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SOLAR POWER GENERATION SYSTEM AT HOUSEHOLD SCALE

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ABSTRACT
Solar power plants are renewable energy systems that utilize sunlight as a power source to generate electricity. The conversion of light energy into electrical energy is achieved through the photovoltaic effect. The process of converting solar energy into electrical energy is made possible by photovoltaic solar panels, which convert solar light energy into electricity. This technology began to be widely known and began to be widely used. Its use is widespread, ranging from large factories, office buildings, commercial buildings, shopping centers, hospitals, hotels, and households The purpose of this study is to know and analyze household-scale solar power generation systems. The method used in this study is a literature review, data used in the form of articles in electronic databases such as Google Scholar, in the period 2006 to 2023. The results showed that solar power plants (PLTS) are the right choice to overcome the energy crisis in Indonesia. Solar Power Plant Energy (PLTS) is abundant sunlight. Solar Power Plant System (PLTS) at the household level using Solar Home System (SHS) which is increasingly adopted in Indonesia (especially in households). The implication in this study is to provide a deeper understanding of household-scale solar systems, including the associated advantages and challenges. This can help individuals, institutions, and governments make better decisions regarding the use of renewable energy.

Keywords: Power Plant, Solar Power Plant, Solar Home System.

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INTRODUCTION

Solar power plants (PLTS) are the best solution for reducing dependence on fossil fuels and decreasing greenhouse gas emissions (Ipung & Thamrin, 2023). PLTS also meets daily electricity needs while reducing environmental and climate impacts (Iswandi & Dewata, 2020). Besides mitigating environmental and climate impacts, PLTS (*Pembangkit Listrik Tenaga Surya*, Solar Power Plant) also offer other benefits, such as reducing daily electricity usage costs, enhancing energy self-sufficiency, reducing carbon footprint, and being deployable in remote areas (Ardiyanto et al., 2024). Within Solar Power Plants (PLTS), there are systems and components. PLTS (*Pembangkit Listrik Tenaga Surya*, Solar Power Plant) are divided into several types depending on their application. These systems include grid-connected systems, off-grid systems, distributed systems, centralized systems, and hybrid systems. PLTS (*Pembangkit Listrik Tenaga Surya*, Solar Power Plant) operate based on the principle of the photovoltaic effect, where photovoltaics is a technology that directly converts solar energy into electricity (Tambunan, 2020). The equipment within photovoltaics consists of a collection of solar cells arranged in series or parallel, then combined to form solar modules. PLTS (*Pembangkit Listrik Tenaga Surya*, Solar Power Plant) components include solar cells or solar panels, inverters, solar modules, storage systems such as batteries, and measurement systems (Syahwil & Kadir, 2021).

There are several advantages to using PLTS (*Pembangkit Listrik Tenaga Surya*, Solar Power Plant), such as not requiring fuel, not producing pollution and noise during electricity generation, minimal maintenance costs, and ease of operation (Hasibuan et al., 2023). However, its drawback is that solar cells cannot generate electricity without sunlight at night or during rain. Therefore, to overcome this limitation, solar cell systems are equipped with energy storage systems that use lead-acid batteries, which are readily available in the market. Solar Power Generation Systems have three types: Grid-Connected PLTS, Off-Grid PLTS, and Hybrid PLTS (Roza & Mujirudin, 2019). PLTS (*Pembangkit Listrik Tenaga Surya*, Solar Power Plant) based on electric current are divided into two types: PLTS based on DC output and PLTS based on AC output (Ramadhan et al., 2016). The difference between the two is that in DC current-based PLTS, the electric current is directly stored in the battery. In contrast, in AC current-based PLTS, the electric current is directly supplied to appliances as if using electricity from the grid.

Based on the above background, the purpose of this study is to know and analyze household-scale solar power generation systems. This study will comprehensively discuss the solar system used on a household scale. This research will also discuss its operating principles, main components, factors affecting its performance, economic and environmental benefits, and challenges and opportunities for its application. By understanding these systems in depth, readers can consider or increase the use of solar energy in their homes. Therefore, the benefit of this research is that it can be a useful guide for homeowners, industry practitioners, researchers, and other stakeholders who are interested in implementing or developing solar systems on a household scale.

METHOD

The data collection method used in this paper is a literature review via the Internet. The data utilized in this paper consists of research findings from previous researchers obtained from articles in electronic databases such as Google Scholar, spanning from 2006 to 2023. The keywords used for searching these articles are "solar power plants." A total of 1 article and three websites were found and subsequently used as the primary sources for this journal.

