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A Comparative Review of Solar Photovoltaic Energy Promotion Policy in Selected Southeast Asian Countries: Sharing Feed-in Tariffs Experience

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As the Southeast Asian countries heavily rely on coal and natural gas for electricity generation, the governments promote renewable energy as an essential component of sustainable development, energy security, cleaner air, and reduced carbon emissions. Solar photovoltaic is one of the abundant and potential renewable energy sources across those countries. Even though five Southeast Asian countries (Indonesia, Malaysia, Philippines, Thailand and Vietnam) have implemented the FIT policy, the solar PV capacity has significantly varied among these countries, which prompt us to analyse the FIT policy structure, FIT efficiency, drivers, and barriers to penetration solar PV. The results showed that initially, the FIT efficiency is high, and then there is a decreasing FIT efficiency trend found in five Southeast Asian countries. Thailand exhibits relatively stable performance, and Indonesia's FIT performance is unstable, while Vietnam has recently seen a rocketed investment. The vital policy implications would focus on the appropriate FIT policy design along with trade policy and techno-industrial development to penetrate solar PV.

1. Introduction

Today, Southeast Asian countries still heavily rely on conventional energy sources (i.e., coal and natural gas) for economic growth, especially transport and electricity generation. Between 2000 and 2018, carbon dioxide (CO_2) emissions from fuel combustion in Southeast Asia grew from less than 700 million tons (Mt) to more than 1,400 Mt, around 10 % of the world. As energy demand and climate change mitigation in the regions accelerates, the governments of Southeast Asian countries are promoting to development of renewable energy as an essential component of sustainable development, energy security, and reduced carbon emissions. Renewable energy is also presumed to boost the economic growth of the country. Therefore, they began targeting renewable energy development, including geothermal, solar, wind, hydropower, biomass, and other new energies. However, hydropower and biomass are very vulnerable to climate change associated with high temperature and drought (Ibrahim et al., 2021).

Solar energy is an abundant and potential renewable energy source among all renewable energy sources, the most economical solution for the mini-grid and off-grid electrification in rural or remote areas and grid expansion (Shahsavari and Akbari, 2018). The annual average solar irradiation levels range from 1,460 to 2,000 kWh/m^2, and the average daily sunshine hours range from 4 - 6 h/d in the Southeast Asian countries. Solar panels are affordable and the cheapest form of electricity because of the remarkable decline in price over the last decade (IRENA, 2020), which has played a crucial role in energy transition and solar PV development. Among policies of carbon taxes and other market-based instruments, feed-in tariff (FIT), which mandates energy utilities to pay a higher price for renewable electricity to generators than other sources of electricity, has become popular for jumping-starting growth in renewable energy. The success of FIT in increasing renewable energy capacity has thoroughly documented in European and OECD countries (Milanés-Montero et al., 2018).

Among Southeast Asian countries, 5 countries, namely Indonesia, Malaysia, Philippines, Thailand, and Vietnam, have implemented a FIT policy for different technologies of renewables. Those countries also happened to

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experience the top countries with significant growth of renewable energy installation in the region. This paper presents a comprehensive review and comparison of promoting FIT policy, its drivers, and barriers to solar PV growth in five selected Southeast Asian developing countries.

2. Literature review

The feed-in tariff policy has been one of the most popular instruments to penetrate solar PV investment (Du and Takeuchi, 2020). In the FIT scheme, the public authorities guaranteed the tariff for the renewable energy generators for a specified period. Several studies have assessed the FIT policy effects and efficiency in promoting renewable energy development. Dijkgraaf et al. (2018) surveyed 30 OECD countries from 1990 to 2011 and found that the well-designed FIT and policy consistency significantly impact solar PV penetration. On the other hand, the FIT policy design elements (tariff size and duration) positively but not significantly influence solar PV development (García-Álvarez et al., 2018).

