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Study of Solar Photovoltaic Systems to Improve Energy Efficiency for Chennai Flats

S. Binil Sundar[1], Vinayak Dave[2]
[1,2]*Asst Professor (SG), Civil Engineering Department*
Saveetha School of Engineering, Saveetha University, Chennai, India

Abstract--Energy plays an important role in our daily life as well as in the national security of a country. It also runs as the wheel of economy of the country. The recent increase in energy prices, population and industrialization are the most significant threats to energy security. The energy demand is increasing day by day with population growth indicating poor utilization of energy. But Tamilnadu is blessed by plenty of renewable energy possibilities which can be used to eliminate energy scarcity problem and to get a sustainable economic growth. This research focuses mainly on solar energy as a sustainable and renewable choice of technology for the Chennai apartments. Since Chennai has better potential in solar power. In this research different types of apartments were taken into consideration in Chennai for analysis of power consumption and based upon the requirements, various solar PV are compared to support and generate power. A detailed analysis on cost management, payback assessment and carbon footprints have been done based on the data's collected from various Project officers, electrical consultant engineer's and Project manager of different organizations in Chennai. The results show that up to 60% of electricity bill can be saved by using solar panels in apartments. Among various solar panels, mono crystalline solar panel is found to be effective. Though the cost of solar panels are more it can generate better income when the plant is located on suitable site and fast term on payback time.

Keywords: Carbon savings, Cost management, Energy security, Payback period, Renewable Energy Technology, Solar Energy

I. INTRODUCTION

A. Background

Energy is critical, directly or indirectly, in the entire process of evolution, growth and survival of all living beings and it plays a vital role in the socio-economic development and human welfare of a country. India faces a significant challenge in providing access to adequate, affordable and clean sources of energy, the demand and supply imbalance in energy sources is pervasive requiring serious efforts by GOI to augment energy supplies. India imports about 80% of its oil and India was the world's fifth largest net importer of oil. There is a threat of these increasing further, creating serious problems for India's future energy security. There is also a significant risk of lesser thermal capacity being installed on account of lack of indigenous coal in the coming years because of both production and logistic constraints, and increased dependence on imported coal. Significant accretion of gas reserves and production in recent years is likely to mitigate power needs only to a limited extent. Difficulties of large hydro are increasing and nuclear power is also beset with problems. The country thus faces possible severe energy supply constraints.

B. Geography, Location and Climate of Tamil Nadu State

Tamil Nadu is located in the Northern hemisphere in the hot zone between 80 and 13' N latitude and between 780 and 800 E longitude. It is bounded on the east by the Bay of Bengal, in the south by the Indian Ocean, in the west by the states of Kerala and Karnataka and in the north by Karnataka and Andhra Pradesh.. The Western Ghats and the Eastern Ghats meet in the Nilgiris of Tamil Nadu. Rich varieties of flora and fauna are available in the geographical area of Tamil Nadu.. The climate is basically tropical. The state experiences south west and north east monsoon. Average annual rainfall is 925 mm. Chennai is very close to the equator, there is small fluctuation in seasonal temperature. The temperature rises to 40'C during the summer months but the average temperature in the winters revolves around 24'C. In Chennai monsoon rains from June to September.

C. Types of Solar Panel

Mono crystalline Poly crystalline thin film

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Fig 1.1 Mono crystalline



Fig 1.2 Poly crystalline



Fig 1.3 Thin film

D. Aim

The aim of the research is to develop solar energy as a sustainable and renewable choice of technology for Chennai apartments.

E. Objectives

To obtain continuous power supply for apartment.
To determine the payback period of solar energy.
To reduce the level of carbon emission and carbon foot print
To support demand and supply gap for apartments in power shortage

F. Need and Scope of the Project

The project will show the way to meet the power demand by utilizing power from solar PV.
Project will bring cost efficiency for apartment owners. Carbon emission will be reduced.

