# Policy Evaluation of Purchasing Electricity from Rooftop PV by PT PLN (Persero) and Its Effectiveness in Increasing the Renewable Energy Portion on the Energy Mix

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Abstract: In 2017, global cumulative solar photovoltaic (PV) capacity reached almost 398 GW and generated over 460 TWh. However, total installed solar PV in Indonesia is only 0.017 GWp from the potential capacity of 207.9 GWp. To push the development of solar PV capacity, the government stipulated Minister of Energy and Mineral Resources Regulation Number 49 of 2018 on Solar Photovoltaic System Utilization by customers of PT PLN. The energy exported is converted by 65% for non-industrial customers. For industrial customers, it is subject to capacity charges and emergency energy charges. The objectives of this research are to evaluate the implementation of the rooftop PV policy, then to observe alternative solutions to optimize it. The program evaluation method is used. Data obtained through interviews, FGD, and literature reviews. The analysis is done qualitatively and quantitively. The results are challenges on implementing rooftop faced by utilities (existing system condition), consumers (65% not appealing), and government (untracked systems); what are the alternative solutions; how to overcome the intermittent issue.

## 1 INTRODUCTION

Solar Photovoltaic (PV) technology, which converts sunlight into electricity, is a rapidly growing renewable energy resource and assumedly will play a major role in global energy production. Solar energy is abundant, and therefore, Solar PV is one of the most promising renewable energy resources. In 2017, cumulative solar PV capacity reached almost 398 GW and generated over 460 TWh, representing around 2% of global power output.

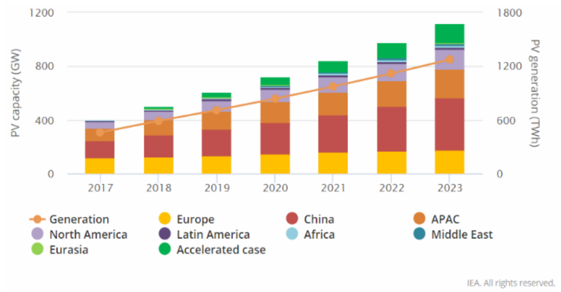


Figure 1: Solar PV Generation and Cumulative Capacity by Region, 2017 – 2023.

Utility-scale projects account for over 60% of total PV installed capacity, with the rest in distributed applications (residential, commercial, and off-grid). Over the next five years, solar PV is expected to lead renewable electricity capacity growth, expanding by almost 580 GW under the Renewables 2018 main case (Figure 1).

However, the growth in Indonesia is not as enthusiastic as its peers do. It is a big challenge for the Directorate General of Electricity (DGE) as a regulator in the electricity sector in Indonesia on this matter. As stated in Presidential Regulation Number 24, the Year 2010 concerning Status, Duties, and Functions of State Ministries and Organization Structure, Duties, and Functions of Echelon 1 of State Ministries, Directorate General of Electricity has duties to formulate and to implement policy and standards on the electricity sector. One of its mission is to optimally utilize primary energy sources and renewable energy by paying attention to their economics.



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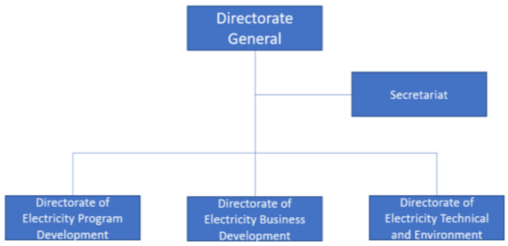


Figure 2: Organizational Structure of DGE.

According to the National Energy Policy, also mentioned in National Energy Planning Policy, such objectives of national energy management are:

- Optimal energy mix: minimum 23% of renewable energy in 2025, and minimum 31% of them in 2050;
- Total power generation capacity installed of 115 Gigawatt in 2025 and 430 GW in 2050.

Solar energy is one of the renewable energy resources that are abundant in Indonesia. However, in 2017, the total installed solar power plant in Indonesia is merely just 0.017 GWp (Electricity Utilities Statistic in Indonesia year 2017) from the potential capacity of 207,9 GWp (RUEN). Therefore, the government-issued Minister of Energy and Mineral Resources (MEMR) Regulation Number 49 of 2018 in order to regulate electricity utilization from Rooftop PV by PLN customers to be absorbed by PLN without disrupting the operation of the electricity system given the intermittent electrical energy from Rooftop PV.

