BAB I
INTRODUCTION

1.1 BACKGROUND OF THE PROBLEM

In this era of rapid technological development and industrialization, the task of providing clean and cost-effective electricity to every individual remains a challenge. With more than one billion people without access to electricity, local power generation solutions are essential to provide sustainable energy for all, but the main concern for the direction of users will remain isolated from national or regional grids for the foreseeable future. However, the number of people, who do not have access to electricity, has increased slightly after years of dedicated efforts and fell below one billion in 2016 (IRENA, 2019). The global electrification rate reached 87% due to universal access to electricity in 2016. In addition, the availability rate of electricity in rural areas has been increasing faster and is currently around 76%. Renewable power generation provides a low-cost solution for bringing reliable electricity to homes, villages or islands from the main grid [1]. So that on-grid and off-grid solar power generation systems (PLTS) are increasingly being used and applied in homes, offices and industry.

Before implementing PLTS, there was a problem because Indonesia is an archipelagic country consisting of around 17,000 islands in an area of 1,904,569 km2 consisting of 1,811,569 km of land area and 93,000 km2 of sea area. Administratively it is divided into 33 provinces, which consist of 440 regencies. And Indonesia is the world's fourth most populous country is the country with the largest economy in Southeast Asia and a member of the G-20 (Group of Twenty) major economic countries. Indonesia's total population reached 205 million in 2000 and continued to increase to more than 254 million in 2013 with an average of 1.66% per year. National economic growth increased, in 2013 it was 5.78% per year and in 2015 Bank Indonesia predicted economic growth of around 5.4% -5.8% per year [2]. Indonesia's strong economic growth has led to a faster increase in energy demand. Energy needs,

especially electrical energy, will continue to increase both from industrial, office and residential customers. Indonesia's electrification ratio projection based on PLN's RUPTL continues to increase from 84% in 2015 to 97% in 2019 [2]. So that it indirectly creates a wave of demand for electricity connection.

With the increasing demand for electricity connections in general, it turns out that the world's energy reserves are also running low, almost half of the existing power plants in the world and especially in Indonesia 95% are produced from fossil energy sources and it is estimated that these fossil energy reserves will run out in the next few years, especially oil reserves. earth in Indonesia will run out in 2023 [3]. The massive use of fossil energy also has an impact on the environment and climate change, especially the depletion of CO2 emissions and this has become a global issue [3]. To overcome this problem, humans are required to start looking for alternative energy sources. The next problem that arises, using this alternative energy, is that the energy produced is not as constant and as large as that produced by fossil energy. So because of that a solution arises to combine renewable energy with fossil energy, the aim of which is to reduce dependence on fossil energy on an ongoing basis.

To overcome this problem, this thesis will design a hybrid generator system (PLTS Hybrid), which is a generating system that uses more than one type of primary energy source (Water, Wind, Diesel, Steam, Geothermal and others) for the same load where other energy sources PLTS will try to be combined with existing PLN energy sources. The main objective of developing a hybrid PLTS is to guarantee the supply of primary energy sources at the generator so that electricity production is also guaranteed. On the other hand, with this hybrid system, the generating system will also become more efficient and economical. As their alternative energy use, to be applied to homes in Indonesia by using the existing hybrid PLTS network. At the same time it can also provide an overview of the benefits on the customer side and not to mention trying to solve the problem of limiting existing regulations. In this research, we will examine the aspects of infrastructure support for the Home

Energy Management System (HEMS) on a hybrid PLTS network for homes in Indonesia, to produce energy efficiency and also benefits for customers when implementing a hybrid PLTS with HEMS infrastructure. At their homes which were directly provided by PT. PLN (Persero) is the provider of the state electricity network.

