Jurnal Pertahanan
Media Informasi tentang Kajian dan Strategi Pertahanan yang Mengedepankan Identity, Nasionalism & Integrity

ISSN : 2087-9415
Vol. 1 | No. 3

Smart Building Perspective in support Energy Security

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Article Info

Keywords:
Solar power,
Optimization,
Smart Building, and
SOP/SOM

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Jurnal Pertahanan
Volume 1 Nomor 3
September-December 2015
ISSN 2087-9415
pp. 197-212

Abstract

The utilization of solar energy in the Auditorium Indonesian Defense University (IDU) is not optimal because problem on the system off-grid The problems that occur due to technical factors (operating system is not in accordance with the concept of smart building) and non-technical (HR, Budget Maintenance, and SOP / SOM). The method used by the researchers is the optimization of observation and interviews. Optimization of solar energy utilization in Building IDU Auditorium is affected by three factors such as human resources, maintenance budgets, and standards of procedure (SOP) and the standard of maintenance (SOM). Besides the three factors were the use operational system that refers to the concept of smart building to be responsible for optimizing the utilization of solar power to support energy security.

Pemanfaatan tenaga surya di gedung Auditorium Universitas Pertahanan tidak optimal disebabkan terjadinya permasalahan sistem off-grid. Permasalahan yang terjadi disebabkan oleh faktor teknis dan non teknis. Metode penelitian yang digunakan peneliti adalah optimasi dengan observasi dan wawancara. Optimasi pemanfaatan tenaga surya di Gedung Auditorium Unhan dipengaruhi oleh tiga faktor yang berupa SDM, anggaran pemeliharaan, dan standar of procedure (SOP) serta standar of maintenance (SOM). Disamping tiga faktor tersebut penggunaan sistem operasional yang mengacu pada konsep smart building juga memberikan pengaruh terhadap optimasi pemanfaatan tenaga surya untuk mendukung ketahanan energi.

Introduction

Solar Power Plant (SPP) is an alternative electric energy sources that utilize sunlight as an energy source that is abundant in number and do not produce exhaust emissions and greenhouse gases, and has flexible properties as easily placed in different locations match needs to be used.

The transfer of energy sources from fossil material into renewable energy (solar) has produced a significant increase. In a system using photovoltaic (PV) to produce electricity able to contribute up to 15% of solar energy capacity by 2013 (Rosalie 2015).

According to Gandhi (2011) some countries like China, India, Japan and Germany are already preparing are not dependent on fossil fuels and start replacing them with renewable energy sources (Rosalie 2015). Renewable energy sources such as biomass, wind, solar, hydroelectric, and geothermal can provide sustainable energy services for resource utilization on a regular basis.

Solar energy can be converted into electrical energy by using a variety of technologies such as photovoltaic (PV) panels, the concentration of solar thermal power (CSP), and concentrating photovoltaics (CVT) (Devabhaktuni, 2013).

Solar energy has advantages when compared to fossil energy such nor exhaust emissions, does not cost energy source, has a solar panel lifetime 25-40 years, flexible operating system.

While the drawbacks in the form of high investment value, requiring the location/land placement of solar panels, the return of capital requires a rather long time. Utilization of solar power currently has a high economic value when applied to the area or areas not reached by the grid.

Utilization of the rooftop solar power is one alternative to support the diversification and conservation of energy because most of the power plants owned by Indonesia currently uses fossil-based energy sources. Utilization of the rooftop solar power is one of the efforts to achieve energy independence and efficiency of energy use by applying the concept of smart

building in an office building. The importance of the use of solar power so that in this study the authors formulate the problem to be analysis: (a) How to use solar power at the IDU?; and (b) How smart building perspective on the use of solar power at the IDU?

Photovoltaic

The sun as an infinite source of energy can be used directly and indirectly, the energy harnessed from the sun known as solar energy (Smith, 1995). The importance of solar energy in economic development has been demonstrated by several studies such as that conducted by Devabhaktuni (2013); Seo (2012); Akikur et al (2013); and Govinda (2012).

Solar energy has been used throughout time, especially for heating and lighting, but also for many other purposes such as cooling, detoxification, desalination and especially for electricity generation (Camacho, 2012). Solar power can be achieved either directly, using photovoltaic (PV) cells, or indirectly, by collecting and Concentrate Solar Power (CSP) to generate steam which is then used to drive a turbine to provide electricity (Camacho et.al, 2012).

