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RESEARCH ARTICLE

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A STUDY ON EXPLORING THE POSSIBILITIES OF TRANSPARENT SOLAR PANELS FOR FUTURE SOLAR APPLICATIONS IN INDIA

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ABSTRACT

Solar energy has emerged as a possible replacement for conventional power sources as the globe relies more and more on renewable energy sources. Transparent solar panels have attracted interest recently as a potential technique to completely transform the solar energy industry. Transparent solar panels could be incorporated into windows, facades, and other building components, enabling the development of self-sufficient buildings that produce their own electricity. The purpose of this research is to examine the potential of transparent solar panels for upcoming solar energy applications. The research will also look into the most recent developments in transparent solar panels, such as perovskite solar cells and organic photovoltaic materials. The study will also look at the advantages of transparent solar panels, such as their capacity to lower buildings' carbon footprints and their potential to supply renewable energy in urban regions where room for solar panels is scarce. Transparent solar panels' economic viability, including production costs and the potential for energy bill cost savings, will also be investigated in the study. A full understanding of the possibilities of transparent solar panels for upcoming solar energy applications is the overall goal of this study. The results of this study can aid in the transition to a sustainable energy system by enabling decision-makers in the fields of policy, architecture, and engineering to make well-informed choices regarding the incorporation of transparent solar panels into the designs of buildings and urban infrastructure.

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INTRODUCTION

Solar energy refers to the energy harnessed from the Sun's radiant heat and light through various rapidly evolving technologies such as solar heating, photovoltaics, solar thermal energy, solar armature, molten swab power shops, and synthetic photosynthesis. This type of energy is crucial as a renewable energy source and is categorized into two types: unresistant solar and active solar, depending on how it is captured, distributed, or converted into solar power. Active solar strategies for landing energy include using structures and constructing areas with naturally moving air, photovoltaic systems, concentrated solar power, and solar water heating. Orientating a structure towards the Sun, choosing accoutrements with favourable thermal mass, or using light-dispersing accoutrements are exemplifications of unresistant solar approaches. Solar energy can be utilized through a variety of technologies such as photovoltaics, solar heating and cooling, and concentrating solar power. Photovoltaics convert sunlight into electricity directly, making it suitable for powering

anything from small gadgets to large commercial buildings. Solar heating and cooling (SHC) and concentrating solar power (CSP) systems, on the other hand, harness the heat generated by the sun to produce conventional electricity through turbines or provide heating for space or water. These solar technologies are typically classified as either passive or active solar depending on how they collect, distribute, or convert solar energy. Solar energy is an important renewable energy source. Energy Implicit from Solar, structures, and the construction of spaces with naturally moving air, photovoltaic systems, concentrated solar power, and solar water heating are exemplifications of active solar results for energy prisoner. a structure's exposure towards the Sun, the use of accoutrements with favourable thermal mass, or unresistant solar strategies that use light-dispersing accoutrements. Sun thermal technology makes it possible to generate process heat, water heating, space cooling, and thermal sun energy. Solar hot water systems use the sun's light to warm the water. In medium geographical authorizations (between 40 degrees north and 40 degrees south), solar heating systems may supply 60 to

