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UTILIZATION OF RENEWABLE ENERGY AT MARINE COMBAT TRAINING CENTER (PUSLATPURMAR-5) BALURAN EAST JAVA USING THE MILITARY MICROGRID CONCEPT TO SUPPORT THE STATE DEFENSE IN INDONESIA

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Abstract

Maintaining energy reliability in military installations is one form of implementing national defense. With energy reliability, military, non-military, and hybrid threats can be prevented. Puslatpurmar-5 is a military installation that requires electrical energy to support the activities of the marine corps of the Navy. The main problem faced by Puslatpurmar-5 Baluran related to energy is dependence on electricity from PLN and renewable energy has not been used optimally in operational activities. The aim of the research is to analyze the availability of renewable energy, the potential utilization of solar, wind and water energy as an alternative option, and the design of the military microgrid concept according to the capacity of solar, wind and waterpower plants that can be developed for Puslatpurmar-5 Baluran. The method used in this study is a quasi-qualitative method combined with field observation data and interviews. The results of the study show that renewable energy that can be utilized at Puslatpurmar-5 Baluran is solar and wind energy. Wind potential has an average speed of 3.9 m/s. Solar potential reaches 5.66 kWh/m^2/d. The energy potential of water cannot be utilized because the speed of the river water is slow, the water discharge is small, and the elevation in the river flow is small. In conclusion, it was found that the use of renewable energy at Puslatpurmar-5 Baluran with the military microgrid concept was able to save PLN electricity costs by 30-43 percent. The design of utilizing wind and solar energy sources is also designed to maintain energy reliability and be safe from cyber-attacks.

Keywords: Wind Energy, Solar Energy, Water Energy, Military Microgrid, Renewable Energy

1. INTRODUCTION

Based on Law Number 3 of 2002 in article 1, paragraph 3 mandates that the implementation of national defense is all activities to carry out national defense policies [1]. Along with this, environmental developments and the context of defense policy strategies bring changes in the form of complex threats that can impact national defense. The types of threats consist of military, non-military, and hybrid threats. Military and non-military integration is needed to protect the territory of the Unitary State of the Republic of Indonesia.

Indonesia has a vast territory of 1.9 million km2 and a seascape of 3.2 million km2. The mainland is spread over 17,000 large and small islands. Indonesian land and waters also have enormous resource potential and have been contested by many parties from the pre-independence era to the present. One of the potential resources that can maintain the

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sustainability of the Indonesian state now is energy. The availability of energy is then utilized and managed to be used for a long time [2].

For this reason, the steps that the Government of Indonesia will take are accelerating the development of energy utilization by increasing the installed capacity of the Micro Hydro Power Plant to 2,846 MW in 2025, the installed capacity of biomass 180 MW in 2020, the installed capacity of wind is 0.97 GW in 2025, solar 0.87 GW in 2024, and nuclear 4.2 GW in 2024. The total investment absorbed by EBT development until 2025 is projected to be USD 13.197 million (Ministry of Energy and Mineral Resources, 2020). As a substitute for diesel energy, various breakthroughs have been made. Diesel can already be obtained from renewable energy and has reached 30 percent, referred to as biodiesel. The need for biodiesel is increasing at an average growth rate of 4.9 percent per year, following the growing demand for diesel oil [3].

According to data from the Ministry of Energy and Mineral Resources, estimates that crude oil production, according to the 2021 State Budget is 705 thousand Barrels per day. Meanwhile, domestic oil demand is around 1.6 million barrels per day. Thus, Indonesia must import to ensure the country's oil supply security. With the increasingly difficult and expensive energy sourced from fuel and coal, new energy is expected to be able to answer this challenge. One of them is the development of renewable energy sources.

Until 2021, around 410 MW of solar energy has been utilized, while the potential is still around 207,900 MW spread throughout Indonesia. Unlike the case with the use of water for electrical energy [4]. The most utilization of renewable energy is through mini-hydro and hydropower plants. The installed capacity so far is around 5,000 MW, and the potential for mini-hydro and hydropower plants can still be developed by around 100,000 MW. Based on the context of energy for defense, Presidential Regulation Number 4 of 2016 in article 14 concerning acceleration of electricity infrastructure mandates that the implementation of acceleration of electricity infrastructure prioritizes the use of new, renewable energy [5]. This Presidential Regulation seeks for the state to put renewable energy as a substitute for fossil energy. It is very important in implementation in military installations to support energy reliability so that military equipment such as radar and telecommunications do not experience blackouts.

The experience blackouts in Java and Bali occurred on April 14, 1997 (Jakarta, Banten, West Java) and the second on August 4, 2019 (11.50 Indonesia Time) to August 5, 2019 (22.00 Indonesia Time) [6]. The incident of a 34-hour power outage (depending on the area) in Java is an important lesson so that a situation like this does not happen again, especially for military installations [7].

