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Article

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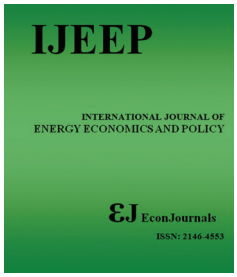

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An International Comparison of Regulatory and Licensing for Solar Rooftop Household Electricity: A Case Study of Thailand, India, and Indonesia

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ABSTRACT

Solar energy is one of the most abundant and ecologically benign renewable energy sources. Each country has different solar rooftop prospects and challenges, but the lessons learnt from one nation can help the others. To enable this transition, the energy regulatory system, including the licensing and permitting procedure and the subsidy mechanism, must be improved. In this study, the licensing process for solar rooftop residential electricity is examined in Thailand, India, and Indonesia, three distinct country contexts. The result showed that every case study had financial challenges due to high capital costs and protracted payback times. The government can provide financial assistance to lessen this obstacle. Countries that continue to employ bill-metering, such as Thailand, must switch to net-metering so that their residents can obtain energy justice and rights pertaining to power generation. In order to lessen the burden of obtaining later approval for the same, it should be recommended that residential structures and other commercial buildings come with a permit for solar installation as a part and parcel of the building construction.

Keywords: Solar Rooftop, Renewable Energy, Regulation, Licensing, Permitting Process
JEL Classifications: K2, L5, P5

1. INTRODUCTION

Energy businesses are important to the social, economic, and environmental structures of the country. It is well known that renewable energy sources such as hydropower, wind power, or solar power are the most outstanding alternative solutions to the growing challenges. Furthermore, the global society has become more aware of and concerned about environmental issues. Recently, the conference of parties (COP27) for the UN Climate Change Conference was held in Egypt to explore the opportunities of the world green economy trend and its effect on the global economy (UNFCC, 2022). In the future, renewable energy will become more and more important in both developed and developing countries.

One of the most plentiful and environmentally friendly renewable energy sources, solar energy has the potential to meet the world's current energy needs without having a negative impact on the environment. Solar PV systems could potentially be utilized to produce heat and electricity separately or together (Dhonde et al., 2022). Although the initial cost of solar technology was high, nowadays, modern manufacturing technology has significantly reduced the production cost and price of solar technology. The cost of electricity at the level of the PV module has decreased to less than 0.02 USD/kWh, making it one of the most affordable technologies for generating electricity (Jager-Waldau et al., 2018). The market for rooftop solar PV systems was estimated at USD 66.84 billion in 2019; from 2020 to 2027, it is anticipated to increase at a compound annual growth rate of 6.1% (Grandviewresearch, 2022). The market is anticipated to increase as a result of increasing use

of renewable energy for electricity production and the abundance of solar energy available during the day.

In Thailand, the installed solar PV capacity increased from 1,425 MW in 2015 to around 2,988 MW in 2020, registering a growth of almost 18% over the course of the year (Statista, 2022). The growth of solar power in Thailand is gaining immense popularity in both the industrial and agricultural sectors (Chimres and Wongwises, 2016; Kumpanalaisatit et al., 2022). Recently, installing solar power in homes is becoming more and more popular. Due to the fact that solar system prices are on the down, there are now significantly more prosumers in office building and residential sectors (Yoomak et al., 2019). Two main reasons for driving solar rooftop growth in Thailand: (1) faster payback period from 17-30 years in 2013 to 6-14 years in 2021 and likely to decrease only 5-12 years in the future; and (2) increasing of Feed in Tariff (FiT) from 1.68 Baht/kWh to 2.2 Baht/kWh, allowing households who install solar rooftop to benefit more from selling electricity (Eckhouse, 2020; EPPO, 2020).

Thai government intends to buy 50 megawatts of electricity from homes in 2021, or roughly 10,000 households, according to the PDP's first revision. The target is to buy electricity from households at 1,100 megawatts in 2028 (MOE, 2018). This means that there are at least 220,000 households who have a solar rooftop installed. In case of achieving the target, it is estimated that the market value of solar rooftop installations for household sector will be worth around 34 billion Baht in 2028.

