Renewable Energy Electric Power Plantfor Rural Needs

Reico Harold Siahainenia, Esther Kembauw

Abstract : This study aims to provide electricity or renewable energy for the people of Maluku who have not yet obtained access to state electricity services (PLN) or to people who enjoy electricity with a 100% elective electricity. The competitive advantage of power plants in this study is called "DISTRICT (Electric Dispenser) RSS-01". This is to reduce operational costs, because pure energy uses renewable energy in the form of pelton turbines driven by steam pressure from pressurized vessels / boilers. Boiler fuel is obtained from burning biomass such as: dry wood, durian skin, coconut shells, nutmeg shells, or walnut shells that are available in large quantities, but which are still not optimally utilized by the community. Water is fed into a pressure vessel / boiler and boiled until it turns into gas. Operational pressure in the boiler is maintained in variations of 1 and 2 bars. Pressurized water vapor is then channeled to press each blades of the pelton so that it rotates the wheels (runner) of the pelton turbine. The turbine then turns the generator dynamo to produce an electric voltage (Voltage). This research is to see variations in boiler vapor pressure on the amount of electric voltage generated. Research has produced boiler press up to 3 bars without damage (burst, leak). At a boiler pressure of 1 Bar, the charging voltage reaches 17.5 Volts, at a pressure of 2 Bar, the electric voltage reaches 20 Volts, while at a pressure of 2.5 Bar the accumulator charging voltage reaches 50 Volts. The resulting voltage has exceeded the maximum charging voltage limit, 15 volts. For this reason, regulators need to be installed to limit the input voltage to the accumulator.

Keywords: Power Generation, Renewable Energy, Rural.

1. INTRODUCTION

The world's population growth that is increasingly high is now pushing for increased energy needs in order to meet the needs of everyday life, not least for people who live in rural areas. Indonesia's electricity needs can be seen from the number of households that have been electrified with the total national households (electrification ratio) is still small, especially in remote or rural areas which indicates that not all Indonesian people can enjoy electricity in this modern era. This shows that not all households in Indonesia have electricity, especially for areas outside of Java. The difficulty of PLN (The National Electric Company) reaching remote areas because of the problem of the large amount of costs required by PLN to reach remote areas is a major problem that has not been electrified in some rural areas in Indonesia. Bhattacharyya (2013) said that most of the electricity problems of developing countries are the weak infrastructure provision, especially for the installation of electrical devices to all regions that tend to be difficult to reach. The PLN are difficult to cover energy needs, especially electrical energy for rural areas, encourages the need to think about the potential use of natural resources in each region to be used as an alternative energy source. Potential in each region varies depending on the type of local resources owned. If utilized as raw material for alternative energy sources, this local resource can support the energy independence of each region, especially rural areas in Indonesia. This will help ease PLN's burden in providing national electricity needs to meet the growing demand every year.

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Renewable energy is defined as energy that comes from renewable sources that are naturally and sustainable, with a production rate faster than the rate of consumption, such as sunlight, wind, rain, tides, waves, and geothermal. Renewable energy has four distinctive functions, namely producing energy for electricity, cooling or heating water and air, transportation, and energy services for remote areas (Ellaban et al, 2014; REN21, 2010; iea.org, 2016; IRENA, 2009). Awareness of the use of renewable energy which is increasing nowadays becomes important as an effort to mitigate climate change because it is considered more environmentally friendly than other energy sources. The 2016 data shows that renewable energy along with several other non-fossil sources supply around 19% of the world's energy needs, with a contribution of 1% of global carbon emissions. While coal, with its energy supply which reaches 27%, actually contributes 44% of carbon emissions. Also compare with 32% of petroleum supplies which produce 35% of carbon emissions and 22% of natural gas supplies which emission reaches 20% of global carbon emissions (IEA, 2018). Greenhouse gas emissions (CO2, CH4, and N2O) due to human activities are very likely to be the dominant factors causing global warming and climate change (IPCC, 2014).Meanwhile, Indonesia is endowed with natural and social landscapes which are supporting factors for the development of renewable energy potentials, such as: 1) the sun shines throughout the year; 2) does not experience winter so there is no large energy demand in the form of heat; 3) a vast sea area as a source of development of marine energy (tides or waves); 4) there is a large dense urban area as a source of energy from waste and waste; 5) the country with the third largest biodiversity in the world as a source of diversification of energy based on living things (biofuels based on plant extraction or algae); 6) having volcanoes and forests, as a potential for geothermal energy, biomass, as well as water and biodiversity conservation functions; 7) the country with the third longest coast in the world and at the same time has mountains as a source of wind energy; 8) rivers, mountains, and irrigation channels as sources of water energy (Pico hydro, micro hydro, mini hydro, hydroelectric power plants); 9) the large number of islands as a potential energy development with local renewable resources; and 10)