The Marine Combat Training Center (Puslatpurmar)-5 of the Indonesian Navy is the area studied in this study. This agency is one of the military installations that defends the sovereign territory of the Unitary State of the Republic of Indonesia (NKRI) on the Indonesian seaside. Puslatpurmar-5 Baluran has an important role as an implementing unit tasked with organizing training for marine corps soldiers as a capacity building in carrying out their duties as professional seaborne soldiers. Energy plays an important role in supporting defense operations

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as a driving force for weapons and defense logistics. Conversely, defense protects energy sources and energy logistics in maintaining national energy needs [8]. The Puslatpurmar-5 Baluran area is located on the island of Java, which still uses an on-grid electricity network (connected to the PLN network) with diesel energy as an alternative in the event of a power outage. The problem faced is that Puslatpurmar-5 depends on State Electricity Company (PLN) electricity. The second is that renewable energy has yet to be utilized optimally at the Puslatpurmar-5 Baluran.

With several energy efficiency innovations, many countries are currently using military microgrid technology. This technology allows the electrical system to use renewable energy potential to be integrated with on-grid electricity (from PLN transmission) in military installations. Microgrid technology uses intelligent inverters that convert water and solar energy to supply electrical loads with advances in communication, computer, and cyber technology [9]. The advantage of using this technology is that the excess power stored in the battery can be used when the electricity is in a peak load state which can prevent blackouts. However, with this technological innovation, in its implementation, it is necessary to deal with several risks that threaten the energy system by installing a cyber-security system. Researchers use a military microgrid design because it relates to national defense at the forefront of energy for defense and defense to support energy.

This study uses five aspects which are used as the main foundation, namely: 1) national defense, 2) energy security, 3) energy for defense, 4) renewable energy to support defense, and 5) utilization of solar, wind, and water energy through the military concept microgrids. Regarding national defense, Indonesia has resources and diversity that can be used optimally but simultaneously pose a threat both from within and outside the country. For potential management to be optimal and threat risk management to be minimized, a national defense system was formed, which regulates the responsibilities and obligations of each member of the Indonesian state, carried out through government functions. This system is called the universal people's security defense system or Sishankamrata [10].

More specifically on energy, maritime security operations play a very high role in guarding Indonesia's energy sources and energy logistics lines. Indonesia has energy interdependence with other countries, particularly in the form of oil imports. So that this supply chain line certainly needs high security so that domestic supply is still sufficient. More technically, the most measurable energy threat with the current state of the energy balance is the crisis in the supply of electricity and oil. The increase in population and the transportation sector has also resulted in a very high demand for electricity, gas, and oil. It is due to supply chain disruptions and an increased demand that cannot be anticipated quickly [11].

Based on the description above, national defense is a force that is put together, both military and civilian, which is held to guarantee the integrity of its territory and protection of the people within it, which is carried out based on awareness of threats and disturbances to the integrity of the nation and state. In energy security, energy is a strategic commodity where its availability is needed to maintain all activities' continuity. Until now, the role of energy is still dominated by fossil energy. However, the limited availability makes fossil energy supply unsustainable in

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the long term, while energy consumption continues to increase along with the increasing population and economic progress. In this Case Energy Security can be defined as a condition of guaranteed energy availability and public access to energy at affordable prices in the long term while still paying attention to the environment that prioritizes the principles of availability, accessibility, affordability, and acceptability and sustainability [12].

The third aspect is energy for defense. Energy is seen as a national component and market commodity and has strategic value in the interests of national and international security politics. In supporting defense, energy is one of gaining military superiority and is the main element by the state in realizing energy security in times of peace and war. In Indonesia, energy use is very important to support national defense. This is stated in Law Number 2 of 2002, which mandates that all efforts be made to defend state sovereignty, the territorial integrity of the Unitary State of the Republic of Indonesia, and the safety of the entire nation from threats and disturbances to the integrity of the nation and state. One of the defense efforts is to utilize energy optimally.

The third aspect is green defense. This aspect initiates the creation of a renewable energy policy supporting energy for defense by developing technology through military microgrids in several military installations in NATO member countries. The concept of green defense reveals how green technology is associated with defense challenges and is also an environmentally friendly solution [13].

In Indonesia, renewable energy for defense is starting to be regulated by several policies. One of them is Presidential Regulation Number 4 of 2016 concerning the Acceleration of Electricity Infrastructure, which mandates that the implementation of accelerated electricity infrastructure prioritizes the use of new and renewable energy [14]. This regulation is reinforced by Presidential Regulation Number 112 of 2022 concerning accelerating renewable energy development for electricity supply. The renewable energy in question is geothermal, water, solar, biomass, ocean waves, and biofuels.

The utilization of renewable energy as a source of energy to support defense is sought to obtain long-term benefits as a substitute for fossil energy sources. Most of Indonesia's borders with other countries are far from the PLN energy network, so that huge costs must be incurred if only supported by PLN electricity. The border area is very vulnerable because it is the entrance to Indonesia. One of the efforts to optimize guarding and surveillance in border areas is to increase the use of renewable energy in the area to be used as energy, especially in meeting the energy needs of military installations.