In order to grow the solar market as expected, regulations related to obtaining licenses to install solar power systems need to be updated and changed, to facilitate energy consumers and society. Enabling everyone can access to affordable, reliable, sustainable, and modern energy, according to the Sustainable Development Goal 7. Most of previous studies are already investigated the promotion of renewable energy in developed countries. (Prehoda et al., 2019) studied the importance of considering how utilities interpret and apply regulations when creating laws and policies that better serve the requirements of consumers. (Lu et al., 2020) reviewed the promotion of renewable energy passing through the energy policy in five countries (i.e., the United States, Germany, the United Kingdom, Denmark and China). (Roberts et al., 2019) suggested that that some problems were unique to the Australian context or to structures governed by strata-type agreements, there were broader lessons to be learned from the Australian experience, including how to design the regulatory framework needed to encourage widespread PV deployment across all residential housing types.

It can be noticed that the opportunities and barriers are unique in each of countries; however, lessons learned from one country can be benefit for the others. Thailand is on the energy transition from fossil fuel-based resources to clean energy resources. It means that the energy regulatory, including the licensing and permitting process, and the subsidy mechanism, needs to be transformed to support this transition. To fulfill the research gap, the objective of this study was to compare licensing procedure and regulatory for installing solar rooftop in three countries, i.e., Thailand, India, and Indonesia. The analysis will provide the opportunities for enhancing the regulatory framework required to facilitate the Thai solar rooftop installation in the future.

2. METHODOLOGY

A case study of solar rooftop installations in Thailand, India, and Indonesia will be conducted in order to better understand the context of solar rooftop installation. A comparative case study enables the analysis of significant differences between three cases, and case study research permits the investigation of context and phenomena when the borders between them are ambiguous. This method is suitable for our research because it allows us to examine the connections between the context of the three case studies of solar rooftop installations and the license permit procedures. While it is true that the generalizability of the results may be partially influenced by their capacity for explanation, the quality of the qualitative data may aid to lessen the limitations of the quantity. The research for this study was done in two parts; the first stage involved desk research to identify the crucial data and points of comparison for the three operations, as detailed in the next section. The second part of the research, which involved gathering primary data through the expert analysis, was then informed by this knowledge.

2.1. The Licensing Procedure for Rooftop Solar Electricity Generation

The licensing procedure for rooftop solar electricity generation varies from country to country. In general, however, there are a few common steps that must be taken in order to obtain a license, as shown in Figure 1.

1. Site evaluation: The first step is to evaluate the suitability of the site for rooftop solar generation. This includes factors such as the amount of sunlight that the roof receives, the slope of the roof, and the structural integrity of the roof.
2. Business model: The next step is to decide on a business model for the project. This could involve selling the electricity generated by the solar panels to a utility company or using the electricity to offset the cost of electricity for the building.
3. Financing: Once the business model has been decided, the next step is to secure financing for the project. This could involve obtaining a loan from a bank or using a government incentive program.
4. Permits and licenses: Once the financing has been secured, the next step is to obtain the necessary permits and licenses. This may involve obtaining a building permit from the local government, and a connection permit from the utility company.
5. Construction and installation: Once the permits and licenses have been obtained, the next step is to construct and install the solar panels. This is a complex process that should be carried out by a qualified solar installer.
6. Grid connection: Once the solar panels have been installed, the next step is to connect them to the power grid. This is usually done by the utility company.
7. Commissioning: Once the solar panels are connected to the grid, the next step is to commission the system. This involves testing the system to make sure that it is operating properly.
8. Once the system has been commissioned, it is ready to start generating electricity. In addition to the steps listed above,

there may be other requirements that vary depending on the specific country or region. For example, some countries may require that solar installers be certified, or that solar projects be approved by a government agency. The licensing procedure was used as a basis for studying the licensing process in each country to compare the differences in each step of the country.