II. LITERATURE REVIEW

A. Literature

Qiankun Wang and Qian Huang (2011) describes that the purpose of this work is to integrate the application of solar system and geothermal energy is to complement each other perfectly and to fully utilize renewable resources for low-carbon and energy saving ideas. In this paper, the application of the composite energy system in the engineering design of a project in Wuhan which belongs to hot summer and cold winter area will be evaluated in such aspects, including technical feasibility, system efficiency, economic and environmental impacts, in order to provide technical and practical experience for the design and application of integrated energy systems in the future.

Andre Stephana, *et al* (2011) describes that buildings consume around 40% of the final energy in most countries but are also responsible for a large part of the energy use in the industrial and transport sectors. Today, most policies and market trends focus solely on the space heating and cooling demands often neglecting to consider indirect energy requirements such as the embodied energy of buildings or the transport energy of their users. This paper assesses different building scenarios located in two urban contexts by integrating the operational energy demand as well as the embodied energy of the dwellings and the transport energy consumption of the users. Results show that space heating represents at most 23% of the total life cycle energy demand over 50

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years and 47% if the rest of operational energies, i.e. domestic hot water and appliances, is considered. Transport consumes 34-51 % of the total life cycle energy consumption while the embodied energy of buildings was found to be of the same order of magnitude as their operational energy. Current energy assessment of buildings therefore often only analyses a small fraction of the total life cycle energy use. We should widen its scope to account for so-called indirect energy consumption. This paper shows that a more holistic approach to the assessment of the energy demand associated with buildings is necessary if significant improvements in their energy efficiency are to be achieved.

III. RESEARCH METHODOLOGY

A. Research Method

Detailed research done in collection of data's and analysis are made, aim to identified and finding the potentials and development in solar energy for housing sector of Chennai. It constitutes of collections of solar energy report from various government and private sectors. In this research data have been collected based on the followings methods:

Sampling and Data collection
Seasonal variations and measures solar energy tech
Cost management
Payback assessment Carbon emission

1) Seasonal Variations And Measures: In this study two different seasons are taken into account, summer and winter. For this two seasons power consumption details will be collect for different housing sectors and then suitable measures will be taken.

2) Solar Technology: Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. In this study photovoltaic panels are taken for assessment.

3) Cost Management: Cost management is the process of planning and controlling the budget of a business. Cost management is a form of management accounting that allows a business to predict impending expenditures to help reduce the chance of going over budget. In this study cost detail for different solar panels are going to be analyzed.

4) Payback Assessment: The length of time required to recover the cost of investment. In this study payback period for different solar panel are going to be calculated.

5) Carbon Emission: A carbon footprint is the measure of the environmental impact of a particular individual or organization's lifestyle or operation, measured in units of carbon dioxide. In this study carbon saving will be calculated.

B. Approaches to Analysis

First, the data collected from the various respondents was analyzed for various questions such as the type of Renewable technologies used by builder for constructing Renewable units, the most suitable Solar technology, the level of success of technologies, the effectiveness of technologies in achieving less carbon emission, the barriers in adopting these technologies, the success of these technologies for housing sector, and the growth rate of these technologies in the past ten years. Next analyzed the data collected from the State electricity board such as the requirement of power for various utilities in the home during summer and winter.

C. Research Questions

The questions were designed based on objectives and the literature review. The questions were drafted carefully and reviewed with the author's tutor. The questionnaire is presented in Appendix 1.

IV. RESEARCH ANALYSIS

A. Background of Study Area

Medavakkam is one among the southern suburbs of Chennai. It is a residential locality close to the Chennai Airport. It is located at 12.917158°N - 80.19287°E

Pallikaranai is a fast growing residential area in South Chennai a metropolitan city in Tamil Nadu, India. It is located at 12.9377°N - 80.2153°E

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Vanagaram is a residential neighborhood in the outskirts of Chennai, India. It is in North-East of Chennai and the fastest developing parts of the city. It is located at 13°3′12″N - 80°9′40″E

B. Sampling Data Using SPSS

SPSS (Statistical Product and Service Solutions) Statistics is a software package used for statistical analysis. SPSS provides facilities for analyzing and displaying information using a variety of techniques. This document uses version 20 of SPSS for Windows 7. Here are a few things that will be included in "The basics of Statistics" section.

