INTERNATIONAL RESEARCH JOURNAL ON ADVANCED SCIENCE HUB
e-ISSN : 2582 - 4376
Open Access
RSP SCIENCE HUB
(The Hub of Research Ideas)
Available online at www.rspsciencehub.com

Special Issue of First International Conference on Advancements in Engineering, Management, Science & Technology (ICEMST 2021)

Study of Solar Energy and Future Needs

Muniyandy Elangovan[1], P Dilli Babu[2], Balaji T[3],
[1,2] Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai, India.
[3]Village Technology School, Villupuram, Tamil Nadu, India
muniyandy.e@gmail.com[1]

Abstract

Energy is important in part of life and life cannot imaging without electricity. Due to environmental pollution, traditional thermal energy such as coal, oil power stations are planned to be reduced. Considering the demand, lot of research is started on renewable energy for commercial as well home applications. When it comes to renewable energy, solar energy is easier to harvest when compared to renewable energy. In this study, a different source of energy is studied and depth study related to solar energy. It is discussed how the energy is created from the source, SUN. Method of harvesting solar energy and different kind of solar panels are discussed. There is also a comparison for each panel and special features of each kind of panel are discussed.

Keywords: Solar Energy, Panel, Thermal Energy, Renewable Energy, Pollution

1. Introduction

Nowadays the usage of vehicles is increased drastically all over the world. Anyway, it is good to see such kind of growth in our society, but it was not only bringing growth but also brought some problems such as vehicle pollution and the high fuel cost. Moreover, it affects majorly middle-class and low-class people [1-5]. However, these categories of people are facing many problems such as electricity bills, taxes, and the cost of fuel. There are many solutions are available for these problems but the efficiency of such kinds of solutions are very low compared to solar energy. Because the total annual potential of solar energy was approximately 1,575-49,837 Elec Joules (EJ) and the total world energy consumption was approximately 559.8 EJ in 2012 [6-8]. However, converting all this energy into electricity for vehicles and houses is not possible but we can convert more than 559.8 EJ. So, if people start using solar energy, then plenty of problems can be solved both for humans and the earth. When it comes to the summer season this solar energy plays a major role and we can generate a vast number of efficiencies comparing to any other season [9-12]. We can convert this solar energy into usable forms of energy by using various technologies which we are going to discuss in this study. Anyway, in this study, I'm going to cover everything about solar energy, solar panels, and future technologies on solar energy.

2. Renewable Energy

All over the world, renewable energy use is getting maximized and these alternative energy sources will not affect climate changes. But first, we should know what is renewable energy? The answer is simple: renewable energy is created from naturally occurring sources that never run out; the most prevalent sources are sun, wind, hydro, geothermal, and biomass. Fossil fuels, such as hydrocarbons, coal, oil, or natural gas, provide nearly 80% of the total energy consumed by humans [13~15]. Renewable energies, on the other hand, are the world's fastest-growing energy source. Renewable energy has numerous advantages, including the ability to prevent climate

change because it produces no direct greenhouse gas emissions. They only emit indirect emissions, which are those that occur from the installation, operation, and maintenance of manufacturing parts, but even these have no impact on humans or the environment. Renewable energy can help to minimize pollution, which in turn can help to reduce health risks and diseases. When compared to non-renewable energy sources, wind, solar, and hydropower systems emit no pollution, while geothermal and biomass energy systems emit significantly less. Third, renewable energy is a dependable source of power since renewable energy sources are long-term and never run out. Renewable energy prices tend to be steady over time because renewable plants are inexpensive to build and the fuel is typically free. While renewable energy offers numerous benefits, it also has drawbacks. Building wind farms is difficult for renewable energy sources to generate power on the same scale as fossil fuels. Dams can cause animal and migration patterns to be disrupted, as well as ecological harm from solar and wind energy. Batteries can store extra energy for later use and only create power when the sun is shining or the wind is blowing. While renewable energy has its drawbacks, it also provides an environmentally benign alternative to the greenhouse gas emissions and pollution caused by fossil fuels, especially as technological advancements make renewable energy more accessible, economical, and efficient. We may be able to put an end to climate change. Though it has several advantages, it also has certain drawbacks, such as the need for a high energy storage capacity and low efficiency, among others/

3. Non-Renewable Energy

It is known that nowadays the usage of fossil fuels is getting reduced slowly because of its harmful nature such as it pollutes the air and causing global warming it also affects human health. So, first, what is non – renewable energy? The answer is very simple that if any energy cannot be transformed or reuse then it is called as non – renewable energy.

