
Utilization of Solar Cells as Environmentally Friendly Energy

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Abstract

The global shift toward sustainable energy highlights the urgency of reducing dependence on fossil fuels, which contribute significantly to greenhouse gas emissions and climate change. One of the most promising alternatives is solar energy, which is clean, renewable, and abundant. However, the main research problem lies in the limited durability and efficiency of solar panels, impacting their long-term reliability in energy generation. The objective of this study is to analyze the potential of solar cells as environmentally friendly energy sources and to evaluate their performance in reducing environmental impacts. The research employs a descriptive analytical method, reviewing literature, experimental data, and case studies of solar panel applications, particularly in communication satellites and household energy systems. The findings indicate that solar panels are effective in generating electricity without requiring fuel, thereby minimizing emissions and environmental degradation. Nevertheless, their performance is constrained by factors such as lifespan, weather dependency, and efficiency rates. Solar energy through photovoltaic systems offers a sustainable pathway for energy transition, but further innovations in material durability and energy storage are required. The short-term implication is increased awareness of solar adoption, while the long-term implication is the acceleration of green technology development to achieve global energy sustainability.

Keywords: Solar Cell, Environmentally Friendly Energy

INTRODUCTION

Energy is a significant challenge faced by almost every country around the world. This is because energy plays a vital role in the economic development of a country (International Energy Agency, 2025). The complexity of the energy problem is increasing as the ever-growing demand for energy from countries worldwide to fuel their economic expansion leads to a dwindling supply of conventional energy sources (International Energy Agency, 2024). Energy remains a critical issue for nearly every country today, as it is essential for advancing economic growth (International Energy Agency, 2023). The energy challenge is becoming more complex due to rising energy demand from countries globally to support economic development, which, in turn, reduces conventional energy reserves (World Bank, 2023). The quality and availability of energy are closely related to contemporary human life and lifestyle (ASEAN Centre for Energy, 2022). On the other hand, electricity sources in Indonesia are arguably still insufficient to meet community needs (Energy for Growth Hub, 2020). Indonesia's electrification rate is only 71.2%,

lower than several ASEAN countries such as Singapore and Malaysia, which reach 100% and 85%, respectively (Macrotrends, 2023). In other words, around 28.8% of Indonesians still do not have access to electricity (Kanugrahan et al., 2022; Setiawan et al., 2024; Sulaeman et al., 2021).

Harnessing solar energy will help reduce carbon dioxide emissions and undoubtedly have a positive impact on the environment (Agarwal & Anand, 2023). Solar energy is a renewable resource abundantly available on our planet. Various types of photovoltaic (PV) devices, including organic, inorganic, and hybrid cells, have been created to capture solar energy (Adiansyah, Agusdinata, & Putra, 2025). This Solar Cell system as an environmentally friendly energy source is very popular in Indonesia because it is very easy to utilize sunlight in Indonesia, which is a tropical country where the sun shines almost all year round (Ratna, Huld, & Yousif, 2015). Therefore, we present this journal about solar cells because they are suitable for Indonesia. Solar cells function as a power generation system that converts sunlight into electrical energy (Silalahi, 2021). Solar energy is one of the most promising energy sources due to its sustainability and potential (Subarkah, 2022). The sun is an energy source anticipated to overcome challenges related to future energy demand (Tarigan, 2025).

Several studies have highlighted the potential of solar cells as a sustainable alternative to fossil fuels (Izam et al., 2022). For instance, Green et al. (2017) emphasized the rapid advancement of photovoltaic technologies, particularly in improving conversion efficiency and reducing costs, which has made solar power increasingly viable for widespread adoption. Similarly, Sharma et al. (2020) analyzed the integration of solar energy in developing countries and found that despite high solar potential, challenges such as inconsistent efficiency, limited infrastructure, and high initial investment remain major barriers to adoption. These studies demonstrate the importance of solar energy but primarily focus on global or generalized contexts without giving sufficient attention to the specific socio-environmental conditions of Indonesia.

