

A Review on the Solar Energy: Potential and Future Prospects

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ABSTRACT: *The progression of novel sun oriented force innovations is viewed as one of numerous essential answers for meeting the world's developing energy interest. In spite of fast development in the field of sun oriented advances, various concentrating sunlight based force (CSP) mechanical difficulties remain, including low sun based cell efficiencies, low-performing balance-of-frameworks (BOS), financial difficulties, and a shortage of qualified labor. The review paper examines the pros and cons of sun based energy advances. An assortment of specialized issues influencing environmentally friendly power research, just as helpful cooperations between administrative strategy systems and their future possibilities, are likewise examined in present paper. A potential guide for the field of sun based science is investigated to help open new courses as far as sun based energy examination and practices. Sunlight based energy is the most ample, unlimited, and economical sustainable power asset at present accessible. This paper presents a forward-thinking and nitty gritty recent status and future prospective of sun powered energy, just with their advantages, limits, future viewpoint. This concise representation would be very useful for solar system designers, scientists, and decision-makers who want to make a substantial contribution to this topic in order to make the planet a more energy-efficient place in the future.*

KEYWORDS: *Concentrated Solar Power (CSP), Environment, Renewable Energy, Solar Energy, Technology.*

INTRODUCTION

For the planet Earth, Sun is a foremost wellspring of boundless free energy (sun oriented energy). New advancements are as of now being utilized to deliver power from sun based energy gathered. These techniques have effectively been demonstrated and are normally utilized as supportable options to non-hydro advancements all throughout the planet. Sunlight based energy can meet the world's energy needs if collecting and conveyance advances are promptly accessible. Sun oriented energy enters the earth more than 4,000,000 exajoules (1 EJ = 10¹⁸J) every year, with roughly 5 10⁴ EJ effectively harvestable. Notwithstanding this enormous potential and expansion in mindfulness, the commitment of sun based energy to the worldwide energy supply is as yet unimportant. The measure of energy blocked by the earth from the sun is roughly 1.8 10¹¹ MW, which is a few times more noteworthy than the current pace of all energy utilization. Thus, this paper analyzes the advances made in sun oriented energy innovative work since its initiation.

Due to the rapid decline of conventional sources of energy, as well as today's ever-increasing energy demand in light of environmental issues, careful studies into new, more effective, and environmentally sustainable power plants has been undertaken. Since natural issues are developing all throughout the planet, new energy and sustainable fuel advancements are being investigated constantly forcefully. Most of environmentally friendly power sources like breeze, miniature hydro, flowing, biomass, sun and geothermal based are converted over into power so it tends to be carried either to the utility framework straightforwardly or detached burdens. Since old occasions, humanity has utilized an assortment of consistently advancing innovation to outfit sunlight based energy, brilliant light, and warmth from the sun. Sun oriented energy innovations incorporate sun based warming, sunlight based photovoltaic, sun powered warm power, and sun based engineering, all of which will assist with tackling a portion of the world's most squeezing energy issues. For the sake of the future of the earth, it is also important to use environmentally sustainable energy sources. Sustainable power sources, for example, sun based, wind, hydropower, and geothermal, are crucial in such manner since they are harmless to the ecosystem. Be that as it may, sunlight-based energy could be a most ideal alternative for the future prospective on account of a few motives: Firstly, It is the most bountiful environmentally friendly power source, and the sun discharges it at a pace of 3.8 10²³ kW, of which the earth blocks roughly 1.8 10¹⁴ kW. Sunlight based energy shows up on Earth in an assortment of ways, including warmth and light. The majority of this energy is lost because of dissipating, reflection, and ingestion by mists as it passes. As per contemplates, sun-based energy can satisfy worldwide energy need in an acceptable way since it is bountiful in nature and a

costless wellspring of energy. Secondly, it is a convincing wellspring of energy on the planet since it is non-expendable and has higher creation efficiencies than other fuel sources. The conveyance of sun-oriented radiation and its power are two significant components that impact the presentation of the sun-based PV industry. These two factors are very factor across nations. Other sustainable power potential has been determined by the International Energy Agency (IEA). As demonstrated in Figure 1. Environmentally friendly power will contribute 450 billion kWh each year by 2030. In any case, because of low productivity and other Safety, Health, and Environmental concerns, sun powered can offer not as much as wind and bio-mass. We present a worldwide situation for sun-oriented energy advances as far as their latent capacity, current ability, possibilities, constraints, and approaches in this article. This will assist us with growing our comprehension on how much additional we can rely on sunlight-based energy to satisfy the future energy need.