Example – coal, petroleum, natural gas;

4. Solar Energy

Now comes solar energy which comes under the renewable energy source. We all know that renewable energy will not give greater efficiency like non – renewable energy but when it comes to solar energy the sun is having a large potential to produce energy more than renewable but it is still now impossible to transfer everything into electricity/

4.1 How the solar energy is created in the sun?

Before learning about this solar energy generation process, we should learn about the different parts and their uses in the sun. Core – this is the center part of the sun which occupies around 20 to 25% radius of the whole sun. because of fusion happening in the core only produces 99.9% of the solar energy. Radioactive zone – this is next to the core part which occupies 0.7 of solar radii. There is no fusion happening in this zone, but the solar materials will remain hot every time. Convective zone – this is the zone that occupies the rest of the 70% radius of the sun. like radioactive zone here also there will be no fusion takes place. But the key factor of this zone is that it transfers the heat from the core and radioactive zone to the photosphere. If it is not present in the sun, then the temperature of the outer layer of the sun will start to reduce. Photosphere – this is the final layer of the sun which is the visible one. It only radiates the sunlight and heat to space and earth. The temperature present in this layer is about 4500 – 6000 k. the ozone layer will reduce the UV rays from the sun to the inside earth but it emits some rays inside the earth.

4.2 How the fusion process takes place in the core part of the sun?

Fusion is the unique nuclear reaction that powers the sun. The conversion of hydrogen to helium is known as fusion. we know that when two hydrogen atoms get ram together then the leftover will be helium atoms. Fusing two atoms, on the other hand, is difficult since two protons have the same charge and are both positively charged, repelling each other. They don't like to get close together and getting near enough to start fusing needs a lot of energy or velocity, which is highly rare. Gravity's unseen hand demands vast amounts of heat and pressure to force protons together. The sun contains 99.8% of all matter in the solar system, a substantial amount of mass. With incomprehensible gravitational force, the sun is forced together by all its mass. Everything is squeezing due to gravity. Things get close enough together in this nuclear compactor for nuclear fusion to happen. Some of these collisions are so powerful that atoms fuse and release energy every second. When protons bind

together, they shed a small amount of mass, which is converted into energy. Every second of every day, roughly 5 million tons of matter is converted to energy.

5. Methods of Harvesting Solar Energy

- Photovoltaic - solar panels
- Thermal energy - harvesting
- Solar - water heater
- Vacuum tube - solar water heater
- Molten salt - solar power

5.1 Photovoltaic solar panels

The arrangement of solar cells in order is called solar panel or photovoltaic cell. These solar cells are made up of silicon called silicon wafers. The electron in the silicon crystals will don't have freedom, so they won't move freely. There are 4 valence electrons are there in silicon crystal and 5 valence electrons in phosphorus. When we inject phosphorus into silicon wafers, then there will be unstable so that the electrons will start moving randomly if they get external energy like solar energy. So whenever the electron flows there will be a current.

5.2 Energy harvesting (Thermal)

The sun produces many radiations including infrared radiation at different wavelengths and heat. With the help of this thermal energy harvesting, we can convert this heat into electrical or mechanical energy. Now the question will raise that "can we solve all electricity problems by using this method?" but the answer is "not fully". However it won't produce that much greater efficiency like fossil fuel but instead of wasting the heat from the environment, engines, machines, etc…we can convert them into usable forms of energy like" electricity". TEGs (Thermo Electric Generator) are present in thermal energy harvesting for converting heat into electricity. These thermoelectric devices having major advantages such as being lightweight, no or less maintenance, and also, they are very compact.

