Comparative Analysis of Efficiency of Solar Cell Utilization and PLN Energy Sources

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ABSTRACT

Solar cells are one of the renewable energy sources that are increasingly popular in generating electricity. On the other hand, PLN (State Electricity Company) energy sources use fossil fuels such as coal, oil, and natural gas. In the comparative analysis of the efficiency of utilizing solar cells and PLN energy sources, several factors need to be considered. The purpose of this study is to analyze the efficiency of utilizing solar cells and PLN energy sources. The purpose of this study states that in the comparative analysis of the efficiency of utilizing solar cells and PLN energy sources, solar cells have advantages and disadvantages as well as PLN energy sources. In this context, the choice between solar cells and PLN energy sources must consider these factors as well as local conditions and specific energy needs. The research method used is qualitative descriptive research with the literature review method.

Keywords: Electricity, Solar panels, PLN.

INTRODUCTION

One of the fields of science that is closest to human life is physics [1]. Physics technology can help humans. Because physics is implicit in advanced technology, all tasks become easier[2]. Technology can combine several physics concepts into one type of equipment, so there are devices that use only one physics concept, and there are those that use more than one physics concept. The equipment that will be used by humans will be based on physics. Current technology will be enhanced by the latest physics discoveries. Unbeknownst to them, everyone needs knowledge and to keep up with technological advancements in order to live well. Where, of course, technological advancements are influenced by physics that has been studied by experts experienced in their fields[3]. Studying physics has many benefits. Without physics, all the sophisticated equipment that can simplify human tasks would not come into existence.

Modern technology encourages humans to discover many things about the existence of electrical energy sources. Electric energy has developed into one of the most important components in human life today[4]. Energy conversion produces most of the energy, which comes from oil, gas, and fossil sources. However, we must consider some drawbacks of using these resources; one of them is the depletion of natural resources used as electrical energy. Even in the use of renewable energy, the sun has many energy sources available worldwide, especially in Indonesia. Solar photovoltaic panels convert solar energy into electrical energy when used as electrical energy [5].

One of the most important things in human life is electricity, which is needed for many things, such as households, industries, businesses, social activities, government office buildings, and street lighting[6]. The demand for electrical energy increases along with

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technological advancements and sector developments in South Sumatra province. Therefore, the demand for electricity changes every year. Therefore, the problem arises of how to meet energy needs without sacrificing the State Electricity Company, the energy provider. Having good and precise planning is one way to avoid losses. Predicting electrical load can be done to provide information to PLN. There are many techniques that can be used to predict electrical load. One of the methods that can be used is linear regression. In terms of forecasting electricity load in South Sumatra from 2016 to 2025, this approach shows more accurate results than other approaches. The prediction results determine whether the existing power plants are sufficient to meet the demand or if additional power plants are needed[7].

The semiconductor components of solar cells have the ability to use solar energy to generate direct current electricity [8]. When the solar cell receives photons from a light source, electrons are released from their atomic structure. A current is formed when the released electrons move freely through the crystal lattice. In this situation, the silicon alloy is called an N-type (negative) semiconductor because electrons are negatively charged subatomic particles. Actually, the way solar cells work is the same as the way semiconductor diode devices work. When light comes into contact with the cell and is absorbed by the semiconductor material, electrons are released. In semiconductor materials, the sigma force will change if these electrons can move to different layers. The flow of the electric field is generated by the repulsive force of the semiconductor material. Electrons are then directed to the initial and final channels to be used in electrical equipment[9].

The need for electricity for both industry, offices, and the general public and individuals is increasing rapidly. This increase in electricity demand has resulted in an energy crisis. Therefore, solar energy is chosen as an alternative energy to produce electricity. A solar panel module works optimally to convert solar energy into solar energy at a temperature of around 25 degrees Celsius with a production capacity of 1 kW/m². However, when operating in the field, solar panels usually receive heat due to solar radiation so that the temperature of the panel exceeds its optimal temperature value which causes the performance and efficiency of monocrystalline and polycrystalline solar cells to drop drastically when the temperature rises. Currently, especially in urban areas, cooling machines can be found in almost every shop, office building and household. Cooling machines can be refrigerators, freezers, chillers and air conditioning. The most common use of cooling machines is for room conditioning and preservation of food or beverages. The main purpose of the air conditioning system is to maintain the condition of the air in the room which includes regulating temperature, relative humidity, air circulation speed and air quality. The installed air conditioning system must have the right cooling capacity and can be controlled in its operation. The equipment capacity can be calculated based on the cooling load at any time which is constantly changing [10].