1.2 IDENTIFICATION OF PROBLEMS

From some of the descriptions put forward in the background, the following problems can be identified:

1. Developed and developing countries are beginning to simultaneously make the transition to full use of electrical energy, in order to reduce and suppress the use of fossil energy.
2. With the increase in demand for electricity connections in general, it turns out that the world's energy reserves are also dwindling.
3. Presidential Regulation (Perpres) of the Republic of Indonesia (RI) Number 55 of 2019, which regulates the acceleration of the battery-based electric motorized vehicle program for road transportation. So the use of electric power will increase if it supports this presidential regulation
4. How to reduce the use of electricity whose energy is obtained from fossil energy products
5. Implementation of the HEMS platform as energy management, in systems for distributing renewable and non-renewable electrical energy in hybrid PLTS

1.3 SCOPE OF PROBLEM

Limitations of the problem of this research are:

1. The energy source for implementing this hybrid system comes from 2 or more sources, which when implementing the HEMS (Home Energy Management System) platform will not necessarily be directly supported by the system directly.

2. Must pay attention to the regulatory guidelines of the Minister of Energy and Mineral Resources of the Republic of Indonesia regarding Ministerial regulations number 49 of 2018 and number 4 of 2020.
3. The hybrid PLTS system that is made is still a general installation, a hybrid PLTS with electricity connections, solar panels and batteries as energy storage.
4. This research is still limited to using a simulation application, namely Homer pro.
5. How to apply an energy management platform in Homer pro simulation software.

1.4 FORMULATION OF THE PROBLEM

From some of the descriptions that the author put forward in the background section, the writer can formulate the problem as follows:

1. What is the feasibility of the Hybrid PLTS system with the HEMS platform, when applied to homes, especially in Indonesia, can it meet energy efficiency targets in an economic sense?
2. What is the economic potential of implementing this system when it is used by the Indonesian people?
3. How to design a hybrid PLTS model with the HEMS platform at home in Indonesia using the HOMER Pro application?
4. Where are the location of energy efficiency from an economic perspective on the customer side and the advantages of implementing this HEMS?
5. What is the feasibility, if it is implemented in houses in Indonesia?
6. What is the capability of the PLTS model system after being given the HEMS platform in the management of receiving electrical energy and storing it and managing its energy output?

1.5 RESEARCH PURPOSES

Based on the formulation of the problem, it can be seen that the research objectives are as follows:

1. To find out the feasibility of implementing the HEMS platform for energy management in hybrid PLTS implemented at homes in Indonesia.
2. To find out how the Homer Pro software works to optimize costs.
3. To determine the value of economic efficiency obtained from the application of the HEMS platform in PLTS Hybrid.
4. To find out the energy potential that can be obtained from a combination of the hybrid PLTS system and the HEMS platform.

1.6 HYPOTHESIS

This research will examine the feasibility of implementing the HEMS platform on hybrid PLTS as an electricity network system that will be applied to homes in Indonesia combined with the PLN electricity network. With this system, researchers will design a HEMS platform as a management control of electrical energy to find economic potential or efficiency value in an economic sense. Even though it's still only a simulation through the Homer Pro application, it can at least provide an overview of the feasibility of this system. So that in the future the results of this simulation can be made real products. And can be developed for further research.

1.7 RESEARCH METHODS

The research methodology that will be used in the preparation of this thesis includes literature studies from various studies that have been carried out before, then the method selection stage is carried out which is then followed by system design. After that, the calculation process was carried out and continued with the simulation design on the Homer Pro software. When the simulation results are following the calculations produced, it can be continued with the HEMS design and finally the needs analysis and design to get results and conclusions. The stages in this study are described in Figure 1