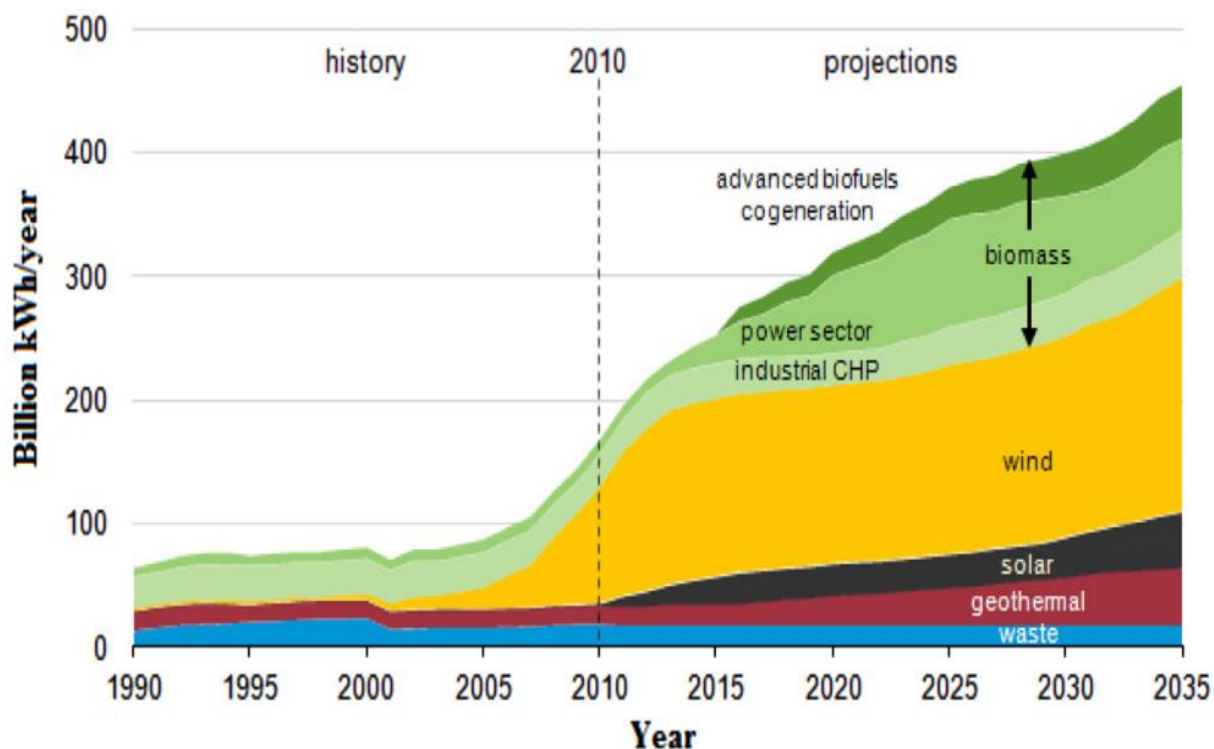


Figure 1: Projected Non-Hydro Power Renewable Electricity Generation, 2010–2035[1].

1. Solar Energy

The Latin word solar refers to sun, which is a strong spring of energy that can be cast-off to heat, light, and cool our homes and businesses. Passive solar architecture, Solar water heating for space heating and cooling, and solar photovoltaic for electricity are the most widely used solar technologies for homes and businesses. The systematic figure of the solar energy is shown in the Figure 2.

