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Remedies For Electricity Crisis With The Help Of Solar Photo Voltaic Glass Windows

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ABSTRACT:

The global electricity crisis is a pressing concern, particularly in rural areas where access to reliable energy sources remains limited. This study explores the potential of solar photovoltaic (PV) glass windows as a sustainable solution to mitigate electricity shortages in these regions. Solar PV glass windows, which integrate photovoltaic technology into building materials, offer a dual advantage: providing natural light and generating renewable electricity. The study examines the technical feasibility, cost-effectiveness, and socio-environmental impact of deploying PV glass windows in rural settings. The study also examined current approaches, community awareness, government policies regarding this technology. Challenges such as affordability, awareness, and maintenance are critically analysed to identify practical solutions. This study proposes a roadmap for integrating this technology into rural energy frameworks through government policies, private sector involvement, and grassroots-level initiatives. The findings aim to inspire scalable, sustainable solutions to empower rural communities and bridge the energy gap.

KEYWORDS: *solar PV glass windows, electricity crisis, clean energy*

INTRODUCTION

The energy crisis is a growing concern that affects nearly every aspect of modern life, from economic stability to environmental sustainability. It represents the challenges faced by global society due to the increasing demand for energy and the insufficient supply of affordable, clean, and reliable energy resources. At its core, the energy crisis is driven by the world's overdependence on fossil fuels, geopolitical instabilities, technological challenges, and the slow transition to renewable energy sources. These issues create a complex web of economic, environmental, and social consequences that need urgent attention.

The electricity crisis is a complex, global issue that refers to the inability of existing systems to generate, distribute, or manage sufficient electricity to meet growing demands. This situation is becoming more critical as the world's population grows, urbanizes, and relies increasingly on energy-intensive technologies. Electricity is central to economic growth, industrial development, and daily life. However, the current systems in place, built primarily around fossil fuels, are facing significant challenges in ensuring consistent, affordable, and sustainable energy. The crisis has multifaceted causes, including over-reliance on fossil fuels, outdated infrastructure, rising demand, geopolitical tensions, and the slow transition to renewable energy sources.

The consequences of this crisis are far-reaching, affecting economies, the environment, and the social fabric of many nations. Rural areas, particularly in developing countries, often face severe electricity shortages or lack access to reliable electricity altogether.

This situation exacerbates rural poverty, hinders economic development, and perpetuates social inequalities. The electricity crisis in rural areas is primarily caused by a combination of underdeveloped infrastructure, high costs, and limited investment. Extending electricity grids to remote rural regions is often expensive due to the geographical spread and low population density, making it economically unviable for energy companies. Additionally, many rural areas rely on outdated or inadequate power generation systems, leading to frequent outages and unreliable supply. The reliance on traditional energy sources like biomass further exacerbates the issue, as these alternatives are inefficient and harmful to health.

One innovative solution to mitigate this crisis is the use of solar photovoltaic (PV) glass windows. These windows integrate solar cell technology into building materials, allowing structures to generate electricity. Solar photovoltaic glass windows are transparent or semi-transparent windows that have embedded solar cells. They function as both windows and solar panels, converting sunlight into electricity while allowing natural light to enter buildings. This technology can be applied to both residential and commercial buildings.

Solar PV glass windows are highly beneficial for rural areas facing an electricity crisis, offering a sustainable and efficient energy solution. These innovative windows, embedded with transparent solar cells, generate clean energy from sunlight while serving their primary purpose of providing natural light and ventilation. In rural regions where extending traditional power grids is often impractical and expensive, solar PV windows enable decentralized power generation, allowing households and community buildings to produce their own electricity. This localized approach enhances energy independence and reduces reliance on unreliable or polluting energy sources, such as kerosene and diesel generators.