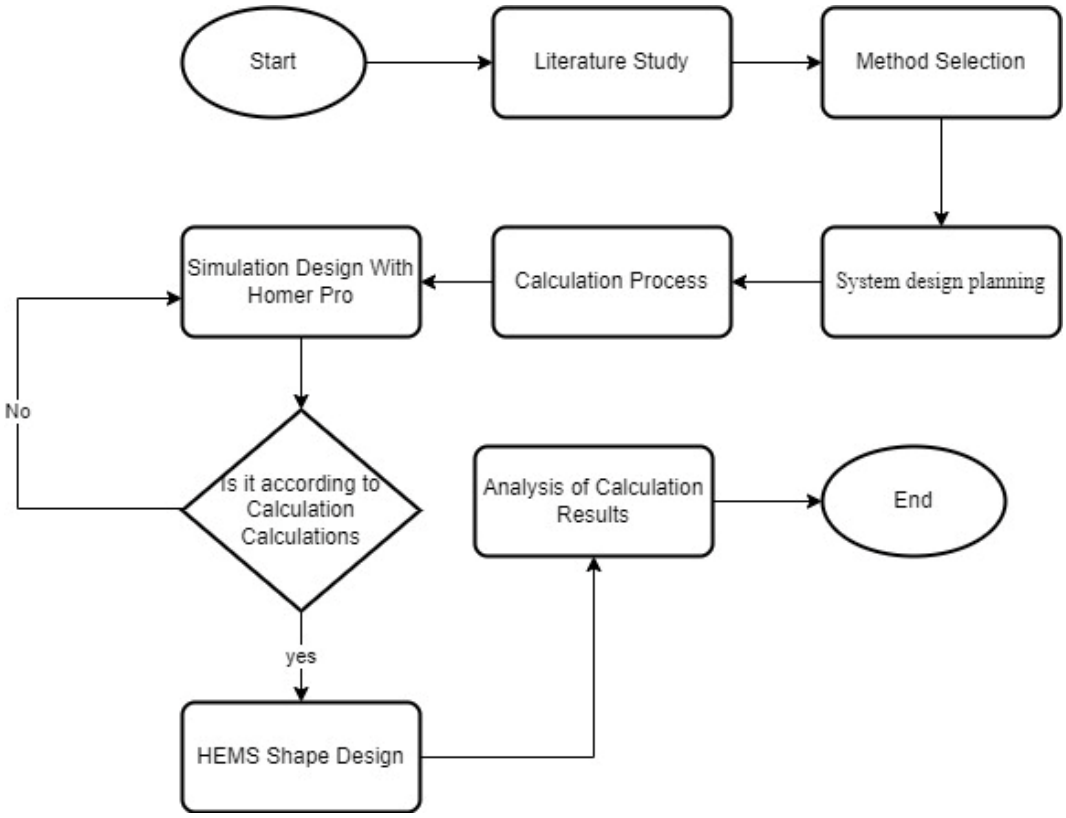

Figure 1. Research Methodology Flowchart

1. Literature Study

   Search and collect literature and studies related to the problems in this thesis in the form of reference books, articles, or journals related to the study of the application of a home energy management system at home, then identify system requirements and energy sources: in this method, several identifications are carried out starting from sources energy used, then the common devices used in the house from here we can know each amount of energy or the total energy received and will be used. Then the battery media as a decent energy storage

2. Method Selection

   The selection of the proposed method is a parameter of the feasibility of studying the implementation of home energy management systems at homes in Indonesia. In this study, the parameters used are the energy efficiency

created, the energy produced from available natural resources, and the economic potential provided by this system.

3. System design planning

   In this method will be recorded a load of electric power used. Then proceed with designing a PLTS system, using a hybrid inverter, designing an electricity distribution system and energy storage based on established government regulations. Each component needed is taken based on the available e-commerce applications and websites.

4. Calculation Process

   Calculations will be carried out, by performing calculations from the data obtained. The calculation is the total daily electricity load then the number of PLTS components needed, the last is cost calculation value, annual electricity demand and others.

5. Simulation Design With Homer Pro

   After the calculated value or system calculation is obtained, the system design will be created and simulated in the Homer Pro software, the simulation results will be compared with the results of the previous calculation process. If the data is appropriate, the researcher will proceed to the next process, which is to design the form of HEMS to be used.