There is less evidence regarding the effects and efficiency of FITs in developing countries. A study by Tantisattayakul and Kanchanapiya (2017) demonstrated that the current feed-in tariff in Thailand is not sufficient to promote solar PV investment in the residential sector. The low-interest-rate loan found to be the best measure for promoting and stimulating renewable investment. The FIT policy resulted in a high concentration of project ownership in the Philippines and, as a result, reduce public support for FIT (Barroco and Herrera, 2019). The FIT policy has no significant effect on renewable investment and independent power producer growth in Indonesia (Ambarita and Kawai, 2018). A study by Ghazali et al. (2020) examined whether auctions could replace FIT in Malaysia and concluded that competitive bidding is preferable to support mature technology and large-scale generations, while FIT should sustain to support new technologies. Most studies that discussed the effects of FIT policies had restricted their inquiry to the U.S.A., Europe, or OECD countries; few studies included developing countries. Even when included, the investigation is often limited to China, India and Brazil. Thus, this study focused on the selected Southeast Asian countries approach to solar PV development through the FIT policy and what constitutes the efficiency of FIT that might help to explain the divergent results of each country policies.

3. Data and methods

This study obtained data from country-specific documents and international report. The data on solar PV installed capacity were collected from publically available websites of the International Energy Agency (IEA) and International Renewable Energy Agency (IRENA) while the data on the FIT rate collected from relevant government ministries and the OECD database. Then, a simple FIT efficiency calculated by considering the ratio of output (i.e., solar PV capacity growth rate expressed in percentage) and input variable (the FIT rate expressed in USD/kWh). The formula is given in Eq(1), where *t* indicates the year :

$$FIT\ effciency_t = \frac{(Solar\ PV\ capacity_t - Solar\ PV\ capacity_{t-1})/Solar\ PV\ capacity_{t-1}}{FIT\ rate_{t-1}} \quad (1)$$

The implementation of FIT policy and its measured efficiency in each country will be compiled. These five case studies form the basis of a comparative analysis focused on how their respective FIT policies operate and its barriers or success contribute to their efficiencies.

4. Case study results and discussions

To understand the FIT policy on solar PV penetration, we will discuss renewable energy policies, structures, and its efficiency for five case studies in Southeast Asian countries.

4.1 FIT policy, its structures and solar PV trends in five selected Southeast Asian countries

In 2006, the government of Indonesia had enacted a national energy policy. The country has targeted to increase the development of 6,500 MW of solar power by 2025 and 45,000 MW by 2050. According to the FIT schemes regulated in the Minister of Energy and Mineral Resources Regulation no. 04/2012, the price of each type of renewable source fixed at between 0.07 USD/kWh and 0.18 USD/kWh (The WB, 2021), depending on the types of renewables, level of voltage generated, and geographic location. The FIT policy is stipulated in government regulation no. 79/2014 on National Energy Policy (NEP) and stated that the selling price of renewable energy must determine upon the FITs mechanism. In 2013, the first FIT on solar energy released, and the FIT rate varied from 0.25 USD/kWh to 0.30 USD/kWh. This FIT only used for 3 y, and in 2016, the new FIT for solar energy has been released, which varied from 0.15 USD/kWh to 0.25 USD/kWh (Figure 1a). The FITs aim to support achieving 23 % renewable production in the Indonesian energy mix in 2025. The vision and challenges to reach this target are elaborated in the presidential regulation no. 22/2017 on National Energy Planning (NEP).