As per MEMR Regulation Number 49 of 2018, the maximum capacity of Rooftop PV that can be installed is 100% of the power connected to the National Electric Company PLN. From this capacity, the energy exported to the grid is valued at 65% of the actual exported energy. This provision applies to non-industry customers, while for industrial customers, it is subjected to capacity charge and emergency energy charge costs following the provisions of the Minister of Energy and Mineral Resources Regulation Number 01 of 2017 on Parallel Operation of Power Plants with the PT PLN (Persero) Electric Power Network.

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# 2 METHODS

## 2.1 Conceptual Framework

The exploration of the research is of basis to evaluate a public policy or regulation that is already implemented. The program evaluation is chosen where the policy that will be evaluated could be associated with the program, where this program contains an objective to achieve something. And also, the policy that will be evaluated in this research in particular.

Framework for program evaluation:

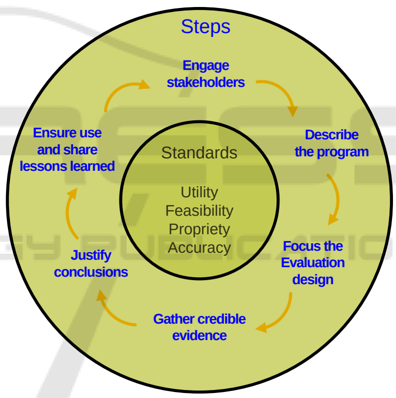


Figure 3: Evaluation Framework.

There are six steps to evaluate a program.

Step 1: engage stakeholders
Step 2: describe the program
Step 3: focus the evaluation design
Step 4: gather credible evidence
Step 5: justify conclusions
Step 6: ensure the use and share lessons learned

### 2.1.1 Engage Stakeholder

Table 1: Stakeholder Identification.

| No | Stakeholders | Scopes |
|---|---|---|
| 1 | DGE* | Electrification Ratio, targeting 100%;<br>Operation Certificate, registered in DGE;<br>Power purchase agreement approval must be processed via DGE;<br>BPP calculation approval;<br>RUPTL of PLN |
| 2 | DGNREEC** | The findings of the evaluation needed by the government in order to make sure that the program is effectively in line with the government target to meet the RUEN energy mix target of 23% Renewables Energy in 2025. |
| 3 | Jakarta Office of Industrial and Energy | Solar potential coverage in the region;<br>Operational Permit must be approved from this agency;<br>Local Contractor of PV Rooftop must obtain a permit from this agency |
| 4 | PT PLN (Persero) | Owner of existing network grid;<br>The existing contract with IPP;<br>Energy transaction; |
| 5 | Rooftop PV Supplier | Supplier of the equipment of solar PV;<br>Business affected |

* Directorate General of Electricity
** Directorate General of New and Renewable Energy and Energy Conservation

### 2.1.2 Describe the Program

The program here is a product that has been through a public policy process. There are several motives that infuse why the policymaker is endorsing the agenda of issuing the policy. Some of them are energy trilemma, grid edge, and sustainable development goals. Paris Agreement on Climate Change also came out as one of the motives.

The program itself is about the Utilization of Rooftop Solar Power Generation Systems by Customers of PT PLN (Persero), as enacted by Minister of Energy and Mineral Resources Regulation Number 49 of 2018.

### 2.1.3 Focus the Evaluation Design

The evaluation designed by conducting several steps:

- Literature Review (Background of Public Policy, Policy Analysis, Energy Trilemma, Grid Edge overview, Paris Agreement and SDG, Policy Statement, Levelized Cost of Electricity)
- Arranging interviews with stakeholders to gather useful data (DGE, DGNREEC, PLN, and PV Supplier)
- Qualitative analysis and calculation if necessary
- Benchmarking with other countries.

### 2.1.4 Gather Credible Evidence

- Collecting interview results to build a conclusion of policy evaluation
- Mapping and collecting necessary data given by stakeholders or other credible sources
- Applicable rules that the current program related to.

### 2.1.5 Justify Conclusions

- Qualitative and calculation supported the hypothesis
- Benchmark practice in other countries on the respected matter
- Focus Group Discussion related to the issues.