Mean, variance, Standard deviation, descriptive statistics One sample Statistics

Produce bar charts

Paired sample correlations

C. SPSS Window Process

The SPSS window can be viewed in two different windows. They are data view and variable view.

1) Variable View: Variable View contains descriptions of the attributes of each variable in the data file. In Variable View:

Rows are variables.

Columns are variable attributes.

All of these attributes are saved when you save the data file.

D. Graph

The data may be broken down further with tables, which shown the joint distribution of two variables values as graphs.

1) Pie Chart Results

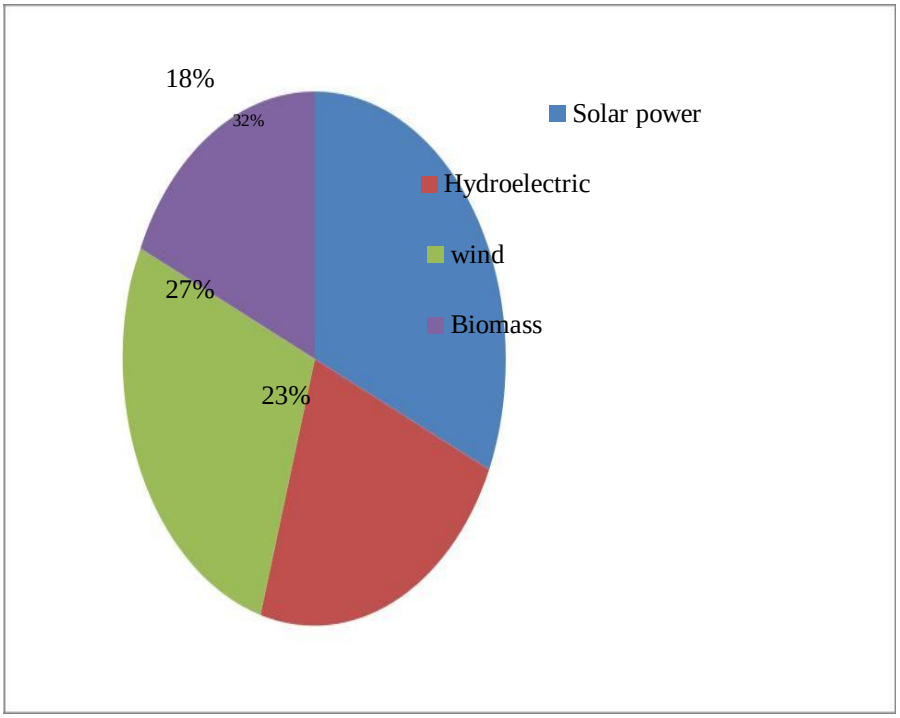


Fig 4.1 Factors relating to Renewable Energy

The pie chart is drawn to find the main key factors in this set of questionnaire and using this main key factors analyze is done. Figure (4 . 1) represent that 32% of respondents are choosen that solar energy is better renewable energy .

