# COMPARATIVE ANALYSIS OF COSTS BETWEEN THE USE OF PLN ELECTRICITY AND PV ROOFTOP FOR 30/60-TYPE HOUSE IN SUKABUMI, INDONESIA

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## ABSTRACT

*Housing development in Indonesia, especially in Sukabumi, in the last few years, many simple houses of type 30/60 have been built as a type of simple house that has received subsidized KPR facilities and is the type of house most sold in Indonesia. The problem studied in this study is that there is no incentive provided by the government to encourage the use of PV Rooftops. This study aims to see a comparison in the process of using PV rooftops with the installation of PLN electricity in the Home Ownership Credit (KPR) scheme, especially for subsidized KPR, which is the prima donna of housing in Indonesia today. So that it can provide input on what incentives should be done by the government. The method used is a comparison of the life cycle costs between the use of PLN electricity and PV Rooftop. From the results of the cost analysis carried out financially, this design has not been profitable from a financial point of view due to the high credit interest rate, namely 10%. Therefore, there needs to be a credit interest subsidy so that it can decrease to 5% -8% to obtain benefits compared to the use of electricity from PLN.*

**Keyword: -** *PV Rooftop, Grid, 30/60-type house, NPC, NPV, and IRR*

## 1. INTRODUCTION

One of the government's efforts to increase Indonesia's renewable energy mix is by encouraging efforts to expand rooftop solar panels (PV rooftops) for households. P use of total PV rooftop in the housing sector can reduce the environmental impact by 40% compared to the p use of total conventional energy [1]. However, until now, there has been no clear incentive to increase the use of rooftop solar panels. The main threat of rooftop PV applications in Indonesia's small house sector is in the financial aspect. The middle to lower-income earners mostly owns tiny houses on loan, making it impossible for them to invest in rooftop PV by themselves. Even though the public's interest in getting a stable electricity file with the PV rooftop application [2].
In Indonesia, especially in Sukabumi, in the last few years, many simple houses of type 30/60 have been built as a type of simple house that has received subsidized KPR facilities and is the type of house most sold in Indonesia. The subsidized building certainly requires new electricity connections. One of the incentives that are being studied and proposed in this study is the comparison in the process of financing the use of rooftop solar panels with the installation of PLN electricity in the Home Ownership Credit (KPR) scheme, especially for subsidized KPR, which is the prima donna of housing in Indonesia at this time, the analysis carried out in this study is to use the cost of the life cycle (life cycle cost). The results of this study are expected to become a consideration for the government, developers, and banks in formulating the right KPR policy for the community so that the use of roof solar panels (PV Rooftop) in simple 30/60 type houses in particular and other types of houses, in general, can be produced so that could provide an incentive to accelerate the use of rooftop solar panels for households.

## 2. LITERATURE REVIEW

The rooftop solar panel is one alternative source of electricity based on renewable energy, currently being widely used to increase the renewable energy mix in Indonesia [3]. Besides, the use of rooftop solar panels as one of the renewable energies is very environmentally friendly. Aberilla, et al (2020) stated that the use of rooftop solar panels can reduce the environmental impact by up to 40% compared to the use of electricity from conventional energy sources [1]. Unfortunately, research on the use of rooftop solar panels is still focused on using it in large houses or offices with high electricity needs, so it is still limited to its use as a complement to electricity from PLN. Whereas the greatest potential is precisely in simple houses with small household electricity needs , especially in rural areas or small cities so that rooftop solar panels have the opportunity to become the main source of household electrical energy and can replace electricity from the PLN network which in some areas is less stable and low reliability [4].

However, the main obstacle to using rooftop solar panels in simple households is the aspect of financing. The middle to lower class society will certainly not be able to finance the installation of rooftop solar panels independently, while banks do not have accurate references regarding the economic aspects and analysis of rooftop solar panel financing for simple houses [3].

In addition, from the aspect of the community's need for stable electricity and a willingness to pay with a financing scheme that is in accordance with income, [2] with the research object of the Banda Aceh community, conclude that the community has the willingness to finance household-based electricity procurement. PLTS as long as the financing scheme is charged according to people's income.