### 2.1.6 Ensure Use and Shared Lesson Learned

- The evaluation is expected could be reviewed by the respective agency
- And also as an alternative solution for stakeholders

## 2.2 Method of Data Collection and Analysis

Data obtained through interviews, focus group discussions, as well as literature reviews from books, journals, publications, and other reliable sources. The analysis is done qualitatively and also simulates various sensitivity scenarios to calculate the potential savings that might be obtained by the customer.

# 3 ANALYSIS

## 3.1 Business Situation

Generation Cost of Production (BPP) for PLN has been enacted by Minister of Energy and Mineral Resources Decree Number 55 K/20/MEM/2019 of 2019 on Cost of Production of Power Plant for PT PLN (Persero) Year 2018. The decree divided BPP into one National BPP, six Regional BPP, 25 Distribution BPP, and several systems and sub-systems BPP. National BPP is 1119 Rp/kWh or 7.86 cents US$/kWh (Rp 14246/US$, Bank of Indonesia Average Rate Exchange in 2018). The lowest BPP is in West Java and Central Java Distribution, with 984 Rp/kWh or 6.91 cents US$/kWh, and up to highest BPP in several Distributions with BPP of 3041 Rp/kWh or 21.34 cent USD$/kWh. Then comes price constraint on developing solar PV with IPP mechanism due to regulation of generating purchasing price by PLN:

- In the event that the BPP Generation in the local electricity system is above the average of Indonesia National BPP, the purchase price of electricity from Solar PV shall be a maximum of 85% (eighty-five percent) of the BPP Generation in the local electricity system;
- In the event that the BPP Generation in the local electricity system is the same or below the national BPP average, the purchase price of electricity from Solar PV shall be determined based on the agreement of the parties.

The comparison of renewable energy potential in Indonesia versus its installed capacity based on the statistic of electricity state in Indonesia year 2017 could be found on this table.

Table 2: Comparison of Potential and Installed Capacity (the Year 2017 Data).

| No | Sources of Energy | Potential (MW) | Installed Capacity (MW) | Utiliz. |
|---|---|---|---|---|
| 1 | Geothermal | 29.544 | 1.805,40 | 6,11% |
| 2 | Hydro | 75.091 | 5.124,06 | 6,82% |
| 3 | Mini-micro Hydro | 19.385 | 326,08 | 1,68% |
| 4 | Bioenergy | 32.654 | 36 | 0,11% |
| 5 | Solar | 207.898 | 17,02 | 0,008% |
| 6 | Wind | 60.647 | 1,12 | 0,002% |
| 7 | Wave | 17.989 | n.a | n.a |

For solar energy, in 2017, the total installed capacity of all types of solar PV installed reported to the government was only 17,02 MW, merely just 0,008% of all its potential could be counted by the data. So, the potential is there. However, the utilization is still far from its optimum figure. Meanwhile, in the roadmap of new and renewable energy development (EBT) stated on Electricity Procurement General Plan (RUPTL), 63 MWp of solar-powered generation newly additional capacity installed in 2019, from only 17,02 MW installed in 2017. The hope of the installation of rooftop PV should help to reach this target.

That is why the issuance of Ministry of Energy and Mineral Resources Regulation number 49 of 2018 on Utilization of Rooftop Solar Power Generation Systems by Customers of PT PLN (Persero) should alleviate the number of solar PV utilization on customers side. However, the implementation of the regulation should always be evaluated in terms of attractiveness and the effectiveness given.

## 3.2 Results and Discussion

The household consumers of rooftop PV get their energy from the PV production, all converted in 1:1 ratio if their real energy needs are absorbed for their own use. Then, if the energy produced from PV is more than what can they use on their own, the user may export their surplus of energy (kWh) to the grid (PLN). However, the conversion would not be in a 1:1 ratio, but a 1:0.65 ratio. Meaning that for every 1 kWh energy exported to PLN, PLN will count it as 0.65 kWh and will be calculated as energy credit for the following month's transaction. Illustration of Rooftop PV Production could be seen in Figure 4.

Customers' electrical energy credit transactions at the end of the month are calculated as follows:

Customer’s Electricity Bill (kWh) =
Amount of imported kWh – 65% of Amount of exported kWh

- Amount of exported kWh:
  amount of kWh exported by customers to PLN, counted by the export meter
- Amount of imported kWh:
  amount of kWh imported by customers from PLN

Notes that:

1. In the case that the amount of electricity exported is greater than the amount of electricity imported in the current month, the

excess will be accumulated and calculated as a deduction for the following month's bill.

