IJSSR
International Journal of Social Service and Research



Vol. 03, No. 07, July 2023
e-ISSN: 2807-8691 | p-ISSN: 2807-839X

# Analysis of the Impact of Electric Charging Infrastructure Provision Rules on the Calculation of Fast and Ultrafast Charging Service Costs at Time Base and Energy Base Charging Stations

**Yundi Haekal Azizi, Hakimul Batih**
Electrical Engineering, PLN Institute of Technology, Indonesia
Email: yundi2110004@itpln.ac.id, hakimul.batih@itpln.ac.id

**Keywords**

*Surcharge Fee, Charging Station, Fast Charging, Ultrafast Charging, Time Base, Energy Base*

**ABSTRACT**

*This study aims to analyze the impact of the issuance of MEMR Regulation Number 1 of 2023 concerning the Provision of Electric Charging Infrastructure for Battery-Based Electric Motor Vehicles, especially focusing on provisions related to electricity tariffs on surcharge fees for KBLBB fast charging and ultrafast charging consumers/customers. The calculation of surcharge fees can be economically affected by investment costs, operational costs, electric vehicle volume, and charging energy per electric vehicle (EV), so this study on surcharge fees is calculated using several scenarios and simulations carried out. The scenario is based on investment costs and operational costs using high and low cost financing calculations, and the simulation in question is on the volume of energy and electric vehicles over the next 15 years with pessimistic, moderate and optimistic simulations. This study uses quantitative descriptive methods that aim to describe or descriptive about a situation objectively using numbers, starting from data collection, interpretation through analysis of the data and appearance and results. The results of calculations from scenarios and simulations that have been carried out, calculations that are close to economics and based on current conditions that low cost scenarios with moderate simulations are appropriate recommendations to be applied at this time. Of course, the amount of application of the service fee must be evaluated by the Government every year, because the calculation component greatly affects the amount of the service fee.*

## INTRODUCTION

Currently, the growth of motor vehicles nationally has increased every year. Based on data from the Central Statistics Agency in 2022, motor vehicles in Indonesia from 2013 to 2021 experienced an average growth of 4.1%. Data shows that in 2021 the number of motorized vehicles reached 143.8 million vehicles with details of 121.2 million two-wheeled vehicles and as many as 22.6 million four-wheeled vehicles (passenger cars, buses, and freight cars).

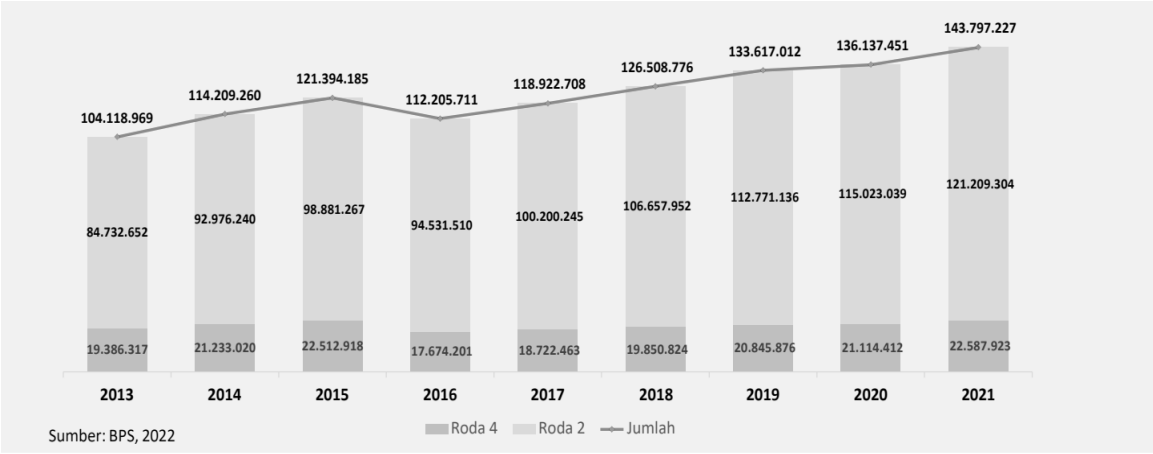


**Figure 1** Growth in the Number of National Motor Vehicles 2013-2021

The growth of motor vehicles nationally is closely related to the consumption of Fuel Oil (BBM). In 2022, the subsidized fuel quota in the State Budget is 23.1 million kL of petralite and 15.1 million kL of diesel. The subsidized fuel quota has exceeded the quota budgeted by the Government at the end of 2022, with the realization of petralite of 29.9 million kL and diesel of 17.8 million kL, so that the average use of petralite is around 2.5 million kL/month and diesel is around 1.5 million kL/month.

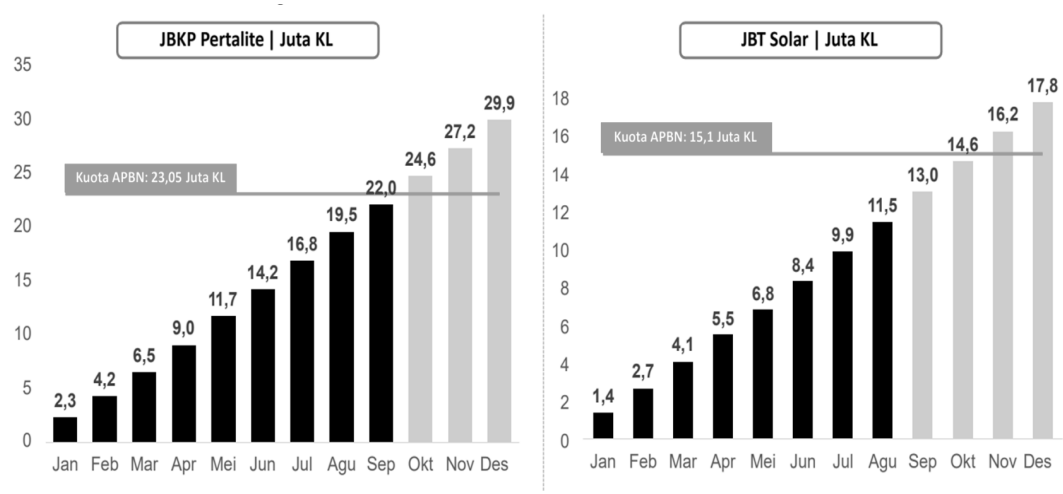


**Figure 2** Realization and Projections of National Fuel Needs in 2022

Along with the times and paying attention to global issues and considering that the transportation sector has the largest portion of national fuel consumption, the transportation sector is the focus of the government's current priority to increase the use of environmentally sustainable energy, one of which is electric vehicles which will have an impact on increasing electricity needs. In addition, Indonesia in COP 21 Climate Change Conference Paris 2015 is committed globally to maintain temperature increases not exceeding 2□C, nationally reduce GHG emissions by 29% from BaU (own capabilities) or 41% (with international assistance) by 2030 according to NDC, and to the energy sector commitment to reduce GHG emissions by 314 – 398 million tons of CO2 by 2030 and Net Zero Emissions in 2060 or sooner, through the development of renewable energy, the implementation of energy efficiency, and energy conservation, as well as the application of clean energy technology.

Technological developments in the transportation sector, one of which is Electric Motor Vehicles (KBL), are projected to increase electricity demand significantly progressively. The Government's seriousness in accelerating KBL is with the issuance of Presidential Regulation Number 55 of 2019 concerning the Acceleration of the Battery-Based Electric Motor Vehicle Program (KBLBB) for Road Transportation, the Government fully supports the observance of KBL in Indonesia. This

development must also be supported by adequate infrastructure in the form of Public Electric Vehicle Charging Stations (SPKLU). The government as a regulator supports the development of the electricity business in accordance with the Electricity Supply Business Plan (RUPTL) of PT PLN (Persero) for 2021-2030.

As a derivative of Presidential Regulation Number 55 of 2019, the Ministry of Energy and Mineral Resources (ESDM) through ESDM Minister Regulation Number 1 of 2023 concerning the Provision of Electric Charging Infrastructure for Battery-Based Electric Motor Vehicles, as the legal basis for the SPKLU and SPBKLU business, in this regulation regulated the provisions of the Electricity business, electricity tariffs, electricity standards and safety of SPKLU and SPBKLU.