RESULTS AND DISCUSSION

The sun is utilized as an alternative energy source to address the energy crisis that has become a pressing issue for humanity, particularly in tackling the use of fossil fuels, which has garnered significant attention from many countries worldwide since the 1970s. Besides the unlimited amount of solar energy available, its utilization does not cause pollution that could harm the environment. The solar energy potential, especially in Indonesia, is immense due to its location on the equator, which divides the Earth into northern and southern hemispheres, resulting in a tropical climate (Prasetyo, 2023). Consequently, Indonesia receives sunlight almost throughout the year across the archipelago, except during rainy seasons or heavy cloud cover.

Why should Indonesia use solar energy? The answer is simple: Indonesia is a tropical country with solar energy potential averaging daily sunshine hours of 4.5 to 4.8 kWh/m²/day (Ari Rahayuningtyas, 2014). Thus, solar energy becomes one of the potential renewable energy sources that can be further developed. Besides being easily obtainable from nature, solar energy is also environmentally friendly. In Indonesia, Solar Power Plants (PLTS) need to be developed and given attention again so that all communities can have sufficient and equitable access to electricity, even in remote areas. The implementation of Solar Power Plants (PLTS) at the household level is an effort by the Indonesian government to reduce non-renewable energy sources and equalize electricity usage in remote areas.

PLTS (*Pembangkit Listrik Tenaga Surya*, Solar Power Plant) application at the household level in Indonesia has begun to evolve. The installed solar cell capacity in Indonesia is almost five mega-watt-peak (MWp). Most of it (approximately 80%) is utilized for household lighting in remote areas, such as solar home systems (SHS), which are 50 Wp. The remainder is applied as hybrid power generation systems (PV-diesel), solar boat systems (SBS), rural public telephone power supplies, telecommunication relay station power supplies (telephone, TV, radio), DC water pump power supplies (submersible pumps), solar cell connection systems to the grid (PV-grid connection systems), etc. (Rahayuningtyas et al., 2014).

The implementation of PLTS (*Pembangkit Listrik Tenaga Surya*, Solar Power Plant) at the household level is the Solar Home System (SHS), which has been implemented in Indonesia (Wahyu et al., 2022). The Indonesian government has planned to provide 1 million Solar Home Systems with a capacity of 50 Wp for low-income communities. The Solar Home System (SHS) operation involves using solar cell modules to convert light energy into electricity, which is then converted by the inverter into AC electrical power for household appliances. The electrical power is sent to the distribution panel or MCB for household use. When the solar panels generate excess power, the inverter sends it to the battery for storage. Excess power is sent to the grid when the battery is fully charged. Suppose the solar panels generate less power than needed, for example, at night. In that case, electricity is drawn from the battery, converted, and sent to the distribution panel. Suppose the battery power is insufficient or the battery power is to be used at another time. In that case, electricity is drawn from the grid.

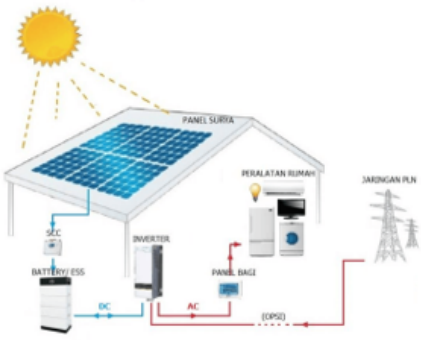

Figure 1. Solar Home System (SHS)

Solar Home System (SHS) components include solar panels, batteries, inverters for AC-DC loads, solar charge controllers, and battery lights, which are lead-acid deep discharge batteries (Mansyur, 2012). However, shallow discharge batteries (car batteries) readily available on the market can also be used. The Solar Home System (SHS) batteries must be properly maintained to ensure their longevity. One way to maintain battery condition during use is by using a Battery Charge Regulator (BCR) (Septayudha et al., 2011). This device is useful for limiting excessive electrical energy usage by the battery or limiting the charging of electrical energy to the battery by the solar cell module. Solar Home Systems (SHS) have advantages such as being installable in various locations, including remote areas lacking electricity. They can also serve as backup power when the electricity from the grid is out (Bachtiar, 2006). One of the drawbacks of the Solar Home System (SHS) is its limited battery life, which can occur due to frequent exposure to fluctuating temperatures (Eteruddin & Halilintar, 2016).