2. The export excess is accumulated for a maximum of 3 months but will be reset every April, July, October, and January.

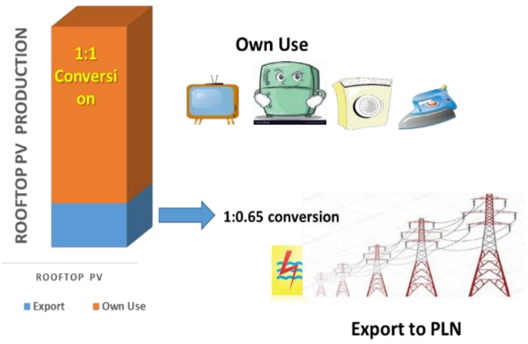


Figure 4: Illustration of Rooftop PV Production of kWh Calculation.

According to MEMR Regulation No. 49/2018, the conversion rate of exported kWh to PLN is 1:0.65, or PLN counted only 0.65 times of the actual kWh it received from customers with rooftop PV. The 0.65 conversion rate on calculating customers kWh by PLN is based on the audit result from the Audit Board of the Republic of Indonesia (BPK) on the 2017 BPP of generation, which is 62% from the total BPP of PLN.

The value of the energy produced by PV (export to PLN) compared to the value of energy imported from PLN (Electricity Rate) is equal to the value of PLN's BPP of generation (62% rounded to 65%). PLN also considered 65% to compensates network risks.

More consideration is needed since the rooftop PV would most likely be installed in LV and MV connected customers and already expensed the connection charge previously.

### 3.2.1 Saving Simulation of Residential Rooftop PV

Table 3: PV Energy Production.

| PV Energy Production | Power PU | Durat. (h) | Energy PU | % of total PV Energy | % of Total Daily Energy |
|---|---|---|---|---|---|
| Self-Consumed | 0.76 | 4 | 3.04 | 76% | 16.14% |
| Exported to PLN | 0.24 | 4 | 0.96 | 24% | 5.10% |
| Total (PU) (Blue Total Area) | | | 4 | | 21.23% |

Notes of Table 3:

- With this typical production, of the total energy generated by PV, 76% is self-consumed at noon and afternoon time (equivalent to **16.14%** of the total kWh (18.84)) when the production is at peak 1 PU.
- Since the energy is excessed by 24% of total peak production, those energy exported to PLN's grid (equivalent to 5.10 % of the total kWh consumed).
- The amount of energy 5.10% (equivalent to 24% of the total energy generated by PV) is what is affected by the energy transaction conversion factor.
- Of the total energy consumed by households before installing Rooftop PV, PLN will lose the selling of kWh of 16.14% plus a 5.10% * conversion factor (customer savings).
- With a conversion factor of 1: 0.65, the total customer savings is 16.14% + (5.10% * 0.65) = 19.45% of the total kWh consumed.
- If the conversion factor for household consumers is 1:1 instead of 1:0.65, the total customer savings is 16.14% + 5.10% = 21.24% of the total kWh consumed, or 1.79% more saving of energy.

### 3.2.2 Saving Simulation of Industrial Rooftop PV

One industry was a customer of PLN with a capacity contract of 2000 kV (Rate Subclass: I-3), with a load of 1.500 kW. It was then installed a rooftop PV of 500 kWp capacity.

I-3 rate: 1.115 Rp/kWh (off-peak rate)
L rate: 1.650 Rp/kWh (special service rate)

Assuming peak production time of PV is 3.5 hours, monthly saving from PV production is:

**Saving** : 3.5 hours x 500 kWp x 30 days x 1.115 equal to **Rp. 58.537.500 per month.**

Next is the calculation of parallel charge as additional cost due to parallel operation:

1. Connection charge = Rp. 0
   (Already connected with PLN grid, with contract capacity of 2000 kVA at the first time.)
2. Capacity charge
   Highest capacity charge
   = Total Net Capable Capacity (MW) x 40 hours x Electricity Rates
   = 500 kWp x 40 hours x 1.115 Rp/kWh
   = Rp. 22.300.000, -
3. Emergency Energy Charge (EEC)
   Assuming Forced Outage Rate (FoR): 5%, then

= 1 (time/month) x 2 (hours/trip) x 500 kWp x 1.650 Rp/kWh
= Rp. 1.650.000, -

Hence,

Total Addition cost of parallel operation
= Rp. 0 + Rp. 22.300.000 + Rp. 1.650.000
= **Rp. 23.950.000, -**

Thus, the net saving industry gain from installing 500 kWp capacity (under its contract capacity) is Rp. 58.537.500 – Rp. 23.950.000 = **Rp. 34.587.500, -**.