The development of technology continues to grow day by day, with the increasing development of computer science, it is almost inseparable from everyday life, because almost all human activities are carried out by utilizing computer technology in an organization or company. PT Perusahaan Listrik Negara or commonly called PT. PLN is a State-Owned Enterprise that still provides electricity tariff subsidies for households. In the Law of the Minister of Energy and Mineral Resources of the Republic of Indonesia Number 29 of 2016 concerning the Mechanism for Providing Electricity Tariff Subsidies for Households. The electricity subsidy program is one of the poverty alleviation programs by providing electricity

subsidy assistance funds to poor and disadvantaged households paid by the Indonesian Government to PT. PLN (Persero). Based on the problems above, this is the reason the author submitted a research title, namely "Decision Support System in Determining Subsidized and Non-subsidized Electricity Users at PT. PLN (Persero) Tanjung Balai Using the Fuzzy Mamdani Method". In the existence of this system, it is hoped that it can help in decision making to determine prospective subsidy recipients quickly and accurately [11].

Electrical energy is a primary need for all levels of society, Electrical energy has many benefits in everyday life both in the household sector, transportation and industry. The availability of electricity is an inseparable part of today's life. The need for electrical energy is very dominant for humans, starting from the needs in households, government businesses, household industries to large industries and all other aspects of life, so that the availability of electrical energy is currently very important and very influential in increasing the rate of growth of the socio-economic quality of society in general. The forecast of electrical power needs is influenced by one of which is influenced by the right lighting system in a room. The amount of electrical power used is related to government policy, economic level and population and number of households. The higher the level of economy will cause the activity of using electrical power to be higher, as well as for the population [12].
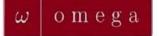
The use of electrical energy in Indonesia continues to increase, this condition will cause problems if the provision of electrical energy is smaller than the capacity needed. The policy taken by PLN (State Electricity Company) which is responsible for providing electrical energy increasingly shows that the electrical energy provided by PLN only has an excess of around 3 GW. If PLN does not immediately add or build new power plants, it will have an impact on the service of electrical energy to consumers, this can affect economic growth considering that electrical energy is a vital need in running large, medium and small industrial activities and some household appliances. Many steps or methods are taken to anticipate these problems by various groups including government agencies, private companies and researchers. These efforts are to find power plants whose primary energy comes from alternative materials and materials that will not run out. This study focuses on the use of light from the sun. The amount of sunlight that shines on the earth is the main factor in this study, every year the sunlight that reaches the earth's surface is 3 x 1024 Joules, the amount of energy is almost the same as 1 x 104 Joules [13].

RESEARCH METHODS

This article on Comparative Analysis of the Efficiency of Solar Cell Utilization and PLN Energy Sources is a qualitative descriptive study using the literature review method. Qualitative descriptive research is research that describes the object or subject being studied objectively. This is done with the aim of systematically describing the facts and characteristics of the object and frequency being studied precisely [14] The literature review method is a method where researchers collect literature from several sources, including: printed books, scientific journals, and online news articles that contain the information needed regarding the problems that will be discussed in the research [15]. In this study, the sources used are those related to the Efficiency of Solar Cell Utilization and PLN Energy Sources. The literature review method consists of several processes, namely finding relevant literature, evaluating literature review sources, identifying themes and gaps between theory and existing conditions, creating an outline structure, and compiling a literature review review. In this study, the stages that will be carried out are: (a) Searching for literature on

the Efficiency of Solar Cell Utilization and PLN Energy Sources, (b) Identifying between the literature obtained and existing conditions, (c) Reviewing the Efficiency of Solar Cell Utilization and PLN Energy Sources in the literature, namely choosing an energy source that is in accordance with existing conditions and problems, (d) Drawing conclusions.

RESULTS AND DISCUSSION

The comparative analysis of efficiency between the use of solar cells and PLN energy sources involves assessing the extent to which each energy source can produce maximum output with the given input. Several factors that need to be considered in this analysis include conversion efficiency, production costs, space utilization, and sustainability.

Conversion efficiency refers to the extent to which solar cells are able to convert solar energy into electrical energy, and the extent to which PLN is able to convert fuel into electrical energy. Solar cells have varying efficiencies depending on the type and quality of solar panels used. Solar cell efficiency can also be affected by environmental factors such as sunlight intensity and the ability of solar panels to absorb sunlight. PLN's conversion efficiency depends on the type of fuel used and the electricity generation process applied.