Solar power is energy produced by harnessing the sun by using equipment that could generate electrical energy (Daniel, 2014) using solar panels (photovoltaic) as a medium that serves generate voltage from the solar cell process (Camacho, 2012). The magnitude of the voltage produced by the solar panels is influenced by the intensity of solar radiation and the size of the solar panel (Daniel, 2014).

To achieve efficiency of energy conversion depends on the PV panels that generate power. In addition to weather conditions, not linear at the level of irradiation and temperature (Piegari, 2010). Figure 1.1 illustrates the basic photovoltaic components that are used to capture solar energy. Sunlight is captured by a panel that contains elements that can store or reflective to be converted into electrical energy (Rosalie, 2015).

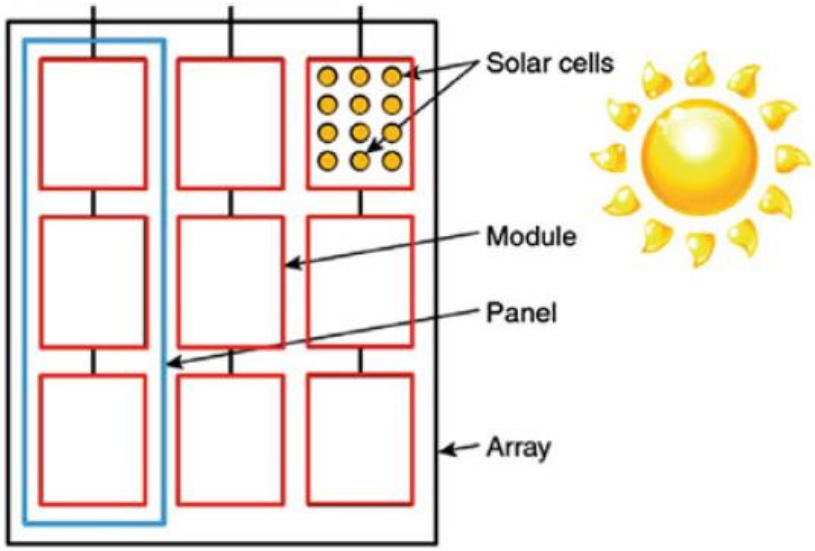

Figure 1. Basic Components Photovoltaic

The basic components of a photovoltaic system in figure 1.2, the photovoltaic unit that captures solar energy and an inverter that converts the power from DC to AC, power lines and other power system components, as well as storage batteries. Absorption of solar energy into electrical energy is affected by the PV panel and the method of installation of PV on the roof (Solomon, 2014). There are three different methods of installing the PV system to the roof structure: ballast, roof-mounted bearings, and inherent structural.

According to Jackson (2008), a grid-connected PV system essentially consists of the following components: (1) PV modules / arrays (several PV modules connected in series or in parallel with the mounting frame); (2) The combination of PV array (with protective equipment); (3) direct current (DC) cables; (4) The main DC disconnect/isolator switch; (5) inverter; (6) AC cord; (7) the meter cupboard with power distribution system, supply and feed the meter, and electrical connections (Jackson, 2008).

While solar systems consist of solar panels, charging regulator circuit, electrical energy storage, inverter, wiring and connectors, and other mechanical equipment (Kumara, 2010). The Solarpower Electric Generator (Indonesia: Pembangkit Listrik Tenaga Surya (PLTS)) components include a solar panel,

charger controller, battery, and inverter.

Smart Building

Wang *et.al* (2012), found Smart Building is a building form that reflects the state of the future generations by utilizing computer and intelligence technology to achieve a level of comfort and optimum energy consumption. Smart Building focuses on real-time response to demand and increased control in detail (Kiliccote *et.al*, 2011) and thus appears the difference with the previous generation through the theme of responsiveness, adaptability and flexibility continuously (Cook and Das, 2007; Wang *et.al*, 2012a, b) as well as higher performing (Buckman, 2014).