The fourth aspect is utilizing Solar Energy, Wind, and Water through the Military Microgrid Concept. In defense, the microgrid concept is more focused on being a military microgrid concept. The military microgrid is a small power grid in military installations with access to local energy sources that use digital system technology to monitor and control energy transfer from generators to meet load requirements. In contrast to the smart grid, Military Microgrid prioritizes 2 important principles: energy reliability and energy security factors [15]. Energy reliability emphasizes the readiness of military installations in the face of on-grid power outages, so the electrical installations remain fully operational without outside electricity. Often

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referred to as island mode or island mode. Meanwhile, energy security places more emphasis on cyber security. The military microgrid is a device connected to the internet network, so there will likely be a security threat from the internet network side. In a military microgrid, it is necessary to secure the network with cryptographic encryption to lock information data into interconnected blocks. The information packages are distributed from the grid to the users [16].

2. RESEARCH METHOD

The method used in this study is a quasi-qualitative method with a phenomenological design which is an approach that aims to understand the utilization of renewable energy in the Baluran Region, Situbondo Regency, and East Java Province. The Puslatpurmar-5 Baluran area was chosen as the research location because the area has a strategic location to be reached by all Indonesian Navy units (located in the Indonesian archipelagic sea lanes - 2 area); has an area with renewable resources potential (especially solar and water power); the most important area in Amphibious operations training, Special Operations, supporting the implementation of Command Education; is an area that is often used for training/testing the function of Weapons Ammunition, testing combat units in the ranks of the Marine Corps for Jaya Fleet Training; as a common training ground for the TNI, combat readiness training for TNI units, and also the Military and Civil Engineering Department. The time used in this research was 4 (four) months, from August 2022 to December 2022 [17].

Researchers used a purposive sampling technique as a research subject. The purposive sampling technique is a non-random sampling technique because the selected objects and subjects are based on certain considerations [18]. The research subjects were stakeholders related to research, including the Puslatpurmar-5 Baluran agency, the Regional Government of East Java Province, the Regional Government of Situbondo Regency, academics or experts, and renewable energy entrepreneurs. The objects in this study are solar radiation, water flow (hydro), and wind speed (wind) with daily periods around the Puslatpurmar-5 Baluran area so that it can be used as research material in realizing the utilization of solar, wind resources, and water.

3. ANALYSIS AND DISCUSSION

The analysis and discussion in this study include the availability of renewable energy, the use of renewable energy, and the design of military microgrids.

Energy Availability

Observations at Puslatpurmar-5 Baluran were carried out to obtain information, relationships, and influence to obtain one of the objectives of using renewable energy, which is to maintain energy reliability. To support the reliability of this energy, this can be done by utilizing the renewable energy around it, including water, wind, and solar radiation. Puslatpurmar-5 has a strategic location to be reached by all Indonesian Navy units throughout Indonesia. It has an area of about 6000 ha with complex regional contours (beaches, savannas, mountains, hot and cold weather when it rains), is the most important area in Amphibious operations exercises,

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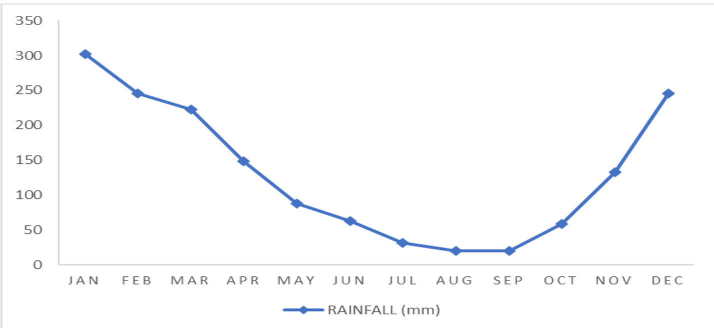
and special operations, supports the implementation of Command Education (Dikko), as a place joint TNI training, combat readiness training for National Soldier units, as well as Military Basic Education (Diksarmil) / Basic National Defense Education (Diksarbelneg). Besides that, it has a viewing point around 100-150 meters above sea level which can see and monitor the progress of the entire series of combat exercises on land in the Puslatpurmar 5 Baluran area.

Fig 1: River conditions at the Kalokoran Dam

The water potential at the Puslatpurmar-5 Baluran Headquarters that can be utilized is the Kalokoran River which flows along the Banyuputih sub-district, Situbondo Regency. The Kalokoran River is under the authority of the Bondowoso PSDA, the Public Works and Water Resources Office, and the Regional Government of East Java Province. With an elevation of +28.04. The Kalokoran Dam, which is behind the Puslatpurmar-5 Baluran Headquarters, shows that the river's flow cannot be used as energy to drive turbines because the velocity of river water is very slow. The condition of the river flow is relatively flat. The water level is not sufficient to divert it into the intake of a micro-hydro power plant.