2. REVIEW OF LITERATURE

(Deepak, Chandra Shekhar Malvi 2022) Several factors affect the performance of photovoltaic panels like latitude, longitude, tilt angle, dust accumulation, shadow, bird droppings, operating temperature, and so on; out of these parameters, dust is less acknowledged. Therefore, in this paper, the effect of the dust accumulation trend on a glass slide sample for 7 days at a geographical location, Gwalior, India, was observed. The characterizations of the dust, such as the transmittance, density, and particle size, were analysed using a UV-vis spectrometer, chemical balance, and optical microscope, respectively.

(Neelam Rathore, Narayana Lal Panwar 2021) Solar photovoltaic technology is an efficient option to generate electricity from solar energy and mitigate climate change. Although the development and growth of solar photovoltaics has had a positive impact on energy system decarbonization, but end-of-life solar panels might become toxic waste if not properly disposed of. Presently in India, approximately 200,000 tonnes of solar photovoltaic waste are expected to be produced by 2030 and 1.8 million tonnes by 2050, by which time solar waste could grow to 60 million tonnes globally. Solar waste has recently been included in the category of waste electrical and electronic equipment to restrict the negative influence of continual development. Recent advancements have been focused only on increasing the efficiency of solar photovoltaic panels without considering the impact of waste solar panels on the environment and the issue of appropriate disposal of waste panels. Effective and ecofriendly methods for recycling end-of-life waste are rarely considered. There is a need to critically investigate and manage the disposal and recycling of solar panels waste.

(Emillio Pulli 2020) Highly transparent PVs represents a valid possibility to substantially offset fossils fuel consumption worldwide. Their effective commercialization and widespread adoption require the mutual optimization of PCE and AVT. The challenge is given by the intrinsic conflict between transparency and light harvesting concepts.

(A Syafiq, A K Pandey 2018) Solar energy provides heat and electricity for useful real-life applications abundantly and free of cost. Moreover, in contrast to the non-renewable sources of energy, solar energy is environment friendly producing almost zero emission. Therefore, solar energy is considered as the most sustainable solution to energy crisis all over the world.

Although state-of-the-art technology is available for solar thermal conversion, solar electricity from photovoltaic (PV) modules still grabs the major focus due the higher grade of the harvested energy. Application of PV modules, both in standalone and grid-tied mode, is growing day by day

(Philip Sandwell 2016) Over one billion people lack access to electricity and many of them in rural areas far from existing infrastructure. Off-grid systems can provide an alternative to extending the grid network and using renewable energy, for example solar photovoltaics (PV) and battery storage, can mitigate greenhouse gas emissions from electricity that would otherwise come from fossil fuel sources.

2.1 RESEARCH GAP

First and foremost, solar PV glass windows must improve their ability to convert sunshine into electricity. Researchers ought to work on creating new materials or refining those that are already in use, such as organic photovoltaics and perovskites. The objective is to increase the efficiency of these windows without reducing their transparency. The durability and longevity of these windows provide another significant problem. Over time, the materials we currently employ might not hold up as well in inclement weather. Therefore, we must research ways to increase their stability and weather resistance. The economic viability of solar PV glass windows also represents a significant research gap.The environmental impact of these products is not thoroughly researched. The merits and downsides of solar PV glass technology for the environment from the time it is created until it is discarded need to be thoroughly examined. This entails investigating environmentally appropriate methods for recycling and disposing of it at the end of its useful life. There is also insufficient research on the social and cultural dimensions of energy use in rural areas. Rural populations often rely on traditional energy sources like firewood, and the transition to modern energy technologies can be slow due to cultural practices, lack of awareness, and trust issues. Understanding these social factors is crucial for designing energy policies that are more inclusive and tailored to rural needs.