5.3 Solar water heater

It's a gadget that traps infrared light from the sun and uses it to heat water. The solar water heater is made up of an insulated box with a black inside. The copper pipes are installed in the form of a coil in this box and then painted black from the outside. To avoid heat loss due to convection and radiation, the box is sealed with a glass lid. The pipes' ends are linked to the storage tanks, and cold water now flows into the copper tubes from the bottom of the storage tank. The sun's infrared energy is contained inside the box. As a result, the water inside the copper pipes becomes lighter as it heats up. The heavier cold water from the storage tank flows down into the copper pipes at a lower temperature, while the lighter hot water goes into the storage tank. The thermal siphon effect refers to the continuous circulation of water and the mechanism by which water is heated; as a result, We get hot water by capturing solar energy, which is renewable, non-polluting, and abundant.

5.4 Vacuum tube solar water heater

A vacuum tube solar water heater is also called an evacuated solar water heater. Which works almost similar to a solar water heater but with a different mechanism. These evacuated tube solar collectors just as ordinary collectors capture solar radiation utilizing a flat metallic absorber plate. However, in vacuum collectors, the plate is split into parallel strips. Each strip is attached to a metallic tube in good thermal contact with it. This kind of tubes is manufactured with a selective coating to reduce infrared emission losses as much as possible.

5.5 Molten salt solar power

Like all the sunlight extraction technologies molten salt solar power also uses electromagnetic radiation. This molten salt solar power melts the salt and transfers the water to the heat exchanger. Now the heat exchanger converts the water into steam. Stream turbine is included as a part of the molten salt solar power plant to produce electricity. So now the stream from the heat exchanger is diverted to the stream turbine, now the stream turbine will start to generate electricity. Now the molten salt will be saved in the tank for later use especially when the sunshine is very low.

6. Solar Energy

It can convert the sand into 99.9% silicon crystals by following some steps.

Step 1 : mix sand + carbon = silicon crystal

Step 2: convert the silicon crystals into gaseous form.

Step 3: Then mix it with hydrogen (result: we'll get polycrystalline silicon).

Step 4: Then reshape into silicon cubes.

Step 5: cut the silicon cubes into small pieces which are called silicon wafers.

The electrons in the silicon crystal won't have freedom so that they won't move freely. There are 4 valence electrons are there in silicon crystal and 5 in phosphorus. When we inject phosphorus into silicon wafers, then there will be unstable so that the electrons will start moving randomly if they

get external energy. The sunlight contains full of photons so when it hits the silicon cell, the additional electrons in phosphorus will start to move. But we cannot generate electricity when these free electrons move randomly. So we need a driving force to move these electrons in a particular path. So if we use the PN Junction diode then it is possible.

Step 6: when sunlight hits the solar cell then the depletion region in the PN junction will start producing holes in the P junction and there will be little negative charge will be present and it produces electrons in the N region with a little negative charge so that it creates a driving force now.

Step 7: now all the electrons will travel in a uni-direction (so whenever the electron flows there will be a current)

Step 8: all these solar cells are inter-connected with copper strips.

Step 9: so finally, the electric power will be generated from the solar panel. Electricity. There are two categories of solar panels.

6.1 Mono facial solar panel

These are one kind of panels where silicon wafers are attached only on one side of the plate. So that the efficiency will be lower comparing to bi-facial solar panels.

6.2 Bi-facial solar panel

These are a kind of panel where silicon wafers have attached both sides of the plate. Here the efficiency will be higher compared to the mono facial solar panel. Approximately it can produce more power almost 10 – 20% of mono facial solar panels and sometimes it can produce.

7. Solar Panel and Types

- Monocrystalline-Panel
- Polycrystalline-Panel
- Thin-film solar cells
- Amorphous silicon - solar cell
- Biohybrid - solar cell
- Cadmium telluride - solar cell
- Concentrated PV cell.

7.1 Monocrystalline solar panel

These panels are also called first-generation solar panels. It is called a monocrystalline solar panel because it is made up of monocrystalline silicon. It appeared to be the uniform dark color with white round edges. It is made up of the purest form of crystalline silicon so that the efficiency will be higher than other types of solar panels. It occupies very little space so that it will be helpful for small area people.