In the Regulation of the Minister of Energy and Mineral Resources Number 1 of 2023, there are 3 (three) parts of the regulation of electricity tariffs at SPKLU, namely: a) Electricity tariffs from PLN to Business Entities (Upstream), are subject to bulk tariffs (20 kV Medium Voltage) of Rp. 714/kWh or charged with special service rates (Low Voltage) of Rp. 1,650/kWh with a coefficient of N = 1. b) Electricity tariff to consumers / customers of KBLBB (Downstream), charged to consumers from SPKLU Business Entities is a maximum of Rp. 2,467 / kWh, for slow, medium, fast, and ultrafast charging technology. c) Service fees for KBLBB fast and ultrafast charging consumers / customers (not yet further regulated the amount imposed in the Decree of the Minister of Energy and Mineral Resources)

Therefore, this study focuses on provisions related to electricity tariffs on service costs for KBLBB fast and ultrafast charging consumers/customers, by calculating economically against investment and operational costs, as well as projections for the next 15 (fifteen) years on the development of electric vehicle volume and charging energy per electric vehicle (EV) with scenarios and simulations based on data collected. By getting a service fee for fast and ultrafast charging technology, it can also be seen that the concept of Energy Base or Time Base is the most appropriate to do in Indonesia.

## METHODS

The data collection method is carried out to collect and retrieve the necessary data, including through primary data, secondary data, or other methods. Assumptions and parameters to obtain the results of the calculation of service costs and the calculation of energy base and time base are with data needs, including: a) Investment costs in the form of prices from the formation of charging stations such as unit charging costs, shelter construction costs, new installation costs, other administrative costs. b) Operational costs such as maintenance costs, land rental costs, telecommunication costs, electricity purchase costs. c) other data needed are the comparison of electric car batteries, warranty or operating life of a product due to the relationship between the warranty and the investment financing scheme for 15 years, and data on the realization of use or transactions at charging stations with the national average.

The data sources used in this study are based on primary and secondary data, with the following data details:

Primary data; 1) Sampling of realization data at SPKLU at the Office of the Directorate General of Electricity of the Ministry of Energy and Mineral Resources, PT PLN (Persero) Distribution of Jakarta Raya and Tangerang, and PT PLN (Persero) Head Office. 2) Interviews with staff and officials at the Office of the Directorate General of Electricity, Ministry of Energy and Mineral Resources and PT PLN (Persero).

Secondary Data; 1) Details of investment costs such as unit charging costs, shelter costs, new installation costs, SLO costs with data from Business Entities, PT PLN (Persero), Enhancing Readiness for The Transition to Electric Vehicles (ENTREV), and public hearing results. 2) Details of operational costs such as maintenance costs, land rental costs, telecommunication costs, electricity purchase costs with data from Business Entities, PT PLN (Persero) and Enhancing Readiness for The Transition to Electric Vehicles (ENTREV), and public hearing results. 3) Other required data such as Inflation, electricity tariffs, Public Street Lighting Tax, Purchase Electricity Tariffs, operating life, and other data based on the results of public consultations, interviews, in Government Regulations, digital data disbursement, relevant studies, and other methods.

Data analysis is the result of calculating service costs using high cost and low cost scenarios, as well as projections of energy volume and EV volume with pessimistic, moderate, and optimistic simulations. The results of the analysis provide input from assumptions and calculations that are affected by service costs in addition to also affecting the calculation of energy base and time base. Data analysis methods used to process data and analyze data are:

*Data Processing Methods*

SPKLU rates for fast and ultrafast charging technology are determined by the components of investment costs, operational costs, the number of electric vehicles and the amount of energy. The component is calculated using an IRR of 15% which assumes the loan interest rate reaches 12% and the income of the Business Entity (10%-15%) so as to get the Net Benefit value as the equation (2.2.) used in the theoretical basis.

With the large amount of data obtained in the study, the data for investment costs and operational costs are categorized into high cost and low cost, as well as calculation simulations for the number of EVs and energy in the form of pessimistic, moderate, and optimistic simulations.

A hypothesis testing tool that uses an excel program by entering data components obtained by calculating using equations. The hypothesis of this study is that with the additional investment and operations, the tariff should be on fast and ultrafast charging technology charging stations will exceed the tariff set in the Ministerial Regulation or >Rp2,467 / kWh, so that the difference in the cost of the load is replaced with service costs in one charge. The following is the hypothesis testing process that will be carried out in this study to obtain service fees:

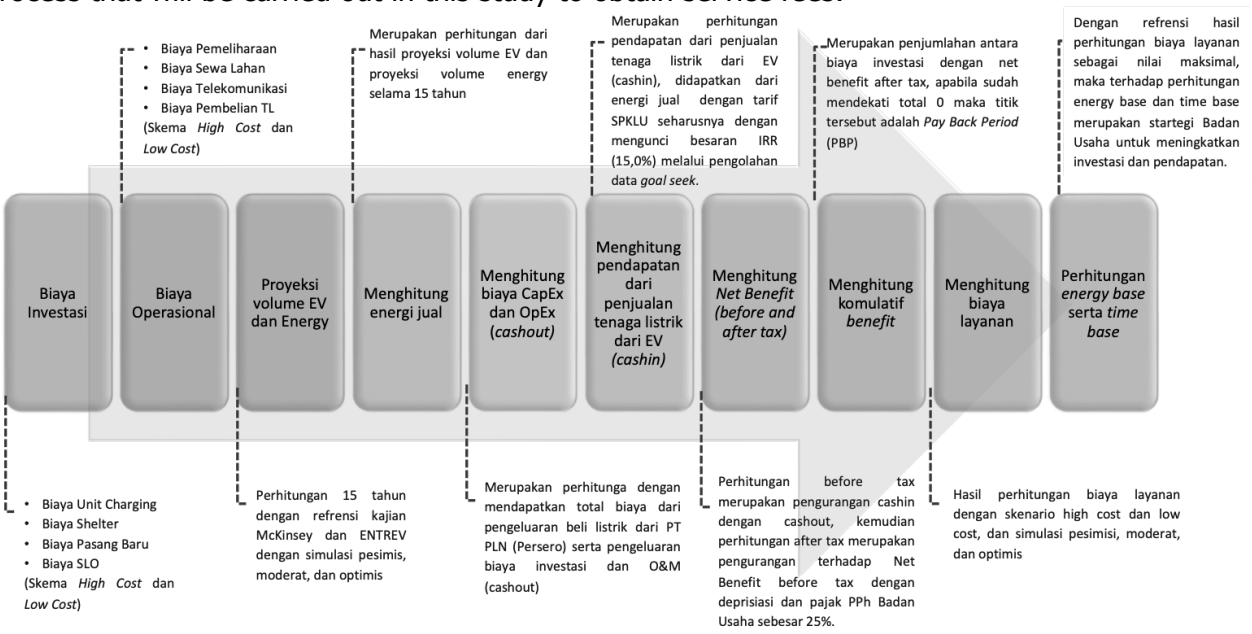


**Figure 3** Service fee calculation process

With provisional data obtained from PT PLN (Persero) that currently using investment costs and operational costs to charge electric vehicles one charge requires Rp3,125 / kWh (16.9 kWh per transaction) for fast charging technology charging stations and Rp3,798 / kWh (18.6 kWh per transaction) for ultrafast charging charging stations. So that the temporary calculation service fee is as follows:

$$Service\ Fee = \left(Rates\ SPKLU_{\ should} - Rates\ \ SPKLU_{\ According\ to\ Candy}\right) x\ Volume\ Energy\ rata - rata (3.1)$$