3. THE CASE STUDIES

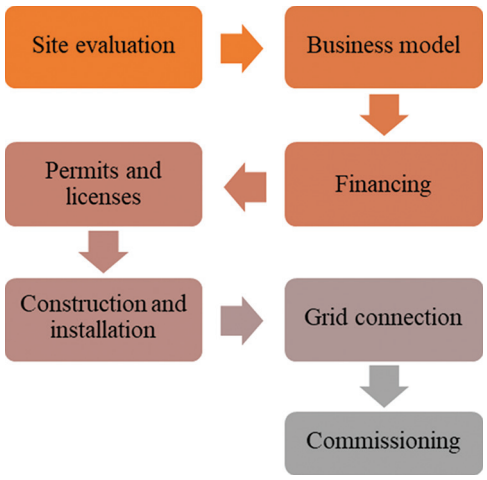
3.1. Thailand

3.1.1. General requirements

In Thailand, the process of applying for solar rooftop installation involves three state agencies: Energy Regulatory Commission (ERC); Local Administrative Organization; and Metropolitan Electricity Authority (MEA) or Provincial Electricity Authority (PEA). Depending on the installed capacity of the system, several permissions and licenses are needed, as shown in Table 1. The process of applying for solar rooftop installation starts from submitting documents to the MEA or the PEA to express intention to install solar rooftop. After that, a license will be obtained for the applicant to produce regulated electricity.

It is important to determine whether the roof structure can sustain the weight before installing a lot of solar panels on it. The installer must submit a building extension application form to the local administrative organization to receive the Certificate Building Construction, Modification or Relocation Permit No. 1 (Potosat et al., 2017).

Figure 1: The licensing procedure for rooftop solar electricity generation



Metropolitan Electricity Authority (MEA) or the Provincial Electricity Authority (PEA), where the electricity authority will bring the electricity meter to be replaced. This meter is an anti-reverse type. In case of selling electricity back, the type of meter will be another type that can release electricity back to the utility transmission line.

3.1.2. Technical requirements

In Thailand, the installation of the PV modules should allow the solar receiving side of the modules to face south or near south that is acceptable. The solar cells are tilted at an angle with the north-south plane about 10-20° (Thitithomrongchai, 2021). The circuit connection of the solar panel set should be in accordance with academic principles and must be protected for good safety, based on IEC 60364-7-712 (IEC, 2002).

3.2. India

3.2.1. General requirements

Throughout the entire year, India enjoys a colossal amount of sunlight. More individuals are switching to solar energy due to the solar industry's growing innovation and the concern of climate change in power production. There are two types of solar power: (1) A ground-mounted solar plant and (2) a rooftop solar power plant. To establish solar power, citizens must abide by specific guidelines outlined by the state. State rules, the solar plant's capacity, and the type of building—industrial, commercial, or residential—all affect the permissions required for establishing rooftop solar power plants. The approval and permit process can be illustrated in Figure 2.

The permitting process for rooftop solar power plants depends on the state in which it is installed, the size of the power plant and the building belongs to (residential, commercial, or industrial). Usually the permits required are three-fold:

