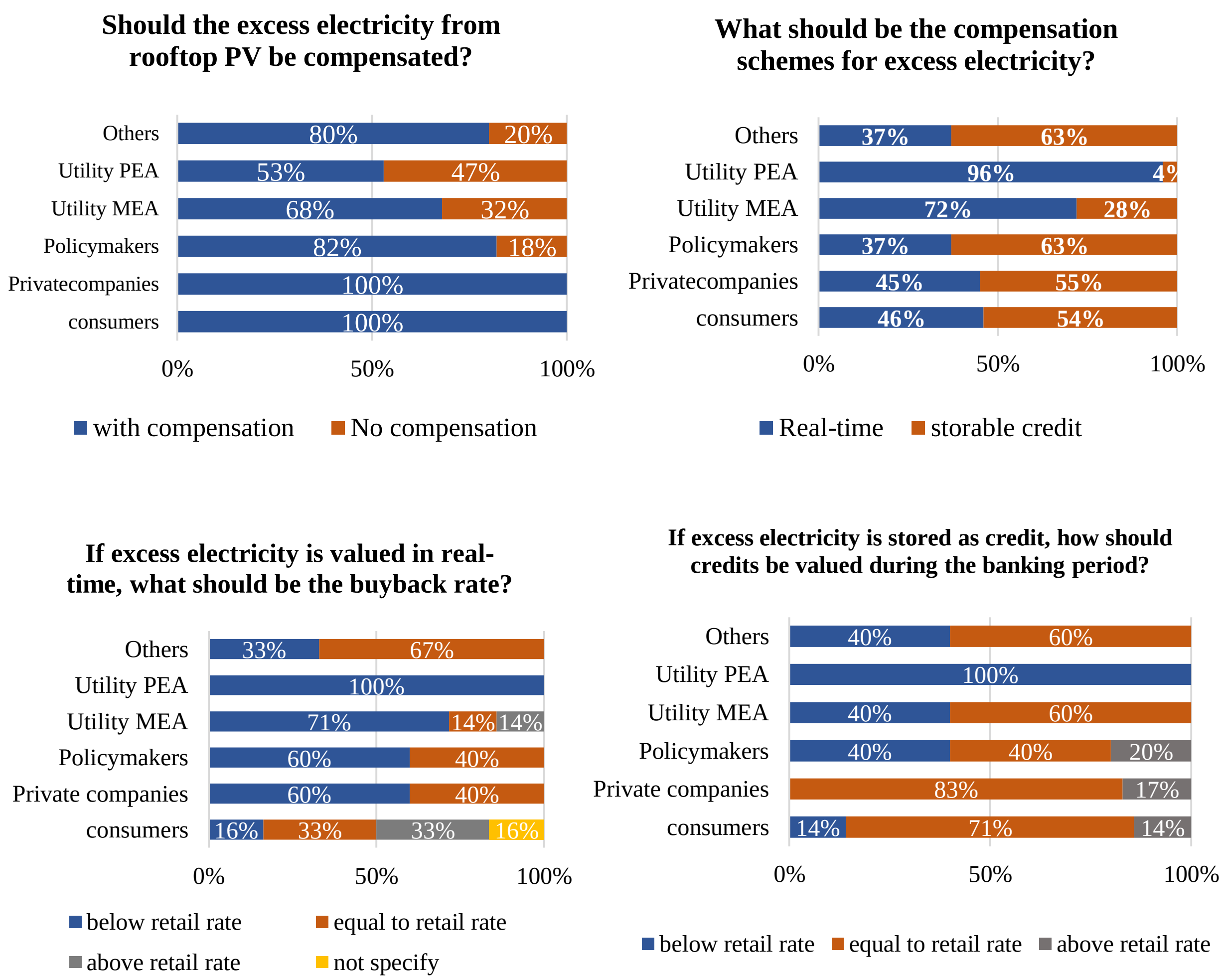


Figure 5. The result of excess generation scheme design, classified by each stakeholder.

for excess PV generation with the rate should be valued at the price below retail rate, which is called net billing. Whereas most of stakeholders agreed that the excess part of electricity should be collected in credits within one year period and the rate of that part should be valued at the price equal to retail rate. This may be due to the scheme seemed to be more attractive especially to consumer and private companies and could stimulate the market expansion. This selected scheme design is called net metering with rolling credit and with buyback. In term of compensation, the benefit of net metering scheme is that the electricity that self-consumed and flow back into the grid is allowed the compensation at retail rate, which is very attractive to consumers. However, this compensation may result to faster and higher in revenue losses of utilities if there is higher distributed solar photovoltaic penetration.

For net billing, the rate of excess electricity can be valued at below, equal, or higher than retail rate, depending on the market condition. It may depend on the most of the power that generated from the rooftop PV system and consumed power that generated from the rooftop PV system and consumed, even the buy-back rate is low, and it might stimulate the market. However, the key point is that the rate of excess electricity requires certain justification and it needs to be updated on regular basis (e.g. yearly). The reasons why utilities seem to prefer net billing than net metering can be considered in term of accounting set-up and taxes. Net billing can be set up account easier because net metering may require setting up new accounting system for excess generation that will flow back into the grid in the current month, which is credited into the subsequent bill. In term of taxes, since net metering require two meters for monitoring the electricity that consumed from grid and excess part of PV electricity that flow back into the grid separately, so utilities can collect taxes from excess electricity that purchased, whereas the taxes revenue can be lose from the compensated credits. Additionally, considering the meter, net metering requires only one meter, which residential consumers no need to change a new meter, they still can use their existing electromechanical meter because this type of meter allow the electricity run backward. Unlike net billing, the higher cost can occur to utilities for providing new meters; besides, net billing need to set up the meter to have hourly time stamp and requires more memory on the meters and recruits more staff in order to read different

Analysis of the pros and cons of net metering and net billing.