In accordance with the formula above, the amount of service fees obtained is as follows:

a. SPKLU *fast charging*

$Service\ Fee =$
$(3.125 - 2.467)\ x\ 16{,}9 = \text{Rp}11.120$

b. SPKLU *ultrafast charging*

$Service\ Fee =$
$(3.798 - 2.467)\ x\ 18{,}6 = \text{Rp}24.757$

The result of the service fee is the calculation of the upper limit, therefore the result of each calculation of the time base or energy base at the charging station does not exceed what is calculated in the equation (3.1.). The calculation of time base or energy base at fast and ultrafast charging stations can be formulated with the following equation:

a. *Time Base*

$$Time\ Base = \frac{Service\ Fee\ _{calculation}}{time} \quad \textbf{(3.2)}$$

$$Service\ Fee\ _{Time\ Base} = Time\ Base\ x\ (n)waktu \quad \textbf{(3.3)}$$

b. Energy Base

$$Energy\ Base = \frac{Biaya\ layanan\ _{perhitungan}}{kWh\ rata{-}rata} \quad \textbf{(3.4)}$$

$$Service\ Fee\ _{Energy\ Base} = Energy\ Base\ x\ (n)kWh \ldots \quad \textbf{(3.5)}$$

## RESULTS AND DISCUSSION

By doing a calculation analysis to get the value of the SPKLU tariff should be (Rp/kWh) for fast and ultrafast charging technology in each high cost and low cost scenario as well as pessimistic, moderate and optimistic simulations with a 15 year operating period. Furthermore, in order to be able to calculate service costs, the difference between the coefficients applied by Business Entities to consumers is required with the difference from the SPKLU tariff that should be the PT PLN (Persero) rate for Business Entities which has been regulated in the Minister of Energy and Mineral Resources Regulation Number 1 of 2023. The following is the calculation result from the calculation analysis to get the service fee in each scenario and the simulation that has been carried out:

**Table 1**
**Calculation of fast charging service fees**

| Uraian | *Fast Charging* | | | | | |
|---|---|---|---|---|---|---|
| | *High Cost* | | | *Low Cost* | | |
| | Pesimis | Moderat | Optimis | Pesimis | Moderat | Optimis |
| Tarif SPKLU Regulasi (Rp/kWh) | 1.645 | 1.645 | 1.645 | 1.645 | 1.645 | 1.645 |
| Tarif SPKLU Seharusnya (Rp/kWh) | 4.425 | 3.693 | 3.295 | 3.718 | 3.176 | 2.882 |
| Faktor N | 2,69 | 2,25 | 2,00 | 2,26 | 1,93 | 1,75 |
| Kelebihan N (1,5) | 1,19 | 0,75 | 0,50 | 0,76 | 0,43 | 0,25 |
| Tarif Kelebihan N (Rp/kWh) | 1.958 | 1.226 | 829 | 1.251 | 710 | 415 |
| Rata-Rata Energi (kWh) | 19 | 21 | 23 | 19 | 21 | 23 |
| Biaya Layanan (Rp) | 37.035 | 25.816 | 18.881 | 23.661 | 14.937 | 9.453 |
| Biaya Layanan + PPN 11% (Rp) | 41.109 | 28.656 | 20.958 | 26.264 | 16.580 | 10.492 |
| IRR (%) | 15% | 15% | 15% | 15% | 15% | 15% |
| PBP (tahun) | 7,26 | 7,05 | 6,87 | 7,32 | 7,10 | 6,94 |

**Table 2**
**Ultrafast charging service fee calculation**

| Uraian | *Ultrafast Charging* | | | | | |
|---|---|---|---|---|---|---|
| | *High Cost* | | | *Low Cost* | | |
| | Pesimis | Moderat | Optimis | Pesimis | Moderat | Optimis |
| Tarif SPKLU Regulasi (Rp/kWh) | 1.645 | 1.645 | 1.645 | 1.645 | 1.645 | 1.645 |
| Tarif SPKLU Seharusnya (Rp/kWh) | 6.922 | 5.506 | 4.739 | 5.146 | 4.219 | 3.717 |
| Faktor N | 4,21 | 3,35 | 2,88 | 3,13 | 2,57 | 2,26 |
| Kelebihan N (1,5) | 2,71 | 1,85 | 1,38 | 1,63 | 1,07 | 0,76 |
| Tarif Kelebihan N (Rp/kWh) | 4.455 | 3.039 | 2.272 | 2.679 | 1.752 | 1.250 |
| Rata-Rata Energi (kWh) | 19 | 21 | 23 | 19 | 21 | 23 |
| Biaya Layanan (Rp) | 84.253 | 63.971 | 51.764 | 50.661 | 36.876 | 28.480 |
| Biaya Layanan + PPN 11% (Rp) | 93.520 | 71.008 | 57.458 | 56.234 | 40.932 | 31.612 |
| IRR (%) | 15% | 15% | 15% | 15% | 15% | 15% |
| PBP (tahun) | 7,19 | 6,99 | 6,81 | 6,81 | 7,04 | 6,86 |

## Calculation of Time Base

Service fees that have been obtained for each SPKLU of fast and ultrafast charging technology in each high cost and lowcost scenario as well as pessimistic, moderate and optimistic simulations become a recommendation for the upper limit in the application of Energy Base by Business Entities in the future. The time base recommendation referred to is the average use of time for each technology used (fast or ultrafast charging) with conversion in the form of units of Rp/time. So that the cost of time base services is the length of time each customer fills it as in equations (3.2) and (3.3.).

Using references to the Literature Review in table 2 and references to primary and secondary data results as table 4.3 below that level 3 charging (fast charging) requires a charging time of ± 30 minutes – 1 hour and level 4 (ultrafast charging) requires a charging time of ± 15 minutes – 30 minutes.

**Table 3**
**Calculation of ultrafast charging service fee**

| Deskripsi | Level 1 (Pengisian Lambat/ Slow Charging) | Level 2 (Pengisian Menengah/ Medium Charging) | Level 3 (Pengisian Cepat/ Fast Charging) | Level 4 (Pengisian Sangat Cepat/ Ultra Fast Charging) |
|---|---|---|---|---|
| Lokasi | Instalasi Khusus (Rumah) | Instalasi Khusus (Kantor) | SPKLU (Stasiun Pengisian) | SPKLU (Stasiun Pengisian) |
| Arus Keluaran Maksimum (A) | 16 AC | 63 AC | 100 AC/250 DC | 300 AC/500DC |
| Daya Keluaran (kW) | ≤ 7 kW | ≤ 22 kW | ≤ 50 kW | > 50 kW |
| Jenis Konektor Plug-in | Tipe 2 (IEC 62196-2) | Tipe 2 (IEC 62196-2)<br>Tipe Pengisian Gabungan (Combined Charging Type) CCS dan Chademo (IEC 62196-3) | | |
| Waktu Pengisian*) | ± 8 jam | ± 2 – 4 jam | ± 30 menit – 1 jam | ± 15 – 30 menit |

Using equations (3.2.) and (3.3.) the result of the time base calculation is:

**Table 4**
**Fast charging time base service fee calculation**

| Uraian | *Fast Charging* | | | | | |
|---|---|---|---|---|---|---|
| | *High Cost* | | | *Low Cost* | | |
| | Pesimis | Moderat | Optimis | Pesimis | Moderat | Optimis |
| Biaya Layanan (Rp) | 37.035 | 25.816 | 18.881 | 23.661 | 14.937 | 9.471 |
| Biaya Layanan (Rp) + PPN 11% | 41.109 | 28.656 | 20.958 | 26.264 | 16.580 | 10.513 |
| Maksimal Charging (menit) | 60 | 60 | 60 | 60 | 60 | 60 |
| Biaya Layanan Time Base (Rp/menit) | 617 | 430 | 315 | 394 | 249 | 158 |
| 10 menit (Rp) | 6.172 | 4.303 | 3.147 | 3.944 | 2.490 | 1.575 |
| 30 menit (Rp) | 18.517 | 12.908 | 9.440 | 11.831 | 7.469 | 4.726 |
| 60 menit (Rp) | 37.035 | 25.816 | 18.881 | 23.661 | 14.937 | 9.453 |