6. HEMS Shape Design

   In this method, an energy management system will be designed based on the design of the system to be made.

7. Analysis of Calculation Results

   The calculation results will be analyzed by taking into account parameters related to the feasibility of implementing a home energy management system at home in Indonesia.

1.8 SUMMARY OF PREVIOUS RESEARCH

- Eric Timotius Abit Duka, I Nyoman Setiawan, Antonius Ibi Weking, "Planning of a Hybrid Solar Power Plant in the Parking Area of the Human Settlement Service Building, Highways and Irrigation Service of Badung Regency" Electrical Engineering Study Program, Faculty of Engineering, Udayana University (2018).

The resulting research results:

The parking area for the Cipta Karya Office building, the Bina Marga Office and the Irrigation Office of Badung Regency plan a PLTS with a capacity of 148.274 kW which will supply 30% of the electricity consumption in the building of 2.310 MWh. PLTS will work in hybrid with the PLN system. It is necessary to carry out further research on the use of PLTS in the parking area of the Cipta Karya Service Building, the Bina Marga Office, and Badung Regency Irrigation, including Utilization of batteries as an energy storage medium, so that PLTS can be used at night or when the weather is cloudy and an investment study is carried out on the design This PLTS is to find out the benefits of economic value in the future.

- Matthew Sau and Hestikah Eirene Patoding, "Solar-Diesel Hybrid Power Plant Design Model with the Homer Pro V3.9.1 Application" Indonesian Christian University Paulus Makassar (2017).

The resulting research results:

Based on the simulation model that has been made it can be concluded that:

a) The solar-diesel hybrid generator model that has been made for a load requirement of 500 Wp (Watt-peak) requires a power inverter output of 0.169 kW (kiloWatt)
b) b. The HOMER PRO V3.9.1 simulation shows that the power source is from solar panels only, generators only, and a combination of

generators and solar panels is technically feasible. Figure 2 shows the results of the simulation and optimization carried out by HOMER PRO V3.9.1. PV (Photovoltaic) panels as the most economical source of electrical energy. This can be seen from the smallest NPC value, which is $4,690. The combination of the PV Panel with Diesel/Genset of $4,987 and the Genset/Diesel alone has the largest NPC of ($)1.15M because the operating costs of the system with the generator are very large.