Malaysia has been exerting tremendous efforts toward renewable energy deployment since 2001 and implemented different program such as the Building Integrated Photovoltaic project (2005–2011). The government established other policies, including National Green Technology Policy (2009) and Tenth Malaysia Plan (2011–2015). In 2011, the renewable energy act enacted to implement the FIT system for four renewable energy resources of biogas, biomass, mini-hydro, and solar photovoltaic (PV). Under the FIT mechanism, renewable energy producers can be homeowners, business owners, private investors, or even farmers. The contract duration of the FIT mechanism is 21 y for solar PV in Malaysia, and the renewable fund currently funded through both the Ministry of Finance and electricity consumers. Consumers who use electricity with more than 300 kWh/month can be surcharged 1 % from their electricity bill. The FIT mechanism implementation is dependent on the available renewable fund and quota where the government has fixed a total allocation of 511 MW for various renewable energy resources, including 196 MW for the year 2011 and 2012, 190 MW for 2013, and 125 MW for the first half of 2014. FIT has been ceased to be used in Malaysia and replaced with net energy metering policy.

In 2008, the Philippines established a renewable energy framework through the renewable energy act and the National Renewable Energy Program (NREP) to install a renewable energy capacity of 15,304 MW by 2011. The Energy Regulatory Commission released Resolution No. 16 on July 12, 2010 (which later amended through ERC Resolution No. 15, 2012) detailing the implementing rules on establishing the FIT system, a non-fiscal incentive mechanism. According to the National Grid Corporation of the Philippines (NGCP), FIT-eligible plants contributed an additional 1,376 MW of installed capacity from 2014 to 2019. For the first time, solar PV FIT price was 0.22 USD/kWh (The WB, 2021) with 50 MW of installed capacity, and ERC released Resolution No. 06, series 2015, revising the installation target for solar energy generation from 50 MW to 450 MW and setting a new Solar FIT rate of 0.21 USD/kWh (Figure 1a). The FIT mechanism guarantees a purchase agreement for 20 y with priority connection to the transmission or distribution system and priority scheduling and dispatch in the spot market.

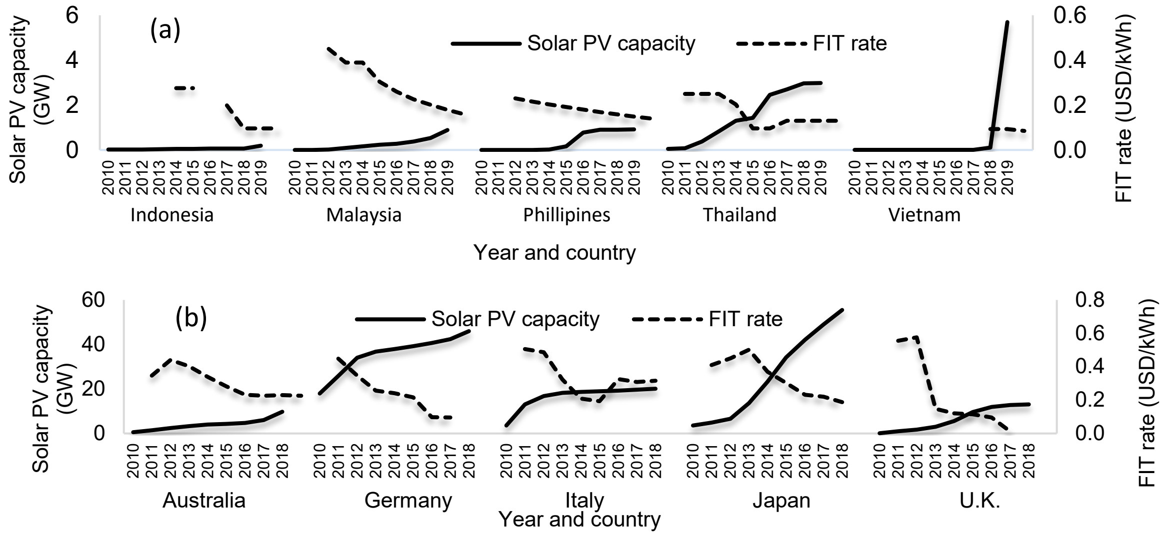

Figure 1: Trend of solar PV capacity and FIT rate in selected (a) Southeast Asian countries and, (b) OECD countries