**Table 5**
**Ultrafast charging time base service fee calculation**

| Uraian | *Ultrafast Charging* | | | | | |
|---|---|---|---|---|---|---|
| | *High Cost* | | | *Low Cost* | | |
| | Pesimis | Moderat | Optimis | Pesimis | Moderat | Optimis |
| Biaya Layanan (Rp) | 84.253 | 63.971 | 51.764 | 50.661 | 36.876 | 28.480 |
| Biaya Layanan (Rp) + PPN 11% | 93.520 | 71.008 | 57.458 | 56.234 | 40.932 | 31.612 |
| Maksimal Charging (menit) | 30 | 30 | 30 | 30 | 30 | 30 |
| Biaya Layanan Time Base (Rp/menit) | 2.808 | 2.843 | 2.301 | 2.252 | 1.639 | 1.266 |
| 10 menit (Rp) | 28.084 | 28.431 | 23.006 | 22.516 | 16.389 | 12.658 |
| 30 menit (Rp) | 84.253 | 63.971 | 51.764 | 50.661 | 36.876 | 28.480 |
| 60 menit (Rp) | - | - | - | - | - | - |

*Energy Base Calculation*

Just like the calculation of the time base, the service costs that have been obtained at each fast and ultrafast charging technology charging station in each high cost and low cost scenario as well as pessimistic, moderate and optimistic simulations become an upper limit recommendation in the application of Energy Base by Business Entities later. The energy base recommendation in question is the average use of battery capacity with conversion in the form of per unit Rp/kWh. So the cost of energy base services is an energy base with purchases in each kWh by consumers as equations (3.4.) and (3.5.). Currently, there are no battery standards set by the Government of Indonesia for the minimum and maximum capacity installed in electric cars to be able to measure energy base usage. Another reference is to find the comparison value of electric car batteries with existing brands in Indonesia, with an average battery value of 50 kWh, along with the references obtained:

**Table 6**
**Brand and capacity of electric car batteries in Indonesia**

**) Pengisian baterai dari 20% ke 100%*

| Merk | Kapasitas Baterai |
|---|---|
| Tesla Model S | 100 |
| Tesla Model 3 | 50-75 |
| Lexus UX 300e | 54,3 |
| Nissa Leaf | 40 |
| BMW i4 | 80 |
| BMW iX | 70 |
| Toyota C + POD EV | 9,06 |
| Wuling | 17,3-26,7 |
| Ioniq | 38,3 |
| Kona | 39,2 |
| **Rata-Rata** | **50** |

Using equations (3.4.) and (3.5.) the result of calculating the energy base is:

**Table 7**
**Fast charging energy base service fee calculation**

| Uraian | *Fast Charging* | | | | | |
|---|---|---|---|---|---|---|
| | *High Cost* | | | *Low Cost* | | |
| | Pesimis | Moderat | Optimis | Pesimis | Moderat | Optimis |
| Biaya Layanan (Rp) | 37.035 | 25.816 | 18.881 | 23.661 | 14.937 | 9.471 |
| Biaya Layanan (Rp) + PPN 11% | 41.109 | 28.656 | 20.958 | 26.264 | 16.580 | 10.513 |
| Rata-Rata Kapasitas Baterai (kWh) | 50 | 50 | 50 | 50 | 50 | 50 |
| Biaya Layanan Energy Base (Rp/kWh) | 741 | 516 | 378 | 473 | 299 | 189 |
| 10 kWh (Rp) | 7.407 | 5.163 | 3.776 | 4.732 | 2.987 | 1.894 |
| 30 kWh (Rp) | 22.221 | 15.490 | 11.329 | 14.197 | 8.962 | 5.683 |
| 50 kWh (Rp) | 37.035 | 25.816 | 18.881 | 23.661 | 14.937 | 9.471 |

**Table 8**
**Calculation of ultrafast charging energy base service fee**

| Uraian | *Ultrafast Charging* | | | | | |
|---|---|---|---|---|---|---|
| | *High Cost* | | | *Low Cost* | | |
| | Pesimis | Moderat | Optimis | Pesimis | Moderat | Optimis |
| Biaya Layanan (Rp) | 84.253 | 63.971 | 51.764 | 50.661 | 36.876 | 28.480 |
| Biaya Layanan (Rp) + PPN 11% | 93.520 | 71.008 | 57.458 | 56.234 | 40.932 | 31.612 |
| Rata-Rata Kapasitas Baterai (kWh) | 50 | 50 | 50 | 50 | 50 | 50 |
| Biaya Layanan Energy Base (Rp/kWh) | 1.685 | 1.279 | 1.035 | 1.013 | 738 | 570 |
| 10 kWh (Rp) | 16.851 | 12.794 | 10.353 | 10.132 | 7.375 | 5.696 |
| 30 kWh (Rp) | 50.552 | 38.382 | 31.058 | 30.397 | 22.125 | 17.088 |
| 50 kWh (Rp) | 84.253 | 63.971 | 51.764 | 50.661 | 36.876 | 28.480 |

**The Effect of IRR on the Amount of Electric Vehicle Tariffs**

To facilitate the value needs of a project, sensitivity analysis is needed in order to see what happens with project analysis, if there is a change in the basis of calculating costs and benefits. In table 4.9 and table 4.10, sensitivity is obtained related to IRR with electric vehicle tariffs for fast and ultrafast charging technology charging stations, that every change in IRR by 2% affects the amount of electric vehicle tariffs and also affects the mass of the pay back period. The following are the results of IRR sensitivity to electric vehicle tariffs:

**Table 9**
**IRR sensitivity to electric vehicle tariffs on fast charging**

| *Fast Charging* (Rp) dan (PBP) | | | | | | |
|---|---|---|---|---|---|---|
| **Skenario** | **Simulasi** | **IRR (%)** | | | | |
| | | **11,0** | **13,0** | **15,0** | **17,0** | **19,0** |
| High Cost | Pesimis | 3.870 (8,32) | 4.135 (7,75) | 4.425 (7,26) | 4.734 (6,74) | 5.061 (6,12) |
| | Moderat | 3.300 (8,14) | 3.485 (7,56) | 3.693 (7,05) | 3.911 (6,41) | 4.138 (5,86) |
| | Optimis | 2.989 (8,03) | 3.133 (7,44) | 3.295 (6,87) | 3.464 (6,24) | 3.638 (5,71) |
| Low Cost | Pesimis | 3.339 (8,36) | 3.516 (7,81) | 3.718 (7,32) | 3.929 (6,83) | 4.148 (6,20) |
| | Moderat | 2.907 (8,18) | 3.033 (7,61) | 3.176 (7,10) | 3.324 (6,48) | 3.478 (5,92) |
| | Optimis | 2.673 (8,06) | 2.771 (7,48) | 2.882 (6,94) | 2.994 (6,30) | 3.115 (5,76) |

**Table 10**
**IRR sensitivity to electric vehicle rates on ultrafast charging**

| *Ultrafast Charging* (Rp) dan (PBP) | | | | | | |
|---|---|---|---|---|---|---|
| **Skenario** | **Simulasi** | **IRR (%)** | | | | |
| | | **11,0** | **13,0** | **15,0** | **17,0** | **19,0** |
| High Cost | Pesimis | 5.763 (8,26) | 6.302 (7,69) | 6.922 (7,19) | 7.566 (6,62) | 8.231 (6,04) |
| | Moderat | 4.666 (8,12) | 5.066 (7,51) | 5.506 (6,99) | 5.942 (6,37) | 6.430 (5,81) |
| | Optimis | 4.088 (8,01) | 4.397 (7,40) | 4.739 (6,81) | 5.081 (6,20) | 5.455 (5,67) |
| Low Cost | Pesimis | 4.426 (8,32) | 4.773 (7,74) | 5.146 (7,25) | 5.545 (6,72) | 5.974 (6,10) |
| | Moderat | 3.707 (8,14) | 3.951 (7,55) | 4.219 (7,04) | 4.500 (6,40) | 4.798 (5,85) |
| | Optimis | 3.318 (8,02) | 3.505 (7,43) | 3.717 (6,86) | 3.934 (6,23) | 4.162 (5,70) |

**Effects of IRR on Service Fees**

Regarding service fees as costs that will be incurred by consumers later, it can be seen in table 11 and table 12 there are sensitivity results related to IRR with the service costs of each fast and ultrafast charging technology charging station, that every change in IRR by 2% affects the amount of service fee tariffs and also affects the mass pay back period. Here are the results of IRR sensitivity to service fees:

**Table 11**
**IRR sensitivity to service charges on fast charging**

| *Fast Charging* | | | | | | |
|---|---|---|---|---|---|---|
| **Skenario** | **Simulasi** | **IRR (%)** | | | | |
| | | **11,0** | **13,0** | **15,0** | **17,0** | **19,0** |
| High Cost | Pesimis | 26.358 (8,32) | 31.549 (7,75) | 37.035 (7,26) | 42.877 (6,74) | 49.062 (6,12) |
| | Moderat | 17.539 (8,14) | 21.433 (7,56) | 25.186 (7,05) | 30.400 (6,41) | 35.178 (5,86) |
| | Optimis | 11.899 (8,03) | 15.181 (7,44) | 18.881 (6,87) | 22.723 (6,24) | 26.688 (5,71) |
| Low Cost | Pesimis | 16.495 (8,36) | 19.843 (7,81) | 23.661 (7,32) | 27.653 (6,83) | 31.795 (6,20) |
| | Moderat | 9.226 (8,18) | 11.919 (7,61) | 14.937 (7,10) | 18.044 (6,48) | 21.286 (5,92) |
| | Optimis | 4.699 (8,06) | 6.932 (7,48) | 9.453 (6,94) | 12.013 (6,30) | 14.770 (5,76) |

**Table 12**
**IRR sensitivity to service charges on ultrafast charging**

| *Ultrafast Charging* | | | | | | |
|---|---|---|---|---|---|---|
| **Skenario** | **Simulasi** | **IRR (%)** | | | | |
| | | **11,0** | **13,0** | **15,0** | **17,0** | **19,0** |
| High Cost | Pesimis | 62.338 (8,26) | 72.531 (7,69) | 84.253 (7,19) | 96.436 (6,62) | 109.012 (6,04) |
| | Moderat | 46.292 (8,12) | 54.712 (7,51) | 63.971 (6,99) | 73.151 (6,37) | 83.423 (5,81) |
| | Optimis | 36.941 (8,01) | 43.982 (7,40) | 51.764 (6,81) | 59.568 (6,20) | 68.090 (5,67) |
| Low Cost | Pesimis | 37.053 (8,32) | 43.615 (7,74) | 50.661 (7,25) | 58.215 (6,72) | 66.328 (6,10) |
| | Moderat | 26.106 (8,14) | 31.242 (7,55) | 36.876 (7,04) | 42.798 (6,40) | 49.071 (5,85) |
| | Optimis | 19.396 (8,02) | 23.567 (7,43) | 28.480 (6,86) | 33.432 (6,23) | 38.628 (5,70) |

*Comparison of Fuel Car Savings with Electric Vehicle*

It is necessary to compare the cost of fuel cars with electric cars to find out the benefits that will be felt by the community later. Comparison using assumptions and consumption of fuel and electricity obtained from the Ministry of Energy and Mineral Resources. The following assumptions and calculation results are used for potential savings in comparison of fuel cars with electric cars using low cost scenarios and moderate simulations of each fast and ultrafast charging station:

**Table 13**
**Calculation of fuel car savings with electric cars**

| Item | | Nilai | Satuan |
|---|---|---|---|
| Asumsi Jarak Tempuh Per Bulan | | 1.250 | km/bulan |
| Asumsi Konsumsi BBM | | 10 | km/Liter |
| Kebutuhan BBM Per Bulan | | 125 | Liter/Bulan |
| Asumsi Harga Bahan Bakar | | 15.000 | Rp/Liter |
| Biaya BBM | | 1.875.000 | Rp/Bulan |
| Kebutuhan Energi Per Bulan | | 187,69 | kWh/Bulan |
| Tarif Listrik $SPKLU_{regulasi}$ | | 2.467 | Rp/kWh |
| Biaya Layanan + PPN 11% | $Fast_{Low\ Cost,\ Moderat}$ | 16.580 | Rp/Pengisian |
| | $Ultrafast_{Low\ Cost,\ Moderat}$ | 40.932 | Rp/Pengisian |
| Biaya Listrik SPKLU (Asumsi 10 kali pengisian) | $Fast_{Low\ Cost,\ Moderat}$ | 628.826 | Rp/Bulan |
| | $Ultrafast_{Low\ Cost,\ Moderat}$ | 872.349 | Rp/Bulan |
| Penghematan Biaya Listrik Terhadap BBM | $Fast_{Low\ Cost,\ Moderat}$ | 66% | % |
| | $Ultrafast_{Low\ Cost,\ Moderat}$ | 53% | % |

*Sensitivity of Fuel Saving Cars with Electric Vehicles to IRR*

In order for the calculation value to get one point of equal IRR on the sensitivity of electric vehicle tariffs and service costs with fuel savings for fuel cars with electric car comparisons, sensitivity is needed. The following is the sensitivity of savings from each scenario and simulation carried out on saving fuel cars with electric vehicles:

**Table 14**
**Sensitivity savings with IRR highcost scenarios simulated pessimists**

| No | Skenario High Cost, Simulasi Pesimis | | Satuan | IRR | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 11% | 13% | 15% | 17% | 19% |
| 1 | Biaya Layanan | *Fast* | *Rp/Pengisian* | 26.358 | 31.549 | 37.035 | 42.877 | 49.062 |
| | | *UltraFast* | | 62.338 | 72.531 | 84.253 | 96.436 | 109.012 |
| 2 | Biaya Layanan + PPN 11% | *Fast* | | 29.257 | 35.019 | 41.109 | 47.593 | 54.459 |
| | | *UltraFast* | | 69.195 | 80.509 | 93.521 | 107.044 | 121.003 |
| 3 | Biaya Listrik SPKLU (Asumsi 10 kali pengisian/bulan) | *Fast* | *Rp/Bulan* | 755.599 | 813.219 | 874.114 | 938.960 | 1.007.614 |
| | | *UltraFast* | | 1.154.977 | 1.268.120 | 1.398.234 | 1.533.465 | 1.673.059 |
| 4 | Penghematan Biaya Listrik terhadap BBM | *Fast* | *%* | 60% | 57% | 53% | 50% | 46% |
| | | *UltraFast* | | 38% | 32% | 25% | 18% | 11% |

**Table 15**
**Sensitivity savings with IRR highcost simulation scenarios are moderate**

| No | Skenario High Cost, Simulasi Moderat | | Satuan | IRR | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 11% | 13% | 15% | 17% | 19% |
| 1 | Biaya Layanan | *Fast* | *Rp/Pengisian* | 17.539 | 21.433 | 25.186 | 30.400 | 35.178 |
| | | *UltraFast* | | 46.292 | 54.712 | 63.971 | 73.151 | 83.423 |
| 2 | Biaya Layanan + PPN 11% | *Fast* | | 19.468 | 23.791 | 27.956 | 33.744 | 39.048 |
| | | *UltraFast* | | 51.384 | 60.730 | 71.008 | 81.198 | 92.600 |
| 3 | Biaya Listrik SPKLU (Asumsi 10 kali pengisian/bulan) | *Fast* | *Rp/Bulan* | 657.708 | 700.932 | 742.590 | 800.466 | 853.501 |
| | | *UltraFast* | | 976.867 | 1.070.329 | 1.173.104 | 1.275.002 | 1.389.021 |
| 4 | Penghematan Biaya Listrik terhadap BBM | *Fast* | *%* | 65% | 63% | 60% | 57% | 54% |
| | | *UltraFast* | | 48% | 43% | 37% | 32% | 26% |

**Table 16**
**Sensitivity savings with IRR highcost scenario optimistic simulation**

| No | Skenario High Cost, Simulasi Optimis | | Satuan | IRR | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 11% | 13% | 15% | 17% | 19% |
| 1 | Biaya Layanan | *Fast* | *Rp/Pengisian* | 11.899 | 15.181 | 18.881 | 22.723 | 26.688 |
| | | *UltraFast* | | 36.941 | 43.982 | 51.764 | 59.568 | 68.090 |
| 2 | Biaya Layanan + PPN 11% | *Fast* | | 13.208 | 16.851 | 20.958 | 25.223 | 29.624 |
| | | *UltraFast* | | 41.005 | 48.820 | 57.458 | 66.120 | 75.580 |
| 3 | Biaya Listrik SPKLU (Asumsi 10 kali pengisian/bulan) | *Fast* | *Rp/Bulan* | 595.104 | 631.535 | 672.605 | 715.251 | 759.262 |
| | | *UltraFast* | | 873.071 | 951.226 | 1.037.606 | 1.124.230 | 1.218.825 |
| 4 | Penghematan Biaya Listrik terhadap BBM | *Fast* | *%* | 68% | 66% | 64% | 62% | 60% |
| | | *UltraFast* | | 53% | 49% | 45% | 40% | 35% |