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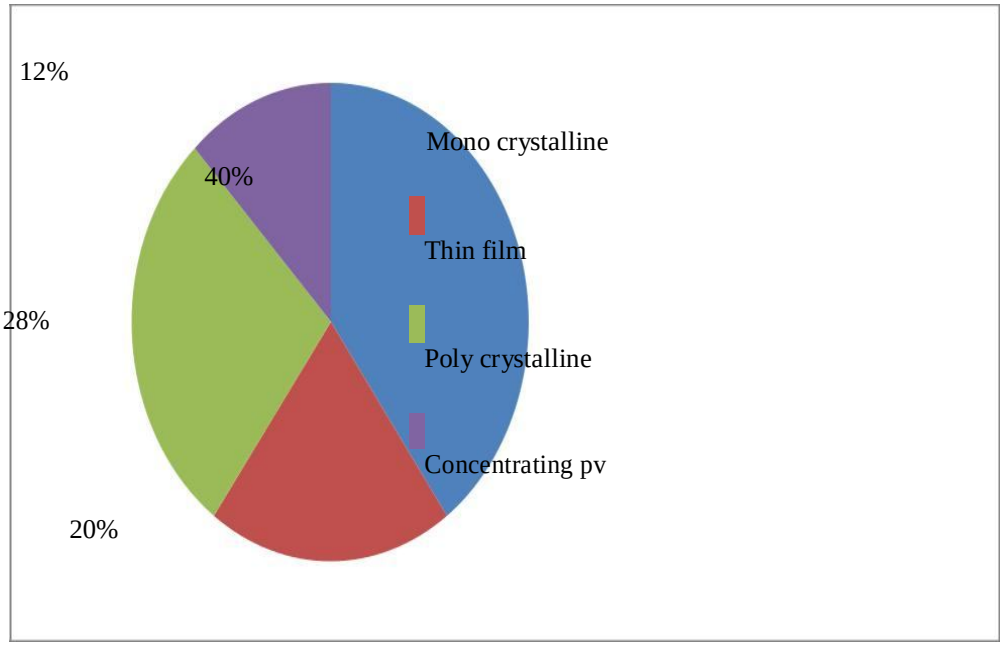


Fig 4.2 Factors relating to Solar Energy

The pie chart is drawn to find the main key factors in this set of questionnaire and using this main key factors analyze is done.

Table 4.1 power consumption detail for independent house (Vanagaram, Chennai)

S.No	House	Month	EB Units	Cost / unit	Cost	Average per season
1	H 1	April	720	5.75	3105	Summer
		May	760	5.75	3335	1480
		November	540	5.75	2070	Winter
		December	520	5.75	1955	1060

Comparison of Power Usage in Apartments, Chennai

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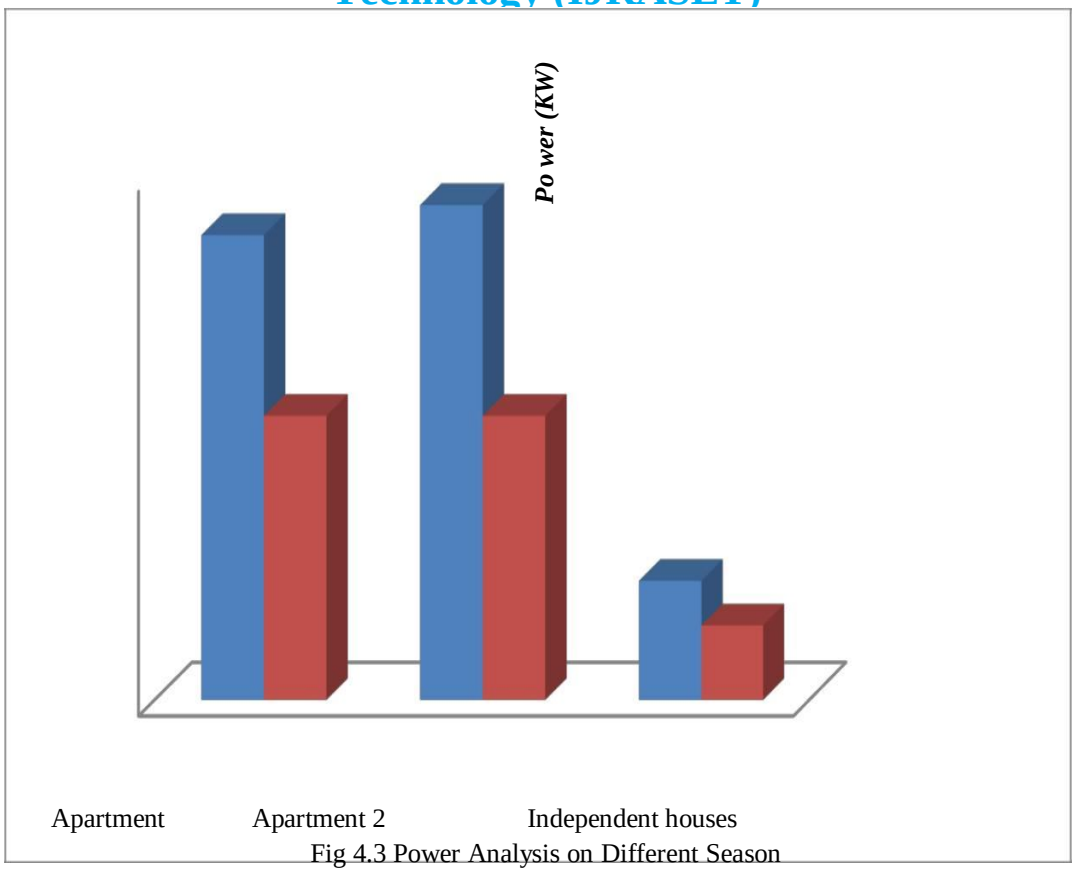