Building-integrated photovoltaics (BIPV) is considered as a functional part of the building structure, a design that replaces conventional roofing materials such as shingles, tile, slate and metal roofing (Crawford, 2006). Architectural elements can be made with opaque or transparent form between cells and can be used for curtain walls, awnings, windows and skylights (Barkaszi, 2001). BIPV solar energy is a multifunctional product that generates electricity through a combination of construction materials roof with solar panels (Peng, Huang, Wu, 2011). BIPV is one of the best ways to harness solar power (Huang, 2012). Utilizing renewable energy sources to meet the needs of smart building with eco-friendly oriented, high level of comfort and efficiency by developing an effective control system (Wang, 2012).

Renewable Resources

Once the importance of renewable energy sources so that much research has been done by Mohanty *et.al*, (2002), Dean (2006), Nigam and Singh (2011), and Sadigh *et.al* (2015). The use of photovoltaic (PV) to collect solar energy and convert into electrical energy is increasingly recognized as an important component of the technology of renewable energy sources in the future (Sean, 2005).

Renewable energy sources on a small scale has the potential to substitute the energy needs of a

building that utilizes smart building concept. The utilization of solar energy in building rooftop Auditorium.

Optimization

An action to obtain the best results with the given situations in the design, construction, and maintenance of systems engineering with the ultimate goal of all such decisions is to minimize the effort required or to maximize the desired benefits. Effort required or intended use in practice can be expressed as a function of the decision variable, so that optimization can be defined as the process to obtain a state which gives maximum or minimum value of a function. The stages in the optimization method is.

a. Identifying the problem and the factors that influence.
b. Setting goals and decision-making criteria.
c. Developed several alternative models
d. analyzing models
e. Choosing the best model.

In addition to the activities expected to be optimal utilization of solar power also their contribution to the use of electrical energy. The study used data sourced from the supporting documents, observation and documentation of the object, while the primary data in the form of interviews with sources regarding the use of electrical power is held directly on the main distribution panel (MDP) of every building in the IDU.

Research Method

The method we chose for the preparation of this paper is to use qualitative methods, so that the data collection techniques used are in the form of observation and questioning of sources and data existing conditions in the field that can be used to support the settlement of this study. However, due to time constraints we are currently preparing this paper uses literature or literature that has been there.

Result and Discussion

The installed capacity of 30 kWp consisting of 120 solar panels with 250 Wp specification capable of producing the equivalent of 150 kWh per day, which is equipped with a battery with a maximum capacity of 165 kWh power saving. PLTS installed using smart grid Operational

systems whose systems are connected on the current work PLTS generate electric power system will implement battery charging and excess power will be used to substitute the electricity network.

SPP also has an operational system off grid solar power which will use the power stored in the battery to supply power to the load is attached, so that the event of disruption of electricity blackouts, the SPP will be backing up the existing grid in the Auditorium Building.

This is because these solar systems using the operating system and the smart grid connected solar power is already equipped with the Automatic Transfer Switch (ATS). To support the data analysis required data on the use of electrical energy in every building in the IDU and more specifically in the building Auditorium.

PLTS Utilization Concepts Using Smart Building

The use of technology as an application in the concept of smart building in an office building that is applied with a source of solar energy is one of the smart building concept that was developed in advanced countries by utilizing the existing local energy source. Exploit the potential of solar energy that is used as an alternative energy source that serves to substitute the electricity network and can contribute to national energy security as well as to provide added value for IDU as capable of producing electrical energy to reduce dependence on the electricity network.

Renewable Resources

Utilization PLTS in IDU is one form of utilization of the potential of local energy as an energy source to substitute grid is one form of the concept of smart building that utilizes solar power as a source of energy power plant to supply the electricity needs of the building Auditorium included in smart building.

Utilization of PLTS is integrated with storage means the voltage in the form of battery, the power generated by the solar power of 150 kWh per day and the battery capacity of 165 kWh, the use of solar power can make a major contribution in the concept of smart building as a

source of energy that can be used to reduce energy use electricity, solar power utilization which apply the concept of smart building needs to be supported by the operating system that is able to regulate the use of energy produced by solar power and battery use as an energy source at night.

Operational Systems PLTS

Operational systems PLTS system uses smart grid connected currently used basically already substituted networks of electricity, so the energy use of electricity could be reduced by 150 kWh per day by utilizing the electric energy generated by solar power during the day directly used to substitute electricity network.

