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Solar Energy and its Applications-Need, Overview and Future Scope

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Abstract: ***The demand for energy is growing day by day in the whole world. After the oil crisis in 1973, the world have to think about the alternative resource of energy apart from conventional energy resources (coal, gas and petroleum etc.). Solar energy is the most important alternative resource of the world and has a large potential to fulfill the increasing energy demand. India is very lucky as the solar radiation is available throughout the country with large amount. To promote the renewable energy, government of India launching many schemes for the renewable energy resources. Jawaharlal Nehru National Solar Mission (JNNSM) is one among them launched on 11th January 2010, under National Action Plan on Climate Change (NAPCC–2008). This paper provides an overview on solar energy in India. It reviews the current status of solar energy in terms of existing capacity, along with historical trends of solar energy. The paper also focuses on the different application area. Also it takes overview of the technical and economic barriers and challenges for development and utilization of solar energy technology. Finally, a review based on of overview of the solar energy and its different applications.***

Keywords: oil crisis, renewable energy, solar energy, solar radiation

I. NEED

Use of conventional energy sources for power production, transportation and power producing devices demands huge amount petroleum products such as Petrol, Diesel etc. This may cause pollution, global warming, climate change and human health problems. Developing countries like India needs energy for its continuous development, as energy is the backbone of GDP. Natural resources like coal, oil and natural resources are limited and may not be available for long run. To maintain sustainable development, Worlds need the sources of energy which can satisfy this increased demand as well as there should not be any environmental issues.

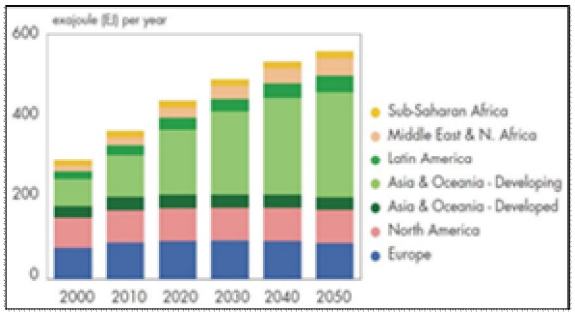


Fig.1. Increase in worldwide energy demand up to 2052. (Source – University of Twente, Nedarland.)

II. INTRODUCTION

Electricity is very important factor which affects urbanization, industrialization, economic growth and improvement of living standard of society. India is ranked fifth in the electricity generation in the world [1]. Presently, India has installed capacity of 276.783 GW out of which 69.6% is from thermal, 15.2% from hydro, 2.1% from nuclear and about 13.2% from renewable energy sources (as on August 2015)[2-4]. Fig.1. shows the energy requirement in India. Thus, Indian power sector is based on fossil fuels, with about three-fifths of the country's power is generating by reserves of coal. The thermal power station emit a high amount of toxic gases such as NOx, COx and SOx gases which is ingenious to health and environment.[5] Also due to the limited stocks of the conventional resources, the world has to think about the alternate source of energy. Now a day's most of the countries are emphasizing on the development of renewable energy resources. In the renewable energy resources, solar energy plays important role and it is a tremendous potential to fulfil the worlds energy need. The sun is the planet's most powerful source of energy and also the most unused source of energy by humans. Solar energy is abundant and offers a solution to fossil fuel emissions and global climate change. The rate of energy received by the earth from solar energy is approximately 1,20,000 TW (1TW = 1012W or 1

trillion watt). This is much high from both the current annual global energy consumption rate of about 15 TW, and any additional requirement in future [6].

Solar power is a clean, environmental friendly source of energy. There are no toxic by-products or emissions. Heat coming from sun is directly utilized for water heating, room heating, vaporization etc. Solar water heating systems are in high demand. Typically 30–40% of a family's electricity bill is devoted to water. Solar water heating system can save the individual family from 70% to 90% of the total amount spent on the electricity used for heating water. The system generally meets all of the summer time heating needs [7]. During times of decreased sunlight, the system will preheat the water then bring it up to temperature by the conventional water heating system already in place.

India was the first country in the world to set up a Ministry of non-conventional energy resources in early 1980[1]. The Solar and wind energy are freely available and they are environment friendly. The wind energy systems are not possible at all sites because of low wind speeds and it is more unpredictable than solar energy [8]. Solar energy is the most important renewable energy resource which is available in most of the country of the world. Even its technically available potential is much higher than the current total primary energy demand. Solar energy technology is very important tool which can lowers worldwide carbon.