**Table 17**
**Sensitivity savings with low cost scenario IRR pessimistic simulation**

| No | Skenario Low Cost, Simulasi Pesimisis | | Satuan | IRR | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 11% | 13% | 15% | 17% | 19% |
| 1 | Biaya Layanan | *Fast* | *Rp/Pengisian* | 16.495 | 19.843 | 23.661 | 27.653 | 31.795 |
| | | *UltraFast* | | 37.053 | 43.615 | 50.661 | 58.215 | 66.328 |
| 2 | Biaya Layanan + PPN 11% | *Fast* | | 18.309 | 22.026 | 26.264 | 30.695 | 35.292 |
| | | *UltraFast* | | 41.129 | 48.413 | 56.234 | 64.619 | 73.624 |
| 3 | Biaya Listrik SPKLU (Asumsi 10 kali pengisian/bulan) | *Fast* | *Rp/Bulan* | 646.120 | 683.283 | 725.663 | 769.974 | 815.950 |
| | | *UltraFast* | | 874.314 | 947.152 | 1.025.363 | 1.109.212 | 1.199.266 |
| 4 | Penghematan Biaya Listrik terhadap BBM | *Fast* | % | 66% | 64% | 61% | 59% | 56% |
| | | *UltraFast* | | 53% | 49% | 45% | 41% | 36% |

**Table 18**
**Sensitivity savings with IRR low cost simulation scenarios are moderate**

| No | Skenario Low Cost, Simulasi Pesimisis | | Satuan | IRR | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 11% | 13% | 15% | 17% | 19% |
| 1 | Biaya Layanan | *Fast* | *Rp/Pengisian* | 9.226 | 11.919 | 14.937 | 18.044 | 21.286 |
| | | *UltraFast* | | 26.106 | 31.242 | 36.876 | 42.798 | 49.071 |
| 2 | Biaya Layanan + PPN 11% | *Fast* | | 10.241 | 13.230 | 16.580 | 20.029 | 23.627 |
| | | *UltraFast* | | 28.978 | 34.679 | 40.932 | 47.506 | 54.469 |
| 3 | Biaya Listrik SPKLU (Asumsi 10 kali pengisian/bulan) | *Fast* | *Rp/Bulan* | 565.434 | 595.326 | 628.826 | 663.314 | 699.300 |
| | | *UltraFast* | | 752.802 | 809.812 | 872.349 | 938.083 | 1.007.714 |
| 4 | Penghematan Biaya Listrik terhadap BBM | *Fast* | % | 70% | 68% | 66% | 65% | 63% |
| | | *UltraFast* | | 60% | 57% | 53% | 50% | 46% |

**Table 19**
**Sensitivity savings with IRR low cost simulation scenario optimistic**

| No | Skenario Low Cost, Simulasi Pesimisis | | Satuan | IRR | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 11% | 13% | 15% | 17% | 19% |
| 1 | Biaya Layanan | *Fast* | *Rp/Pengisian* | 4.699 | 6.932 | 9.453 | 12.013 | 14.770 |
| | | *UltraFast* | | 19.396 | 23.567 | 28.480 | 33.432 | 38.628 |
| 2 | Biaya Layanan + PPN 11% | *Fast* | | 5.216 | 7.695 | 10.493 | 13.334 | 16.395 |
| | | *UltraFast* | | 21.530 | 26.159 | 31.613 | 37.110 | 42.877 |
| 3 | Biaya Listrik SPKLU (Asumsi 10 kali pengisian/bulan) | *Fast* | *Rp/Bulan* | 515.184 | 539.971 | 567.954 | 596.370 | 626.973 |
| | | *UltraFast* | | 678.321 | 724.619 | 779.154 | 834.121 | 891.796 |
| 4 | Penghematan Biaya Listrik terhadap BBM | *Fast* | % | 73% | 71% | 70% | 68% | 67% |
| | | *UltraFast* | | 64% | 61% | 58% | 56% | 52% |

*Policy Support Accelerates EV Ecosystem*

The need for support from the Government in the form of policies, one of which can be in the form of incentives such as: a) NIDI and SLO costs that can be borne by the Government of Rp1,000,000 to Rp2,000,000 can save investment costs of 0.4% to 1%. b) The connection fee is borne by the government by 50% of IDR 15 million to IDR 51 million so that it can reduce investment costs by 5% to 24% in 2023 and in 2024. c) With the digitization of payments by PLN, there is no need for UJL. d) Changes in the design of SPKLU, the total investment cost will be much reduced with SPKLU without using shelter can save Rp71 million to Rp200 million. So that it has the potential to reduce investment costs by 30% which has an impact on the cost of fast and ultrafast charging charging station services.

**Figure 1** SPKLU without shelter with waterproof IP

Gas station operating hours data as a basis for calculating the number of electric vehicles charging at charging stations. In attracting investment from gas stations to support the development of charging stations and improve the electric vehicle ecosystem in Indonesia, this study collects supporting data from 6 largest gas stations in Jakarta, namely MT Haryono, Lenteng Agung, Yos Sudarso, Kalimalang, Bintaro, and Daan Mogot related to operating time as a comparison with the weighted average of 6 gas stations that the average operating hours of gas stations of 9.0 hours / day are equivalent to the number of electric vehicles as many as 18 units that do Charging 30 minutes each. Of course, this assumption using 10 liters takes 50 seconds (according to the specifications of the equipment at the gas station), considering the opening and closing time of the number until payment, and the weighted average is calculated from the average time of the total simultaneous transaction of one day (h) with the filling time (i) in units of hours as table 20 below:

**Table 20**
**Gas Station Operating Time Comparison**

| SPBU | Jumlah Dispenser | Jumlah Nozzle | Transaksi/ hari | Volume BBM Liter/hari | Pengisian Rerata (Liter/Transaksi/ hari) | Jumlah transaksi simultan/ dispenser | Total transaksi simultan satu hari | Asumsi Waktu Pengisian | | Waktu Operasi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | detik/ pengisian | menit/ pengisian | Menit Operasi | Jam Operasi |
| *a* | *b* | *c* | *d* | *e* | *f = e/d* | *g* | *h = d/(bxg)* | *i = ((f/10)x50)+30* | *j = i/60* | *k = jxh* | *l = k/60* |
| MT Haryono | 11 | 60 | 8.806 | 70.361 | 8,0 | **2** | 400 | 70 | 1,2 | 467 | **7,8** |
| Lenteng Agung | 6 | 36 | 5.152 | 45.933 | 8,9 | **2** | 429 | 75 | 1,2 | 534 | **8,9** |
| Yos Sudarso Sunter | 6 | 27 | 4.219 | 58.163 | 13,8 | **2** | 352 | 99 | 1,6 | 580 | **9,7** |
| Kalimalang | 4 | 20 | 4.729 | 34.220 | 7,2 | **2** | 591 | 66 | 1,1 | 652 | **10,9** |
| Tangsel Bintaro | 6 | 42 | 5.663 | 61.224 | 10,8 | **2** | 472 | 84 | 1,4 | 661 | **11,0** |
| Daan Mogot | 10 | 30 | 4.887 | 52.932 | 10,8 | **2** | 244 | 84 | 1,4 | 343 | **5,7** |
| **Rata-Rata Tertimbang Utilisasi 6 SPBU** | | | | | | | | | | | **9,0** |

*Service Cost Calculation Recommendations*

The service cost for fast and ultrafast charging technology charging stations that are right now is carried out with low cost scenarios and moderate simulations. The recommendation is based on looking at the realization of the volume of electric vehicles and energy used today and also against the references to McKinsey and ENTREV studies, while the current investment and operational costs are needed the lowest to achieve the development of fast and ultrafast charging technology charging stations and electric vehicle ecosystems with an IRR of 15% and PBP of 7 years. Here are the recommended service fees:

**Table 21**
**Fast and ultrafast charging service fee calculation**

| Uraian | Fast Charging | UltraFast Charging |
|---|---|---|
| Tarif SPKLU Regulasi (Rp/kWh) | 1.645 | 1.645 |
| Tarif SPKLU Seharusnya (Rp/kWh) | 3.176 | 4.219 |
| Faktor N | 1,93 | 2,57 |
| Kelebihan N (1,5) | 0,43 | 1,07 |
| Tarif Kelebihan N (Rp/kWh) | 710 | 1.752 |
| Rata-Rata Energi (kWh) | 21 | 21 |
| **Biaya Layanan (Rp)** | **14.937** | **36.876** |
| **Biaya Layanan + PPN 11% (Rp)** | **16.580** | **40.932** |
| **IRR (%)** | **15%** | **15%** |
| **PBP (tahun)** | **7,05** | **7,04** |

As for other alternative recommendations given, the Government can take into account the staging scheme in a given year to maintain an IRR of 15% but the Pay Back Period can be faster than < 7 years.