- Efficiency rate -
- ~20%
- Advantages –
- Higher efficiency
- Space efficient
- Higher life span
- Lower installation cost
- Non-hazardous to environment
- Dis – advantages -
- Quite expensive
- Easily covered by dirt, shade, or snow
- Applications –
- Commercial and residential solar installation
- To charge laptops
- To charge digital cameras
- To charge mobile phones
- To power microwaves and fridges
- To power gardening features or outdoor lighting system

7.2 Polycrystalline solar panels

These panels are also called first-generation solar panels. It is called a polycrystalline solar panel because it is made up of monocrystalline silicon or polysilicon. It appeared to be square solar wafers and it has blue with a speckled look. It is manufactured by melting raw silicon, which is a less expensive and quicker procedure. So that the efficiency will be lower than monocrystalline solar panels. It occupies a very large space so that it will be helpful for large area owners.

- Efficiency rate -
- ~15%
- Dis - Advantages –
- Lower efficiency compared to monocrystalline solar panels
- Acquire large space
- Lower life span
- Advantages -
- Cheap
- Applications –
- It is appropriate for roof-mounted arrays and is used to supply electricity to nearby areas in huge solar farms.
- Used in traffic lights in rural areas, off-grid residences, and other applications

7.3 Thin-film solar panels

It comes under the 2nd generation of solar panels and it is mainly used in smaller solar systems and

some power stations. If you think the cost of other solar panels is very expensive then you can buy this solar panel which is very less in cost. But one main disadvantage is, it will give you very little efficiency. There are also certain advantages, such as excellent flexibility and resistance to high temperatures.

- Efficiency rate –
- ~7-10%
- Advantages –
- Low cost
- Easy to manufacture
- Very flexible
- Dis - advantages -
- Less efficiency
- Less lifespan
- Applications –
- It can be used in forest regions
- It can be used in solar farms
- It can be used to power traffic and streetlights
- It can be installed on the roofs of buses to power tiny equipment
- It can be used for Wi-Fi modems and fans, among other things.

7.4 Amorphous silicon solar cell

These kinds of solar panels are mainly in pocket calculators. It uses triple layered technology which is very useful for thin-film variety.

- Efficiency rate –
- ~7-10%
- Advantages –
- Cheap
- Made up of easily available and cheap materials.
- Dis – advantages –
- Less efficiency
- Applications –
- Used to power pocket calculators and watches.

7.5 Biohybrid solar cell

It is discovered by the expert team at Vanderbilt University and it is still in the research process. The main motto of this research process is to emulate the natural process of photosynthesis. And one of the great advantages is that there will be no power loss in the conversion of solar energy into electrical energy. The lifespan of this solar panel is very less (few weeks to nine months).

7.6 Cadmium telluride solar cell

It is named cadmium telluride solar cell because this technique uses cadmium telluride to produce cells at a very low cost with a payback time of less than a year. It requires almost the very least amount of water for production. It is having one major disadvantage such as it is toxic. Because of this reason only it is not advisable to use.

Efficiency rate –
~22.1%%
Advantages –
•Low cost
•Requires less amount of water for production
Dis - advantages -
•Toxic.

7.7 Concentrated PV cell

It gives more efficiency around 41% comparing to other solar panels. It has curved mirror surfaces and lenses which pay the way for greater efficiency.

Efficiency rate –
~41%
Advantages –
•Very high performance
•Greater efficiency
Dis - advantages -
•Solar tracker and cooling system are strictly required to gain high efficiency.

8. Upcoming Solar Energy Innovations

- Solar paint – it is the paint applied on the surfaces of the houses and takes energy from the sun and then converting into energy.
- Solar window
- Solar cars
- Solar roads
- Solar water (aka solar desalination process) steps.

9. Demand for Solar Energy

The International energy agency referred that solar energy will be going to rule the electricity world in the future. And it is estimated that it will grow around 13 to 15% after 2020. It is more cost-effective when compared to other energies. The demand for coal is going down drastically, it clearly shows that the demand for other energies will increase slowly in upcoming years such as solar energy.

Conclusions

The International energy agency referred that solar energy will be going to rule the electricity world in the future. And it is estimated that it will grow

around 13 to 15% after 2020. It is more cost-effective when compared to other energies. The demand for coal is going down drastically, it clearly shows that the demand for other energies will increase slowly in upcoming years such as solar energy. From the current study, any author can understand the importance of solar energy and the source of energy created for a better understanding of renewable energy as Solar energy. The currently available solar panel categories are discussed and each panel type with its feature is discussed from a technical as well as economic point of view. This can help the investor and researcher for better understanding.