Fig 4.3 Power Analysis on Different Season

Figure (4.3) shows the power analysis detail for different seasons. In that figure we can find out that in summer season usage of power is more when compare to winter. Tables (4.1) and figure (4.3) show the requirement of power for various types of houses during summer and winter. Among various types of houses the requirement of power during summer for Apartment no.2 is 6.6 KW which is higher than all other types of houses. Similarly during winter season the requirement of power for that Apartment is 3.8 KW which is higher than other types. The analysis on requirement of power for house helps both the consumer who are the owners of the house and the builders who develop the renewable unit. This information helps the builders to design and develop a suitable Renewable unit with a capacity more than that of the requirement of power for the houses. Similarly it helps the consumers to decide the type of solar unit to buy and install in their house.

E. Comparison Of Cost For Different Types Of Solar Panels For Various Houses

1) Annual Climate Graph Of Chennai:

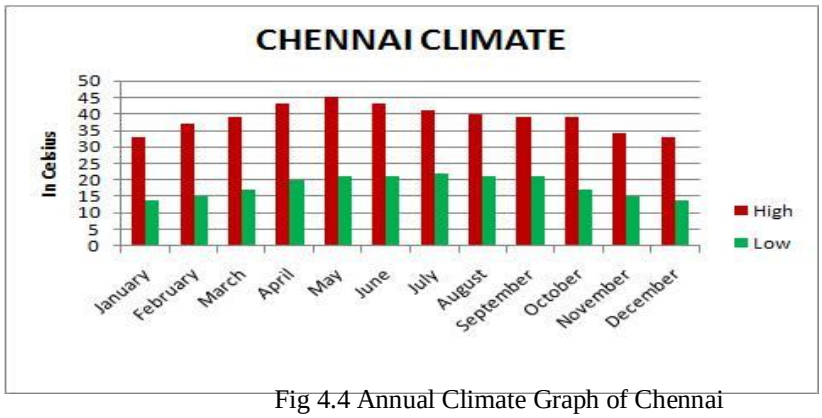


Fig 4.4 Annual Climate Graph of Chennai

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Figure (4.4) shows the gradual increase of temperature. The highest temperature i s occurs in April and May , which is the months where we can reach the maximum level of output in solar panels. During this period we can save lots of energy.

F. Payback Assessment Of Various Houses

The payback period represents the time it takes the investment to be paid back. The payback period method is commonly used by companies to evaluate investments: the goal is to choose a project that will recover the investment in the shortest time. When the payback period is shorter than the cutoff period, the investment can be accepted. When the payback period is longer than the cutoff period, the investment cannot be accepted in accordance with the payback period method.

Table 4.2 Payback Assessments for Thin Film Solar Panel

Type of Houses	Plant Output Required (Kw)	Total Plant Output (Kw)	Power Consumed By Each House Each Year	Annual Savings Cost	Capital Cost (In Lakhs)	Payback Period (In Years)
H1	6.3	4600	6.2	26,450	6,20,000	24
H2	6.7	5760	6.6	33,120	6,40,000	20
H3	1.5	820	1.4	4,715	1,20,000	26

Tables (4.2) show the assessment of various houses are done with reference to the payback period (Appendix 2), which can be interpreted with different analysis on required output on solar panel, average power consumptions in kW, annual savings; capital cost varies with increase in power required and according to the available space.