*Recommendations for the Right Service Fee Scheme in Indonesia*

The calculation of time base as an appropriate recommendation is carried out in Indonesia, this is because the time scale is 60 minutes (fixed) and which is easier for people to calculate when compared to the energy base which needs further study of the determination of battery capacity based on the existence of variations of cars that already exist in Indonesia. As for further application, it will be regulated by the

Business Entity, but the service fee with a time base does not exceed the service fee for fast and ultrafast charging technology charging stations that have been determined by the Government. Calculation of service costs with time base as follows:

**Table 22**
**Fast charging time base service fee calculation**

| Urauian | Fast Charging | Ultrafast Charging |
|---|---|---|
| Biaya Layanan (Rp) | 14.937 | 36.876 |
| Biaya Layanan (Rp) + PPN 11% | 16.580 | 40.932 |
| Maksimal Charging (menit) | 60 | 30 |
| Biaya Layanan Energy Base (Rp/kWh) | 249 | 1.639 |
| 10 menit (Rp) | 2.490 | 16.389 |
| 30 menit (Rp) | 7.469 | 36.876 |
| 60 menit (Rp) | 14.937 | - |

*Recommendations for Further Research*

There is a more in-depth calculation of service costs using regional factorization. This research can use schemes based on area, which can be urban, suburban, and remote areas. So that it can see the density of population and the size of the area in using charging stations and electric vehicles. Of course, in urban areas with densely populated areas and with minimal land to get and build SPKLU is more difficult, so SPKLU rates and service fees are more expensive compared to suburban and remote areas. As for Indonesia, there is already Presidential Regulation Number 112 of 2022 concerning the Acceleration of Renewable Energy Development for Electricity Supply which regulates the number of location factors in Indonesia.

PRESIDEN
REPUBLIK INDONESIA

LAMPIRAN II
PERATURAN PRESIDEN REPUBLIK INDONESIA
NOMOR 112 TAHUN 2022
TENTANG
PERCEPATAN PENGEMBANGAN ENERGI TERBARUKAN UNTUK PENYEDIAAN TENAGA LISTRIK

BESARAN ANGKA FAKTOR LOKASI (F)

| No. | Wilayah | Semua Kapasitas |
|---|---|---|
| 1. | Jawa, Madura, Bali | 1,00 |
| | - Pulau Kecil | 1,10 |
| 2. | Sumatera | 1,10 |
| | - Kepulauan Riau | 1,20 |
| | - Mentawai | 1,20 |
| | - Bangka Belitung | 1,10 |
| | - Pulau Kecil | 1,15 |
| 3. | Kalimantan | 1,10 |
| | - Pulau Kecil | 1,15 |
| 4. | Sulawesi | 1,10 |
| | - Pulau Kecil | 1,15 |
| 5. | Nusa Tenggara | 1,20 |
| | - Pulau Kecil | 1,25 |
| 6. | Maluku Utara | 1,25 |
| | - Pulau Kecil | 1,30 |
| 7. | Maluku | 1,25 |
| | - Pulau Kecil | 1,30 |
| 8. | Papua Barat | 1,50 |
| 9. | Papua | 1,50 |

PRESIDEN REPUBLIK INDONESIA,

ttd.

JOKO WIDODO

Salinan sesuai dengan aslinya
KEMENTERIAN SEKRETARIAT NEGARA
REPUBLIK INDONESIA
Kepala Biro Perundang-undangan dan
Administrasi Hukum,

Silvanna Djaman

SK No 135452 A

**Figure 4** Annex to Presidential Regulation Number 112 of 2022 concerning the Acceleration of Renewable Energy Development for Electricity Supply

## CONCLUSION

Based on the findings of the research results on the Impact Analysis of the Rules for the Provision of Electric Charging Infrastructure on the Calculation of Fast Charging and Ultrafast Charging Service Costs at SPKLUs with Time Base and Energy Base as presented in Chapter IV, some research conclusions can be put forward as follows:

1. Investment costs, operational costs, projected electric vehicle volume and energy volume greatly affect electric vehicle tariffs and service costs. In the investment and operational cost data collected, there are many price variations, so investment costs and operational costs are needed in high cost and low cost scenarios. Meanwhile, the projection of electric vehicle volume and energy volume uses a 15-year projection with pessimistic, moderate, and optimistic simulation divisions. The results of the calculation of service costs are obtained with each scenario and simulation carried out.

2. Projections of the volume of charging energy (kWh / unit / day) and EV volume (unit / day) at fast and ultrafast charging stations, projected based on data on the realization of PT PLN (Persero) SPKLU for the last 3 years (2020-2022) obtained an average of 18 kWh / unit / day and 9 units per day. In line with the reference McKinsey study growth in Southeast Asia on average 9 units / day is assumed as the base number, the increase in the number of vehicles uses a growth of 45%, while for kWh consumption per unit is assumed the average charging capability per vehicle. So that projection simulations using forcesting in excel software are obtained on average for 15 years as follows:

a. Pessimistic simulation, energy volume 19 kWh/unit/day and EV volume 13 units/day

b. Moderate simulation, energy volume 21 kWh/unit/day and EV volume 15 units/day

c.Optimistic simulation, energy volume 23 kWh/unit/day and EV volume 17 units/day

3.Based on data processing and data analysis, the following are the results of the calculation of investment costs, operational costs and service costs for each highcost and low cost scenario, as well as pessimistic, moderate, and optimistic simulations that have been carried out:

a. Fast Charging

| No. | Item | Satuan | *Fast Charging* | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *High Cost* | | | *Low Cost* | | |
| | | | Pesimisi | Moderat | Optimis | Pesimisi | Moderat | Optimis |
| 1 | Biaya investasi | Rp | 730.702.918 | 730.702.918 | 730.702.918 | 491.274.000 | 491.274.000 | 491.274.000 |
| 2 | Biaya operational per tahun | Rp/Tahun | 185.339.007 | 235.380.097 | 280.140.897 | 185.130.774 | 235.171.864 | 279.932.663 |
| 3 | IRR | % | 15% | 15% | 15% | 15% | 15% | 15% |
| 4 | PBP | Tahun | 7,3 | 7,0 | 6,9 | 7,3 | 7,1 | 6,9 |
| 5 | Tarif jual listrik SPKLU Seharusnya | Rp/kWh | 4.425 | 3.693 | 3.295 | 3.718 | 3.176 | 2.882 |
| 6 | Rp Kelebihan N sbg Biaya Layanan | Rp | 37.035 | 25.816 | 18.881 | 23.661 | 14.937 | 9.471 |
| | Biaya Layanan (+ PPN 11%) | | 41.109 | 28.656 | 20.958 | 26.264 | 16.580 | 10.513 |

b. Ultrafast Charging

| No. | Item | Satuan | *Ultrafast Charging* | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *High Cost* | | | *Low Cost* | | |
| | | | Pesimisi | Moderat | Optimis | Pesimisi | Moderat | Optimis |
| 1 | Biaya investasi | Rp | 1.543.545.918 | 1.543.545.918 | 1.543.545.918 | 950.915.000 | 950.915.000 | 34.440.570 |
| 2 | Biaya operational per tahun | Rp/Tahun | 189.820.579 | 239.861.669 | 284.622.469 | 189.594.513 | 239.635.603 | 284.396.403 |
| 3 | IRR | % | 15% | 15% | 15% | 15% | 15% | 15% |
| 4 | PBP | Tahun | 7,2 | 7,0 | 6,8 | 7,3 | 7,0 | 6,9 |
| 5 | Tarif jual listrik SPKLU Seharusnya | Rp/kWh | 6.922 | 5.506 | 4.739 | 5.146 | 4.219 | 3.717 |
| 6 | Rp Kelebihan N sbg Biaya Layanan | Rp | 84.253 | 63.971 | 51.764 | 50.661 | 36.876 | 28.480 |
| | Biaya Layanan (+ PPN 11%) | | 93.520 | 71.008 | 57.458 | 56.234 | 40.932 | 31.612 |

The service cost for fast and ultrafast charging technology charging stations that are right now is carried out with low cost scenarios and moderate simulations. The recommendation is based on looking at the realization of the volume of electric vehicles and energy used today, as well as on references to McKinsey and ENTREV studies, while the current investment and operational costs are needed the lowest to achieve the development of fast and ultrafast charging technology charging stations and electric vehicle ecosystems with an IRR of 15% and PBP of 7 years.