Fig 2: Precipitation in the Puslatpurmar-5 Baluran area in 2021



Source: processed by researchers from NASA data.., (2022)

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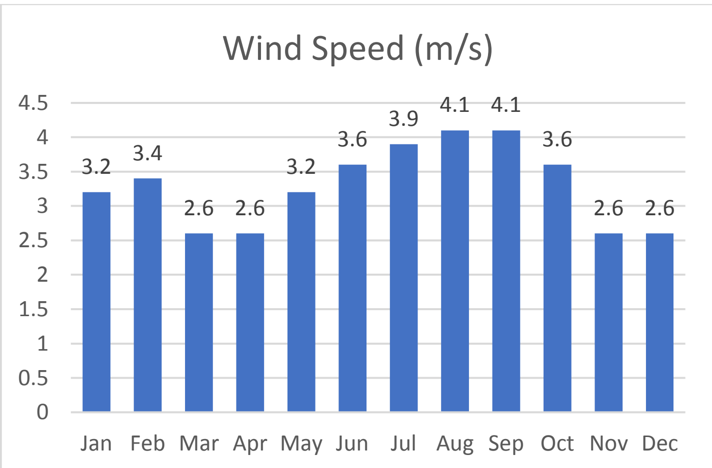
In projecting rainfall many researchers use the probability density function and daily rainfall the usage of the gamma distribution, despite the fact that the gamma distribution representing daily rainfall is also questionable [21] however the drawback of using the gamma distribution is that it isn't always usually clear-cut to estimate the dimensions and shape of the two parameters [22], and it is pretty difficult to characteristic it to massive-scale climatic situations. therefore, by looking at discern 2, a simpler answer is that the graphical form fulfills the multiplication function between the fraction of wet days and the exponential distribution to explain the chance of excessive rainfall with the subsequent equation [23]:

$$Pr(X > x) = f_w e^{-x/\mu}$$

Where X is the amount of 24-hour rainfall and x is the brink (eg 50 mm) that defines excessive rainfall. The reducing (negative) exponential distribution is a subset of the gamma distribution [24] and consequently shares some of the same homes. So that it can be regarded that the overall projection of climatic conditions in the marine center fulfills the negative exponential function. In addition, the volume of river water is only optimal in certain periods, namely during high rainfall, namely November (132.9 mm), December (245.83 mm), January (302.25 mm), and February (245.28 mm). March (222.58 mm), and April (148.8 mm). Meanwhile, the volume of water will recede and even dry out from May to October (5 months) because it is entering the dry season (Figure 2).

Figure 3 shows that the energy potential utilized at the T-12 review point is solar energy and wind energy. Based on data from NASA in 2021, the average wind speed will reach 3.9 m/s. With current technology, the ideal speed for turning a windmill is 3 m/s [19]. This average speed figure means that the T12 region is suitable for developing wind power plants. The maximum speed of wind power occurs in August and September, with a range of 4.1 m/s.

Fig 3: Wind Speed at Puslatpurmar-5 in 2021



Source: Processed by researchers from Ret screen data NASA.., (2022)

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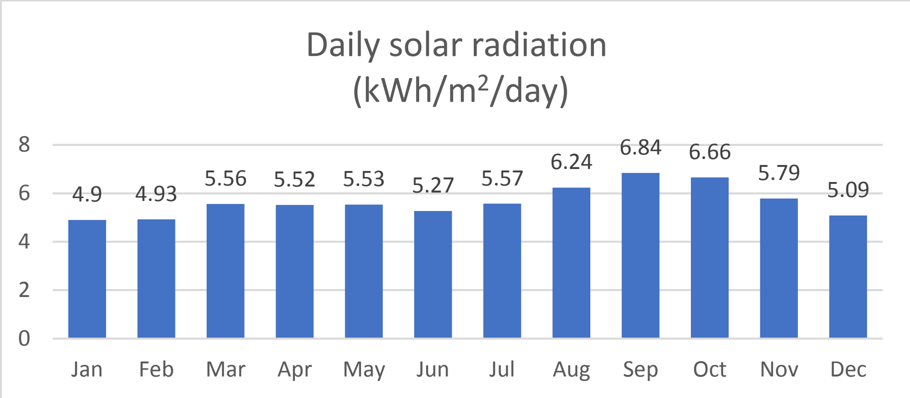
Fig 4: Daily Solar Radiation at Puslatpurmar-5 in 2021



Source: Processed by researchers from Ret screen data NASA. (2022)

Furthermore, in Figure 4, on the utilization side of solar radiation, solar energy is potential energy to be utilized as an energy source in the Puslatpurmar-5 Baluran area. This area can be said to receive consistent solar radiation every day. Based on data from NASA in 2021, the average daily solar radiation reaches 5.66 kWh/m^2/day, with the highest radiation occurring from August to October at 6.24 to 6.84 kWh/m^2/day. Fig. 4 above shows that solar radiation in the Puslatpurmar-5 Baluran area has the potential to generate electrical energy because it has a high radiation level, which is more than 3 kWh/m^2/day. This area is very suitable to be developed as a solar power plant.