consumption of large animal protein (poultry, cattle, goats, pigs), as a source of biogas (Budiarto, et al, 2017). Indonesia actually has a large number of potential renewable energy sources. Some of them can be immediately applied in the country, such as: bioethanol as a substitute for gasoline, biodiesel to replace diesel, geothermal power, micro hydro, solar power, wind power, even garbage / waste can be used to generate electricity. The Maluku region as an island economy has a different structure from one region to another. This can be seen clearly because between one region (city and district) separated by the sea. The total area, which is generally separated by the sea, is certainly already scattered. (Kembauw E. et al, 2018) this has resulted in remote villages that are still often found that are not yet or difficult to reach by the electricity network from PLN. Along with this also, national electricity reserves are increasingly limited, while for the construction of a large-scale power plant also requires a large investment. Therefore it is necessary to look for strategic efforts to help reduce the problem of electricity supply, which is directed by utilizing the potential of local primary energy sources in the region, especially new renewable energy sources in accordance with the direction of national energy policy. Utilization of local energy for electricity generation is expected to support local government programs in the effort to supply and fulfill electricity needs more equitably for the community, especially for rural communities. One of SDG's Goals is clean and affordable energy, namely Goal 7. Target Goal 7 which is the 2030 agenda includes achieving universal access to modern, affordable and reliable energy; increased utilization of renewable energy; doubling energy efficiency; support the development of energy and technology infrastructure to provide access to sustainable energy; thereby encouraging the growth of international cooperation to facilitate these targets. This reason renewable energy is a smart choice for rural community development in the archipelago, given the limited supply/scarcity of fuel and the availability of capital, transportation that is able to operate especially when the sea is surging with waves reaching 4 meters will cause high operational costs of power plants made from fossil fuel. This will have an impact on the number of villages that enjoy electricity and the electrification ratio is still low. This research produces modular renewable electricity for use by the community to optimize efforts to increase economic capacity and other needs. The comparative advantage of this power generation system is that it does not use fossil fuels at all. This makes it easy and can be applied in all corners of the country, both those that have been electrified but low elective or those that might not be electrified for certain reasons. Finally, we hope that these machines will be able to motivate the public to be even more active in fighting for a better life. Based on the background above, the problem in this research is: How to generate renewable energy electricity. The concept used to solve this problem is to channel pressurized steam to rotate the generator so that the charging voltage is at least 15 volts. So specifically this research aims to design renewable energy electricity generation technology to be distributed to injection molding devices.

2. RESEARCH METHODS

Energy resources are a basic need and are an absolute component when we want to build a civilization of society of a nation or the world today. The absence of energy resources or the inability of a society or country to provide energy resources results in the weak capability of a community or country in building their civilization (Boedoyo, M. S., Sugiyono. A, 2000). Electricity is part of the citizens' needs that must be met by the government which cannot be accessed by the entire population and the fulfillment of the groups of citizens who have been experiencing deficits so that in many areas there are always blackouts in turn. Not only is this very influential on the supply of electricity to households but also affects the ability of citizens and the business world to produce.

2.1. Initial Drive System

Prime movers (Prime movers) consist of a turbine to produce rotation while a boiler to produce a rotating force. Based on these functions, each prime over component is designed with the following steps:

a. Steam Boilers.

1. Preparation Stage

Calculate the volume of the boiler and water in the boiler so that the operating time per day is at least 8 hours. The power of the boiler wall is able to withstand the water pressure needed to produce a minimum rotation of 1500 RPM turbines. Provides a broad cross-sectional area touched by fire to make the boiler heating process effective. In the preparation stage the boiler dimensions are calculated, both the plate thickness and height of the boiler tube and the fire pipe tube.

b. Manufacturing and Assembly Stage

The base plate and cover plate are circular in shape and parallel to the number of fire pipes. Wall plates in rollers form tubes with diameters equal to the diameter of the base and cover. Welding of fire pipes in holes located on the base plate and cover plate. Welding of water inlet pipe, water drain pipe, steam pipe and water vapor pressure meter. Welding pipes for upper and lower glass holders to control the water level in the boiler. Preparation of a boiler foundation holder which is welded to the boiler base plate.

c. Testing Phase

First open the inlet valve and steam valve, and close the exhaust valve. Install a water hose and put water into the boiler while observing the surface of the water in the boiler through a glass control pipe. After the water level is as desired, the wood / shell is inserted into the boiler furnace and ignited while observing the pressure in the boiler to the appropriate pressure, then the steam valve is opened so that water vapor comes out and is channeled through the steam conduit to the turbine located in the turbine house.