Thailand government has launched the policy to motivate the private sector for investment in renewable electricity generation since 2007. It was called “Adder” (or Premium-price FIT), which could be considered as a form of FIT since it is incentivised the power generator a fixed payment (0.23 USD/kWh (The WB, 2021)) on top of retail electricity tariff. The Adder program was offered for solar PV (large scale) and was closed in June 2010, resulting in 829 MW of solar power by the end of 2013. The Adder Programme causes some uncertainty associated with the computation of tariffs in the long term due to global energy commodity prices volatility. The other possible reasons for the Adder program discontinuity are that tariff does not accurately reflect the levelised cost of energy (LCOE), limited supervision by weak regulatory agencies, lack of coordination and difficulty among six separate national energy plans supervised different government bodies. Between 2007 and 2013, the growth of Thailand’s grid-connected solar PV capacity has been phenomenal, averaging 211 %/y. 99 % of this growth comes from large-scale solar PV. After the pause of solar PV support between 2010 and 2013, the Thai National Energy Policy Commission (NEPC) has approved two FIT programs offered for rooftop solar systems in July 2013. The new FIT scheme has a fixed-price structure with a contract duration of each project to 25 y. The first FIT program has included rooftop FIT and community ground-mounted solar PV FIT with a combined total target of 1,000 MW. Its FIT rate ranges from 0.06 USD/kWh to 0.07 USD/kWh, dependent on the installation scale. The second FIT program has been determined for community-ground mounted solar. This program had built-in degression in three steps, with the rate of 0.32 USD/kWh for years 1-3, 0.21 USD/kWh for years 4-10, and 0.15 USD/kWh for years 11-25 (The WB, 2021). According to IEA, the total installed capacity of solar PV in Thailand has increased from 1,304 MW in 2014 and reached 2,987 MW in 2019 (Figure 1a).

Vietnam started the FIT for wind energy in 2011 and then biomass and solid waste in 2014. Solar PV was not considered a viable electricity generation option until 2015, when Vietnam's Renewable Energy Development Strategy was issued. In 2017, the government had implemented the FIT mechanism for solar power. Under this FIT implementation, solar power projects (both utility-scale and rooftop) that started their operation before June 30 2019, would sell their electricity to the state-owned Vietnam Electricity (EVN) and its subsidiaries at a fixed FIT of 0.09 USD/kWh for 20 y. The new FIT rate revised since February 20 2020, has already introduced and in place for two additional years, from July 1 2019, to 2021. The revised FITs rate ranges from 0.07 USD/kWh to 0.11 USD/kWh, dependent on the type of solar power technology and region of deployment. The lead-up to the expiration of the initial solar FIT saw a remarkable boom in Vietnam's installed capacity of solar PV. As of the end of 2018, only 86 MW of solar PV capacity was in place. By the end of June 2019, this had increased to 4,450 MW. Vietnam moved well past Thailand to have the largest installed capacity for solar power generation in ASEAN. Vietnam accounted for 49 % of ASEAN's total solar PV installed capacity as of mid-2019. Solar PV growth is continuously increasing to 5,695 MW at the end of 2019 (Figure 1a).

The overall solar PV capacity has increased from 2010 to 2019, and the FIT price appears in decreasing trend (Figure 1a and Figure 1b). There might be a decreasing trend of FIT rate in both developing and developed countries due to cost reductions such as initial investment, solar panel, overall installation, and innovation of technology. Though Indonesia is a pioneer in introducing FIT policy among five Southeast Asian countries, the country does not have significant solar PV growth (Figure 1a). Thailand is leading with a steady increasing trend, and Vietnam has a rocketed solar PV capacity in the recent year. The Malaysia and Philippines are approaching similarly regarding solar PV capacity (Figure 1a). It can be seen from Figure 1a and Figure 1b that there is a significant solar PV development in five selected OECD countries compared to five selected Southeast Asian countries.