India is situated in sunny belt so that India is endowed with vast solar energy potential. Government of India had launched Jawaharlal Nehru National Solar Mission (JNNSM) in 2009. The target was to start Grid connected Solar Projects of 20 GW by 2022. In May 2015 government increases the target to 100 GW by 2022. This paper provides an overview on solar energy in India. It reviews the current status of solar energy in terms of existing capacity, along with historical trends of solar energy.

The cost of solar energy technologies are rapid declining in the recent past years and it is showing potential for continuous declines in the near future. Currently, the installed capacity of solar energy projects in India is about 4.22 GW. India is planning to produce 100 GW of solar power by 2022. [9]

III.CURRENT STATUS OF SOLAR RADIATION IN INDIA

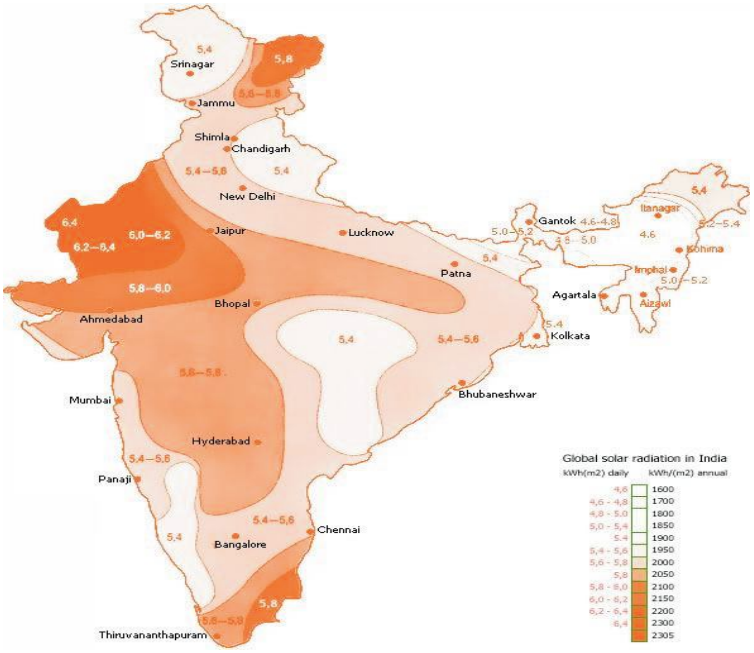


Fig.2. Solar radiation in India (Source: S.E.A, Tamilnadu)

India is ranked 11th in solar power generation in the world as on Jan. 2014[3]. Government funded solar energy in India only accounted for about 6.4 MW/yr of power as of 2005. In 2010 capacity of 25.1MW was added and 468.3MW in 2011. In 2012 the capacity increase more than two times and become 1205 MW. During 2013 capacity added by 1114 MW and during 2014 capacity added by 313 MW [5]. In August 2015, the installed grid connected solar power capacity is 4.22 GW. The price of solar energy has come down from Rs. 17.90 per unit in 2010 to about Rs. 7 per unit in 2015. It is expected that with technology improvement and market competition solar power will reach grid parity by 2017-18[10].

The Grid parity means the cost of electricity generated from alternative energy becomes equal or less than the cost of purchasing power from the grid [11]. Grid parity is very important term in the solar system and preferably photovoltaic panel [12]. The

Charanka Solar Park [13], at current installed capacity of 224 MW is the largest Solar Park in Asia, was commissioned on April 19, 2012[14]. In India, Rajasthan has the largest share of solar power generation of 28.4% and Gujarat share is 24.4% as on September 2015[15].

IV. SOLAR THERMAL COLLECTORS

Solar thermal collector is the heart of the system, which captures the solar heat and transfers it to circulating media. Commercially available solar collectors are shown in Fig. below. Ayden Hakan et al.,(2014)envisaged the solar preheating and superheating added OTEC system. Yamada Noboru et al., (2009) simulated the solar boosted OTEC system using 5000 m² flat plate collector and efficiency increased by 1.5 times.