For the case of rooftop PV with this parallel operation policy could be associated with grid compensation that PLN charged to the owner of PV, for using PLN as backup/supplement. The amount of capacity charge alone has offset the potential saving by 38.1% of customers. This should be a consideration to engage more with industry groups to help to achieve renewable energy targets of the energy mix as mandated by RUEN.

This net saving after parallel charges applied would be the basic calculation on how much would the investment needed on installing rooftop PV, when is the BEP, and is it feasible or not considering the lifetime of the equipment, and so on. These might be well also addressed as consideration on how the industry could help them producing cleaner energy and help the government reach the 23% target of the renewable energy mix in 2025.

### 3.2.3 Decreasing Interest of Rooftop PV On-Grid

Data collected from PT Rekasurya Prima Daya (PT RPD), one of the distributor and provider of rooftop PV to be installed on its customer's property. This company has been marketing its product since 2016, prior to the commencement of MEMR Regulation Number 49 of 2018, with total package sold were 25 kWp in 2016, 140 kWp in 2017, and 260 kWp in 2018.

Table 4: PT RDP Rooftop PV Sold in 2016 – 2019 (as of July 31st).

| Year | Capacity (kWp) | Spots |
|---|---|---|
| 2016 | 25 | 7 |
| 2017 | 140 | 14 |
| 2018 | 260 | 9 |
| 2019 | 13 | 2 |

*"In fact, making customer interest decreases, because they only got paid 65% of the total kWh exported. In addition, customers must get permission from PLN, which sometimes has not been socialized to all PLN work areas so that the process would take longer." (Muhammad Fadli Salim, Director of PT RPD, July 29th, 2019).*

### 3.2.4 Distributed Generation Trends

Data collected from FGD, Distributed PV (DPV) is a disruptive but at the same time unveil opportunities

- Rapidly deploy much-needed capacity
- Tap new sources of investment capital
- Reduce air emissions
- Empower consumers

Distributed PV also is challenging on how we plan, operate, regulate, and even conceptualize the power system. However, consumers are no longer waiting for regulatory, legal, and technical issues to be resolved, leading to untracked systems.

Grid codes/standards are playing an important role in Distributed PV Grid integration out of 4 trends.

### 3.2.5 Benchmark

In Malaysia, the Net Energy Metering (NEM) scheme is similar to what the export-import meter scheme in Indonesia based on MEMR Regulation Number 49 of 2018. In Malaysia, FiT for Solar PV not viable post-2017 due to limited RE Fund. It is moving towards auction since price reduction and NEM to focus on rooftops (minimize land use). NEM is introduced to continue the development of the solar PV market. The difference is, Malaysia applied quota allocation for NEM; 500 MW for 2016 – 2020 (100 MW per year).

Effective on 1 st January 2019, the Net Energy Metering (NEM) has been improved by adopting the true net energy metering concept, and this will allow excess solar PV generated energy to be exported back to the grid on a "one on one" offset basis. This means that every 1 kWh exported to the grid will be offset against 1 kWh consumed from the grid, instead of at the Displaced Cost previously. This comparable with the Indonesia scheme of the conversion rate of 1:0.65, while in Malaysia, it is 1:1. Since implementing this 1:1 offset basis, the numbers of approved capacity have been rising double the number of that in the previous year (Figure 5).

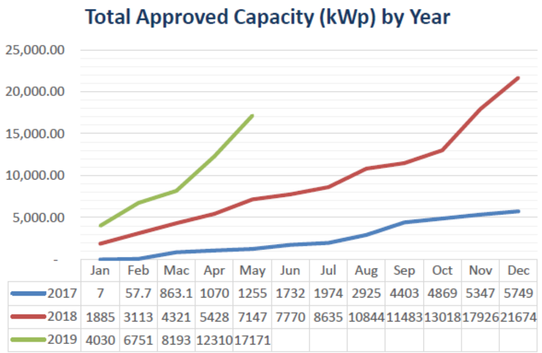


Figure 5: Total Approved PV Capacity (kWp) by Year in Malaysia.