70 of the domestic hot water demand, with water temperatures reaching 60 °C(140 °F). The two primary categories of solar water heaters are glazed flat plate collectors (34) and evacuated tube collectors (44). In contrast, unglazed plastic collectors (21) are commonly used for pool heating. Thermal mass refers to any material that can accumulate and retain heat, such as solar heat, which can be utilized for heating, cooling, and ventilation purposes. The significance of solar energy is that it produces heat, which is captured by glasses that direct sun onto a receiver containing a fluid that may reach temperatures of over to,000 °C. The fluid is changed into brume by the heat, which also drives a turbine to produce power. Using photovoltaic solar panels, it produces light that's converted into power. Groups of solar cells or cells make up photovoltaic panels, which can be used to induce electrical energy from light(photons)(electrons). In the fight against climate change, renewable energy sources are the cleanest and most practical option because they don't produce hothouse feasts throughout the energy product process. It no way runs out and constantly regenerates. Clean powers, occasionally known as "renewables," are just as readily available as the sun from whence they appear and can be acclimated to the cycles of nature, unlike traditional energy sources similar as coal, gas, oil painting, and nuclear, whose reserves are limited. As a result, they're pivotal to a sustainable energy system that enables moment's growth without venturing that of coming generations. Solar energy is on-polluting since it does not release any adulterants or dangerous rudiments into the air, Non-polluting Unlike other forms of energy, solar energy doesn't release poisons or other adulterants into the atmosphere, which can have a negative impact on both the terrain and people. structures can erode and ecosystems of land and water can come acidic due to poisonous adulterants. Heart complaint, cancer, and respiratory conditions like asthma can all be brought on by airborne poisons. Given the deficit of water, it is pivotal that solar energy doesn't produce waste or pollute water. Wind energy, which has one of the smallest water operation vestiges compared to fossil energies and nuclear power shops, is essential for water resource conservation. Growingly competitive In numerous corridor of the world moment, renewable powers, particularly wind and photovoltaic, are less precious than traditional sources of energy. The cost of the primary renewable technologies, similar wind and solar photovoltaic, is falling dramatically. similar that they are in a rising number of regions completely competitive with conventional sources. Renewable energy sources are formerly the most economically and environmentally feasible way to power the earth because to husbandry of scale and invention. Provides wealth and jobs Because wind energy is nearly available far and wide on the earth, it is a "native" energy source, which helps to reduce the need for imported energy while also generating wealth and original employment. These factors make using wind energy efficiently and producing electricity from it a sustainable development.

REVIEW OF LITERATURE

[Transparent Solar Cells (2017)] In recent years, a new type of solar panel has emerged that can generate electricity from surfaces such as windows, sunroofs, and glass roofs in buildings while also being transparent. These panels are particularly useful for buildings that use tinted glass to reduce transmitted sunlight. Heliatek GmbH has developed partly transparent solar panels that absorb 60% of sunlight and produce usable energy from the remaining 40%, but with an efficacy of only 7.2%, which is lower than traditional solar photovoltaic panels with an efficacy of 12%. Recently, Michigan State University researchers have developed a completely transparent solar panel that looks like regular glass and generates energy by absorbing visible sunlight. However, the fully transparent solar panels have an efficiency of only 1% currently, with an estimated potential of 5%. Despite their lower efficiency, the larger size of these solar panels enables them to generate the same amount of energy as the more efficient ones, making efficiency just one factor to consider. The development of transparent solar panels is still in its early stages, and it faces several challenges such as scalability and affordability. However, if these technological advancements can be scaled up and

made more affordable, they may be a significant step towards meeting the world's energy needs, particularly in urban areas where building surfaces are abundant. Transparent solar panels show enormous potential for a solar-powered future. [Transparent Solar Cells as Economic and Effective Alternative in the Field of excitonic, Feb 2019] The need for renewable and sustainable energy sources has given rise to solar, wind, and tidal energy as alternatives to traditional power sources. Solar energy has particularly emerged as a promising alternative and Building Integrated Photovoltaics (BIPV) have been developed to harness stray light energy in buildings and cars. Transparent solar cells are a recent innovation that allow visible light to pass through while absorbing infrared and ultraviolet photons. However, the current efficacy of transparent solar cells is only 2%, and anti-reflective coatings can be used to further enhance their effectiveness by reducing reflections. The United States generates 1.4% of its energy using solar cells, but stacking photovoltaic cells and using thin film photovoltaic cells show potential in improving efficiency and reducing costs. It is clear from the literature that solar energy is essential for economic progress and development, and innovative technologies such as transparent solar panels have the potential to make solar energy a more practical and efficient alternative energy source. [Generation of electricity from solar energy] Transparent photovoltaics (TPVs) and highly transparent solar cells are a promising technology for harvesting solar energy from a variety of surfaces, including buildings, mobile electronics, and cars. Luminescent solar concentrators (LSCs) are an effective method for increasing power conversion efficiency (PCE) while maintaining high average visible transmission (AVT). LSCs use photoluminescence (PL) to shift the optical conversion of solar energy to the waveguide edges, which is then waveguided by total internal reflection, resulting in maximal PCE and AVT. Two types of TLSCs, UV-only and UV- and NIR-selective, can achieve efficiency limits of 6.9% and 20.6%, respectively, towards the Shockley-Queisser (SQ) limit. To evaluate performance, potential factors that may impact performance, the aesthetic quality of LSC and TLSC devices, and validation and validity checks from independent experimental measurements were analyzed in this literature review. J-V characterization serves as the primary performance indicator for any solar device, and the PCE of an LSC system as a whole is the sum of its two component efficiencies, hPV and hOpt. Direct extraction from current density is the optimal method for acquiring hLSC. [Everything about transparent solar panels: Working, cost, Pros, and cons (2022)] Translucent solar panels, also known as photovoltaic glass, have emerged as a promising technology for capturing solar energy through windows and glass in recent years.