### 2.2 Electricity Tariff Policy

The tariff policy in 2019 still uses the Regulation of the Minister of Energy and Mineral Resources of the Republic of Indonesia Number 41 of 2017 [5]. The household electricity tariff for the 900 VA class in October 2019 was recorded at IDR 1,352 per kWh. For the household group of 1,300 VA and above, it is set at IDR 1,467.28 per kWh. Meanwhile, for the 450 VA and 900 VA customers who still receive electricity subsidies, the electricity rates are IDR415 per kWh and IDR 605 per kWh, respectively.

### 2.3 Life Cycle Costs

Life cycle costs is a method of estimating the total cost incurred during a maximum period of operation of the (age) of a project is a common method used to assess the feasibility of a project based on financial analysis [6].

Life cycle costs are shown by calculating the Net Present Cost (NPC), that is the total cost over the life of the project that has been discounted to the present. The NPC of a project can be calculated using a formula [6].

$$NPC = C_{ann} \times \frac{(1+i)^N - 1}{i(1+i)^N}$$

Description:

$NPC$ : Net Present Cost

$C_{ann}$ : total annual costs

$i$ : annual interest rate (%)

$N$ : project age (years)

In addition, to compare between two or more projects, the Net Present Value (NPV) and Internal Rate Return (IRR) of a project are also calculated NPV is the projection of profit from a project when compared to normal conditions that are currently running (business as usual). NPV can be calculated using the formula [7]:

$$NPV = NPC_{proposed} - NPC_{current}$$

Description:

$NPV$ : Net Present Value

$NPC_{proposed}$ : NPC of the proposed system

$NPC_{current}$ : NPC current condition

In addition, in the consideration of the feasibility study of a planned project, the rate of return of a project can also be calculated which is an indicator of the level of efficiency of an investment made. IRR is obtained by calculating the interest rate (i) when the NPV is equal to zero [7]:

$$NPV = \sum_{t=1}^{N} \frac{C_t}{(1+i)^t} - C_0 = 0$$

Description:
$C_t$ : total cash flows thet occurred in the period year t
$C_0$ : total initial investment cost of the project
$i$ : interest rate
$N$ : project age

## 3. METHODOLOGY

### 3.1 Data collection technique

In writing this study the authors conducted data collection techniques using observation data collection techniques, namely direct research on the object of research where the data obtained was based on the results of field identification / measurement which were then formulated on several main problems relevant to the purpose of this study and study literature. Primary data, which is collected directly from the field or research object.
When the collection is done by means of measurement, it is called metric data. Secondary data, which is collected through intermediaries or other sources. For example, journals, or other publications. Data like this usually called non-metric data.

### 3.2 Method of Analysis

This research was conducted using an analysis based on the method of life cycle costs to be able to compare with the use of PLN electricity. The results will be compared with the life cycle costs under current conditions) to obtain NPV and IRR values.

### 3.3 Study Limits

To conduct an analysis of the comparison of PLN electricity, it is necessary to determine several conditions as the basis for the study to be carried out, namely:

- Survey of simple house electricity usage type 30/60
  To obtain data on household electricity needs which will be used as a reference in designing a PV rooftop, it is necessary to survey the actual electricity consumption in simple houses type 30/60 in the City and District of Sukabumi.
- Validation of daily electricity demand
  From the survey conducted, then the data processing performed to determine the results of the analysis of the electricity needs of daily, weekly, and monthly in accordance average household electricity consumption profile of respondents mentioned. The monthly electricity demand data sourced from the monthly electricity bill is then compared with the multiplication of the average daily electricity demand from the survey results to validate the daily electricity demand data from the survey with the real usage shown by the PLN electricity bill. The following are the results of the electricity consumption survey:

**Table -1:** Validation of daily electricity demand data

| No. | Housing area | Monthly electricity requirement (kWh) | Daily electricity requirement in 30 days (kWh) | Gap (%) |
|---|---|---|---|---|
| 1 | Sakura Gardenia | 89,1 | 77,6 | 1,93 |
| 2 | Karang Kencana | 79,8 | 78,2 | 2,04 |
| 3 | Haidar Sentosa | 79,0 | 77,4 | 2,07 |

| | | | | |
|---|---|---|---|---|
| 4 | Kenari Indah Makmur | 80,4 | 78,9 | 1,90 |
| 5 | Griya Pesona | 78,3 | 76,8 | 1,95 |

The results of the validation in the table above can be used as a reference for electricity demand in this study.