4.2 FIT efficiency in five selected Southeast Asian countries

This study excluded Vietnam in Figure 2a as the FIT efficiency showed an outlier value compared to the other four countries (FIT efficiency in Vietnam is 115.9 in 2018 and 567 in 2019). The average feed-tariff rate is 0.19 USD/kWh in five Southeast Asian developing countries (Figure 1a) and 0.28 USD/kWh in selected five OECD countries (Figure 1b). The results showed that initially, the FIT efficiency is high, and then there is a stable FIT efficiency found in both developed and developing countries (Figure 2). That means, apart from FIT price, there are various factors such as fiscal burden, consumers' willingness, solar panel costs, grid connection, and project financing affecting solar PV penetration between two groups. The increasingly heavy tariff burden to households is one of the obstacles of FIT policy promotion, especially in developing countries where the FIT has started. In developing countries, electricity utility consumers usually unwilling to pay the FIT burden, and it is difficult for the government to pay the FIT subsidy as it makes the fiscal burden. Furthermore, the economic and financial factors that have impeded renewable growth in developing countries are high initial capital, lack of financial institutes, lack of investors, competition from fossil fuels, and fewer subsidies (Raza et al., 2015). Moreover, most developing countries are suffering to produce solar panels and other related materials locally.

Southeast Asian countries in this study experienced a FIT policy failure to penetrate solar PV. However, OECD countries found FIT policy successful in developing solar PV (Dijkgraaf et al., 2018). Recently developed countries carry out an unscheduled, often-last minute adjustment of FIT, which have a less certain perspective on profitability for investors. Also, there is unhealthy competition in the electricity market, seemingly from the overprotected FIT promotions. Therefore, developed countries introduced a more market based feed-in premium (FIP) policy to benefit FIT investment momentum on solar PV. Unfortunately, Southeast Asian countries in this study failed to adopt the appropriate policy to penetrate solar PV.

The Philippines showed a sharp decreasing trend of FIT efficiency while Vietnam experienced a sudden increasing trend recently. The highest FIT efficiency on solar PV found in Vietnam compared to other countries. Though Vietnam is a latecomer to introduce the FIT policy compared to other Southeast Asian countries, their solar PV capacity has increased significantly. Vietnam has implemented the generous FIT price and introduces other measures such as inviting foreign investment in the solar industry, ease of trade policy, and tax exemption, which significantly impact the private investment in solar PV (Do et al., 2020). However, Vietnam faced some barriers to political and policy, economic and financial, technical, social and environmental to penetrate solar PV. The political and policy barriers are FIT continuity uncertainty, un-bankable public-private partnership (PPA) terms (Breu et al., 2019), slow and inadequate technical regulations, lack of clarity and delay in the project approval process, delays in the land acquisition process and allegation of misconduct by officials. High initial investment cost, low regulated electricity price, lack of clarity in future electricity price, low FIT rates, (Do et al., 2020) limited capital and financial channels (Dapice, 2018) to attract long-term loans commonly cited as economic and financial barriers. Technical, social and environmental barriers are lack of qualified human resources, inadequate infrastructure, weak grid capacity, lack of reliability and stability of the grid, lack of public awareness (Neefjes and Hoai, 2017).