Most of the on board thermal energy demands consists water heating for bathing and cleaning, space heating & cooling, cooking, preservation of foods and commodities, fisheries etc. State of the art solar collectors are capable enough to meet the requirement efficiently.[16]

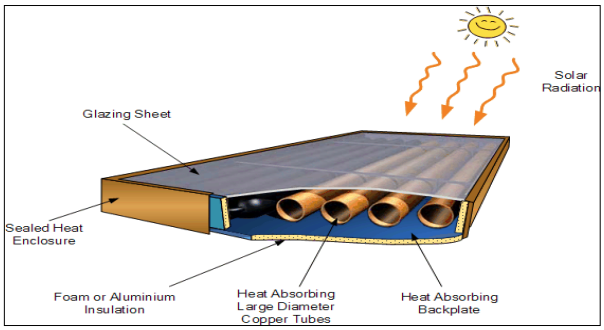


Fig.3. Flat Plate Collector.

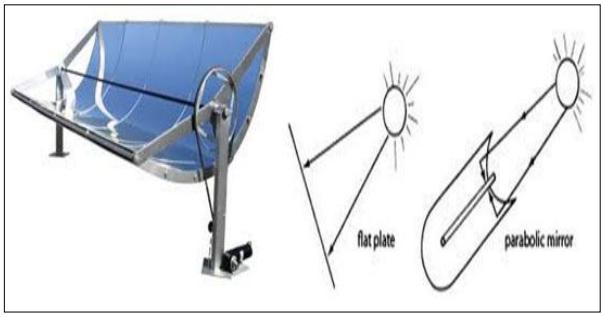


Fig.4. Parabolic Trough.

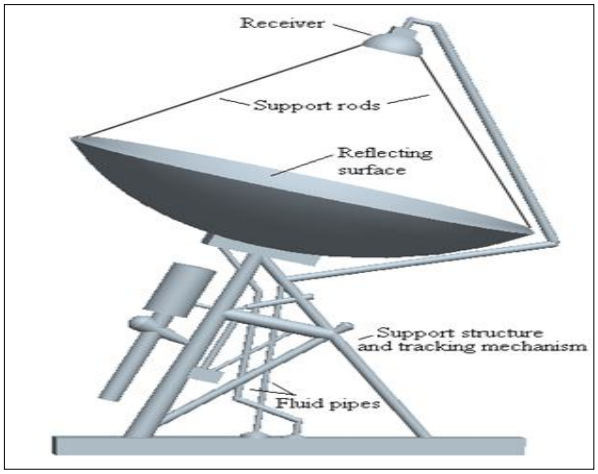
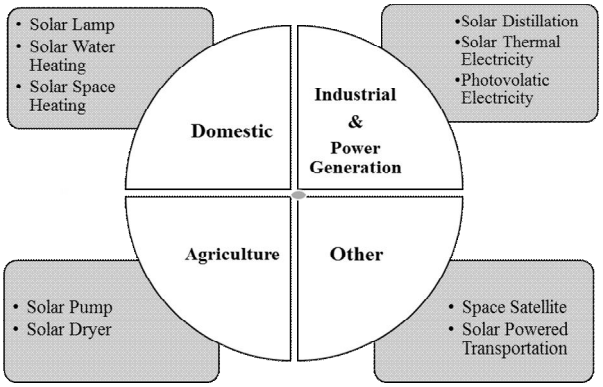


Fig.5. Parabolic Dish.

V. SOLAR APPLICATIONS



A. Domestic Applications

1) Solar Lamp

Fig.6. Solar Lamp Model.

A solar lamp also known as solar light or solar lantern, is a lighting system composed of an LED Lamp, Solar Panel, and battery charge controller and there may also be an inverter. The lamp operates on electricity from batteries, charged through the use of solar photovoltaic panel.

Solar-powered household lighting can replace other light sources. Solar panels receives the solar radiations and convert it into electricity which is cheaper than the standard lamps. In addition, solar lamps reduce risk like electric shock and human health. However, solar lamps may have higher initial cost, are weather dependent.