- Finalization of solar roof panel design data

  In this study, the simulation of the role of the roof solar panel design which is suitable for a simple 30/60 type house is as follows:

  1) Panel surya : 1100Wp (4 x 275Wp)
  2) Inverter : 450 Vac
  3) Battery : 12V/400Ah (2 x 12V/200Ah)

  The cost assumptions used in this study are as follows:

**Table -2:** Cost Asumptions

| | | |
|---|---|---|
| Nominal discount rate | 10.00% | |
| Expected inflation rate | 2.50% | |
| Real discount rate | 7.32% | |
| Grid Price/kWh | Rp 1,352 | |
| Grid consumption | 79.32 | kWh/month |
| Benefit per year | Rp 1,286,887.68 | |
| Grid price inflation | 3.00% | |
| SLO cost | Rp 1.100,000.00 | |
| **Rooftop solar panel component cost:** | | |
| Solar panel 275Wp | Rp 1,250,000.00 | Per unit |
| Battery Deep Cycle 12V/200Ah | Rp 3,590,000.00 | Per unit |
| Inverter MPPT 1000W | Rp 3,650,000.00 | Per unit |
| Installation cost | 10% | |
| **Rooftop solar panel component life:** | | |
| Solar panel 275kWp | 25 | Year |
| Battry Deep Cycle 12V/200Ah | 12 | Year |
| Inverter MPPT 1000W | 15 | Year |

Note:

- The 10 % interest rate is determined based on the data on the “Basic Credit Interest Rate” issued by the Financial Services Authority per 2020 (www.ojk.go.id [8]).
- The 2.5 % inflation rate is determined based on the 2020 average “Bank Indonesia Inflation Report” (www.bi.go.id [9]).
- The project life of 25 years is determined based on the economic age standard for PV mini-grid established by NREL (www.nrel.gov [10]).
- The tariff policy in 2019 still uses the Regulation of the Minister of Energy and Mineral Resources of the Republic of Indonesia Number 41 of 2017. The household electricity tariff for the 900 VA class in October 2019 was recorded at IDR 1,352 per kWh.
- The increase in PLN costs is assumed to be 3%.
  The cost of capital for equipment is determined based on the bid price from the supplier [11].

## 4. DISCUSSION

From the calculations of NPC, NPV and IRR which were carried out with the help of Microsoft Excell 2016 software, the following results were obtained:

**Table -2:** Comparison of NPC, NPV, and IRR value with various credit interest rate schemes

| No | Item | Credit Interest Rate | | |
|---|---|---|---|---|
| | | 10% | 8% | 5% |
| 1 | $NPC_{PL}$ | Rp20,803,391 | Rp25,370,726 | Rp 35,666,122 |
| 2 | $NPC_{PV\ rooftop}$ | Rp23,174,010 | Rp24,218,940 | Rp 26,041,689 |
| 3 | NPV | -Rp2,370,619 | Rp 1,151,286 | Rp 9,624,433 |
| 4 | IRR | -1,50% | 0,62% | 3,89% |

From the table above, it can be seen that by using an interest rate of 10%, the value of the PV Rooftop NPC is greater than the NPC Grid. The NPV value obtained was –Rp 2,370,619. Meanwhile, the IRR value is -1.50%. This can be due to the large cost of installing PLTS which makes people not interested in installing PLTS Rooftop. Seeing the amount of investment needed for the PLTS Rooftop installation, only people with middle and upper economic levels are able to install it. Meanwhile, people with middle to lower economic levels tend not to be able to install PLTS Rooftop in their homes. In addition, investors are not stimulated to build PLTS because of the high investment costs. Therefore, the development of PLTS Rooftop cannot be separated from incentives from the government. In addition, this is because the interest rate is still high, which is 10%.

Another thing with those who use credit interest rates of 8% and 5%, where it can be seen that the smaller the interest rate, the Internal Rate Return (IRR) increases.

So it can be concluded that a lower credit interest rate subsidy is needed than the current one. So that the use of rooftop solar panels is financially profitable. At least the interest rate charged is around 5%-8%.

## 5. CONCLUSIONS

From the analysis that has been done it can be concluded that:

- The higher the credit interest rate, the smaller the NPV value.
- The higher the credit interest rate, the smaller the IRR value.
- Financially, this plan has not been profitable in financial terms due to the credit interest rates as high as 10%. Therefore, there needs to be a credit interest subsidy so that it can decrease to 5%-8% in order to obtain benefits compared to electricity use from PLN.

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