Solar cells generally require significant initial investment to purchase and install solar panels, but the operating costs are relatively low because the solar energy used is free. On the other hand, PLN requires investment in the construction of power plants, as well as ongoing operating and maintenance costs. PLN also requires costs to obtain fuel and meet environmental requirements.

Solar cells utilize land or roofs of buildings for solar panel installations. If the available land or roof is large, then solar cells can be utilized efficiently. On the other hand, PLN requires large areas of land to build its

power plants, especially if using certain fuels such as coal.

The analysis also includes considerations about the sustainability of an energy source. Solar cells use renewable energy sources, namely sunlight, so they are considered more sustainable. PLN, especially those using fossil fuels, has limited resources and also contributes to greenhouse gas emissions, which can have a negative impact on the environment.

Solar cells are a technology that uses solar panels to convert solar energy into electrical energy. Solar cell efficiency refers to the extent to which solar panels can convert solar energy into electrical energy. This efficiency can be affected by factors such as sunlight intensity, temperature, shading patterns, and the condition of the solar panels themselves. The main advantage of solar cells is that they use an unlimited renewable energy source (the sun) and can produce clean electricity without carbon emissions. However, solar cell panels have quite high purchase and installation costs. They also require regular maintenance and are inefficient during bad weather conditions or at night. In addition, factors such as geographic location, panel orientation, and the presence of shadows can affect the efficiency and performance of solar cells.

PLN's energy sources involve power plants that use various fuels such as coal, gas, oil, or renewable energy sources such as water and wind. PLN's efficiency can be measured by the extent to which the fuel used can produce electrical energy. This efficiency depends on the type of technology used in the power plant and the efficiency of energy conversion in the process. The advantage of using PLN's energy sources is the availability of stable and reliable electrical energy, regardless of weather or time. PLN also has a mature infrastructure and can meet large energy needs. The disadvantages of using PLN's energy sources are that they depend

on limited fossil fuels and have negative environmental impacts such as carbon emissions, air pollution, and large land use for power plant installations.

In comparing the efficiency between solar cells and PLN energy sources, several factors must be considered, including energy conversion efficiency, production and maintenance costs, space usage, sustainability, and environmental impact. The choice between solar cells and PLN energy sources must consider geographic conditions, energy needs, costs, resource availability, and desired environmental goals.

It is worth remembering that the best solution may involve a combination of both of these energy sources, using solar cells to harness the sun's energy in a supportive environment, while utilizing PLN's energy sources to ensure a reliable and sustainable energy supply overall.

CONCLUSION

Based on the comparative analysis of efficiency between solar cells and PLN energy sources, it can be concluded that both energy sources have advantages and disadvantages that need to be considered before making a decision. Solar cells have the advantage of being an unlimited renewable energy source, do not pollute the environment, and are reliable in conditions of sufficient sunlight. However, they have limitations in terms of efficiency during bad weather or at night, as well as the initial investment costs that may be high. PLN energy sources, on the other hand, can provide a stable and reliable energy supply, even though they use limited fossil fuels. However, they produce carbon emissions and other negative environmental impacts. The choice between solar cells and PLN energy sources must consider factors such as geographic location, energy needs, costs, resource availability, and environmental preferences. The optimal solution may involve a combination of both energy sources, utilizing solar cells in an environment suitable for generating renewable energy, while still utilizing PLN energy sources to meet overall stable and sustainable energy needs. In order to achieve energy sustainability, research and innovation need to be continuously carried out to improve the efficiency and performance of solar cells, as well as reduce the environmental impact of PLN energy sources.

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REFERENCE

[1] A. Renostini Harefa, "Peran Ilmu Fisika Dalam Kehidupan Sehari-Hari," *J. War.* , no. April, pp. 1–10, 2019.

[2] R. F. Daud, I. Komunikasi, U. M. Kotabumi, and L. Utara, "Dampak Perkembangan Teknologi Komunikasi Terhadap Bahasa Indonesia," *J. Interak. J. Ilmu Komun.*, vol. 5, no. 2, pp. 252–269, 2021, doi: 10.30596/interaksi.v5i2.7539.