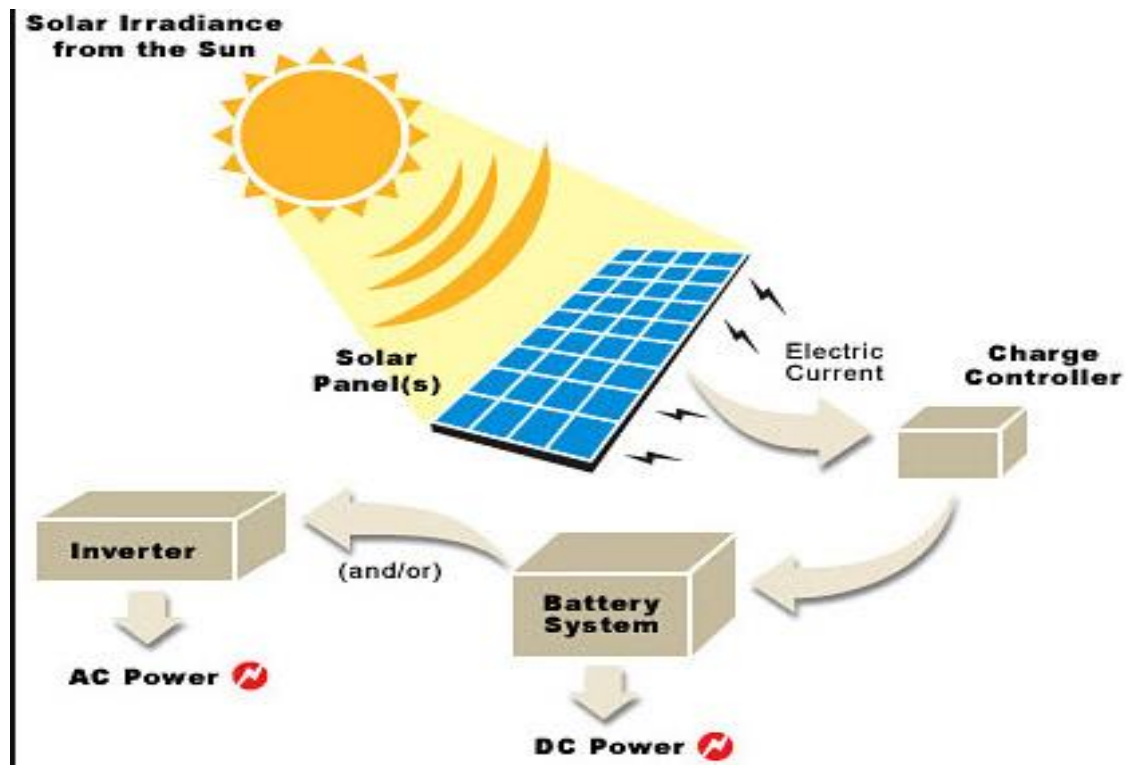


Figure 2: The Systematic Block Diagram Of A Solar Energy[2].

When all is said and done, sunlight-based innovation is divided into two major categories: sun-oriented photovoltaic (PV) modules and concentrating sunlight-based force (CSP). By retaining photons from the light, photovoltaic body turns daylight energy to electricity, and particles move from the lower circle to the higher circle before leaving the parent iotas. CSP makes use of intelligent surfaces to natural light into a shaft and heat a functional liquid in a recipient. The steam produced by the heat is used to power the turbine, and the generator is thus raced to create electricity. Firstly, let's discuss about the solar photovoltaic technology:

2. Solar Photovoltaic Technology:

It is indeed an innovation that effectively converts sunlight into electricity even without a conversion tool. As a result, these instruments are designed to be compact and easy to use. Furthermore, they are capable of producing greater outputs from smaller inputs. As a result, they're found in a variety of applications all around the world. However, it also needs to develop the method in order to produce more results. To create power, photovoltaic frameworks ordinarily use semiconductor materials, the most mainstream of which is silicon. The thought behind this framework is to initiate electrons by furnishing them with additional energy. The electrons in this framework move from a ground state to a higher energy level to be imitated. Because of the energy expansion from daylight, electrons in this framework are initiated from a specific wavelength to a longer wavelength. This actuation generates a plethora of openings and charged particles in the semi-transmitter, ushering in the age of power. A matrix-associated framework is linked to a massive free lattice, which is typically the public power network and feeds power into the framework. They range in size from a couple of kWp for personal use to energy from the sun power stations with capacities of many other GWp. This is the age of understanding of the workings.

A basic photovoltaic system integrated with utility grid is shown in Figure 3. The PV cluster changes the sunlight based energy over to dc power, which is straightforwardly reliant upon insolation. Impeding diode works with the cluster created ability to stream just towards the force conditioner. Without an obstructing diode, the battery would release back through the sunlight based cluster during low insolation. Force conditioner contains a most extreme force point tracker (MPPT) a battery charge and a release regulator. The MPPT guarantees that the most extreme force created by the sun powered PV exhibit is extricated at all moments while the charge release regulator is answerable for forestalling cheating or over releasing of the battery bank needed to store power produced by the sun based energy during dark time. In simple Photovoltaic system, where the PV module voltage is coupled to the output current, MPPT devices are generally thought to

be redundant since the battery voltage is stable and could provide near maximum power range from the Photovoltaic modules.. An independent framework doesn't have an association with the matrix.