However, based on the concept of system smart building that is the system is less than optimal in utilization as should the power generated by the solar power stored in the battery is also used to support the needs of electrical energy at night time so that dependence on energy use can be reduced and the contribution of the utilization of the generated power by PLTS can be optimized when using the smart building concept

Automation systems

This system uses a sensor to determine the current conditions on the ground and supported by a system that serves as the operational controls that respond to events that were going to be giving orders to the motion system to provide a response to the existing conditions.

At PLTS attached is equipped with sensors that can respond to the disruption of power outages, so that during a network outage of electricity automatically PLTS will be backing up the network using the power contained in the battery or from power generated by the solar panels with the time switch over approximately 3 seconds.

Table 1. The Use of Electrical Energy in IDU

No	Location	Average loads		
		Hour	Daily	Monthly
1	Rectorate	34.9	837.2	25.115.0
2	Renku/Aka/LPPM	33.1	795.2	23.855.0
3	Roum/LPPM	33.1	795.2	23.855.0
4	FMP	26.4	634.6	19.038.2

No	Location	Average loads		
		Hour	Daily	Monthly
5	FSP	24.9	597.5	17.925.1
6	Kamnas	19.8	474.0	14.220.0
7	Library	18.9	452.8	13.584.3
8	Dinning Hall	33.8	811.2	24.336.0
9	Auditorium	42.13	1.011.1	30.333.6
	Total	**267.0**	**6.408.7**	**192.262.4**

Contributions Utilization of Solar in IDU

Based on the results of observational data on the SPP at the Rooftop of the building Auditorium IDU, obtained the data that the SPP is attached has a capacity of 30 kWp or equal to 30 kW produced 120 pieces of solar panels of 250 Wp and generate electric power of 120 up to 150 kWh per day (assuming radiation maximum sunlight 4 to 5 hours), PLTS using Bidirectional smart inverter that has the Smart Grid connected operating system that is connected directly to the grid, the electrical power generated will be used to substitute PLTS electricity grid.

PLTS also include Battery 60 Ea arranged in series with a stored power capacity reaches 30 kW which serves as the Power Bank will be used to back up the grid when impaired. PLTS already have a network installation for backing up 10 classrooms and auditorium space in the form of lighting systems and supporting equipment except AC.

Based on Table 2 Flow measurement results that are used on average per day was 42,13 A with voltage (V) which is used with the large 3 phase 380 V, so we get the power used per day in the Auditorium Building of 664.7 kWh. Contributions utilization of solar power to PLN based on the efficient use if the optimal functioning of 22,57%, the use of electrical energy in IDU in August 2016 amounted to 115,051.2 kWh, the amount of the percentage of energy use in buildings IDU Auditorium the overall energy use by 17,33%. Load measurement in Building Auditorium describe the use of air conditioning load of 76A to 110A peak load. The use of outside air conditioning equipment load of 22.35 kWh.

Influence Factors in PLTS Optimization

To obtain in-depth data about the use of solar power in the IDU Auditorium Rooftop, then conducted interviews with respondents from IDU officials, PT Indospech and technicians IDU. The outline of the interview is.

Table 2. Results of Interviews

No	Question	Informant Answer			
		Karoum	**Kabaglog**	**PT. Indospech**	**Technicians**
1	Utilization constraints of PLTS	• Human Resource Management • Budget	• Human Resource Management • Budget	• Human Resource Management • Installation	Operational way
2	SOP and SOM of PLTS	Not Available	Not Available	• Have SOP but SOM Not Available	Not Available
3	Operational way training of PLTS	-	Training	Training	-
4	Automatic Transfer Switch (ATS) optimal appear to function	-	Appear to function	Appear to function	Does not work

The work of the PLTS system may be optimized whether influenced by several factors. According to Table 4.8 presents an overview of the results of interviews of informants found several factors that influence the optimization of solar energy utilization in buildings Auditorium IDU, budget support maintenance, Standard of Procedure and Standards of Maintenance.

Human Resources (HR)

One determining factor for success of the optimal performance of the equipment is a mengawakinya or operationalize human resources. The quality and quantity of human resources greatly affect the performance of the equipment, while the quality and quantity of human resources is also affected by several things such as education level, economic level, the level of skills / expertise, personnel numbers and hours of operation.

Budget Maintenance

Activities to maintain working system of a piece of equipment to keep the optimum cannot be separated from system maintenance are eligible SOM and SOP either of fabrication and released from the institution operationalize the equipment.