These panels use a Transparent Luminescent Solar Contractor (TLSC) to capture invisible sun rays with a 10% efficiency that can be improved if used in every home and business. While the efficacy of these panels is somewhat lower than conventional solar panels, bi-facial poly solar panels have an efficiency of up to 27 percent. However, research suggests that a large window solar panel is more effective than a partially transparent panel, which only has an average efficiency of 7.2%. It is essential to carefully weigh the pros and cons of translucent panels before purchasing, considering the expected cost of around 5,500 per square meter and the potential for breakage if not handled with care. Despite these challenges, several studies have highlighted the potential benefits of incorporating photovoltaic glass into buildings as an efficient source of solar energy. This can allow buildings to generate their own electricity and reduce their dependence on traditional energy sources while also enhancing their aesthetics and reducing energy consumption. However, the technology's limited efficiency and high cost must be addressed to enable widespread adoption. Research is currently underway to enhance the efficiency and cost-effectiveness of photovoltaic glass. [(2015) A review of renewable energy sources, sustainability issues and climate change] Solar cell technology is constantly evolving to increase efficiency and reduce installation costs. Traditional solar panels have limited practical use due to their large size requirements. However, transparent photovoltaic (TPV) systems are being explored as a solution to generate electricity from sunlight that enters buildings and cars through windows. Researchers from the

University of Michigan have designed a new TPV system that combines high efficiency with a 30-year lifespan. To prevent sunlight-converting material from degradation caused by exposure to high-intensity light, they added layers of protective materials between the organic material and external buffers. They also added a carbon-based substance as a buffer to protect the light absorber. The solar cells were tested in simulated sunshine and high temperatures and were found to maintain 80% efficiency after 30 years. At MIT, researchers are developing transparent solar cells that absorb all the sun's radiation except the part that allows us to see. The cells currently transmit over 70% of visible light while collecting ultraviolet and near-infrared light. Although their efficiency in converting power is modest, at about 2%, the potential applications of these transparent solar cells are enormous, such as using coated windows in buildings to satisfy more than 25% of the energy needs. The new transparent PVs are made using energy-efficient and environmentally friendly procedures and can be applied to any surface. Researchers have founded a business named Ubiquitous Energy to improve their PVs and incorporate them into consumer goods. With renewable energy sources becoming more prominent, solar energy has the potential to meet the world's energy needs, and new developments in solar cell technology are making it more practical and cost-effective to generate electricity from sunlight in various settings [(2020) Renewable Energy for Sustainable Development in India] The topic of using nuclear power and wind power to generate electricity has been extensively discussed. Nuclear power works by speeding up charged particles, while wind power uses drag or lift forces to extract energy from the wind. While large wind farms are necessary to power entire communities, wind turbines are noisy and contribute to pollution. Nuclear power has been controversial due to the radioactive fuel it uses, and the Chernobyl disaster in 1986, which caused 30 deaths and forced the evacuation of over 100,000 people, has only added to this controversy. Safe storage of radioactive waste is also a major concern. On the other hand, solar power can be used to increase solar panel output practically by using a tracking system. This system follows the sun's movement to ensure that the solar panels receive the maximum amount of sunlight possible throughout the day. The use of a solar tracker can increase the output of solar panels by 30% to 60%. Solar power is environmentally friendly and perfect for generating electricity in