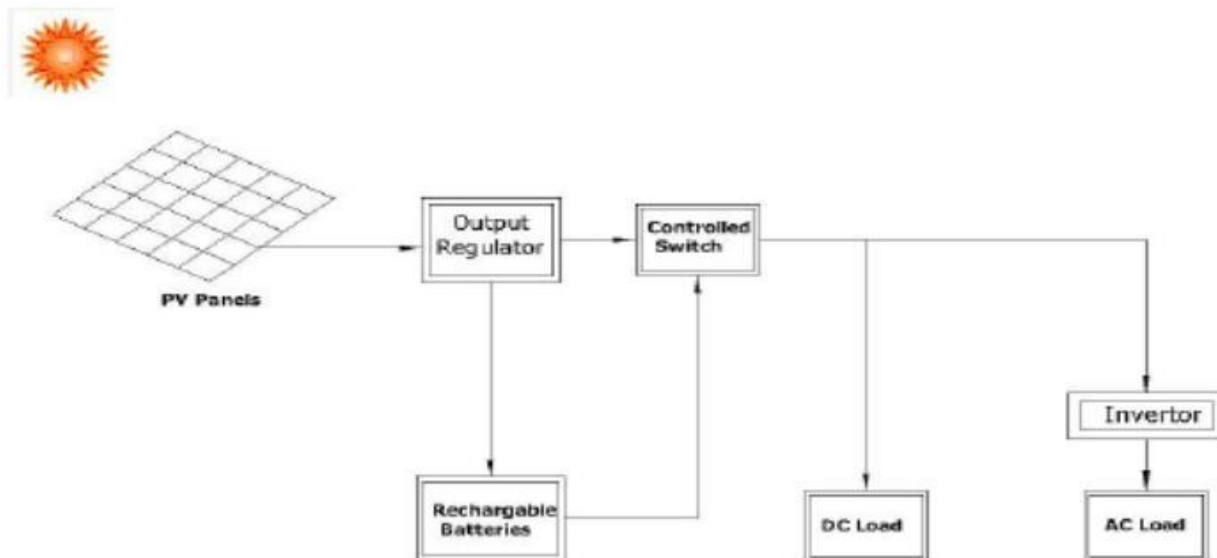


Figure 3: Systematic Block diagram of a Solar Photovoltaic system[3].

3. Solar Thermal: Concentrating Solar Power (CSP):

Concentrating sun based force (CSP) innovations use mirrors to imitate and think daylight into a solitary point where it is gathered and changed over into heat. From that point onward, the nuclear power can be utilized to produce power. Utility-scale projects regularly utilize concentrated sun oriented force frameworks. CSP plants use mirrors to coordinate daylight onto a recipient, which warms a high-temperature liquid and drives a turbine or a motor that drives a generator. Power is the final product. More modest CSP situation can be introduced right where power is required. Single dish/motor frameworks, for instance, can produce 3 to 25 kilowatts of force and are ideal for circulated applications. The basic systematic representation of the CSP is given in the Figure 4.