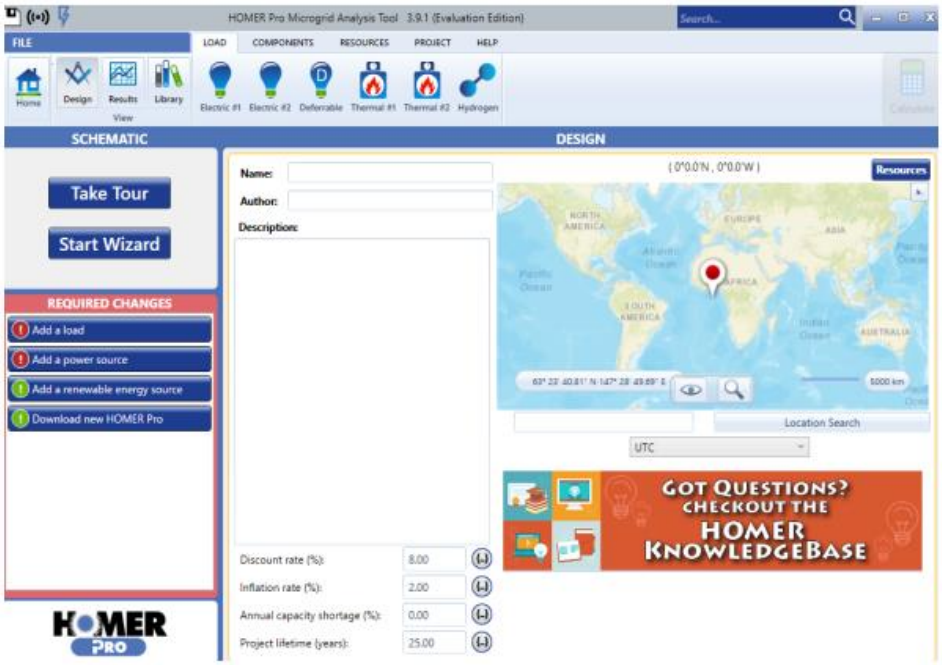

Figure 2. HOMER PRO interface V3.9.1

- Kunaifi, "Homer Program for Feasibility Study of Hybrid Power Plants in Riau Province" State Islamic University (2010).

The resulting research results:

This research is expected to contribute to filling the lack of studies on introducing renewable energy technologies in Riau in particular and Indonesia in general. With the supply of electricity in remote areas of Indonesia, it is hoped that it can help fight poverty, improve health services,

and improve the quality of education, gender equality, and environmental sustainability.

The conclusion of the study:

1. Riau Province has renewable energy sources that can be used to provide electricity to remote villages that are not reached by the PLN electricity network.
2. For Saik Village, the optimal system generated by the HOMER simulation is a PLH system consisting of photovoltaics, hydrokinetic turbines, diesel generators, battery banks and inverters
3. The proposed PLH system is capable of fulfilling 100% load with 21% more capacity. The share of renewable energy generators is 63% of which 55% comes from hydrokinetic turbines.
4. The largest portion of the PLH system cost is the initial cost of 72% if the hydrokinetic turbine uses local products, significant initial cost reductions will be achieved.
5. The selling price of electricity is higher than household TDL but 25% cheaper than a system consisting only of diesel generators which are widely used in remote villages in Indonesia
6. Although the design was carried out in Saik Village, the procedures used can be applied to other villages in Indonesia.

- Syahputra Ramadoni and Soesanti Indah "Planning of Hybrid Micro-Hydro and Solar Photovoltaic Systems for Rural Areas of Central Java, Indonesia" Journal of Electrical and Computer Engineering (2020).

  The resulting research results:

  Bligo Village, Ngluwar District, Magelang Regency, Central Java Province, Indonesia has a relatively high potential for renewable energy sources that can be used to provide electricity to the surrounding community. The water flow in the irrigation canal may be quite large, reaching 6,800 L/s with a head height of 1.9 m so that it can produce a micro-hydro power output of

555 kW. From the simulation of the hybrid model consisting of a designed micro-hydro system, the production of electrical energy can be used to meet the demand for electrical energy for an electrical load of 1023 houses or 3,240 kWh/day, with an average hourly electrical load of 135 kW. The electricity generated can also be channelled into the grid as electrical energy which can be sold to conventional electricity providers, with excess electricity reaching 3,819,127 kWh/year or around 76% of the power produced by micro-hydro plants. Meanwhile, electricity consumption in Bligo Village is only 1,179,851 kWh/year or about 24% of the electricity that can be generated by a micro-hydro power plant.

- Phonphan Nonthanan and Khamphakdi Pracha "Home Energy Management System Based on The Photovoltaic – Battery Hybrid Power System" International Conference on Power, Energy and Innovations (ICPEI 2020), 2020.

  The resulting research results:

  This paper proposes optimal energy management for a grid-connected battery-photovoltaic hybrid power system proposed to manage power flow and minimize electricity costs by using particle optimization (PSO) and Fuzzy Logic Control (FLC). The simulation found that the overall value of electrical energy decreased dramatically, and the charging cycles decreased so that the battery life was longer. The simulation results confirm that the proposed algorithm increases the efficiency of the home energy management system, reduces peak demand and reduces electricity bills for consumers.

  In the future, it is necessary to research to increase the variety of other renewable sources of electricity such as wind power, hydropower, etc. as well as expand the scope of the electricity management system from one house in the form of an electricity-producing community. automatically.