Utilization of Renewable Energy

On the utilization side, electricity usage for operations at Puslatpurmar-5 Baluran is estimated to reach 80,700 Watts consisting of current usage of 78,500 Watts (on grid) and predicted electricity demand in T12 of 2,200 Watts. Through Military microgrid technology, the utilization of renewable energy at Puslatpurmar-5 Baluran can be controlled as needed. It can maintain energy reliability in every marine combat training operation for a certain time. Utilization of this energy in the military aims to maintain energy reliability. If the power goes out, the military base does not want all its computers, telecommunications, and other critical components to fail. Military Microgrid is one of the efforts to make this happen by replacing backup diesel generators. It can fully operate even though no electricity network exists from PLN (island mode).

Table 1: Profile of Electrical Energy Usage Puslatpurmar-5 Baluran

No	Location	Power (watt)	Monthly Usage (KWh)	Cost per month (Rp)
1.	Command Headquarter	66.000	13.500	25.864.950
2.	Mess Marine in Keris	7.700	6300	9.902.277
3.	Mess Marine in Waru	1.300	400	1.592.059
4.	Marine Post in Banongan	3.500	700	463.756
	Total	78.500		37.823.042

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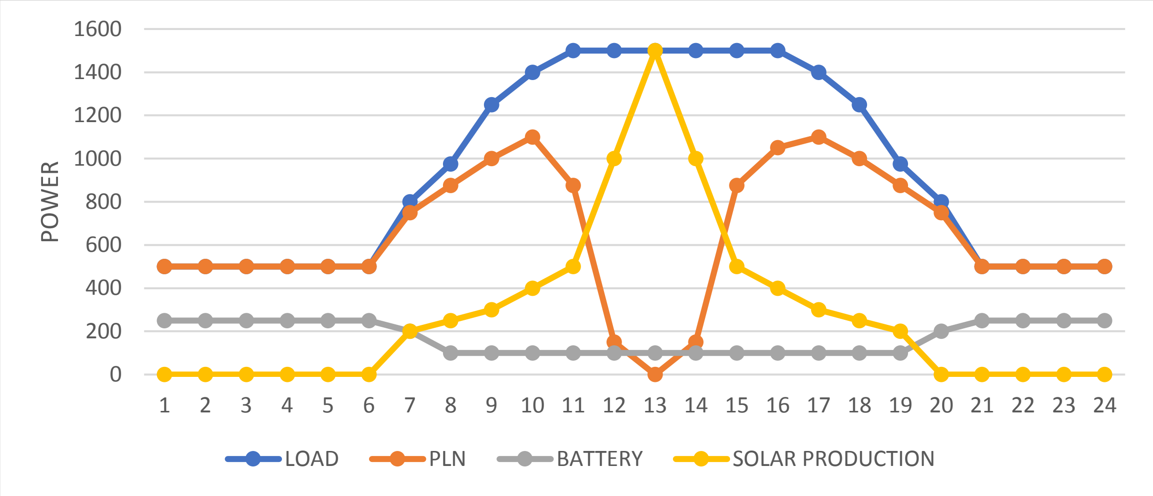
Table 1 above shows that the budget burden profile issued by the Baluran Puslatpurmar-5 Work Unit is an average of IDR 37,823,042 for electricity consumption of 20,500 KWH for 4 locations connected to PLN electricity.

Fig 5: Electrical Load Curve and Solar Energy Supply at Puslatpurmar-5 Command Headquarters



(Processed by researchers., 2022)

At the Puslatpurmar-5 Command Headquarters Location, from Figure 5, it can be obtained that with an average electricity load for the command headquarters for 1 month of 13,500 KWH, the PLTS can save PLN's burden by 43.7 percent or 6,800 Watt (area A). The amount of energy savings from PLN can also maintain energy reliability by maintaining the main functions of military components to last 24 hours, namely communications, radio, servers, and the commander's office.

The highest electrical load is at 09.00 WIB (business start time) until 16.00 WIB with active electrical components, namely air conditioners, computers, servers, dispensers, televisions, and radio monitoring. PLTS can provide maximum energy from 10 am to 15.00 WIB. With this PLTS, PLN's electricity expense can be saved by 43 percent or around IDR 8,600,000 per month.

In maintaining island mode, if the electricity from PLN experiences a blackout, the energy from solar panels stored in 120 Ah batteries of 14 units will be able to maintain the priority components at Mako Puslatpurmar-5 for approximately 24 hours. The prioritized electrical components capable of operating for 24 hours are radio telecommunications, telephone and charging stations, data servers, internet networks, commander's offices, and guard posts. Costs incurred for installation range from 200-250 million rupiah.