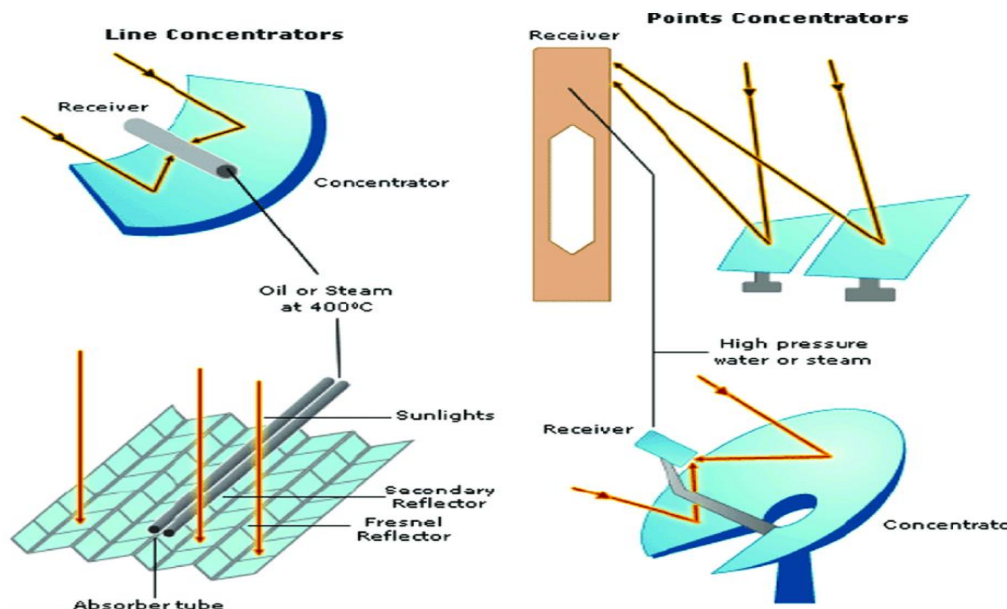


Figure 4: Systematic diagram of Concentrating Solar Power CSP[4].

There are four types of CSP systems available:

- Linear Concentrator System, Wide mirrors capture the sun's energy and reflect and focus it onto a linear receiver tube in linear CSP collectors. The receiver holds a fluid that is heated by sunlight and then used to power a conventional power loop, which generates energy by spinning a turbine and driving a generator. The use of a boiler is unnecessary since steam can be produced directly in the solar field.
- Dish/Engine System: A logarithmic array of mirrors focuses and conserves sunlight onto a centralized device that uses electricity in dish/engine applications. It is basically a CSP technology that generate less energy than other CSP technologies (typically 3 to 25 kilowatts) but has the advantage of being modular. The power conversion unit and solar concentrator are the two main components of the system.
- Power Tower System, Heliostats are a set of flat, sun-tracking mirrors that concentrate sunlight onto a receiver at the top of a tall tower in power tower concentrating solar power systems. In a traditional turbine generator, a heat-transfer fluid heated in the receiver is used to heat a working fluid, which is then used to generate electricity. Water/steam is used as a heat-transfer fluid in some power towers. As much as possible, raise the temperature of the power cycle. To maximise the power cycle temperature, other advanced designs are experimenting with high temperature molten salts or sand-like particles.
- Concentration of Solar Power The extensive use of solar energy decreases or curtails energy output when the sun sets or is blocked by clouds. It's a concentrated solar power (CSP) device in which the sun's rays are redirected onto a receiver, producing heat, which would be used to produce energy that can be used right away or store it for future usage. Mostly as well, CSP systems may provide clean, sustainable power in a versatile, or dispatchable, manner. Several sensible thermal energy storage systems have been tested and implemented since 1985. Which include the two-tank direct system, two-tank indirect system, and single-tank thermo cline system.

4. Limitations and positive impacts of Solar energy

Sun based energy is considered as one of the freshest types of force age. Anyway when contrasted with other energy assets, sun based, energy has additionally a few impediments. In the assembling of PV sun powered cells, some profoundly poisonous materials like, lead, cadmium, nickel, arsenic and others are utilized, those have been confined by worldwide natural approaches. Firstly, lets discuss about the limitation these reasons are as follows;

Quite possibly the main deficiencies of the sunlight based energy framework is the high starting establishment cost; for instance, in mid 2016, the normal cost per watt for sun powered energy in the United States was \$3.70. At the point when the Federal sunlight based tax reduction is considered, an ordinary sun oriented energy arrangement of 5 kW for every family will cost \$13,000. (Subsequently lessening costs by 30%). Long compensation periods and restricted income sources, then again, limit the worth of credits for such plans. Furthermore, most domestic solar panels have efficiencies of about 10%–20%, which is another shortcoming of solar power. Solar panels that are more effective (approximately 20%) are available at a higher cost. Other components' efficiency drawbacks, such as batteries and inverters, are also places where there is space for improvement.