References

Journals

[1]. Wei Wang, Ming Li, Reda Hassanien Emam Hassanien, Yunfeng Wang, Luwei Yang., 2018, 'Thermal Performance of Indirect Forced Convection ISPVTCD and Kinetics Analysis of Mango', Applied Thermal Engineering, Vol. 134, pp. 310-321.

[2]. Merlin Simo-Tagne, André Zoulalian, Romain Rémond, Yann Rogaume., 2017, 'Mathematical modeling and numerical simulation of a simple solar dryer for tropical wood using a collector' Applied Thermal Engineering, Vol. 131, pp. 356-369.

[3]. Ilhem HAMDI, Sami KOOLI, Aymen ELKHADRAOUI, Zaineb AZAIZIA, Fadhel Abdelhamid, Amenallah GUIZANI., Experimental study and numerical modeling for drying grapes under solar greenhouse. 10.1016/j.renene.2018.05.027.

[4]. Wengang Hao, Yifeng Lu, Yanhua Laia, Hongwen Yub, Mingxin Lyu., Research on operation strategy and performance prediction of flat plate solar collector with dual-function for drying agricultural products., 10.1016/j.renene.2018.05.021.

[5]. Ali Heydari, Mehrdad Mesgarpour., 2018, 'Experimental analysis and numerical modeling of solar air heater with helical flow path' Solar Energy, Vol. 162, pp. 278–288.

[6]. Sumit Tiwari, G.N. Tiwari., Energy and exergy analysis of a mixed-mode greenhouse- type solar dryer, integrated with partially covered N-PVT air collector., 10.1016/j.energy.2017.04.022.

[7]. M. Chandrasekar, T. Senthilkumar, B. Kumaragurubaran, J. Peter Fernandes., Experimental investigation on a solar dryer integrated with condenser unit of the split air conditioner (A/C) for enhancing drying rate. 10.1016/j.renene.2018.01.109.

[8]. Prashant Singh Chauhan, Anil Kumar, Chayut Nuntadusit, Jan Burnout., Thermal modeling and drying kinetics of bitter gourd flakes drying in modified greenhouse dryer. 10.1016/j.renene.2017.11.069.

[9]. D.V.N. Lakshmi, P. Muthukumar, Apurba Layek, Prakash Kumar Nayak., Drying kinetics and quality analysis of black turmeric (Curcuma caesia) drying in a mixed-mode forced convection solar dryer integrated with thermal energy storage. 10.1016/j.renene.2017.12.053.

[10]. A.K. Karthikeyan, S. Murugavelh., 2018, 'Thin-layer drying kinetics and exergy analysis of turmeric (Curcuma longa) in a mixed-mode forced convection solar tunnel dryer'Renewable Energy, Vol. 128, pp. 305-312.

[11]. Jin-Hee Kim, Jun-Tae Kim, Performance Analysis of Roof-Integrated Water-Type PVT Heating System International Journal of Smart Home, Vol. 10, No. 3, (2016), pp.301-314.

[12]. Amna A. Alzaabi, Nadine K. Badawiyeh, Hind O. Hantoush, A. K. Hamid, Electrical/thermal performance of hybrid PV/T system in Sharjah, UAE, International Journal of Smart Grid and Clean Energy,(2014),385-389.

[13]. Rajesh Choudhary, Deepak Khurana, Aditya Kumar, and Sudhakar Subudhi, Stability analysis of Al2O3/water nanofluidsJournal of experimental nanoscience, 2017, 1745-8099.

[14]. Y. Khanjari, F. Pourfayaz, A.B. Kasaeian, Numerical investigation on using of nanofluid in a water-cooled Photovoltaic thermal system, Energy Conversion and Management, 122 (2016) 263–278.

[15]. Anuj Kumar Sharma, Arun Kumar Tiwari, Amit Rai Dixit, Characterization of TiO2, Al2O3and SiO2, Fluids, Materials Today: Proceedings, 3 (2016) 1890–1898.