[3] Gunawan, A. Harjono, and H. Sahidu, "Pengembangan Model Laboratorium Virtual Berorientasi Pada Kemampuan Pemecahan Masalah Bagi Calon Guru Fisika," *J. Mater. dan Pembelajaran Fis.*, vol. 5, no. 2, pp. 41–46, 2015, [Online]. Available: jurnal.fkip.uns.ac.id/index.php/fisika/article/view/7782%0A.

[4] H. Muchtar and F. Said, "Sistem Identifikasi Plat Nomor Kendaraan Menggunakan Metode Robert Filter dan Framing Image Berbasis Pengolahan Citra Digital," *Resist. (elektRonika kEndali Telekomun. tenaga List. kOmputeR)*, vol. 2, no. 2, p. 105, 2019, doi: 10.24853/resistor.2.2.105-112.

[5] H. S. Utomo, T. Hardianto, and B. S. Kaloko, "Optimalisasi Daya dan Energi Listrik pada Panel Surya Polikristal

Dengan Teknologi Scanning Reflektor," *Berk. Sainstek*, vol. 5, no. 1, p. 45, 2017, doi: 10.19184/bst.v5i1.5375.

[6]   D. Rizkasari, W. Wilopo, and M. K. Ridwan, "Potensi Pemanfaatan Atap Gedung Untuk Plts Di Kantor Dinas Pekerjaan Umum, Perumahan Dan Energi Sumber Daya Mineral (Pup-Esdm) Provinsi Daerah Istimewa Yogyakarta," *J. Approriate Technol. Community Serv.*, vol. 1, no. 2, pp. 104–112, 2020, doi: 10.20885/jattec.vol1.iss2.art7.

[7]   Y. Hakimah, "Analisis Kebutuhan Energi Listrik Danprediksi Penambahan Pembangkit Listrik Di Sumatera Selatan," *Desiminasi Teknol.*, vol. 7, no. 2, p. 12, 2019.

[8]   M. Idris, "Rancang Panel Surya Untuk Instalasi Penerangan Rumah Sederhana Daya 900 Watt," *J. Elektron. List. dan Teknol. Inf. Terap.*, vol. 1, no. 1, p. 17, 2020, doi: 10.37338/e.v1i1.94.

[9]   F. I. Pasaribu and M. Reza, "Design and Build an Arduino-Based Charging Station Using 50 WP Solar Cells," *R E L E (Rekayasa Elektr. dan Energi) J. Tek. Elektro*, vol. 3, no. 2, pp. 46–55, 2021.

[10]   S. Lubis, M. . Siregar, W. . Damanik, and E. . Hasibuan, "ANALISA NILAI KOEFISIEN PRESTASI (COP) LEMARI PEMBEKU YANG DIHASILKAN OLEH SOLAR CELL," *Pros. Konf. Nas. Soc. Eng. Polmed*, vol. 2, no. 1, pp. 252–260, 2021.

[11]   A. Widarma and H. Kumala, "Sistem Pendukung Keputusan Dalam Menentukan Pengguna Listrik Subsidi Dan Nonsubsidi Menggunakan Metode Fuzzy Mamdani (Studi Kasus : PT. PLN Tanjung Balai)," *J. Teknol. Inf.*, vol. 2, no. 2, p. 165, 2019, doi: 10.36294/jurti.v2i2.432.

[12]   S. Fauziah and S. Muryani, "Decision Support System Untuk Menetapkan Daya Listrik Bagi Pelanggan PLN," *J. Perspekt.*, vol. 17, no. 1, pp. 22–27, 2019, doi: 10.31294/jp.v17i1.5069.

[13]   H. Asy'ari, A. Rozaq, and F. S. Putra, "Pemanfaatan Solar Cell dengan PLN sebagai Sumber Energi Listrik Rumah Tinggal," *Emit. J. Tek. Elektro*, vol. 14, no. 1, pp. 33–39, 2014, doi: 10.23917/emitor.v14i1.12775.

[14]   C. Zellatifanny and B. Mudjiyanto, "The type of descriptive research in communication study," *J Diakom*, vol. 2, no. 1, pp. 83–89, 2018.

[15]   A. Z. Izza, M. Falah, and S. Susilawati, "Problematika Evaluasi Pembelajaran dalam Mencapai Tujuan Pendidikan di Era Merdeka Belajar," *JIIP - J. Ilm. Ilmu Pendidik.*, vol. 6, no. 4, pp. 2871–2880, 2023, doi: 10.54371/jiip.v6i4.1954.