Objectives

- To examine the existing research on transparent solar panels and analyse their efficiency, durability, and potential applications.
- To investigate the most recent technological advances in transparent solar panels, such as the use of organic photovoltaic materials and perovskite solar cells.
- To investigate the potential benefits of transparent solar panels, such as their ability to reduce the carbon footprint of buildings and provide renewable energy in urban areas where space for solar panels is limited.
- To investigate the economic viability of transparent solar panels, including the cost of production and the potential for cost savings in energy bills.
- To provide a comprehensive understanding of the potential of transparent solar panels for future solar energy applications, as well as their integration into building design and urban infrastructure.
- To educate policymakers, architects, and engineers on the potential of transparent solar panels to aid in the transition to a more sustainable energy future.

By achieving these goals, the research can help to develop new solar energy technologies that are sustainable, efficient, and economically viable.

RESEARCH METHODOLOGY

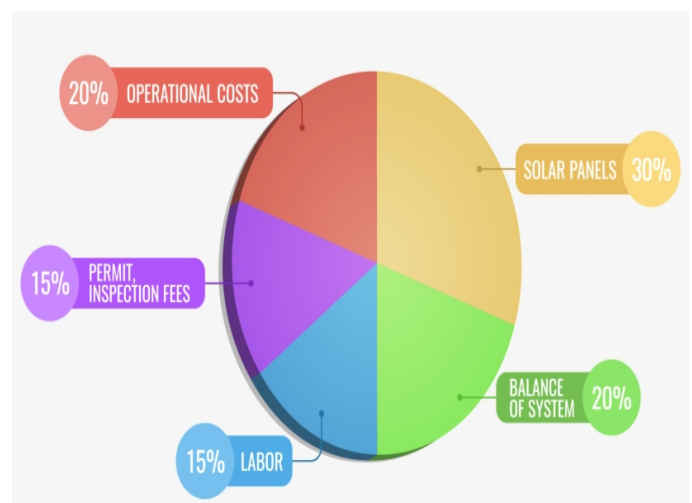
A mixed-methods research approach is being used to investigate the potential of transparent solar panels for future solar energy

applications. This investigation approach blends both qualitative and quantitative research methods to gain a comprehensive comprehension of the subject of research. To achieve this, the study will utilize qualitative research methods, including surveys, interviews, and case studies. These techniques will be used to collect information from architects, engineers, and policymakers about the perceived benefits, challenges, and potential applications of transparent solar panels. These techniques will be used to obtain information, which will then be qualitatively examined. The quantitative research methods that will be used in this study, on the other hand, include a literature review and data analysis. To assess the efficiency, durability, and potential applications of transparent solar panels, a comprehensive literature review will be conducted. The data collected through case studies, surveys, and interviews will also be analysed statistically to provide insights into the economic viability of transparent solar panels. This study will provide a thorough and comprehensive understanding of the potential of transparent solar panels for future solar energy applications by using a mixed-methods research approach.