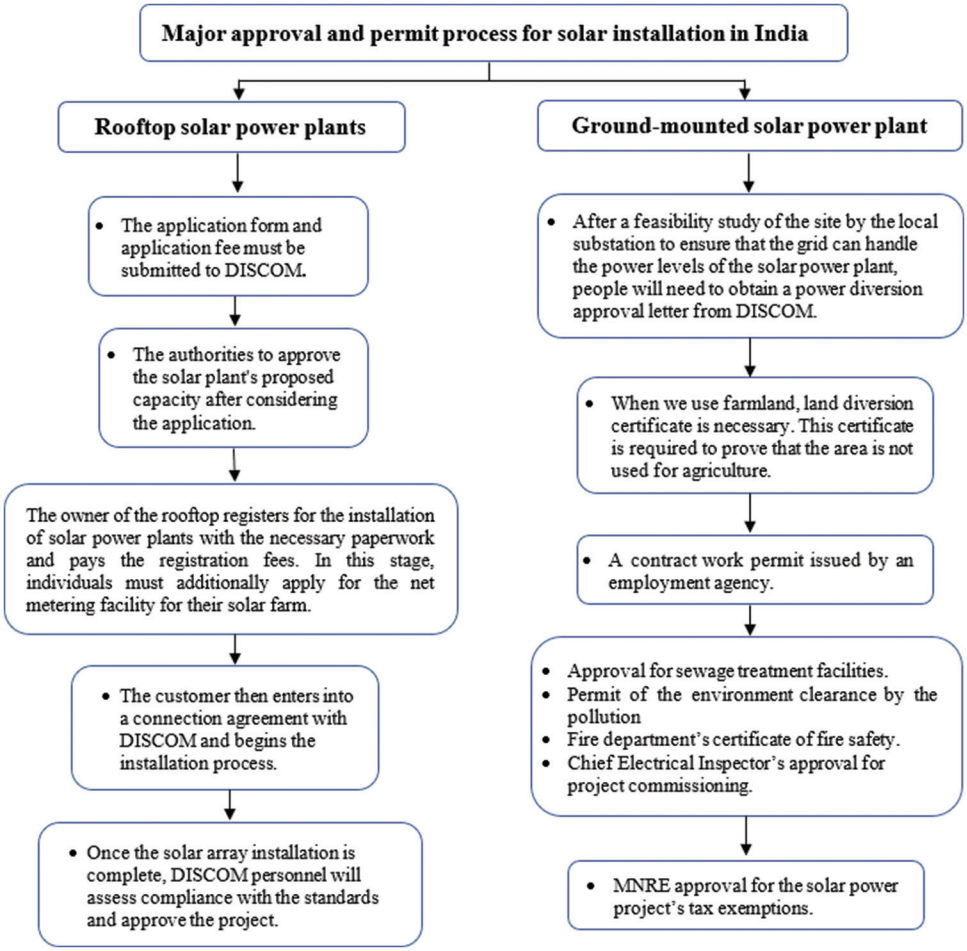
1. Electrical permits: Electrical permits for rooftop solar power plants typically go through three stages: registration, connectivity, and feasibility research. An application and an application fee must be submitted by the consumer to the power distribution company (DISCOM). The DISCOM will then decide if it will approve the connection for the requested capacity. The consumer will register for the solar power

Table 1: Solar power generation and related licenses in Thailand (Adapted from ERC, 2023)

Power generation characteristics	Solar rooftop (installed on the roof of the building)	
PV panel capacity	<1,000 kW_p[1)]	≥1,000 kW_p[1)]
Environmental and Safety Measures	Mini COP[2)]	Mini COP[2)] and ESA[3),4)]
Power Generation License	Notification for Exemption[5)]	✓
Factory Operation License	×	✓
Certificate building Construction, Modification or Relocation Permit No. 1.	Area ≤160 m2 and Weight ≤20 kg/m2	Area >160 m2 and Weight >20 kg/m2
In building control area	× (Notice to local staff)	✓
Regulated Energy Production License		
Inverter ≥200 kVA	✓	✓
Inverter <200 kVA	×	×

[1)] kW_p refers to total capacity installation of photovoltaic panel in kW at standard test condition. [2)]Mini COP refers to Code of Practice (Solar). [3)]ESA refers to Environmental and Safety Assessment. [4)]In case panel size equal to or <1,000 kWp, no ESA report is required

Figure 2: Major approval and permit process for solar installations in India (Adapted from Clair, 2023)



plant together with the required paperwork and registration fees based on the recommended capacity from the discom. Forms can typically be completed online or at the power board to accomplish this. If you are qualified, this phase will also include the permits needed to set up the Net Metering facility. The connection agreement will be executed between the customer and the DISCOM following the registration process. The financial mechanism for surplus units exported to the grid in the event of net metering, as well as other details, should be expressly stated in the connection agreement. Before approving the project, the DISCOM officials will test and analyze the rooftop plant's standard compliance after the solar power plant has been installed (MNRE, 2022).

2. Building permits: The owner of the rooftop contacts the appropriate state building officer in states where building permits are required. Following a site visit, plan review, and on-site building permit issuance, the inspector will issue the permit. Typically, residential users cannot use this. Ground-mounted Solar Power Plant Permits, the permission procedure for ground-mounted solar projects also depends on the state in which it is installed, much like it does for solar power plants on rooftops. The following extra forms of permissions are typically required for ground mounted solar power plants in addition to the standard registration procedures common to all types of solar power plants.
3. Power evacuation permission letter from the DISCOM: To guarantee that the grid can support the power levels from the solar facility, the local substation conducted a feasibility investigation before making this available. Certificate of Land Conversion - Such a certificate is required for the conversion from agricultural to non-agricultural purposes in numerous states. a labor department contract labor license. Approving sewage treatment facilities, the Pollution Control Board has granted environmental clearance, Fire department's certificate of fire safety clearance from the forest service, approval from the project's chief electrical inspector for commissioning, Ministry of New and Renewable Energy (MNRE) approval for the power project's tax exemptions.