Another issue with sun based energy frameworks is short battery lifetimes and the protected removal of spent batteries. Besides, batteries are frequently large and hefty, requiring a ton of extra room. Besides, since sun oriented boards are made of uncommon or valuable metals like platinum, tellurium, or indium, there are deficient reusing offices. Components identified with framework support, for example, a deficiency of qualified labor to fulfill rising needs for sun based force framework establishment, upkeep, investigation, fix, and assessment, are additionally an imperative. Besides, an absence of fundamental specialized information with respect to the shopper (especially in country spaces of the creating scene) as to sun based force frameworks can prompt unpredictable use, cheating the battery, extremity inversion, by-passing the charge regulator, and other gadget hurt.

Another apparent flaw is that energy from the sun can only be used during the day and is most effective when the sun is shining. As a result, solar energy is unlikely to be the most effective source of energy in places where the atmosphere or environment are unsustainable.. Furthermore, the amount of pollution in the construction area can have an consequence on the productivity of the solar cells. The current of silicon solar cells was found

to be reduced by 10% and 7%, respectively, when exposed to exhaust gases and aerosols. Finally, vast areas of land are often needed to produce solar energy on a large scale. According to the rule of thumb, a 1 MW solar plant with crystalline modules (about 18 percent efficiency) would take up about 4 acres (16,187 m²) of land, while nano - structured technologies (12 percent efficiency) will take up about 6 acres (24,281 m²).

5. Solar Energy's Beneficial Effects:

5.1. Saving in Natural Energy Resource:

The depletion of fossil fuel resources is accelerating as energy consumption rises. The rate of energy consumption and output is rising, and by 2025, it is anticipated that energy consumption will outpace electricity generation, resulting in a worldwide energy shortfall.

5.2. Water Consumption Reduction:

One-third of the world's population, according to a World Health Organization survey, is going to lack the necessary amounts of water. According to the United Nations, half of the world's billion people will live in water-stressed countries by 2050, especially in Africa, Asia and Latin America.

It can be shown that water can be conserved and easily used for other purposes when renewable energy bases are used. In the circumstance of PV, the amount of water used for operations is negligible. Although frequent washing surges output, it is because to result in economic losses, according to experimental evidence. Water is required for cooling in Csp plants, as it is in all thermal electric plants. The amount of water used is determined by the plant's design, location, and cooling system type. The use of dry cooling approaches for CSP could significantly reduce water consumption.

5.3. Land Transformation/Land Use:

Sun based, as other efficient power fuel sources, has a few interesting attributes when contrasted with conventional fuel sources. Sun based fuel sources, including conventional force plants, needn't bother with extra asset extraction once the foundation is set up. The land could likewise be utilized for different purposes, like manor and concealing. Little and enormous PV establishments incorporate direct land utilize going from 2.2 to 12.2 sections of land per MW, with a limit weighted normal of 6.9 sections of land per MW. CSP establishments have an immediate land-use thickness going from 2.0 to 13.9 sections of land/MW, with a limit weighted normal of 7.7 sections of land/MW. Petroleum product based plants, then again, need land for both their force plants and asset extraction. For petroleum product based plants, the hour of land change (fundamentally for private or modern regions) is dictated by the measure of extraction each day. Land is frequently named and left on account of fossil or atomic plants looking for fills for possible use[5].

LITERATURE REVIEW

In this paper author analyzed the thorough analysis of the solar energy and in this author also discussed some pervious researches towards it. The qualitative part of research consists of analysis of solar energy and its overview, types, benefits, impacts, limitation and future scopes. The literature review is basically used to identify the major factors which are being involved in solar energy. The following such researches are being mentioned below of the different authors to give solar energy technology a balance review.

Nadarajah Kannan et al. presented an overview of solar energy. Hence, examined about the sun powered energy, among other maintainable wellsprings of energy, as a hopeful and openly accessible fuel hotspot for managing long haul issues in energy emergency. Because of the popularity of oil, the sun-oriented industry is increasing steadily all over the world, despite the fact that petroleum derivatives and significant fuel sources are limited, and different sources are expensive. Likewise, examined about the need of sunlight based industry with its key ideas, universes energy situation, features of explores done to update sun oriented industry, its expected applications and obstructions for better sun powered manufacturing in forthcoming to determine energy emergency[6].

Ehsanul Kabir et al., demonstrated and Solar energy has been studied, and the benefits and drawbacks of solar energy technology have been presented. Furthermore, a variety of technological issues impacting renewable energy research are addressed, as well as positive relations between regulatory policy systems and their future prospects. A potential roadmap for the field of solar science is also explored in order to help open new paths in terms of solar energy research and practises.[7].