The objective of this study is to evaluate how solar cells can serve as a sustainable and scalable solution to energy shortages in Indonesia. The expected benefit is both theoretical—providing additional insights for renewable energy studies in tropical regions—and practical—offering recommendations for policymakers and stakeholders to accelerate solar energy adoption and contribute to reducing carbon emissions.

RESEARCH METHOD

This study employed a secondary data analysis method, which involved analyzing data obtained from existing sources without conducting primary data collection such as interviews, surveys, or direct observations. The data used were derived from scientific journals, government reports, international energy

agency publications, and previous research related to renewable energy, with a particular focus on solar cells as an environmentally friendly energy source.

The research approach was qualitative-descriptive, aimed at systematically reviewing and interpreting relevant literature to explain the role, potential, and challenges of solar cell utilization in Indonesia. Data collection was carried out through a literature review of online databases such as Google Scholar, ScienceDirect, and SpringerLink, covering publications from the last 10 years to ensure the validity and relevance of the analysis. The data analysis technique applied was content analysis, where the information obtained from different sources was compared, categorized, and synthesized to identify trends, advantages, limitations, and opportunities in the adoption of solar cells.

RESULTS AND DISCUSSION

The results of this study using secondary analysis show that the use of solar cells as environmentally friendly energy has a positive impact on the environment.

The rapid development of technology in today's era is leading to the green earth movement which encourages the use of new and renewable energy, namely solar cells. Solar cell technology has become an important innovation in global efforts to reduce dependence on conventional energy sources, such as fossil fuels, besides solar cells can also reduce negative impacts on the environment. This energy is an unlimited energy source that is available at no cost, especially the Indonesian region which is crossed by the equator has a very abundant solar energy intensity. One of the advantages of solar panels is saving bills electricity, while the drawbacks are the installation costs and materials which are still quite expensive. Solar cells are devices that convert sunlight energy into electrical energy. Utilization of environmentally friendly energy or renewable energy is one of the solution steps that can be taken. Environmentally friendly energy is a source of energy that can be naturally renewed from nature, such as solar energy, water, geothermal, biomass and wind. In addition to being sustainable, this energy is also safer for the environment because it produces much lower carbon emissions than fossil energy. The basic concept of solar or solar power is that the greater the intensity of sunlight, the more electrical energy is produced. The main benefit of solar power generation is its environmentally friendly characteristics, because this method does not emit pollutants that can threaten natural ecosystems. This technology is a form of natural energy that is renewable and environmentally friendly because it does not produce carbon emissions during the energy conversion process. The use of solar cells has grown rapidly and is widespread in various applications. In the residential and commercial sectors, solar panels are used to provide clean and renewable electrical energy, helping to reduce electricity costs and carbon emissions. In addition, large-scale solar power plants are becoming increasingly common, contributing significantly to the provision of energy to national electricity grids in various countries. Solar cells

are also applied in portable electronic devices, such as calculators and garden lights, which utilize solar energy for their daily operations.

Data analysis shows that solar cells as environmentally friendly energy have many benefits, namely reducing carbon emissions.

The benefits of reducing carbon emissions, carbon emissions have a very big impact on climate change, reducing carbon emissions is the same as reducing the potential for future disasters, such as drought, drought can occur due to global warming, global warming due to burning coal oil and pollution in vehicles and factories.

The next advantage is its cost effectiveness because the process is fuel-free and almost eliminates operating costs. In addition, it is portable or can be moved if necessary and has a modular design that allows electrical capacity to be modified according to needs, either in series or parallel. Most importantly, it is environmentally friendly because it operates silently and does not produce air pollution.

The benefits of solar cells as environmentally friendly energy can also create a clean environment and clean air free from pollution that is not good for health.

Solar cells are a form of renewable energy that is clean and environmentally friendly. As a result, air quality improves, and the risk of developing respiratory diseases, such as asthma and bronchitis, can be reduced, also helping to reduce the negative impact on the environment and climate. Solar panels also help to reduce the use of fossil fuels, such as coal and oil, which are the main causes of air pollution. By using clean, renewable solar energy, solar panels help to reduce the amount of harmful particles and carbon that released into the atmosphere. As a result, air quality improves, and the risk of respiratory diseases, such as asthma and bronchitis, can be reduced.