2) Solar Water Heating

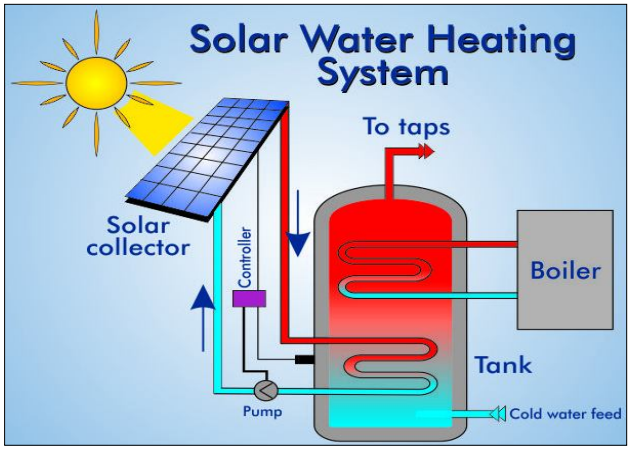


Fig.7 .Block diagram of Solar Water Heating System

Solar energy can be used to heat water. Heating water for bathing, dishwashing, and clothes washing is the second largest home energy cost. Installing a solar water heater can reduce your water heating bill by as much as 50 percent. A solar water heater works a lot like solar space heating. In our hemisphere, a solar collector is mounted on the south side of a roof where it can capture sunlight. The sunlight heats water in a tank. The hot water is piped to faucets throughout a house, just as it would be with an ordinary water heater.[17]

3) Solar Space Heating

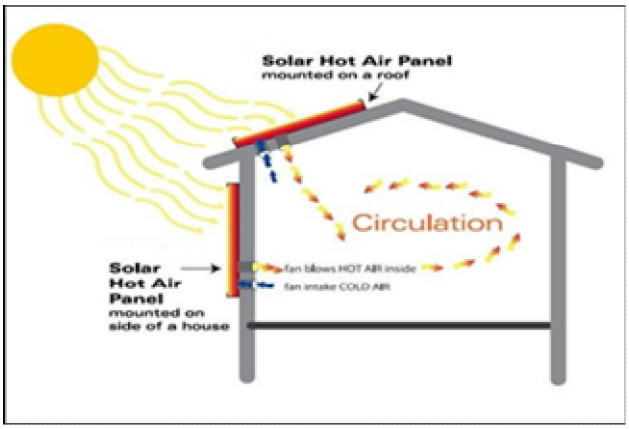


Fig.8 .Block diagram of Solar Space Heating System

Space heating means heating the space inside a building. Today, many homes use solar energy for space heating. A passive solar home is designed to let in as much sunlight as possible. It is like a big solar collector. Sunlight passes through the windows and heats the walls and floor inside the house. The light can get in, but the heat is trapped inside. passive solar home does not depend on mechanical equipment, such as pumps and blowers, to heat the house, whereas active solar homes do.[17]

B. Industrial And Power Generation

1) Solar Distillation

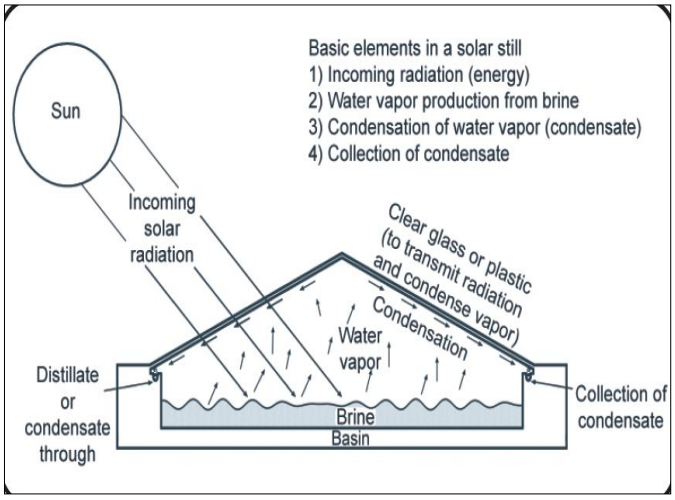


Fig.9. Solar Distillation.

Solar distillation is the use of solar energy to evaporate water and collect its condensate within the same closed system. Unlike other forms of water purification it can turn salt or brackish water into fresh drinking water. The structure that houses the process is known as a solar still and although the size, dimensions, materials, and configuration are varied, all rely on the simple procedure where in an influent solution enters the system and the more volatile solvents leave in the effluent leaving behind the salty solute. [18]

2) Photovoltaic Electricity

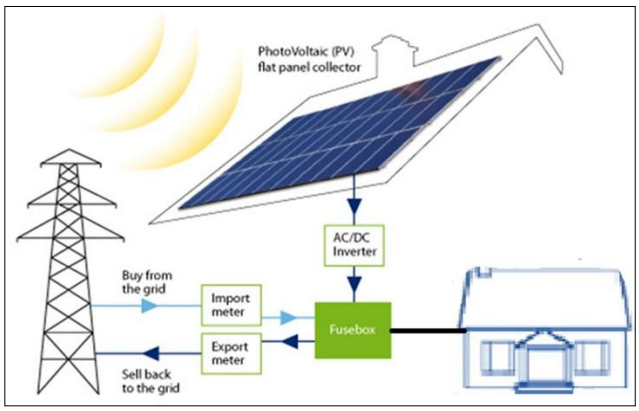


Fig.10. Photovoltaic Electricity.