The study discussed the pros and cons of net metering and net billing based on perspectives from each stakeholder group. This analysis based on the outcome of detailed supporting scheme design through questionnaires. For self-consumption scheme, most of stakeholders satisfied with no compensation for self-consumed part of PV electricity. This feedback suggested that the respondents believe this scheme is already profitable without adding premium tariff. Since self-consumed electricity is allowed and the prosumers are able to consume their own PV generation which is valued at retail rate, it will instantaneously reduce electricity bill. In term of compensation, consumer would prefer net metering mechanism because the excess generation is valued at retail rate, which is very attractive and encouraging for rooftop PV system adaptation. In addition, specifically for residential consumers, there is no need to pay for a new meter because the existing meter allowed the excess generation to run backward into distribution grid. As for private companies, which prefer net metering because this scheme does not require any payment during the year due to the excess of PV electricity as it is kept in credits, which means no need to set quota. In addition, at the end of banking period, the left credits can be valued at zero. However, this scheme would impact utility company in term of revenue losses and increase burden in term of accounts and taxes. Both utility companies think net metering is not an option as it would require complex account setting and inability to collect tax.

These two issues will be the problems that prevent the net metering scheme to be implemented. In term of the rate, if excess generation is valued at the full retail rate, utility companies may lose their revenues faster because they typically purchase electricity from the Electricity Generating Authority of Thailand (EGAT) at a wholesale rate. So, both utility companies would prefer net billing with real-time buyback but should not be hourly netting because it requires changes in digital meter setting to collect more data and also imply changing or further training of meter reading personnel towards a digital savvy and recent metering technology.

CONCLUSIONS

The stakeholders' perspective above reflect their point of views on each element of self-consumption scheme, including net metering and net billing in order to design the potential scheme for promoting rooftop solar PV system in Thailand. Since natural energy transition from conventional energy sources to renewable energy sources may profound consequences for the utilities. So, they may need more ambitious in order to make a transition toward self-consumption schemes. The implication for scheme selection from stakeholders' perspectives can emerging insights on the future of policy and regulation electric power system point of view to greater attention to consumers' attitudes and behaviors and additionally calls for consumers' active participation in the decision making.

ACKNOWLEDGMENT

The authors would like to thank EDS and ERIC of Chulalongkorn University for providing a platform in conducting this study and the Energy Conservation Promotion Fund (ENCON Fund) for supporting this research through the Rooftop Pilot Evaluation Project and all informants who provided inputs into our study through workshops, surveys, and interviews.

REFERENCES

[1] Dehler, J. (2015). Self-consumption of electricity from renewable sources. An Energy think tank tank informing the European Commission. https://publikationen.bibliothek.kit.edu/1000052980.

[2] Renewables 2016 Global Status Report. http://www.ren21.net/wpcontent/uploads/2016/05/GSR_2016_Full_Report_lowres.pdf , 2016.

[3] International Energy Agency Photovoltaic Power Systems Programme, 2016 http://iea-pvps.org/index.php?id=353

[4] El tawil, M., Zhao, Z. (2010). Grid connected photovoltaic power systems: Technical and potential problems-A review. Renewable and sustainable energy reviews, 14, 112-129. Doi: 10.1016/j.rser.2009.07.015

[5] Luthander, R., Widen, J., Nilsson, D., Palm, J. (2015). Photovoltaic self-consumption in building: A review. Applied Energy, 142. 80-94. http://dx.doi.org/10.1016/j.apenergy.2014.12.028.

[6] Tongsopit, S., Moungchareon, S., Aksornkij, A., & Potisat, T. (2016). Business models and financing options for a rapid scale-up of rooftop solar power systems in Thailand. Energy Policy. doi:10.1016/j.enpol.2016.01.023

[7] GIZ (2017). Thailand Solar PV Policy Update. http://www.thai-german-cooperation.info/admin/uploads/publication/384bf513d3c90d94c609e739be270b3den.pdf

[8] Hughes, L., & Bell, J. (2006). Compensating customer-generators: a taxonomy describing methods of compensating customer-generators for electricity supplied to the grid. Energy Policy, 34(13), 1532-1539. doi:10.1016/j.enpol.2004.11.002S.

[9] Dufo-López, R., & Bernal-Agustín, J. L. (2015). A comparative assessment of net metering and net billing policies. Study cases for Spain. Energy, 84, 684-694. doi:10.1016/j.energy.2015.03.031.

[10] Wan (1996). Net metering programs. National Renewable Energy Laboratory (NREL). http://www.nrel.gov/docs/legosti/old/21651.pdf.

[11] Eid, C., Reneses Guillén, J., Frías Marín, P., & Hakvoort, R. (2014). The economic effect of electricity net-metering with solar PV: Consequences for network cost recovery, cross subsidies and policy objectives. Energy Policy, 75, 244-254. doi:10.1016/j.enpol.2014.09.011.