Omar Ellabban, et al., demonstrated about an overview of the solar energy and explored accordingly. The current state of renewable energy resources, high-tech advances to expand their need, forthcoming prospects, and implementation are all discussed in this paper. Furthermore, the paper depicts the effect of smart grid technology and power electronics, which will empower a proportional share of renewable energy resources to be utilised.[8].

After researching about the above mentioned research paper, it can be said that the research has been done keeping various means of Solar energy but the balance view has not been provided as some of the research papers are missing the noble future uses of this technology along with enhancements that are being required for strengthening it and some research papers are not clearly mentioning the limitations and future perspective of the technology. So basically it does not conclude a balance view about such a rapidly growing fabulous technology so our research paper overcome all such limitations and all these factors are thoroughly analyzed and mentioned in such a manner that it is easily understood and most importantly the future noble uses of Solar energy are clearly mentioned and analyzed to give it a balance view. This study is useful for those interested in learning more about studies in the field of solar energy. The current state of solar energy and its potential future are discussed.

DISCUSSION

1. *The Future prospect of Solar Energy:*

Sunlight based energy is perhaps the most ideal decision for satisfying potential energy need since it outflanks other environmentally friendly power sources regarding accessibility, cost adequacy, availability, limit, and quality. Specialists have effectively estimated the progression of sun based energy in and amongst different pieces of a photosynthetic living being interestingly. It's significant that when perovskite sun based cells previously showed up in 2009, their exhibition was simply 3.8 percent. Accordingly, hazy perovskite sun oriented cells with high force change proficiency and apparent light transmission while hindering infrared light have been made, making them ideal contender for sun based windows..

Photovoltaic technology is nowadays being used in distant electricity supply, and it can be used to power electrical appliances directly or through a current drawn from a storage battery. For better control, the remote can be adjusted properly. Electrical shielding, lighting, and water pumping are all examples of applications where this technology is now generally used. Sun based energy can also be used to charge a variety of electronic devices in locations where plug-in electricity is unavailable.

2. *Solar Energy for Wastewater Treatment:*

Various manufacturing processes use a vast quantity of water, which is then emitted into the atmosphere as leachate with a higher biochemical oxygen demand, cause enormous harmful effects on the environment and living organisms. Treatment of such a strong effluent to a safe level of its parameters is complicated, energy-intensive, and costly. As a result, several organizations seem to be unable to afford it. And from the other hand, both countries need the implementation of a wastewater treatment system. PV panels are crucial for supplying electricity to various pumping station components in effort to minimize pollution and increase efficiency.

3. *Space Application:*

The technology of spacecraft is now very common all over the world. Many studies are carried out in this area in order to improve it. The design of space systems must take into account the charging of spacecraft. For simulation, different computer models are used. The most significant effect in spacecraft charging is electrostatic discharge, which is generated using solar energy. This can happen as a surface dump or as a stock discharge. Due to the complexity of the developments, photovoltaic power plants have been well incorporated in earth-orbiting spacecraft at low earth geosynchronous orbits. and environmental issues associated with

nuclear power sources in spacecraft technology. According to the National Aeronautics and Space Administration, solar arrays can also be used for deep space emissions (NASA).

CONCLUSION

Sun powered energy innovation has become a notable and generally utilized innovation everywhere on the ecosphere. To do this, millions of dollars have been spent, with significantly more arranged sooner rather than later, to settle the sun based industry's current impediments. In both created and agricultural nations, a scope of new huge scope sun based force (for instance, CSP) projects are coming on the web or are in the arranging stages. While CSP is more costly than PV innovation, it has been discovered to be ideal for locales without ordinary mists or cloudiness. PV advancements for the present may keep on being the essential wellspring of sun based force age. Besides, because of the sluggish advancement of supporting strategies and establishments, the likely interest for off-lattice heavenly bodies remains generally undiscovered.

As a result, many attempts are being made around the world to incorporate more renewable energy sources into the energy mix. Renewable energy supplies are novel power generation options with tremendous potential, since they can theoretically satisfy the demand of universe total energy several times over. The review paper provides an recent and comprehensive overview of solar energy's current state and potential projections, as well as its advantages, shortcomings, and future prospects. This concise review paper is very helpful for solar system designers, scientists, researchers, and policymakers who want to make a noteworthy influence to this field in the future in order to make the planet a more energy productive place.

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