Photovoltaic comes from the words photo, meaning light, and volt, a measurement of electricity. Sometimes photovoltaic cells are called PV cells or solar cells for short. Solar-powered toys, calculators, and roadside telephone call boxes all use solar cells to convert sunlight into electricity. Solar cells are made up of silicon, the same substance that makes up sand. Silicon is the second most common substance on Earth. Solar cells can supply energy to anything that is powered by batteries. Electricity is produced when radiant energy from the sun strikes the solar cell, causing the electrons to move around. The action of the electrons starts an electric current. The conversion of sunlight into electricity takes place silently and instantly. There are no mechanical parts to wear out compared to other ways of making electricity, photovoltaic systems are expensive and many panels are needed to equal the electricity generated at other types of plants. 3,000 homes. [17]

3) Solar Thermal Electricity

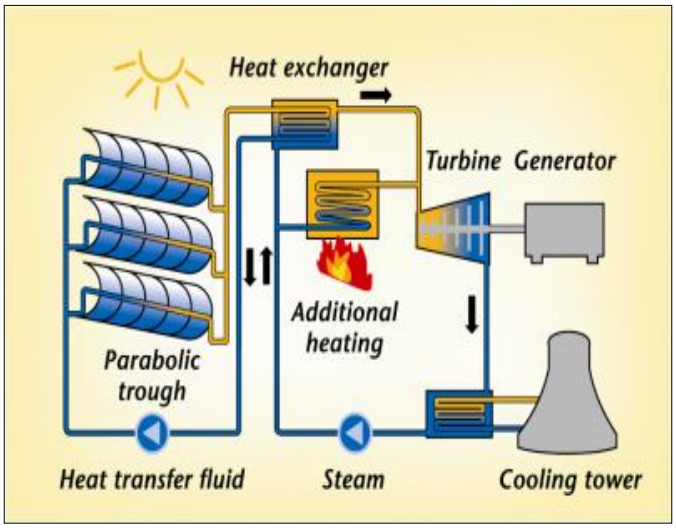


Fig.11. Solar Thermal Electricity .

Like solar cells, solar thermal systems, also called Concentrated Solar Power (CSP), use solar energy to produce electricity, but in a different way. Most solar thermal systems use a solar collector with a mirrored surface to focus sunlight onto a receiver that heats a liquid. The super-heated liquid is used to make steam to produce electricity in the same way that coal plants do. Solar energy has great potential for the future. Solar energy is free, and its supplies are unlimited. It does not pollute or otherwise damage the environment. It cannot be controlled by any one nation or industry. If we can improve the technology to harness the sun's enormous power, we may never face energy shortages again.[17]

C. Agriculture Application

1) Solar Pump

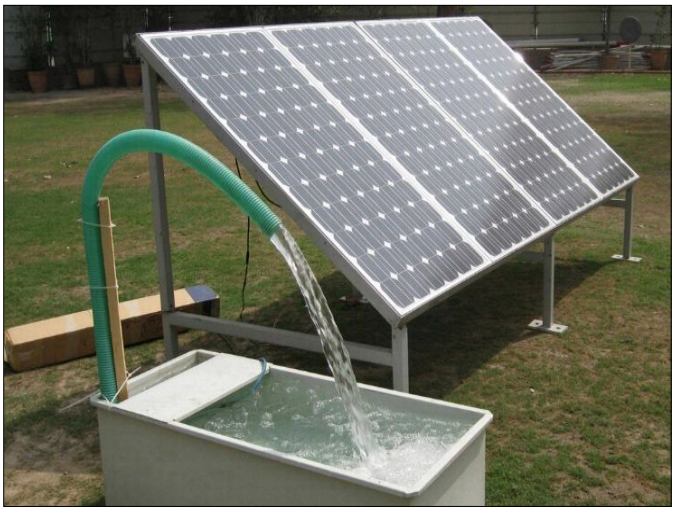


Fig.12. Solar Pump.