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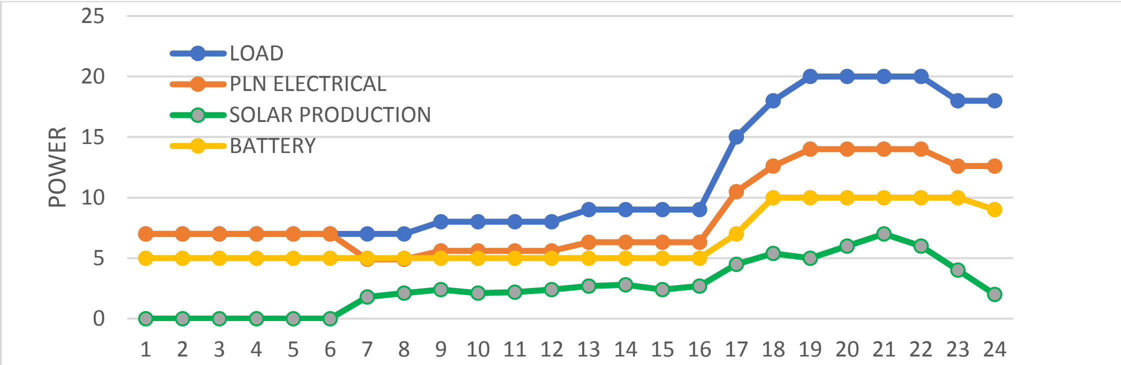
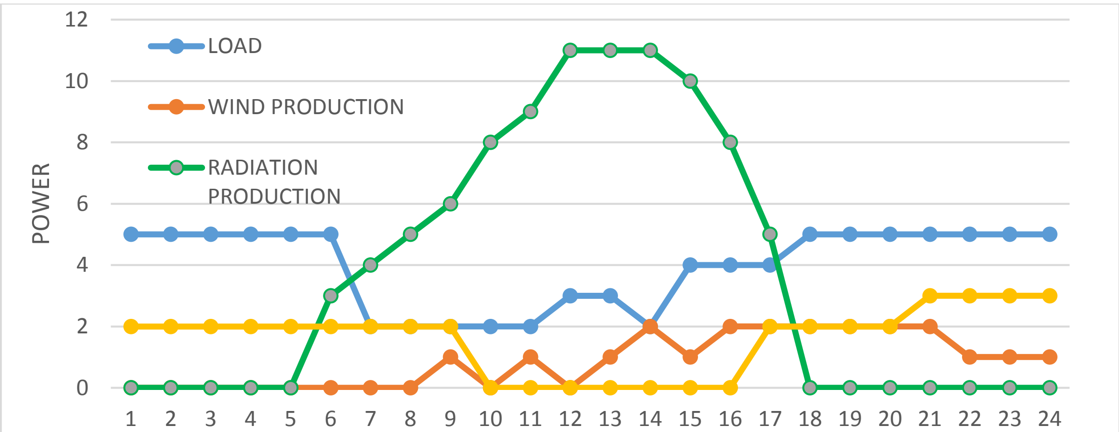
Fig 6: Electrical Load Curves and Solar Energy Supply at the Keris Marine Mess and Waru Marine Mess



(Processed by researchers., 2022)

The second location is Marine Keris and Mess Marine Waru. With the location of the same place, in Figure 6, it is explained that the highest electrical load is at 17.00 WIB (break start time) to 24.00 WIB, with the active electrical components being the guard post, computers, air conditioners, dispensers, televisions, and lights. PLTS can provide maximum energy from 10 am to 15.00 WIB. With the PLTS, PLN's electricity burden can be saved by 30 percent or around IDR 3,000,000 per month. In maintaining island mode, if the electricity from PLN experiences a blackout, the energy from the solar panels stored in 120 Ah batteries of 4 units will be able to maintain the priority components in Mess Marines Keris and Waru for approximately 24 hours. The prioritized electrical components capable of operating for 24 hours are radio telecommunications, telephone and charging stations, data servers, internet networks, and guard posts. Costs incurred for installation range from 50-70 million rupiah.

Fig. 7. Electric Load Curve, Solar – Wind Energy Supply, and Battery Storage Power at Monitoring Point T-12