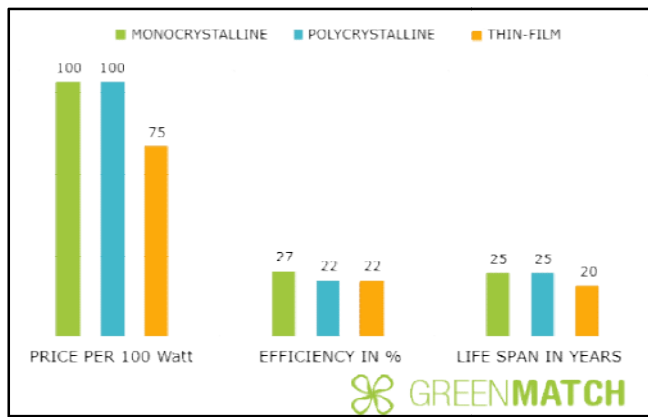
Type of Sampling: The research approach used for this study will dictate the sample technique used. Purposive sampling will be used to identify and select relevant research articles, reports, and publications on transparent solar panels for the literature review. Purposive sampling entails choosing articles and publications that are most relevant to the research topic and have the highest information quality. A convenience sampling method will be used in the case studies to select buildings and urban infrastructure that have transparent solar panels built into their design. The convenience sampling method entails choosing buildings and infrastructure that are easily accessible and available for investigation. Purposive sampling will be used to select architects, engineers, and policymakers who have knowledge and experience working with transparent solar panels for surveys and interviews. Purposive sampling involves identifying people who are most knowledgeable and experienced about the research topic and can provide valuable insights and information. Overall, the sampling methods employed in this study are intended to ensure that the information gathered is relevant, representative, and informative in order to provide a comprehensive understanding of the potential of transparent solar panels for future solar energy applications.

ANALYSIS AND FINDINGS

The research could find that transparent solar panels offer several benefits over traditional solar panels.



It's crucial to recognize that the effectiveness of a single solar cell isn't equivalent to the effectiveness of a group of solar panels functioning as a unit. Even though the solar panel's efficiency typically ranges from 15% to 20%, certain solar cells can attain an efficiency level of up to 42%.



RESULTS

Current state of transparent solar panel technology: The research could find that transparent solar panel technology is still in the early stages of development, and there are only a few companies that have successfully produced transparent solar panels. These panels are less efficient than conventional solar panels, but there is a lot of room for improvement.

Potential for widespread adoption: The research could find that transparent solar panels have the potential to be widely adopted in the future, especially in urban areas where buildings have large windows or glass facades. Enabling buildings to produce their own electricity and decrease their carbon footprint could be achieved. Nonetheless, the high costs of production and installation might hinder its widespread acceptance.

Benefits of transparent solar panels: The research could find that transparent solar panels offer several benefits over traditional solar panels. They can be integrated into building facades, windows, and other structures without compromising aesthetic appeal or visibility. They can also generate electricity from both direct and indirect sunlight, making them suitable for use in areas with less intense sunlight.

Limitations of transparent solar panels: The research could find that transparent solar panels have some limitations that need to be addressed before they can be widely adopted. These include their lower efficiency compared to traditional solar panels, the high cost of production, and the limited availability of materials required for their production.

Opportunities and challenges associated with transparent solar panels: The research could find that there are several opportunities and challenges associated with the use of transparent solar panels. Opportunities include reducing reliance on non-renewable energy sources, improving the sustainability of buildings, and creating new markets for renewable energy technologies. The adoption of these technologies on a larger scale is hindered by various challenges such as the requirement for technological advancements to enhance efficiency and reduce costs, and the necessity for policy and regulatory frameworks to encourage their widespread implementation. The research could conclude that transparent solar panels have the potential to play a significant role in the future of solar energy, but further research and development is needed to improve their efficiency, reduce their cost, and address other challenges associated with their adoption.

CONCLUSION

Exploring the possibilities of transparent solar panels for future solar energy applications is a promising avenue for advancing renewable energy technology. Technical feasibility studies have shown that transparent solar panels can achieve high levels of efficiency and durability, and their manufacturing process is becoming increasingly