A solar pump is pump a running on electricity generated by photovoltaic panels or the radiated thermal energy available from collected sunlight as opposed to grid electricity or diesel run water pumps. The operation of solar powered pumps is more economical mainly due to the lower operation and maintenance costs and has less environmental impact than pumps powered by an Internal Combustion Engine (ICE). Solar pumps are useful where grid electricity is unavailable and alternative sources (in particular wind) do not provide sufficient energy

2) Solar Dryer

Fig.13. Solar Dryer.

Solar dryers expose the substance to be dehydrated to direct sunlight. Historically, food and clothing was dried in the sun by using lines, or laying the items on rocks or on top of tents. In Mongolia cheese and meat are still traditionally dried using the top of the ger (tent) as a solar dryer. In these systems the solar drying is assisted by the movement of the air (wind) that removes the more saturated air away from the items being dried. More recently, complex drying racks and solar tents were constructed as solar dryers. One modern type of solar dryer has a black absorbing surface which collects the light and converts it to heat; the substance to be dried is placed directly on this surface. These driers may have enclosures, glass covers and/or vents to in order to increase efficiency.

D. Other Applications

1) Solar Powered Space Satellite

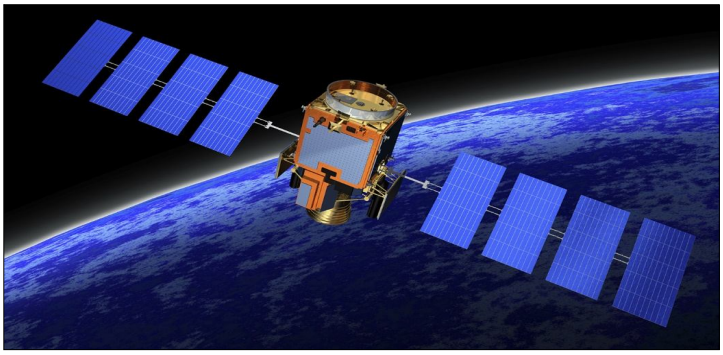


Fig.14. Solar Powered Satellite.

Spacecraft operating in the inner Solar system usually rely on the use of photovoltaic Solar panels to derive electricity from sunlight. In the outer solar system, where the sunlight is too weak to produce sufficient power, Radioisotope thermoelectric generators (RTGs) are used as a power source.

Solar panels on spacecraft supply power for two main uses:

a) Power to run the sensors, active heating, cooling and telemetry.

b) Power for spacecraft propulsion– electric propulsion, sometimes called solar-electric propulsion.

2) Solar Powered Transportation

Fig.15. Solar Powered Vehicle.

Fig.16. Solar Powered Train.

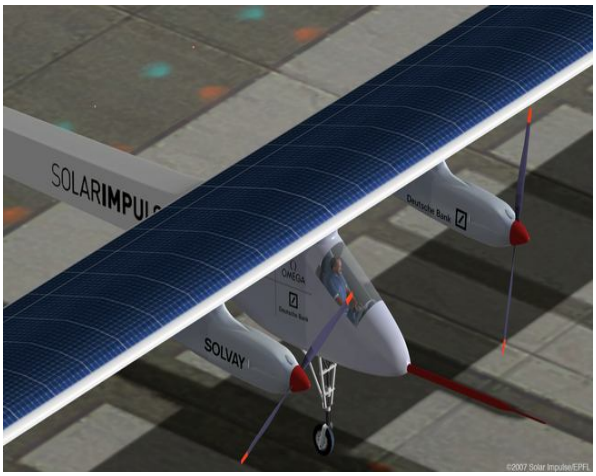


Fig.17. Solar Powered Plane.

A solar vehicle is an electric vehicle powered completely or significantly by direct solar energy. Usually, photovoltaic (PV) cells contained in solar panels convert the suns energy directly into electric energy. The term "solar vehicle" usually implies that solar energy is used to power all or part of a vehicle's propulsion. Solar power may be also used to provide power for communications or controls or other auxiliary functions.

Solar vehicles are not sold as practical day-to-day transportation devices at present, but are primarily demonstration vehicles and engineering exercises, often sponsored by government agencies. However, indirectly solar-charged vehicles are widespread and solar boats are available commercially.

VI. CHALLENGES

A. Development of low cost technolog
B. Awareness in society about renewable energy
C. Effective solutions for low solar radiation regions.
D. Minimizing capital investment.
E. Adopting technological development program for research and commercialization.