Thailand also just launched its Net Energy Metering scheme. Key points from rooftop PV net metering launched by Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA) are:

- The capacity quota for MEA: 30 MWp
- The capacity quota for PEA: 70 MWp
- Maximum capacity per meter: 10 kWp (3-phase power system, 380/220 V) or 5 kWp (1-phase power system, 220 V)
- Export tariff: 1.68 THB/kWh
- Import tariff: 3.80 THB/kWh
- Tariff period: 10 years
- Connection Charges : 8,500 THB (9,095 THB incl. tax).

Thailand is currently conducting Peer-to-peer energy trading using the blockchain pilot project. The technology of energy transfer's data that would be the basis of energy transactions will be using blockchain. The advantage for the nation with this P2P under blockchain technology:

- Support renewable energy
- Support Thailand 4.0
- Enhance competitive for the Thai industry.

While for the people, it empowers people to manage energy, besides passive income for prosumers.

# 4 CONCLUSIONS

## 4.1 Challenges of Implementing Rooftop PV

For utilities, rooftop PV as a distributed generation can give the opportunities for the system overall and for utilities by supplying electricity directly to some percentage of customers, and depending on the status of the grid infrastructure, allows deferral of capital investments to maintain and upgrade grids and related services when these are less economical. However, grids with distributed generation (including solar rooftop PV) facing challenges where they become active and see power flowing in both directions, with a higher number of active customers to manage and a change in the load profile by reducing demand from the central generation. The requirements that allow management of the flow of electricity in real-time, including revised roles of network operators and proper network technology, are yet to be fully developed in most of the countries. Rooftop PV utilization requires a network feasibility study, which should be based on the distribution network grid code, while there is currently no distribution network grid code, so there are doubts in it.

For customers, with only 65% of exported kWh counted in credit, the customer could choose way under their installed watt capacity rooftop PV, and use it exclusively for their own use, for a reason that

- Cheaper investment
- No hassle of re-applying for rooftop PV user to PLN
- No need to change the existing meter.

The export excess is accumulated for a maximum of 3 months, but will be reset every April, July, October, and January is not really appealing. No benefit for industry or large-scale rooftop PV with energy production is bigger than its consumption.

For the government, the preferences of self-consumed the rooftop PV, not connected with the grid through net metering, leads to the difficulty of controlling the amount of intermittent generation connected to the grid.

## 4.2 Conversion Factor of 65%

PLN counted only 0.65 times of the actual kWh it received from customers with rooftop PV. The 0.65 conversion rate on calculating customers kWh by PLN is based on the audit result from the Audit Board of the Republic of Indonesia (BPK) on 2017 BPP of generation, which is 62% from the total BPP of PLN.

The value of the energy produced by PV (export to PLN) compared to the value of energy imported from PLN (Electricity Rate) is equal to the value of PLN's BPP of generation (62% rounded to 65%). PLN also considered 65% to compensates network risks.

### 4.3 Possible Alternatives to Conversion Factor

From the focus group discussion, interviews, and benchmark on other countries, these could be alternatives on conversion factor on other rules on connecting rooftop PV to the grid:

1. 1:1 Conversion Rate for Residential Consumers that are less commercial
2. 1:0.65 Conversion Rate for Commercial and Industrial Group of Consumers, however, eliminating the emergency charge and capacity charge
3. 1:1 for all groups of consumers, but regulator limiting the capacity by quota, based on the feasibility of the sub-system, and according to the applied grid code.

### 4.4 Overcoming Intermittent Issue of Rooftop PV

The difference in network quality in each region requires rules in rooftop PV interconnection with the grid as well as rules regarding the operation of rooftop PV connected to the grid (grid code). The code is to regulate the technical requirements for connecting solar power plants based on grid characteristics. The existence of these codes can improve the integration of rooftop PV generator optimization so that the grid is not interrupted by the presence of intermittent solar PV.

It is better for the customer, especially household customer, to install rooftop PV with the capacity of their daylight load capacity, not peak load capacity, so all production is optimally consumed by house load.

The evaluation of this research is expected could be reviewed by respective agencies and stakeholders and to help the government in reaching the target of 23% Renewable Energy in 2025.

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