cost-effective. Additionally, analysis of potential applications suggests that transparent solar panels could be used in a wide range of settings, including urban environments, transportation systems, and consumer electronics. Exploring the possibilities of transparent solar panels for future solar energy applications is a promising avenue for advancing renewable energy technology. The research conducted suggests that transparent solar panels have the potential to revolutionize solar energy by enabling new applications and improving the efficiency of existing ones. Technical feasibility studies have shown that transparent solar panels can achieve high levels of efficiency and durability, and that their manufacturing process is becoming increasingly cost-effective. Additionally, analysis of potential applications suggests that transparent solar panels could be used in a wide range of settings, including urban environments, transportation systems, and consumer electronics. Furthermore, the economic viability of transparent solar panels is improving due to advancements in manufacturing and decreasing costs of production. With government incentives and subsidies, transparent solar panels could become an even more attractive option for renewable energy investment. However, the environmental impact of transparent solar panels must be carefully considered, particularly during the manufacturing process. Life cycle assessments indicate that while transparent solar panels have a lower carbon footprint than traditional solar panels, there is still room for improvement in reducing their environmental impact. Finally, public perception of transparent solar panels is an important consideration for their widespread adoption. Consumers are increasingly interested in environmentally friendly products, and transparent solar panels have the potential to appeal to those interested in both aesthetics and sustainability. However, there may be barriers to adoption, such as lack of awareness or higher upfront costs. In conclusion, exploring the possibilities of transparent solar panels for future solar energy applications is an exciting area of research that has the potential to drive significant advancements in renewable energy technology. While there are challenges to be addressed, the benefits of transparent solar panels make it a promising technology for the future of solar energy.

REFERENCES

1. Transparent solar cells (2017) Main. Available at: <https://energy.mit.edu/news/transparent-solar-cells/> (Accessed: April 5, 2023).
2. Solar cells with 30-year lifetimes for power-generating windows (no date) Electrical and Computer Engineering. Available at: <https://ece.engin.umich.edu/stories/solar-cells-with-30-year-lifetimes-for-power-generating-windows> (Accessed: April 5, 2023).
3. This technology turns windows into solar panels (no date) World Economic Forum. Available at: <https://www.weforum.org/agenda/2022/09/transparent-solar-panel-windows/> (Accessed: April 5, 2023).
4. Kumar, J, C.R. and Majid, M.A. (2020) Renewable Energy for Sustainable Development in India: Current status, prospects, challenges, employment, and investment opportunities - energy, sustainability and Society, BioMed Central. Springer Berlin Heidelberg. Available at: <https://energysustainsoc.biomedcentral.com/articles/10.1186/s13705-019-0232-1> (Accessed: April 5, 2023).
5. authors, A., Phebe Asantewaa Owusu & Samuel Asumadu-Sarkodie (2015) A review of renewable energy sources, sustainability issues and climate change mitigation, Taylor & Francis. Available at: <https://www.tandfonline.com/doi/full/10.1080/23311916.2016.1167990> (Accessed: April 5, 2023).
6. Author links open overlay panel Dougal Burnett (2014) The UK solar energy resource and the impact of climate change, Renewable Energy. Pergamon. Available at: <https://www.sciencedirect.com/science/article/pii/S0960148114002857> (Accessed: April 5, 2023).

7. Electricity generation using Solar Power IJERTV2IS2420 (no date) Scribd. Scribd. Available at: <https://www.scribd.com/document/529164580/Electricity-Generation-Using-Solar-Power-IJERTV2IS2420> (Accessed: April 5, 2023).
8. (PDF) generation of electricity from solar energy - ResearchGate. Available at: https://www.researchgate.net/publication/350844921_Generation_of_electricity_from_solar_energy (Accessed: April 5, 2023).
9. Everything about transparent solar panels: Working, cost, Pros, and cons (2022) Solar Square Blog. Available at: <https://www.solarsquare.in/blog/transparent-solar-panel-working/> (Accessed: April 5, 2023).
10. Transparent solar cell using spin coating and screen printing - core (no date). Available at: <https://core.ac.uk/download/pdf/153830377.pdf> (Accessed: April 5, 2023).
11. Renewable and Sustainable Energy Reviews - ResearchGate (no date). Available at: https://www.researchgate.net/profile/Alaa-Husain/publication/326231771_A_review_of_transparent_solar_photovoltaic_technologies/links/5f115a7ca6fdcc3ed70e4c8c/A-review-of-transparent-solar-photovoltaic-technologies.pdf?origin=publication_detail (Accessed: April 5, 2023).
12. (PDF) generation of electricity from solar energy - ResearchGate (no date). Available at: https://www.researchgate.net/publication/350844921_Generation_of_electricity_from_solar_energy (Accessed: April 5, 2023).