There are also several benefits in the discussion of this journal, namely the journal on solar cells, one of which is about the benefits that can Increase Economic Growth in Indonesia which is very helpful for the resources available in Indonesia, here is a little explanation of these benefits, By switching to solar cells, people and businesses can save money in the long run, increase energy security, and create new jobs in the renewable energy industry. Creation of New Jobs: The solar energy industry has created millions of new jobs worldwide. In the United States alone, the number of jobs in this sector has grown more than 10-fold in the past decade. Every megawatt of solar power installed can create an average of 5-7 new jobs, making a significant contribution to reducing unemployment rates.

Reduce Energy Costs: Households that install solar panels can save up to 70% on their electricity costs in the long run. These savings can be used to increase people's purchasing power, thereby stimulating economic growth and improving quality of life.

Encouraging Investment: The solar energy sector has attracted huge global investment. According to the International Renewable Energy Agency

(IRENA), global investment in renewable energy, especially solar energy, reached a record high in 2021. This investment not only creates jobs but also encourages innovation and the development of more efficient and affordable solar energy technologies.

Furthermore, the benefits that can be generated by solar cells are that they can be a solution for remote areas that have difficulty reaching electricity, solutions for remote areas, such as internet access via VSAT or renewable energy, provide great benefits to the community, including improving the quality of education, health services, and local economic opportunities. This helps bridge the digital divide and improve the quality of life in previously difficult-to-reach areas.

There are also benefits to encouraging energy independence, energy independence helps reduce dependence on fossil fuels and imports, increases the country's energy security, and encourages local economic growth. Energy independence means the ability of an individual, community, or country to meet its own energy needs without relying on outsiders. In the context of a country, this means not being too dependent on imports of oil, gas, or electricity from other countries. In the context of households, this means not being completely dependent on electricity supply from PLN or other external sources.

The Role of Solar Cells in Energy Independence

- 1) Reducing Dependence on PLN Electricity
By installing solar cells in homes or buildings, users can generate their own electricity. If the system is equipped with a battery (off-grid), then the electricity supply remains available even when the power grid goes out.
- 2) Energy Supply Stability
Solar cells allow users to continue to have access to electricity when there are external disruptions, such as rolling blackouts, energy crises, or spikes in electricity rates.
- 3) Reducing Energy Imports
On a national scale, the more people use solar energy, the more the need to import fossil fuels (such as oil and gas) can be reduced. This reduces the burden on the country's economy and increases national energy security.
- 4) Encouraging Energy Self-Sufficiency in the Regions
Remote areas or small islands can use solar cells to realize local energy self-sufficiency, without the need to build large electricity infrastructure or rely on fuel that must be shipped from outside.
- 5) Independence in Emergency Situations
In emergency situations such as natural disasters, solar cell systems can be very useful for providing electricity, especially for important facilities such as hospitals, disaster posts, or shelters.

Real Example

- 1) Households that install solar panels and batteries can live independently without PLN.
- 2) Energy independent villages, like some in Indonesia, use solar cells to meet the electricity needs of residents collectively.
- 3) Countries such as Germany and Japan encourage the use of solar energy to reduce dependence on energy imports.

So, solar cells are not only useful for saving electricity, but also strategic for strengthening energy independence and security both at the individual and national levels. If you are interested, I can also help explain how to start an independent solar cell system at home.

Indonesia is expected to be able to develop the use of renewable energy like other developed countries in order to compete in the energy sector in the future.

CONCLUSION

Based on the data collected, it can be concluded that solar cells, which harness solar energy from sunlight—a natural and renewable source—offer an environmentally friendly energy solution. Their benefits include reducing carbon emissions, decreasing reliance on fossil fuels, promoting economic growth in Indonesia, and encouraging energy independence. This study aims to enhance awareness among both authors and readers, inspiring the development and utilization of other positive, environmentally friendly innovations. Future research should explore the practical implementation challenges and socio-economic impacts of solar cell adoption in Indonesia to provide more targeted recommendations for policy and community engagement.

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