3.2.2. Technical requirements

Technical specification for solar rooftop installation was provided by MNRE (MNRE, 2023). PV modules and solar cell should be made in India. All equipment must be corresponding to Indian standard and IEC standard. All PV modules shall have a performance warranty that is >90% for the first 10 years and >80% for the next 15 years. Additionally, the modules must offer a performance warranty of more than 97% for the first year after installation, with a degradation rate of <1% annually.

3.3. Indonesia

3.3.1. General requirements

There are many different types and sizes of residential installation capacity, but the homes in urban areas tend to be dominated by

installations with 1300 kVA and 2200 kVA, for example, Surabaya. These capacities range from 3 to 15 kWh/day in terms of energy usage (Tarigan, 2020). Customers of National Electricity Grid (Perusahaan Listrik Negara, PLN) must submit an application for its construction and installation to the General Manager of the appropriate PLN Distribution Office in order to install solar rooftop in Indonesia. Prior to providing its approval, PLN will analyze and verify the application within 15 (fifteen) working days as of the submission of a correct and complete application. Customers who want to build and install rooftop solar power plants must additionally apply for an operational license that permits captive power generation in compliance with current electricity rules. In addition, a Certificate of Operational Feasibility (Sertifikat Laik Operasi, or "SLO") must also accompany the installation of rooftop solar panels. To make that the electrical installation meets the standards and can be deemed ready to operate, SLO entails a series of assessments, examinations, and verifications carried out by a Technical Inspection Institution recognized by Ministry of Energy and Mineral Resources (MEMR). Only a construction company with a business license for electricity supporting services may build the rooftop solar panel itself.

Customers of PLN who are pre-paid must convert to post-paid status before using electricity generated from rooftop solar panels. The applicant must submit the request to become a post-paid customer along with the request for the construction and installation of rooftop solar power plant to the General Manager of the appropriate PLN Distribution Office. The customer's rooftop solar panel's connected capacity to PLN, as determined by the total capacity of the inverter, is limited to 100% of that amount. After the rooftop solar panel has secured a SLO at the cost of the consumer, PLN will additionally install an electricity export-import meter (meter kWh ekspor-impor energi listrik) for the clients.

If the customer exports more electricity to PLN than the customer imports from PLN in a given month, the difference will be accumulated and deducted from the customer's electricity bill for the following month. MEMR enacted the regulation on rooftop solar (MEMR 49/2018) to install net metering for the residential, commercial, and industrial for PLN (Tarigan, 2020). The regulation has been improved to the new regulation (MEMR 26/2021), as shown in Table 2.

3.3.2. Technical requirements

MEMR issued the Indonesian National Standard (SNI) for photovoltaic modules products to guarantees the quality of solar modules on the market by adopting from international standard IEC 61215 (Pribadi, 2021). Crystalline silicon photovoltaic modules must be fulfilled the Indonesian National Standard (SNI), namely SNI IEC 61215-1:2016, SNI IEC 61215-1-1:2016, and SNI IEC 61215-2:2016. To ensure their quality, security, and usability, all solar modules available on the market must bear the SNI certification. Manufacturers and importers of solar modules made of crystalline silicon must abide by this rule.

4. COMPARISON OF REGULATION AND PERMITS

Permit requirements for solar rooftop installation can be divided into two main criteria: building approval, and operational control. Building approval related to site evaluation, contractual agreement, and corporate and legal incentive. All studied developing countries contains the same contents, except Indonesia. A construction permit is needed. The procedure of grid connection and confirmation is needed to obtain the construction permit, as shown in Table 3. For operational control, among the three developing countries, all case studies are the same. The grid connection and construction permitting process depend on each country. Maximum time period for considering the permission of solar rooftop installation for Thailand, India, and Indonesia are 30, 15, 32 days, respectively (NIC, 2023; PEA, 2018; Simanjuntak, 2022).