CONCLUSION

PLTS (*Pembangkit Listrik Tenaga Surya*, Solar Power Plant) are the right choice for addressing the energy crisis in Indonesia. PLTS (*Pembangkit Listrik Tenaga Surya*, Solar Power Plant) energy,

namely sunlight, is abundant. Therefore, this energy can be converted into electricity, which is then used to fulfill the electricity needs in Indonesia, especially in remote areas that still lack an electricity supply. Unlike other power plants, which may not be available in those areas, sunlight energy is always present (except during rainy seasons and nighttime). Thus, the Indonesian government should further develop it because Indonesia is located on the equator, where sunlight is available throughout the year. PLTS (*Pembangkit Listrik Tenaga Surya*, Solar Power Plant) system at the household level uses Solar Home Systems (SHS), which are increasingly being adopted in Indonesia (especially in households). This is possible because the government supports Solar Home Systems (SHS). Solar Home Systems (SHS) also have many advantages, which is why many households use them. Therefore, homeowners can meet their daily electricity needs.

REFERENCES

Ardiyanto, E. D., Rachmanto, R. A., Arifin, I. Z., Himawanto, D. A., & Widodo, P. J. (2024). *Optimalisasi Daya Fotovoltaik dengan Reflektor Ganda*. MEGA PRESS NUSANTARA.

Bachtiar, M. (2006). Prosedur perancangan sistem pembangkit listrik tenaga surya untuk perumahan (solar home system). *SMARTek*, *4*(3).

Eteruddin, H., & Halilintar, M. P. (2016). *Penggunaan Solar Home System (SHS) pada Sistem Kelistrikan di Fakultas Teknik Universitas Lancang Kuning Pekanbaru*.

Hasibuan, A., Siregar, W. V., & Sayuti, M. (2023). *Pemanfaatan Energi Angin Untuk Pembangkit Energi Listrik Di Daerah Kepulauan Menggunakan Kincir Angin Skala Kecil*. Feniks Muda Sejahtera.

Ipung, M. S. A., & Thamrin, S. (2023). Pemanfaatan pembangkit listrik tenaga surya sebagai alternatif energi masa depan. *Jurnal Pengabdian Kepada Masyarakat Nusantara*, *4*(3), 2427–2435.

Iswandi, U., & Dewata, I. (2020). *Pengelolaan Sumber Daya Alam*. Deepublish.

Mansyur, I. (2012). Studi Komparatif 2 Model Pembangkit Listrik Sistem Hibrid PLTS Dan PLN/Genset. *Prosiding Hasil Penelitian Fakultas Teknik UNHAS*, *6*.

Prasetyo, S. Y. J. (2023). *Modul Pembelajaran Matakuliah Pemodelan dan Simulasi*.

Rahayuningtyas, A., Kuala, S. I., & Apriyanto, I. F. (2014). Studi Perencanaan Sistem Pembangkit Listrik Tenaga Surya (Plts) Skala Rumah Sederhana Di Daerah Pedesaan Sebagai Pembangkit Listrik Alternatif Untuk Mendukung Program Ramah Lingkungan Dan Energi Terbarukan. *Prosiding SNaPP: Sains, Teknologi*, *4*(1), 223–230.

Ramadhan, A. I., Diniardi, E., & Mukti, S. H. (2016). Analisis desain sistem pembangkit listrik tenaga surya kapasitas 50 WP. *Jurnal Teknik*, *37*(2), 59–63.

Roza, E., & Mujirudin, M. (2019). Perancangan Pembangkit Tenaga Surya Fakultas Teknik UHAMKA. *Jurnal Kajian Teknik Elektro*, *4*(1), 16–30.

Septayudha, A., Warsito, A., & Karnoto, K. (2011). *Perancangan Inverter Jenis Push-Pull dan On/Off Battery Charger Regulator (BCR) Pada Aplikasi Fotovoltaik Sebagai Sumber Energi Untuk Pompa Air atau Penerangan*. Jurusan Teknik Elektro Fakultas Teknik Undip.

Syahwil, M., & Kadir, N. (2021). Rancang Bangun Modul Pembangkit Listrik Tenaga Surya (PLTS) Sistem Off-grid Sebagai Alat Penunjang Praktikum Di Laboratorium. *Jurnal Pengelolaan Laboratorium Pendidikan*, *3*(1), 26–35.

Tambunan, H. B. (2020). *Sistem Pembangkit Listrik Tenaga Surya*. Deepublish.

Wahyu, S., Hariansyah, S., Lestari, M. D., Nirosyanda, P. S. D., & Djundjunan, B. M. (2022). Inisiasi Usaha Mikro dalam Implementasi Pembangkit Listrik Tenaga Surya di Desa Majalaya Cianjur. *Dedikasi: Jurnal Pengabdian Kepada Masyarakat*, *1*(1), 53–62.