They can set an agreed purchase price which ultimately results in the sustainability of the electric power.

- Sri Aprillia Bandiyah, keswara I Made Hendry, Raharjo Jangkung, and friends, "Standalone Photovoltaic System Cost Optimization for Matantimali Village Central Sulawesi" ICETIR, 2020.

  The resulting research results:

  The 1300VA power requirement in Matantimali Village can be met with the Off-grid PLTS system. Based on the results of the configuration analysis of 11 PV units with 3,686 Wp power, two 2400 W power inverters, and 16 battery units will produce optimal results. they proposal is that the Off-grid solar panel installation system will save IDR 3,543,397 per year compared to conventional electricity in the form of diesel generators and the PLN grid.

- Sri Aprillia Bandiyah, Silalahi Desri Kristina, Foury Rigoursyah Muhammad Agung, “On-Grid Solar Panel System Design for Household Scale Using HOMER Software”. JTIM : Journal of Information Technology and Multimedia, 2019.

  The resulting research results:

  The results of the On-Grid system design for a 900 VA household scale using HOMER recommend a configuration of 6 units of 2040 Wp PV, 4 units of battery, and a 2 kW inverter. The system configuration can meet the electricity load requirement of 45.5% of the daily load consumption with the lowest total NPC cost compared to other system configurations, which is IDR 75,300,000.00. The on-grid solar panel system that has been designed will gain an annual profit of 1,806,884 IDR compared to conventional electricity use (PLN) and only takes 7 years to recover investment costs.

1.9 RESEARCH CONTRIBUTION

In this research a hybrid PLTS system will be developed, because Hybrid PLTS is a collection of power generation sources and loads that operate when connected to the utility network, but can also continue to operate when disconnected from the utility network. This means that PLTS Hybrid is a combination of On-grid and Off-grid PLTS models at once [4].

Table 1. PLTS comparison

Parameter	PLTS Off grid	PLTS On grid	PLTS *Hybrid*
Utility Connection	No	Yes	Yes
Operation Without Utilities	Yes	No	Yes
Control System	Simple	Complex	Most Complex
Blackstart ability	Yes	No	Yes
Development Flexibility	Currently	High	Moderate

The table above shows that the control system needed for the Hybrid PLTS system is considered the most complex because of the need for the system to integrate PV (Solar panels), batteries, diesel, and other utilities. It requires an appropriate operating scheme design so that the system is able to respond optimally to every event. This is considered very important because the Hybrid PLTS system can be more reliable than other topologies because the system is connected to utilities and is also able to operate off-grid. However, these advantages can be implemented if the Hybrid PLTS control system is designed comprehensively [4].

Then based on the word "comprehensive" here researcher interested in integrating the Home Energy Management System platform with the Hybrid PLTS system, with the aim of being able to apply it to homes in Indonesia in the future. At the same time, it could improve or become an evaluation of government regulations regarding the application or use of PLTS. Then why choose HEMS?

In the field of network architecture, there are AMI (Advanced Metering Infrastructure) devices that have bridged reliable communication modes to connect both types of energy or power utilities with consumers. This communication medium, paved the way for including the concept of economic incentives conceptualized for smart home, to be managed. This method is used to reduce electricity consumption at peak loads so that it can also reduce the amount of electricity bills.

Such savings methods involve saving electricity bills, upgrading smarthome equipment for residents and implementing various energy conservation methods, etc. Where by applying HEMS to this hybrid PLTS system, maybe we can create a function to achieve the efficiency target that the user wants. In this study the target is efficiency in the economy.

It is hoped that the results of this research can serve as an evaluation of regulations related to energy and mineral resources of the Republic of Indonesia and to carry out improvements in energy efficiency, energy security, energy conservation in the transportation sector and the realization of clean air. Also as a form of Indonesia's commitment to reducing greenhouse gas emissions. Based on Presidential Decree number 55 of 2019.