2.2 NEED FOR THE STUDY

The urgent need for studies addressing the electricity crisis, particularly in rural areas, is underscored by the profound impact that energy access has on overall development, quality of life, and economic opportunities for millions of people worldwide. In many developing countries, rural regions suffer from inadequate energy infrastructure, resulting in unreliable electricity supplies that impede growth and exacerbate poverty. Despite global advancements in renewable energy technologies and international initiatives aimed at universal energy access, a significant portion of the rural population still relies on traditional energy sources such as firewood and kerosene, which not only contribute to environmental degradation but also pose severe health risks. This situation highlights the necessity for targeted research that delves into the unique challenges faced by rural communities, as well as the effectiveness of various interventions aimed at addressing these challenges. Solar PV glass windows offer a promising renewable energy solution that can help decentralize energy generation and reduce the strain on existing power grids, addressing electricity supply shortages that hinder economic development in many regions. In many rural communities, women bear the brunt of energy poverty, often spending hours collecting firewood or dealing with the negative health effects of indoor air pollution from traditional cooking methods. Investigating the gendered impacts of energy access and how renewable solutions can empower women—by saving time, improving health outcomes, and enhancing economic opportunities—is vital for promoting equity in energy transitions. To sum up, this research is essential for resolving the electricity issue, encouraging environmental sustainability, and stimulating economic and technological innovation—all of which will contribute to a more resilient and sustainable energy future.

2.3 PROBLEM STATEMENT

The traditional sources of electricity, such as fossil fuels, are growing more and more inadequate and environmentally unsustainable as the world's energy demands continue to rise. Due to carbon emissions, this scenario has resulted in regular blackouts of electricity, rising expenses, and serious environmental effects. Innovative and long-lasting solutions are urgently needed to successfully handle the electrical crisis in spite of these difficulties. Solar photovoltaic (PV) glass windows present a promising technology that integrates solar energy generation directly into building materials. These windows can potentially reduce reliance on traditional power sources, decrease electricity bills, and contribute to a cleaner environment.

2.4 OBJECTIVES OF THE STUDY

PRIMARY OBJECTIVE:

A study on remedies for electricity crisis with the help of solar voltaic glass windows.

SECONDARY OBJECTIVES:

To assess where the technology of solar voltaic glass windows lies at present, to consider the effectiveness, productivity, and usability aspects of the current offerings.

To identify the technical limitations and constraints that are obstructing the widespread adoption.

To investigate user acceptance, concerns and to access the willingness of users to adopt solar glass windows.

To examine the current state of the guidelines for the installation of solar-powered glass windows through the enacted laws, policies and incentives.

To analyse how reducing reliance on coal, wood, and other non-renewable energy sources might help villages mitigate environmental degradation.

3) RESEARCH METHODOLOGY

3.1 RESEARCH DESIGN

A mixed-method approach will be utilized for the research design of the research project on solar photovoltaic (PV) glass windows as a solution for the electricity problem, with an emphasis on the rural regions. This design will combine quantitative and qualitative methodologies in order to gain a clearer understanding of the potential drawbacks, difficulties, and benefits of the technology. A descriptive Research Design is adopted in this study for the reason being it is concerned with exploring the characteristics of a specific group of individuals i.e. General Public.

3.2 DATA SOURCES

Primary and secondary types can be distinguished amid a variety of data sources. Primary data have been collected from general public from well-structured and validated questionnaire by the researcher. Secondary data is looked at from the extremely trustworthy sources, which include, papers and journal articles, scientific and technical literature, in order to study the issue of solar photovoltaic glass and consider potential avenues for further research.

3.3 SAMPLE DESIGN

A convenient sampling method on equal allocation is adopted in this study. Total sample size of 50 is equally allotted for the respondents in different locations.

3.4 TOOLS & TECHNIQUES

Collected data are processed through SPSS (Statistical Package for Social Sciences). Statistical Tools such as Frequency Distributions, Percentage analysis, Descriptive statistics such as Mean, Standard Deviation, Analysis of Variance (ANOVA), Multiple Regression, Correlation have been be applied in the analysis of the data for drawing the inferences and conclusions in the study.

3.4 LIMITATIONS

The researcher conducted study only in Karnataka region and since the study is focused in this this specific geographical area, results cannot be generalized to other individuals from another area. The study relies more on the perception of the respondents which may change from time to time. This research study covers only the limited number of factors only.

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DATA ANALYSIS & INTERPRETATIONS

Respondents view on Solar Photo voltaic glass windows in reducing energy crisis and enhancing energy efficiency?