1. Electricity system

The electrical system functions to produce electrical voltage sourced from the dynamo generator and from the solar panel, so the two voltages which of course have different capacities need to be converted. The results of the conversion are then stored on the accumulator and then distributed to the DC socket panel and the AC socket panel. From this socket, then the community can use electricity as needed. The stages of the electrical system are as follows:

1.1. Power plants

a. Preparation Stage

The designing the capacity of the dynamo generator and the capacity of the solar panel. The combination of the voltage source is determined after analyzing the community's needs through a questionnaire. Determine the maximum power of the dynamo generator and Watt Peak (WP) from the solar panel. Determine the amount and capacity of the accumulator, determine the type and capacity of the inverter, determine the capacity of the DC to DC converter. Determine the type and capacity of voltage control devices, and amperage resistance. Designing the electrical component installation scheme and layout on the control panel and on the accumulator housing. Design accumulator house construction.

b. Manufacturing or Assembly Stage

Connect the dynamo as the turbine. All components of mechanical system construction become one. The assembly is carried out while paying close attention to the alignment between the axle as the dynamo and the axle as the turbine. Connect the dynamo with the accumulator via the charger. Connect solar panels with different accumulators through the charger controller. Connect the accumulator with the converter and inverter in series. Connect the inverter with the wall socket and the voltage-ampere meter.

c. Testing Phase

During the day when the solar panels function optimally. After the turbine rotates due to pressure from water vapor coming from the boiler, then an observation is made on the charger indicator light and digital voltage meter on the control box to see how much the output voltage is generated after the inverter. Connect with loads (lighting and power) to see the performance of the Electric Dispenser (DISTRICT) RSS-01.

3. DISCUSSION RESULT

The World Summit on Sustainable Development in 2002 held by the United Nations, the energy sector became one of the main conditions that must be met in efforts to reduce poverty. The meeting stressed the importance of energy as a stimulant to increase business productivity and economic activity, create jobs and new sources of income, and improve the quality of life for humanity, especially mothers and children. Until now, the issue of energy utilization in the context of reducing poverty is still relevant, including in Indonesia (Ghazali et al, 2017). Energy triggers economic growth so that it becomes a concern for all countries. Energy access for several countries is still a challenge that must be resolved. Broad distribution of energy services must be carried out while taking into account the environmental impacts of energy usage, so that the provision of modern energy for the community is a prerequisite to meet the Millennium Development Goals (MDGs).New renewable energy has the potential to meet development challenges, economic growth and the environment can be addressed simultaneously. In recent years there have been significant developments in alternative energy technologies. For example, simple technologies such as solar water heaters, solar pasteurizers, wind pumps, better cooking stoves, biomass briquettes, and biogas, make a big difference in energy access for the poor.

a. Steam Boilers / Boilers

The selected steam boiler is of the type of fire pipe boiler. Steam boiler shaped tube, diameter 0.71m, height 0.70m. The boiler wall is made of 6mm steel plate, the lid and base of the boiler are made of 8mm steel plate, circular in diameter 0.71m. There are 10 fire pipes with a diameter of 0.65m made from black pipe. That is installed spreads in the boiler tube. The fire pipe penetrates the base plate and cover plate. On the base plate are placed three feet of the boiler so that the distance between the ground and the bottom of the boiler is 0.3m. This distance will function as a furnace. The furnace as part of the boiler.

***Picture 1**. Fire Pipe Boilers*

Boilers produce working pressures of 1-2 bar or a maximum working pressure of 2.04 kg / cm2. The maximum water volume in the boiler is 0.75 m3. This volume can be used for boiler work for 5 hours continuously. If you want to use a boiler for more than 5 hours, you can reload it. The refill process takes about 0.5 hours.

b. Pelton Turbine

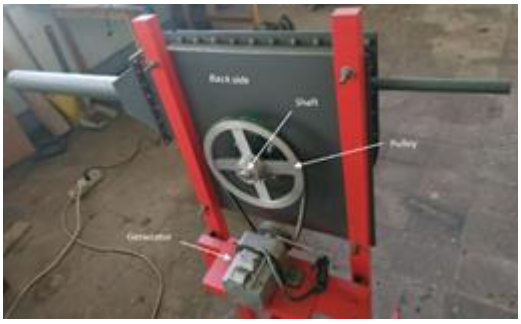
Pelton turbine runners are made of aluminum. Runer 0.25m in diameter. Around the runner, 12 corners (buckets) are placed. The bond between the runner and the bucket is done using bolts or nuts. Turbine shaft 20mm in diameter. Angles, turbine shafts and bolts or nuts are made of stainless steel material.