In the maintenance system required a special budget allocated to support optimal maintenance system, because in an equipment in order to work optimal working conditions should be maintained such equipment in optimum condition. To support the maintenance of a system of such equipment requires funding or budget to be prepared and planned to maintain optimal performance of the equipment.

Standards of Procedure (SOP) and Standards of Maintenance (SOM)

Standard of procedure (SOP) and the standard of maintenance (SOM) has a function for prevention or improvement to maintain the equipment working systems to function optimally. Maintenance management consists of scheduled maintenance performed by qualified personnel who have the capability or associated equipment to maintain the performance of the equipment to operate safely, have optimal performance and long life time.

Operation of solar power generating systems

PLTS operational systems that exist today are simply substituted for the grid during the day, while at night the whole load using the grid. PLTS is equipped with a battery capacity of 30 kW. To optimize the utilization of solar power, there are two concepts of operational systems that can be used are as follows:

a. Using Off Grid Systems. With a battery capacity memanfaatan at night. This concept utilizes 165 kWh of battery capacity, based on Table 4.7 Use of the average load during night time from 18:00 s.d. 6:00 10.7 A. By using the formula (4.1) obtained load used is 7 kWh / hour, thus assuming to maintain life time (depth off discharge) battery use a maximum of 60% of battery capacity that is equal to 99 kWh, so PLTS can operational for the supply of lighting systems and

air conditioning throughout the Panel Room Auditorium Building more than 14 hours. With this system, the use of solar power can be optimized to substitute the grid in Building Auditorium reached 22.57%.

b. Utilizing on Grid Connected solar. The power generated at the solar power when there is no activity or a holiday in the Auditorium building is not an optimal substitute electricity networks, as based on the generated power Figure 4.4 PLTS 17.7 KWh. While the use of the building load Auditorium during holidays 10.7 A, equivalent to 7 kWh, so that there is 10.7 kWh / hour untapped. To optimize the power generated by memaanfaatkan system Grid Connected is adding equipment kWh meter to substitute PLN voltage, so that when PLTS produce more power will be noted how many kWh were substituted into PLN and when using the grid, the number of kWh will be reduced by the load used, Assuming PLTS production time of 8 hours / day will get the power generated on the holiday of 85.6 kWh / day which will be substituted grid.

Conclusion

Renewable energy sources in the form of rooftop solar power in buildings Auditorium serves to substitute the electrical energy and serves as a UPS that can supply 10 classrooms and the auditorium.

Concept of Smart Building on IDU Auditorium currently not met because only some criteria are:

a. Renewable energy resource, using solar power to substitute electricity network to meet the needs of electric energy in the building Auditorium has been fulfilled.
b. Utilization of PLTS is equipped with a battery as a power storage is one of the smart building concept criteria are met.
c. Operational systems that utilize solar power battery system (off-grid) at night to reduce the energy usage of electricity has not been fulfilled.
d. Automation systems, largely unmet automation systems such as motion sensors, humidity, light, and the flood has not been

fulfilled. For automation system which has been fulfilled is a fire extinguishing system and interruption of electricity outages has been backed up using solar.

e. Energy management, the use of energy management in buildings Auditorium yet.
f. Networking and Internet networks are still not optimal.
g. Building design outline has applied the concept of smart building.

Utilization of solar power is not optimally utilized, UPS as a backup energy source cannot back up the grid due to the problems of software and protection systems. Their failure in the inverter so that the battery cannot supply grid is already integrated with solar power despite the conditions optimal battery capacity.

The utilization of solar power can provide savings or have a contribution rate of more than 19% regarding the power generated by solar. Low utilization of solar energy in the building Auditorium IDU is affected by the following three factors:

a. Human resources management mechanical and electrical which has criteria: educated and experts in the field, motivating salary, training, personnel and effective working hours.
b. Maintenance budgets PLTS to maintain optimal performance.
c. SOP and SOM in carrying out operations and maintenance of solar.

Problems failure of the system back up of the PLTS during disturbances or outages of electricity is due to the protection system in PLTS experienced failure based on the track record of the incident on the display Inverter began February 11, 2016 until Sept 10, 2016 so that the inverter system on the battery does not operate normally, problems this resulted in a working system PLTS is not optimal.

Recommendation

Future studies could examines the optimization of human resources, the maintenance budget, SOP and SOM in using PLTS

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