FACTORS	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Energy efficiency	16	35	1	0	0
Energy independence	24	12	2	1	0
Mandatory standard in building construction	8	9	8	1	0
Energy burden	18	33	7	1	0
Efficiency of solar photo voltaic glass	9	4	1	0	0
Economic development	5	5	3	1	0
Invest in solar photo voltaic glass	6	7	1	0	0
Envision the role of solar photo voltaic glass	3	9	1	1	0

ANOVA SINGLE FACTOR

Groups	*Count*	*Sum*	*Average*	*Variance*
Strongly Agree	8	89	11.125	54.41071
Agree	8	114	14.25	155.0714
Neutral	8	24	3	8.285714
Disagree	8	5	0.625	0.267857
Strongly Disagree	8	0	0	0

Source of Variation	*SS*	*df*	*MS*	*F(s)*	*P-value*	*F crit*
Between Groups	1344.15	4	336.0375	7.70602	0.000146	2.641465
Within Groups	1526.25	35	43.60714			
Total	2870.4	39				

INTERPRETATION

F(s) value is 7.70602 and F(crit) value is 2.641465

Since my F(s) value is greater than F(crit), there is significance between the mean of my 8 groups.

My P value is 0.000146.

My P value is less than 0.05

NULL HYPOTHESIS: There is no difference in the mean of 8 groups

ALTERNATE HYPOTHESIS: There is difference in the mean of 8 groups

ANOVA: TWO FACTORS WITHOUT REPLICATION

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
16	4	36	9	300.6667
24	4	15	3.75	30.91667
8	4	18	4.5	21.66667
18	4	41	10.25	239.5833
9	4	5	1.25	3.583333
5	4	9	2.25	4.916667

6	4	8	2	11.33333
3	4	11	2.75	17.58333
Strongly Agree	8	14	6	13.788
Agree	8	114	14.25	155.0714
Neutral	8	24	3	8.285714
Disagree	8	5	0.625	0.267857
Strongly Disagree	8	0	0	0

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	14.98519	14.98519	11.784466	0.041451642
Residual	3	3.814815	1.271605		
Total	4	18.8			

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	315.2188	7	45.03125	1.13913	0.377129	2.487578
Columns	1060.594	3	353.5313	8.943083	0.000517	3.072467
Error	830.1563	21	39.53125			
Total	2205.969	31				

INTERPRETATION

My P value is 0.377129.

My p value is greater than 0.05

There is no significance in accepting the null hypothesis and rejecting the alternative hypothesis

NULL HYPOTHESIS: There is no difference between the mean of my 8 groups

ALTERNATIVE HYPOTHESIS: There is difference between the mean of my 8 groups.

Respondents view on biggest barrier for adapting solar Photo Voltaic glass windows?

OCCUPATION	Number of respondents	Barrier as technological limitations
Student	30	5
Professionals	12	0
Entrepreneurs	0	0
Retired government official	1	0
Others	16	1

CORRELATION

	Number of respondents	*Technological limitation barrier*
Number of respondents	1	0.892796
Technological limitation barrier	0.892796	1

REGRESSION

Regression Statistics	

Multiple R	0.89279579
R Square	0.79708432
Adjusted R Square	0.72944576
Standard Error	1.12765462
Observations	5

	Educational qualification	High installation cost
Educational qualification	1	0.770053
High installation cost	0.770053	1

INTERPRETATION

My p value is 0.04145

My p value is slightly lesser than 0.05.

This suggest that there is statistically significant difference in data

My R value is 0.79

Since my R value is positive, it shows there is positive relationship between two variables.