Qualification requirements of the license applicant and the licensing requirements for solar rooftop electricity in Thailand,

Table 2: The adjustment in the provisions of the three MEMR regulations (Simanjuntak, 2022)

Rooftop solar MEMR regulation			
Revision	No. 49/2018	No. 16/2019	No. 26/2021
Electricity export	65%	As in MEMR Ministerial Regulation No. 49/2018	100%
Availability of export-import kWh meters	Max. 15 business days after SLO (Operation Worthiness Certificate) received by PLN		Max. 15 business days after SLO (Operation Worthiness Certificate) received by PLN
Period for setoff of the unused credit	Max. 3 months		6 months
Timeline for solar rooftop Application	Max. 15 days		5 business days without an adjustment to the Electricity Sale and Purchase Agreement (PJBL) and 12 days with an adjustment to the PJBL
Costumer	Only PLN's customer		PLN customers and customers in non-PLN Business Areas (IUPTLU holders).
Industrial Customer	Subject to capacity charge and emergency electricity purchase with the formula: Capacity cost = total inverter capacity (kW) × 40 (minimum load limit of electricity in one month) hours × electricity tariff. Then multiplied by the electricity tariff.	Subject to capacity charge with formula: Capacity cost = total inverter capacity (kW) × 5 (five) hours × electricity tariff.	Subject to capacity charge with formula: Capacity cost = total inverter capacity (kW) × 5 (five) hours × electricity tariff.

Table 3: Comparison of regulation and permits among three developing countries

Requirements	Stages	Thailand	India	Indonesia
Building approval	Site evaluation	✓	✓	×
	Contractual agreement	✓	✓	✓
	Corporate and legal incentive	✓	✓	✓
Operational control	Permit and license	✓	✓	✓
	Grid Connection and commissioning	✓	✓	✓
	Operation and maintenance	✓	✓	✓

Table 4: Comparative assessment of the requirements of license applicant and others

Country	Licensing authority	Licensing requirements for solar rooftop electricity
Thailand	The Energy Regulatory Commission (ERC)	• Must be a Thai citizen or a legal entity registered in Thailand. • Must have a valid business license. • Must have a technical report prepared by a qualified engineer. • Must pay a licensing fee. • Must obtain a permit from the ERC before installing a solar rooftop system. • The cost of the permit is THB 1,000 (USD 30).
India	The Ministry of New and Renewable Energy (MNRE)	• Must be a resident of India. - Must have a valid PAN card. • Must have a valid electricity connection. • Must have a technical report prepared by a qualified engineer. • Must pay a licensing fee. • Must obtain a license from the MNRE before installing a solar rooftop system. • The cost of the license is INR 5,000 (USD 65).
Indonesia	The Ministry of Energy and Mineral Resources (MEMR)	• Must be a citizen of Indonesia or a legal entity registered in Indonesia. • Must have a valid business license. • Must have a valid electricity connection. • Must have a technical report prepared by a qualified engineer. • Must pay a licensing fee. • Must obtain a permit from the MEMR before installing a solar rooftop system. • The cost of the permit is IDR 1,000,000 (USD 70).

India, and Indonesia are shown in Table 4. It is important to note that these are just the general requirements for licensing solar rooftop electricity in these countries. The specific requirements may vary depending on the size of the system, the location of the system, and other factors. It is always best to contact the relevant government agency to get the most up-to-date information on the licensing requirements. Thailand has the lowest cost of the permit compared with the others. In Indonesia, the licensing process is similar to that in India, but it may be more difficult to find a qualified engineer to prepare the technical report.

There is a difference in the mechanism electricity export to the grid among those countries. In Thailand, government will calculate the excess of electricity and buy back with lower price than electricity from the grid (as shown in Table 5), while India and Indonesia will calculate the excess of electricity, then deducted from the customer's electricity bill. Although the countries have their own standard for solar installation system, International Electrotechnical Commission (IEC) are used in conjunction with it.