VII. FUTURE SCOPE

In India research on solar is in infant stage, there is need to adopt programs on the technological development for its research, commercialization and awareness in society. Also this sector has potential to provide employability and business chances.

VIII. CONCLUSIONS

India is situated in sunny belt so that India is endowed with vast solar energy potential. After detailed study of the solar energy, It is observed that solar energy has high potential to occupy the space between energy demand and supply in future.

Still there is scope to reduce the cost of solar energy system through research and technological development. Though the intensity of solar radiation varies w.r.to geographical and weather conditions, it may better option to reduce stress on Global Energy Demand.

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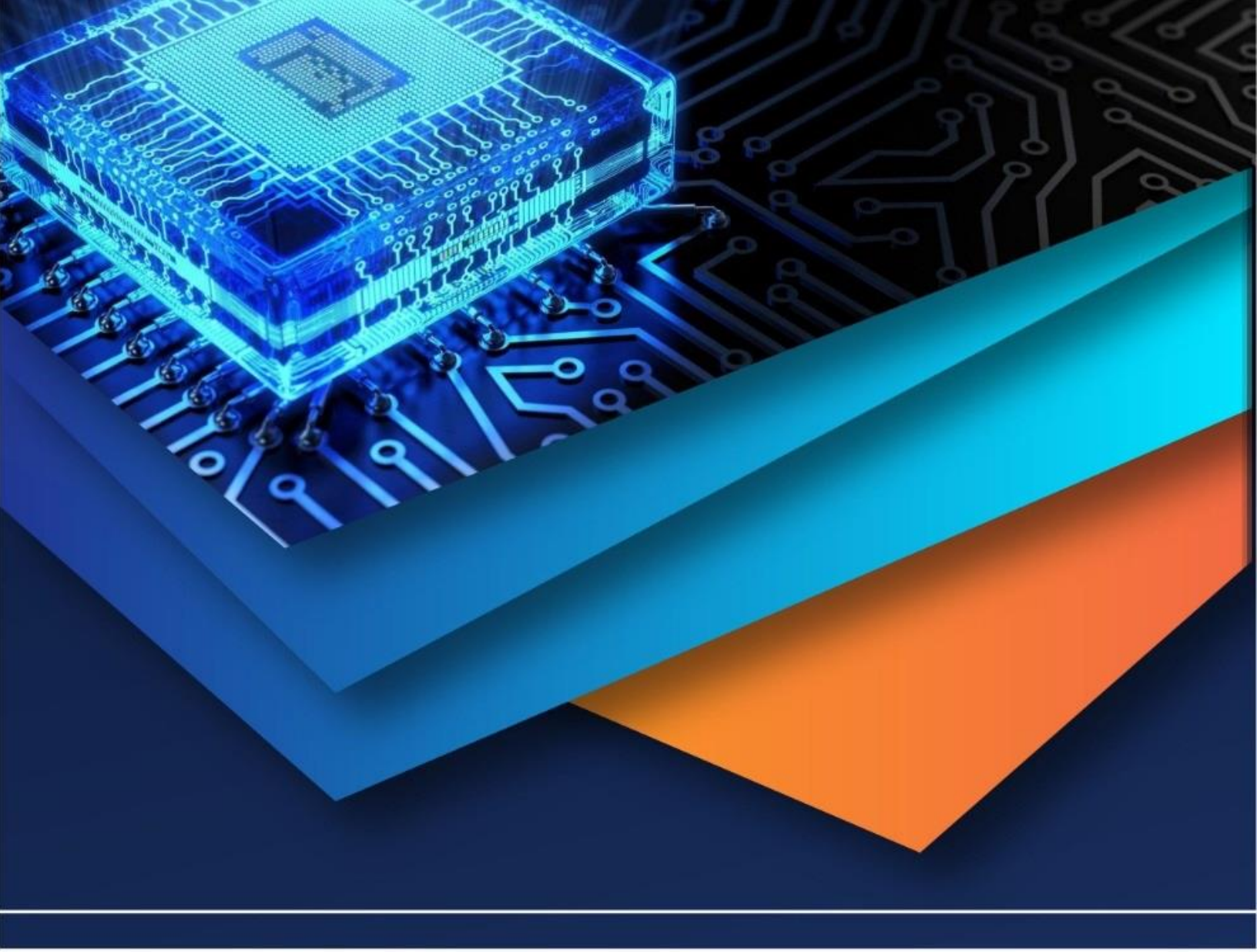

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