G. Result Of Solar Panel Payback

Mono crystalline solar panel: a 6KW mono crystalline solar panel, in an exposed, sun shade area, recent monitoring of a range of small domestic solar systems has shown that a well sited 6 kW could generate around 8,000 kWh per year which is equivalent to around 5.0 tonnes of carbon dioxide a year. A system this size could generate income and savings of around 45,000 a year when eligible for the feed in tariff. A modern solar panel can be incorporated with aerospace technologies with sophisticated, yet simple, designs that allow them to operate reliably for up to a decade or longer without maintenance. These systems can operate for extended periods without attention; it typically require inspection only every two years during their 30 to 40 year design life. The solar energy technologies are very competitive with other renewable energy technologies that are suitable for homes, farms, and small businesses.

H. Carbon Footprint

A carbon footprint is the measure of the environmental impact of a particular individual or organization's lifestyle or operation, measured in units of carbon dioxide.

1) Carbon Emission Assessment For Energy Technology: Table 4.3 represents the carbon emission detail of different solar panels,

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table contains electricity generated from solar panel detail and amount of carbon emission saved.

Table 4.3 Carbon Emission Analyze for Mono Crystalline Solar Panel

Type Of Houses	H1	H2	H3
Power Required In Each System	6.3	6.7	1.5
Electricity Generated From Solar Panel	7200	9000	1600
Carbon Emission (Tones)	6.048	7.560	1.344

V. PAYBACK PERIOD AND COST MANAGEMENT

The solar energy has been analyzed in this report with various key facts in terms of Life time energy, carbon and cost savings for which they are described as follows from the pay back calculation shown in (Appendix 2). Payback period is the length of time required to recover the cost of an investment. The payback period of a given investment or project is an important determinant of whether to undertake the position or project, as longer payback periods are typically not desirable for investment.

Table 5.1 Payback Periods and Cost Management for Mono

Crystalline Solar Panel

Types Of house	Electricity Generated from solar panel per year	Carbon Saving (Tones)	Electricity Saved @ 5.75/kWh Per year	Typical cost & installation(lakhs)	Cost effectiveness of solar panel (years)	Life time Of solar Panel (years)
H_1	7200	5.292	40,365	7,65,000	19	40
H_2	9000	5.628	50,715	7,95,000	16	40

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H_3	1600	1.260	8,165	1,60,000	20	40

Table 5.2 Payback Periods and Cost Management for Poly Crystalline Solar Panel

Types Of house	Electricity Generated from solar panel per year	Carbon Saving (Tones)	Electricity Saved @ 5.75/kWh Per year	Typical cost & installation (lakhs)	Cost effectiveness of solar panel (years)	Life time Of solar Panel (years)
H_1	5400	4.536	31050	660000	22	40
H_2	7200	6.048	41400	680000	17	40
$^{H}3$	1080	0.907	6210	140000	23	40

Table 5.3 Payback Period and Cost Management for Thin Film Solar Panel

Types Of house	Electricity Generated from solar panel per year	Carbon Saving (Tones)	Electricity Saved @ 5.75/kWh Per year	Typical cost & installation (lakhs)	Cost effectiveness of solar panel (years)	Life time Of solar Panel **(years)**
H_1	4600	3.864	26450	640000	24	40
H_2	5760	4.386	33120	620000	20	40

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H_3	820	0.689	4715	120000	26	40