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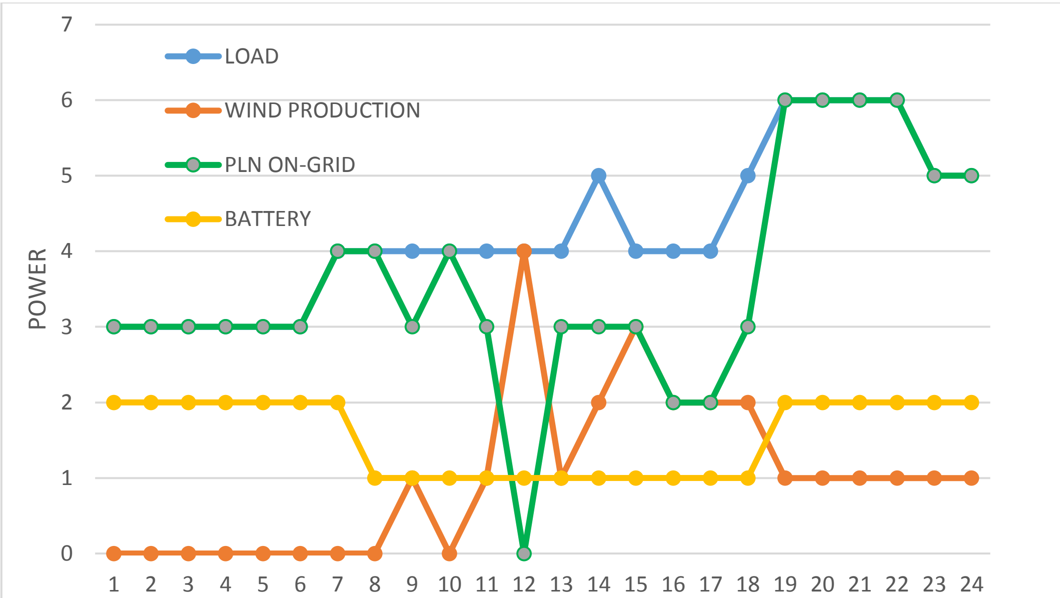
Furthermore, it is the location of the third T-12 Review Point. Figure 7 shows that the highest electrical load is 24 hours (combat training time), with the active electrical components being the guard post, radio communication, lights, water pumps, and searchlights. Solar power plants can provide maximum energy from 10.00 am to 15.00.

Meanwhile, the energy from the wind is, according to the average observation data, from 15.00 to 20.00. Wind and solar power plants are the main energy generators because the PLN network does not cover them. An installed power of 2,200 watts is required where the power usage per month can reach 500 KWH, so battery storage media is needed as an alternative if solar and wind energy are not optimal.

It takes 6 units of 120 Ah batteries to maintain priority components at the T-12 Review Point for approximately 24 hours. In maintaining island mode, the prioritized electrical components capable of operating for 24 hours are telecommunication radio, telephone and charging stations, data servers, internet networks, and guard posts. The cost incurred for installation is around Rp. 100.000.000, - (solar panels and windmills).

Fig 8: Electrical Load Curve, Wind Energy Supply, and Battery Storage Power at the Banongan Marine Post



(Processed by researchers. 2022)

The final location is the Banongan Beach Marine Post. In Figure 8, it is explained that the highest electrical load is at night during training time, with the active electrical components being the guard post, radio communication, lights, and spotlights. Wind power plants can provide maximum energy from 11.00 noon to 18.00. The wind power plant is a supporting energy generator for electricity from PLN. The use of wind energy can reduce the use of electricity from PLN and act as backup power in the event of a power outage from the PLN network.

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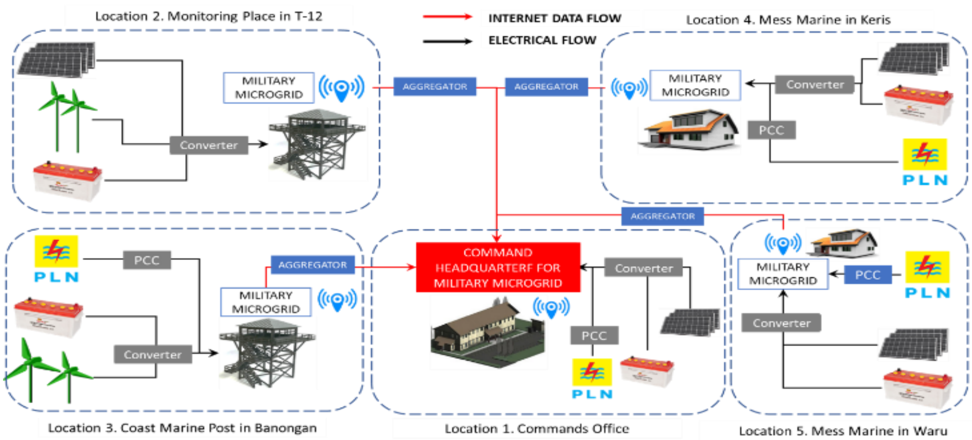
With an installed power of 3,500 Watts and a monthly usage of around 2,000 KWH, wind power plants can save PLN electricity by 50-60 percent each month. In maintaining island mode, if the electricity from PLN experiences a blackout, the energy from solar panels stored in 6 units of 120 Ah batteries will be able to maintain priority components at the Banongan Marine Post for approximately 24 hours. The prioritized electrical components capable of operating for 24 hours are telecommunication radio, telephone and charging stations, viewing tower lights, internet network, and guard posts. The cost of components incurred for installation is around Rp. 100,000,000.