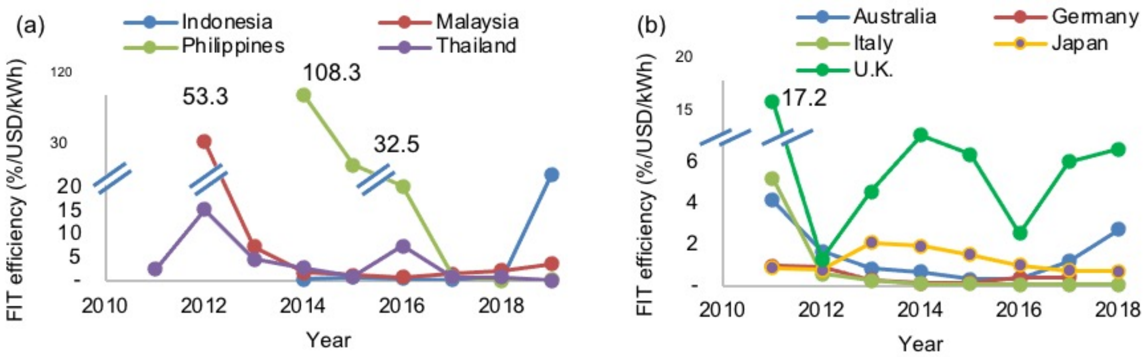

Figure 2: FIT efficiency in selected (a) Southeast Asian countries and, (b) OECD countries

Some barriers indicate a decreasing trend of FIT efficiency on solar PV in the Philippines. FIT in Philippines generally seen to have an increased cost of electricity (La Viña et al., 2018). Moreover, some solar projects applied for FIT but not awarded since a few projects could have quickly exhausted the total technology-specific capacity cap. In addition, the approval of renewable portfolio standard in 2017, which become effective in 2020 with a 35 % renewable share in the energy mix by 2030, might influence the FIT efficiency. Finally, the power investment in Philippines primarily controlled by a few family groups, which has adverse effects on social welfare as highly concentrated industries tends to exhibit low competition (Barroco and Herrera, 2019). Philippines and Malaysia found a similar and sharp decreasing FIT efficiency trend on solar PV promotion compared to Indonesia, Thailand and Vietnam. Thailand shows relatively stable performance, and Indonesia's FIT performance is unstable, while Vietnam has recently seen a rocketed investment. The possible reason for Indonesia's case is that the disruption of FIT implementation from 2014 to 2016 occurred by strict requirement from Solar Panel Manufacturing Association (APAMSI) which wanted to ban foreign bidders and to ensure that all projects used locally-produced solar panels. Additionally, the frequent FIT price changes in Indonesia might reduce the private investors' confidence to invest in solar PV (Ambarita and Kawai, 2018). The FIT burden might have an impact on the solar PV development in these countries.
The low FIT efficiency in Malaysia appeared as competitive bidding is preferable to support mature technology and large-scale generations, while FIT can sustain to support new technologies (Ghazali et al., 2020). The other reasons for low FIT efficiency in Malaysia might be due to the conversion of FIT to net energy metering policy and limited FIT fund source formed from 1 % of the revenue of electricity sold to end-users. In Thailand, the premium-price FIT under the Adder program, whose results have been to drive an impressive growth of large-scale solar power installations (Tongsopit et al., 2015), might affect a slight increase in efficiency between 2011 and 2013 (Figure 2a). While the fixed FIT designed for rooftop solar PV since 2013 showed a low efficiency due to numerous barriers that have been causing rooftop solar projects at all scales to delay in their implementation, including the unavailability of meters, complicated permitting processes, high cost, and lack of feasibility (Tongsopit, 2015).

5. Conclusion

Theoretically, FIT policy should have a significant effect on solar PV penetration; nevertheless, in reality, FIT has not been significantly effective for five selected Southeast Asian countries contrary to OECD countries or other developed countries. The challenges faced by five selected Southeast Asian countries to the development of solar PV through the FIT implementation include frequent tariff adjustment, disruption of FIT policy, increased electricity cost by FIT, a limited quota for FIT induced investors, conversion of FIT to net metering policy, competition from fossil fuels, grid connectivity for solar PV and fiscal burden by FIT. In addition, techno-industrial support for economical solar panels, trade policy for foreign investment, and high initial capital are identified as barriers in the study area. Thus, policymakers in developing countries need to focus on these barriers to penetrate solar PV promoting clean energy worldwide and reducing dependence on conventional fossil fuels. The contributions of this paper can be extended to include cost-benefit analysis and net present value method when the mandated policy data are well enough.

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