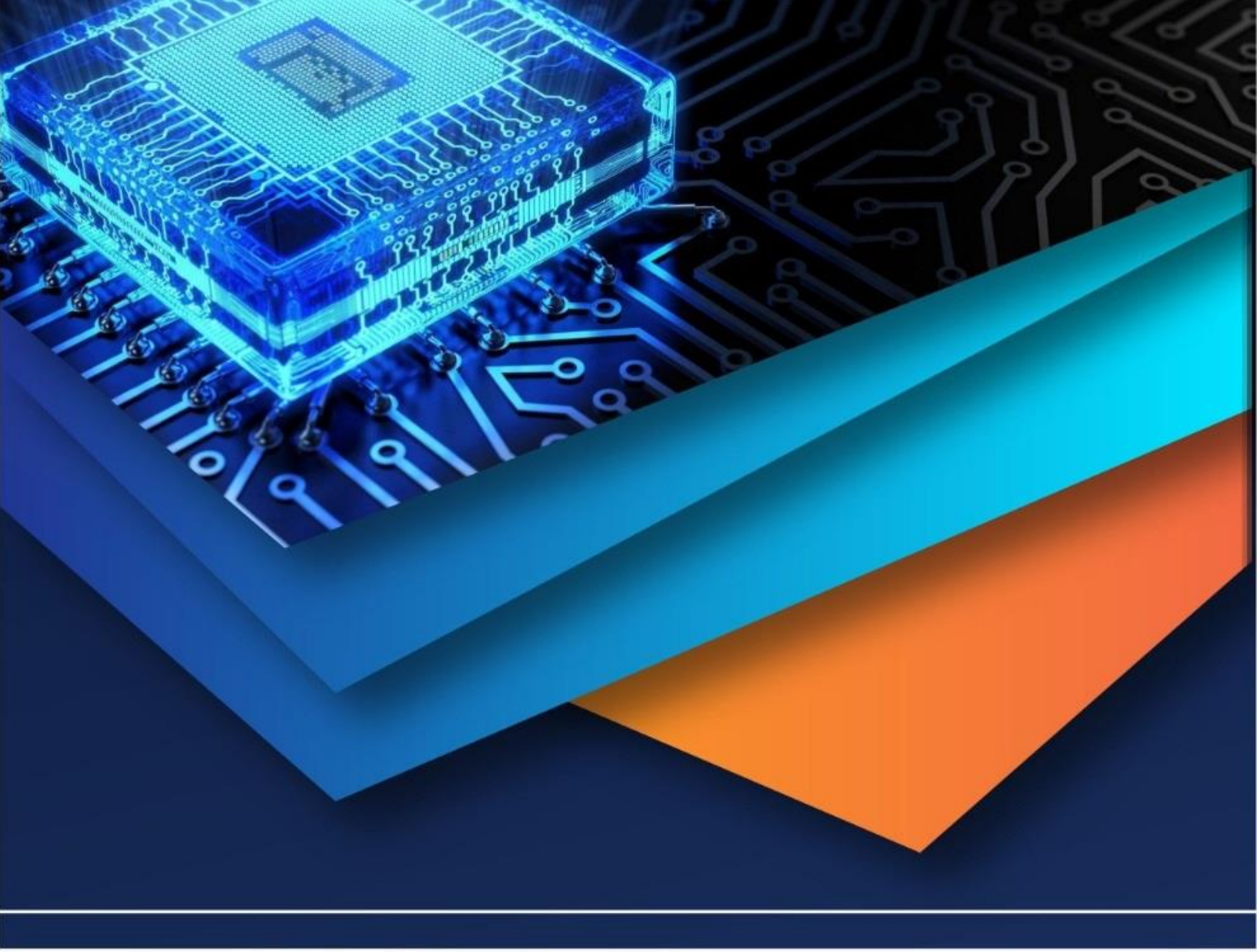
VI. CONCLUSIONS

Among various renewable energy resources, solar energy is found to be more promising and defective.
By using solar panels in our homes we can nearly save 60% of the total electricity bill.
By analyzing various solar panels, mono crystalline type of solar panel found to be more efficient.
The seasonal variations may give different output for different houses based on the solar panel capacity.
Though the cost of solar panel is more compare to other renewable technologies, but it can generate better income when the plant is located on suitable site and fast term on payback time.

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