In Thailand, the system of determining excess electricity from households, which export to the grid, is subtracting the price of electricity (Bill metering), not deducting the unit of electricity (Net metering). Net metering systems can encourage people to reduce their electricity bills and generate income from residual electricity sales, electricity usages will change to prosumer. This will give citizens access to electricity generation rights and energy justice (Sanepong, 2019). There are some weak points discussed in bill metering systems: the price of electricity export to the grid is very low compared to the electricity price from grid; limited only 10 years for exporting excess electricity from household (Teerapong, 2023). These conditions make it difficult for people to profit from solar rooftop power plant installations. The fact that the state sets a fixed price and is the only buyer in the market, which makes trading not reflect to market mechanism.

While Thailand uses bill metering, India and Indonesia are on process transform to decentralization by applying net metering system with solar rooftop installation to household. To reduce the main barriers (i.e., high capital cost, long term return of investment), Indonesia has been revised MEMR regulation, which has amended the requirements from the original purchase of excess electricity at 65 percent change to 100 percent. This action is expected to increase the rate of solar household installation, although the high investment costs of PV systems was identified as the main barriers for investment (Nurwidiana, 2023; Setyawati, 2020). In addition, the lack of the services (i.e., information services, procurement, installation, and maintenance of PV system) are the main concerns from users.

From the comparative analysis of regulations and licensing for solar rooftop installation, it can be seen that the pain point of this development lies in the privatization of the country's electricity business and the reform of the electricity sector. This measure will add more competitors to the electricity market, which resulted in more competition and development and led to a decrease in the price of electricity used by households. It can be observed that a country, like Thailand, has gradually its market structure.

Table 5: Comparative assessment of the legal incentive and permit license

Stages	Issues	Thailand	India	Indonesia	Source
Corporate and legal incentive	Electricity price from grid*	0.123 $/kWh	0.074 $/kWh	0.097 $/kWh	(GrobalPetroPrices, 2023)
	Electricity price for export to the grid	Bill metering (0.063 $/kWh)	Net metering	Net metering	(NIC, 2023; PEA, 2018; Tarigan, 2020)
	Number of years of purchase of electricity from solar rooftops in residential sector	10	Not specifying the purchase period	Not specifying the purchase period	
	% difference price	48.78%	0.00%	0.00%	
Permit and license	Process time consume	30	15	32	(NIC, 2023; PEA, 2018)
	Standard	IEC standard	Indian standard and IEC standard	Indonesian National Standard, IEC standard	

*Electricity price includes all components of the electricity bill such as the cost of power, distribution and taxes, September 2022.

Electricity prices are high compared to countries with structural changes like India and Indonesia. If Thailand wants to stimulate the production of electricity from renewable energy as the target has been set. They should accelerate the implementation of such structural changes. In addition, setting a quota for purchasing electricity from households is another limitation of Thailand. This causes those who install solar rooftop systems to have a long payback period that is not worth the investment. Unlike Indonesia and India, there is no such quota limit.

Countries that are in transition and want to stimulate home solar power generation the measures of India should be taken as an example. India has financial support for investing in the installation of solar rooftop. This enables people to overcome the financial barriers that are the main obstacle in installing solar rooftop systems in developing countries.

5. CONCLUSIONS

All countries are in the process of changing the era of electricity production from fossil fuel to renewable energy. When considering renewable energy as an important component of the entire national energy strategy, the legal procedure used for renewable energy licensing is crucial to the successful implementation of an energy policy. This study investigates the comparison of the regulatory organizations and licensing procedures for producing electricity from solar rooftops. Thailand, India, and Indonesia are the three case studies for identifying the factor of stimulating solar rooftop installation. As can be seen in the above comparison that the solar rooftop installation requires two stages of licensing: one for construction and another for electricity generation. To install solar rooftops for households, every case study has faced financial barriers with high capital cost and long payback periods. This barrier can be alleviated by financial support from the government. India is a good example for this case. In the meantime, countries still use bill-metering like Thailand need to change to net-metering, citizens will then have access to energy justice and rights related to power production. The lead time for obtaining a solar rooftop installation permit in each country takes approximately 1month, except India (15 days). However, in case of Thailand, it should be recommended the residential building and other commercial buildings should come with solar installation permission as a part and parcel of the building construction, therefore reducing the burden of getting later approval for the same.

The study provides a starting point to distill policy implications for improving legal frameworks relevant to solar rooftop installation across three case studies. The conclusions of this study offer practical suggestions for decision-makers to properly implement the strategy and expand the use of solar energy.

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