The calculation of time base as an appropriate recommendation is carried out in Indonesia, this is because the time scale is 60 minutes (fixed) and which is easier for people to calculate when compared to the energy base which needs further study of the determination of battery capacity based on the existence of variations of cars that already exist in Indonesia. As for further application, it will be regulated by the Business Entity, but the service fee with a time base does not exceed the service fee for fast and ultrafast charging technology charging stations that have been determined by the Government.

## REFERENCES

Bibi, N., Shah, I., Alsubie, A., Ali, S., & Lone, S. A. (2021). Electricity Spot Prices Forecasting Based on Ensemble Learning. IEEE Access, 9, 150984–150992. https://doi.org/10.1109/ACCESS.2021.3126545

Buku, K., & Jurnal, D. A. (n.d.). Subyek Electricity & Energy.

Cakrawati Sudjoko. (2021). Strategi Pemanfaatan Kendaraan Listrik Berkelanjutan Sebagai Solusi Untuk Mengurangi Emisi Karbon. Jurnal Multidisipliner Mahasiswa Pascasarjana Indonesia,.

Chittenenden Country RPC. (2014). Electric Vehicle Charging Station Guidebook Planning for Installation and Operation. www.ccrpcvt.org

Deb, S., Tammi, K., Kalita, K., & Mahanta, P. (2019). Charging Station Placement for Electric Vehicles: A Case Study of Guwahati City, India. IEEE Access, 7, 100270–100282. https://doi.org/10.1109/ACCESS.2019.2931055

Dharmawan, I. P., S Kumara, I. N., Budiastra, I. N., Raya Kampus UNUD, J., & Bukit Jimbaran, K. (2021). Perkembangan Infrastruktur Pengisian Baterai Kendaraan Listrik Di Indonesia (Vol. 8, Issue 3).

Ekonomi, P., Melalui, B., Kendaraan, P., Listrik Book, B., Fitriana, I., Pengkajian, B., Teknologi, P., Sugiyono, A., & Hilmawan, E. (2020). Penguatan Ekonomi Berkelanjutan Melalui Penerapan Kendaraan BerbasisListrik. https://www.researchgate.net/publication/352509509

Emanuele, C., Robert, S., Sonja, S., & Fabian, W. (2018). Electric and Plug-in Hybrid Vehicle Networks.

Faia, R., Soares, J., Pinto, T., Lezama, F., Vale, Z., & Corchado, J. M. (2021). Optimal Model for Local Energy Community Scheduling Considering Peer to Peer Electricity Transactions. IEEE Access, 9, 12420–12430. https://doi.org/10.1109/ACCESS.2021.3051004

Glasgow Caledonian University, & Institute of Electrical and Electronics Engineers. (2018). Power Quality Impact of Charging Station on MV Distribution Networks: A Case Studyin PEA Electrical Power System.

Habib, S., Kamran, M., & Rashid, U. (2015). Impact analysis of vehicle-to-grid technology and charging strategies of electric vehicles on distribution networks - A review. In Journal of Power Sources (Vol. 277, pp. 205–214). Elsevier B.V. https://doi.org/10.1016/j.jpowsour.2014.12.020

Institute of Electrical and Electronics Engineers. (2014). EV Charging Stations and Modes:International Standards.

International Conference on Compatibility and Power Electronics 9. 2015 Caparica, Institute of Electrical and Electronics Engineers, IEEE Industrial Electronics Society, Instituto de Desenvolvimento de Novas Tecnologias Caparica, International Conference on Compatibility and Power Electronics 9 2015.06.24-26 Caparica, L., CPE 9 2015.06.24-26 Caparica, L., & IEEE IES CPE 9 2015.06.24-26 Caparica, L. (2015). An Electric Vehicle Charging Station: Monitoring and Analysis of Power Quality.

Jawad, M., Nadeem, M. S. A., Shim, S. O., Khan, I. R., Shaheen, A., Habib, N., Hussain, L., & Aziz, W. (2020). Machine Learning Based Cost Effective Electricity Load Forecasting Model Using Correlated Meteorological Parameters. IEEE Access, 8, 146847–146864. https://doi.org/10.1109/ACCESS.2020.3014086

Kementerian ESDM. (2023). ToR Perizinan Usaha Ketenagalistrikan Untuk SPKLU dan SPBLKU.

Mastoi, M. S., Zhuang, S., Munir, H. M., Haris, M., Hassan, M., Usman, M., Bukhari, S. S. H., & Ro, J. S. (2022). An in-depth analysis of electric vehicle charging station infrastructure, policy

implications, and future trends. In Energy Reports (Vol. 8, pp. 11504–11529). Elsevier Ltd. https://doi.org/10.1016/j.egyr.2022.09.011

Maulana Dwi Nur Dawami, Heryanto, & Akhmad Wahyu Dani. (2020). Kajian Tentang Uji Jalan Kendaraan Listrik Dengan Studi Kasus Perjalanan Bandung Jakarta. Teknologi Elektro, Universitas Mercu Buana.

McKinsey and Company. (2022a). Capturing growth in Asia's emerging EV ecosystem.

McKinsey and Company. (2022b). Future of Asia Capturing growth in Asia's emerging EV ecosystem.

Oprea, S. V., Bâra, A., Preoţescu, D., Bologa, R. A., & Coroianu, L. (2020). A trading simulator model for the wholesale electricity market. IEEE Access, 8, 184210–184230. https://doi.org/10.1109/ACCESS.2020.3029291

Paschalidou, A. K., Petrou, I., Fytianos, G., & Kassomenos, P. (2022). Anatomy of the atmospheric emissions from the transport sector in Greece: trends and challenges. Environmental Science and Pollution Research, 29(23), 34670–34684. https://doi.org/10.1007/s11356-021-18062-5

Perner, A., & Vetter, J. (2015). Lithium-ion batteries for hybrid electric vehicles and battery electric vehicles. In Advances in Battery Technologies for Electric Vehicles (pp. 173–190). Elsevier. https://doi.org/10.1016/B978-1-78242-377-5.00008-X

Sanchari, D., & Karuna, K. (2017). Review of impact of Electric Vehicle Charging Station on the power grid. IEEE.

S&P Global Mobility. (2023). Light Vehicle Powertrain Sample.

Sutra Kamajaya, F., & Muzmi Ulya, M. (2015). Analisis Teknologi Charger Untuk Kendaraan Listrik-Review. Jurnal Rekayasa Mesin, 6(3), 163–166.

Wang, W., Huang, S., Zhang, G., Liu, J., & Chen, Z. (2021). Optimal Operation of an Integrated Electricity-heat Energy System Considering Flexible Resources Dispatch for Renewable Integration. Journal of Modern Power Systems and Clean Energy, 9(4), 699–710. https://doi.org/10.35833/MPCE.2020.000917

Yatriendi, H., Nur Putra, A. M., Fachri, D., & Muchtari, A. (2022). Overview: Perkembangan Teknologi Pengisian Cepat Pada Kendaraan Listrik (Teknologi dan Infrastruktur).