***Picture 2**. Pelton Turbine*

C, Turbine House

Turbine house is made to keep pressurized water vapor fully channeled without losing thrust. Turbine housing is made of painted steel plates with a primary coating and a finish coating. 40mm diameter turbine house. Equipped with a pressurized steam inlet made of ½ inch galvanized medium A pipe, while on the opposite side a vent is made for the steam outlet. The outlet pipe is made of 2 inch galvanized medium A pipe. The turbine housing is equipped with 2 UCP 204 bearing housings, 20mm shaft hole diameter. Bearings are placed next

to the sides and back of the turbine housing to resist the rotating motion of the turbine on a fixed shaft.



***Picture 3**. Front Side Turbine House*

***Picture 4.** Rear Side Turbine House*

d. Home Accumulator

The accumulator house is intended to place the accumulator, the electrical system and the initial drive components besides the boiler. The accumulator house consists of 2 main pillars made of wood. The main pillar is 1.8 m high and 0.4 m apart from each other. At the bottom of each main pillar a 1.5 m long wooden foundation is laid. Between the foot of the main pole and the wooden foundation a score is made of wood. The connection of the main pole legs, foundation wood and reinforcement is tied using a pair of bolts or nuts or rings. At the top end of the two main pillars are placed roof construction. The top of the roof construction is closed using a multyroof roof. Between the two main poles mounted four drawers to place: dynamos, accumulators, and inverters, on the opposite side are placed drawers to place the control box, the socket as the output of the electrical system, as well as input for various equipment that uses electric power that is will be used by the community.

***Picture 5**. Front Side of Home Accumulator*

***Picture 6**. Back Side of Home Accumulator*

***Picture 7**. Knock Down Roof Construction*

e. Electricity system

After the initial drive system, the turbine rotates with a minimum number of revolutions> 1500RPM, then the rotation is continued to the 750W PMA generator dynamo with a minimum rotation of 1500 RPM. The dynamo is connected to the VRLA AGM Deep Cycle Gel 12Vl100 accumulator Ah. LIP 12100G-ICAL through a charger. The DC Electric Voltage from the accumulator is converted to AC voltage through a 2000W / 12V Pure Sine Wave (PSW) inverter. This type of inverter will produce electricity not only for lighting (lamps, laptops, LCDs etc.), but can also be utilized to run machine tools (hand drilling machines, grinding machines, welding machine etc.) with a power below 750 Watt. The results of experiments on the Electric Dispenser RSS-001 as an accumulation of the relationship of water vapor pressure in pressure vessels, boilers, to the electric power output from the dynamo generator can be seen in Fig 1 below:

***Fig 1**. Relationship between Boiler Pressures with Electric Power Dynamo Generator*

No.	Steam Pressure (Bar)	Dynamo Rotation (RPM)	Dynamo output Voltage (Volt)
1	1	1500	16,5
2	2	2500	20
3	2,5	3700	50

***Picture 8**. Renewable Energy Power Generation Set*

IV. CONCLUSION

a. Research has produced boiler pressures up to 3 bars without experiencing damage (bursting, leaking). At a boiler pressure of 1 Bar, the charging voltage reaches 17.5 Volts, at a pressure of 2 Bar, the electric voltage reaches 20 Volts, while at a pressure of 2.5 Bar the accumulator charging voltage reaches 50 Volts. The resulting voltage has exceeded the maximum charging voltage limit, 15 volts. For this reason, regulators need to be installed to limit the input voltage to the accumulator.

b. There are several renewable and environmentally friendly energy sources that can be applied immediately in the country, such as bioethanol, biodiesel, geothermal power, solar power, micro hydro, wind power, and garbage / waste.

c. Cooperation, coordination between technical ministries and support from industry and the community are very important to realize the implementation of these renewable energy sources.

d. The positive impact of the existence of this research is the opening of insights from the public about the use of renewable energy, especially waste / waste for electricity generation so that it can be the first step in realizing an energy independent village.

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