(Respondents view on biggest challenge foreseen in the installation and maintenance of solar Photo Voltaic glass windows)

Educational Qualification	Number of respondents	High initial cost as challenge
Below HSC	5	1
Under Graduate	22	5
Post Graduate	30	3
PhD holders and others	2	1

REGRESSION

Regression Statistics	
Multiple R	0.770053
R Square	0.592982
Adjusted R Square	0.389473
Standard Error	1.496195
Observations	4

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6.522801	6.522801	2.913786	0.22994684
Residual	2	4.477199	2.2386		
Total	3	11			

INTERPRETATION

My p value is 0.77

My p value is higher than 0.05, which shows no significance between variables

R value is 0.59

The relationship between two variables is positive

FINDINGS, SUGGESTIONS & CONCLUSION

5.1 FINDINGS:

The findings of the study on solar photovoltaic (PV) glass windows as a solution to the electricity crisis in rural areas present a compelling case for the adoption of this innovative technology. This study reveals that solar PV glass windows significantly enhance electricity access in regions where traditional power infrastructure is either limited or non-existent. Many rural areas suffer from intermittent power supply or complete reliance on costly diesel generators, which can impose a heavy financial burden on families.

Many respondents are majorly was not aware about solar PV glass windows and how it can improve their lives. Many respondents choose lack of awareness as one of the biggest barriers in implementing this technology.

One of the most significant advantages identified in the study is the dual functionality of solar PV glass windows. These windows serve as both building materials and energy generators, maximizing the use of available space. This aspect is particularly beneficial in rural areas where land may be scarce.

Even though respondents have limited knowledge about this technology, they knew that this technology will enhance the efficiency of their buildings and helps in sustainability. Half of my respondents even pointed out that they highly think, this type of technology should be mandatory in newly constructed buildings.

The study also emphasizes the positive socio-economic impacts of implementing solar PV glass technology in rural settings. The transition to solar energy has stimulated local economies by creating jobs in various sectors, including manufacturing, installation, and maintenance.

Finally, the findings underscore the importance of continuous research and innovation in solar PV technology to maximize its benefits for rural areas. Ongoing advancements in efficiency, storage, and integration with other renewable sources can further enhance the viability and attractiveness of solar PV glass windows as an energy solution.

5.2 SUGGESTIONS:

Launch comprehensive awareness campaigns aimed at educating rural communities about the advantages of solar PV glass windows. These campaigns should highlight not only the immediate benefits, such as energy savings and reduced electricity bills, but also long-term benefits, including sustainability and improved quality of life.

Implement localized training programs that empower community members with the skills necessary to install, maintain, and repair solar PV glass systems. By training local technicians, communities can create job opportunities and build a sustainable workforce capable of supporting the technology.

Collaborate with non-governmental organizations (NGOs) that have experience in renewable energy projects and community development. NGOs can provide valuable resources, technical expertise, and outreach capabilities to help implement solar PV glass projects effectively.

Explore the establishment of microgrids powered by solar PV glass windows in rural areas. Microgrids can operate independently from the central grid, providing reliable electricity even in remote locations.

Encourage the formation of energy co-operatives within rural communities, where residents collectively invest in and manage solar energy systems. This model fosters a sense of ownership and accountability, as community members share the benefits and responsibilities of the solar projects.

5.3 CONCLUSION:

The exploration of solar photovoltaic (PV) glass windows as a viable solution to the electricity crisis in rural areas has revealed a transformative potential that extends beyond mere energy generation. As rural communities grapple with the challenges of energy poverty, intermittent power supply, and reliance on costly fossil fuels, the integration of solar PV glass technology emerges as a beacon of hope. By converting existing infrastructure into energy-generating assets, communities can optimize their resources while enhancing their energy independence. The ability to generate electricity locally empowers households, providing them with a reliable power supply that reduces dependence on external energy sources. The economic implications of adopting solar PV glass technology are profound. By reducing energy costs, families can allocate their financial resources more effectively, improving their overall quality of life. Furthermore, the implementation of solar PV glass projects stimulates local economies by creating jobs in installation, maintenance, and manufacturing.

The environmental benefits of solar PV glass windows are equally significant. By transitioning to renewable energy sources, rural communities can reduce their carbon footprint and contribute to global efforts to combat climate change. This shift not only protects local ecosystems but also enhances the resilience of communities against the adverse effects of climate change. As rural populations become more attuned to sustainable practices, they can play a vital role in preserving the environment for future generations.

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