Next is the Standard Operational Procedure (SOP) policy regarding the operation and maintenance of military microgrid equipment compiled by the Indonesian Navy Headquarters Detachment. This detachment has the task of providing headquarters services which include care, maintenance, and internal affairs related to the maintenance of the military microgrid. The SOPs that need to be implemented for personnel in carrying out the tasks of operating and maintaining the power plant equipment are a) in the initial preparation needed for work equipment and personal protective equipment, reading the operation log sheet, and carrying out instructions by ensuring the collection of daily reports; b) Carry out coordination and monitoring regarding equipment maintenance and ensure the use of spare parts and data usage-data collection: c) Ensure that the amount of electrical and mechanical material is sufficient for operational needs; d) Follow up on work reports that have not been completed; e) Has the aim of preventing equipment damage during electrical operation.

Military Microgrid Design

Based on the results of field observations and interviews with relevant agency officials, academics, and renewable energy business actors. Military Microgrid design, in general, can be described in Figure 9. Military Microgrid design at Puslatpurmar-5 Baluran is adjusted to location considerations and electricity needs, where all locations are connected to electricity and the internet.

Fig 9: Military Microgrid Design at Puslatpurmar-5 Baluran



Source: processed by researchers, 2022

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Figure 9 illustrates two connection streams with the military microgrid control center. Among them is the flow of electricity and data flow. The data stream is streamed over the internet. The application of an aggregator equipped with a Virtual Private Network (VPN) or firewall is very important and functions to maintain security from virtual outside attacks (cyber-attacks) by encrypting information so that data security is maintained and cannot be changed [20]. Then the data is described and sent to the Military Microgrid control center.

4. CONCLUSIONS AND FUTURE WORK

The availability of renewable energy at Puslatpurmar-5 is solely used to anticipate threats to national defense. These threats include blackouts, energy sabotage, and conditions of war. This anticipation is carried out using renewable energy in micro (local) and large (massive) conditions. Based on the Renewable energy sector available in the Puslatpurmar-5 Baluran area is solar, wind, and water energy. Solar energy is especially dominant in all work unit locations. Wind energy dominates at the T-12 Review Point and Banongan Beach Marine Post. Water energy is only in the Command Headquarters.

Renewable energy that has the potential to be utilized in the Puslatpurmar-5 Region of the Baluran Navy is solar energy and wind energy. Wind potential has an average speed of 3.9 m/s. Solar potential reaches 5.66 kWh/m^2/d. The energy potential of water cannot be utilized due to the slow speed of the river water due to low water level elevation and small water discharge in the period from May to October. Utilization of renewable energy at Puslatpurmar-5 Baluran with the Military Microgrid concept can save PLN electricity costs by 30-43 percent (around 130-150 million rupiah per year). If the PLN power goes out, the island mode can last for 24 hours with the help of power storage batteries for important components such as communication (cellular and radio), notebooks, servers, and other equipment can last for 8-10 hours. Meanwhile, the T-12 Review Point, with a power requirement of around 2,200 Watts, can be fully supported (100 percent) by utilizing Solar and Wind Energy, which are priorities for communications, water pumps, and lighting. This utilization also saves operational costs previously supported by a 3,000-Watt generator by 90-100 percent or around 135 million rupiahs yearly. The required human resources must be National Soldier/Civil Servant from the Navy Headquarters Detachment (Denma), provided they have a Competency Certificate for Electrical Technical Personnel and pass a competency test.

Design Utilization of wind and solar energy sources with the Military Microgrid concept at Puslatpurmar-5 Baluran is securely designed for two important things. The first is to maintain energy reliability. In Case Puslatpurmar is not fully dependent on electricity from PLN. When PLN's electricity experienced interruptions and blackouts, operations at Puslatpurmar-5 continued. Second, it is safe from cyber-attacks. Because it is connected to the internet, access protection is carried out using an aggregator tool capable of encrypting incoming and outgoing data at each location. The third is the aspect of sustainability. This Military Microgrid is designed to be environmentally friendly by utilizing local energy.

The recommendations that can be given are: With this research, it is suggested that there needs to be a policy from the Puslatpurmar-5 Baluran leadership to continue this research to Kolatmar

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because the military environment is a vital agency. This concept can anticipate any threats that may occur at any time. In addition, by implementing a military microgrid, according to this research, the budget burden for electricity can be saved. Furthermore, in the maintenance of State Property (BMN), Puslatpurmar-5 and the Headquarters Detachment will carry out an inventory of BMN so that later they can submit budgeting and assign human resources to maintain Military Microgrid equipment and components. Then for PLN, it is necessary to coordinate the implementation of the use of renewable energy for military installations because it aims for national defense. It starts with HR training, guarding PLN's vital objects, technology transfer, and reducing electricity costs.

This system is controlled centrally at the command headquarters, with the internet network connecting all locations. Considering that this equipment is connected to the internet, cyber security should be included in the Indonesian Navy Headquarters Detachment agenda to maintain the security of energy use in military installations.

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