

Renewable Energy: World's Most Required Technique for Electricity

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Abstract

In recent world, the fossil fuels have been used in various sectors to generate energy. But the fossil fuels are very limited with limited supply for fulfilling the needs of human being. So, using renewable sources is a better option to accomplish and generating desired amount of energy. Renewable energy can be generated from renewable sources which are constantly renewed by our nature like the sun, the wind, water, the Earth's heat and plants. These sources can be turned from fuels into usable form of energy. The source of major amount of electricity may be can surely in renewable sources. This review article explains the brief introduction of renewable energy with its types and merits-demerits. It also explains the conversion of the renewable energy into usable electrical energy with brief introduction of solar cell and its various generations. It also gives the ideas about the advantages and future scope of the conversion of the renewable energy into usable electrical energy.

Keywords: renewable energy, conversion of energies, solar cell, generation of solar cell, solar energy

1. Introduction to renewable energy

The resources which renew themselves with the course of rain, wind, tides, sunlight, geothermal heat and waves are basically renewable resources and from that we can obtain renewable energy. Renewable energy sources and appreciable chances for efficiency of energy persist on vast areas, opposite to the other sources of energy which are restricted to some fixed countries. The diverseness of technology, efficiency of energy and fast implementation of renewable energy results in financial profits and security of energy. The pollution occurred by the burning of the fossil fuels, reduction of premature deaths in children and saving of health cost related to that, all these can practically be implemented all over the world is due to these factors only.[1].

1.1 Renewable energy sources and potential energy supplies

Some sources of renewable energy which are being vastly used, are as following: [2,3]

Solar energy: As we know solar energy is biggest nature's gift to us which is a source of heat and light, that we get from sun. We use this energy to various types.

Wind energy: We can use wind energy to generate electricity by the air which creates kinetic energy while in motion. This kinetic energy then converts into electrical energy by the use of turbines and wind.

Geothermal energy: This is a kind of thermal energy which is produced inside the earth. This energy measures the matter's temperature. The origin of geothermal energy is the generation of the planet

and decay of radioactive materials.

Biomass: The energy generated by living or once living organisms is called as biomass energy. The sources of biomass energy are plants such as corn, soy, etc. The heat energy produced after burning the residuals of living organisms is further transformed into electrical energy.

Hydroelectric power: The hydroelectricity can be obtained from harnessing the energy of water which should be flowing or in motion while harnessing electricity.

Ocean power: This is the renewable form of energy drawn from the ocean or sea. The energy is obtained from tides, waves, etc.

Definition of potential: It is necessary to elaborate the kinds of potential in order to access renewable sources of energy. Due to the broad classification of potentials, single definition is not sufficient to define them. There are five categories of potentials:- [4,5]

Theoretical potential: This potential takes highest position in comparison to others. This potential focus on the limitations in terms of nature and climate.

Geographical potential: Maximum source of energy consists of the geographical limitations like usage of land for covering which can decrease the theoretical potential. This is like the theoretical potential restricted due to geographical sites.

Technical potential: The potential of geography is then lessen because of some technical restrictions like efficiency of conversion, getting the technical potential as result.

Economic potential: This type of potential is a technical potential which is observed as competitive.

Market potential: In this category, the net renewable energy which can be applied in markets considering the requirements of energy, technology, prices of renewable energy sources and challenges, is taken. Indeed the chances are inclusive, that market potential can be more than the economic potential but due to challenges and obstructions the market potential is less. So, we are able to define the technical potential as the overall quantity of energy which is generated is the primary source, the social and the geographical problems and the practical deprivation in transformation process. The decision was taken to only count the distribution of cost for electricity which is renewable due to the deficiency of data for renewable fuels and heat.^[6]

2. Renewable Energy Conversion Technologies

Renewable energy conversion technologies are mentioned below^[7].

- 1) Solar energy conversion technologies.
 - Photovoltaic cells.
 - Concentrated solar power.
 - A) Parabolic trough system.
 - B) Solar disc system.
 - C) Power Tower System
- 2) Biomass energy conversion technologies.
 - Biochemical platform (sugar).
 - Biogas platform (anaerobic digestion).
 - Thermochemical platforms.
 - A. Gasification
 - B. Pyrolysis
 - Carbon rich chain platform (biodiesel).

- 3) Geothermal energy conversion technologies.
 - Dry steam plants.
 - Flash power plant.
 - Binary geothermal plants.
 - Binary/flash combined geothermal plants.
- 4) Hydropower conversion technologies.
 - Mini hydro.
 - Small and large-scale hydropower plants.
- 5) Wind energy conversion technologies.
 - Tiny wind machines.
 - Shoreward wind turbines.
 - Inshore wind turbines.
- 6) Ocean energy conversion technologies.
 - Tidal head energy.
 - Energy of waves.
 - Energy of ocean and tides.
 - Thermal energy conversion of ocean.
 - Gradient of salinity/osmotic energy.

3. Merits and demerits of renewable

1. Merits of renewable ^[8]

- Renewable energy is eco-friendly.
- It is safe and clean form of energy to use.
- Renewable energy will never run out.
- It has stabilized global energy prices.
- It requires less maintenance.
- Lower reliance on foreign energy sources.
- Renewable saves money and can be profitable.
- It can also be used to recycle our waste products.

2. Demerits of renewable ^[8]

- The electrical generation capacity is still not large enough.
- There are so many geographical limitations.
- It is not always a commercially viable option.
- It still generates some amount of pollution.
- Renewable technologies can take a lot of space.
- Requires a huge upfront capital outlay.
- Expensive storage costs.
- Low efficiency levels.

4. Role of renewable world energy and electricity supply

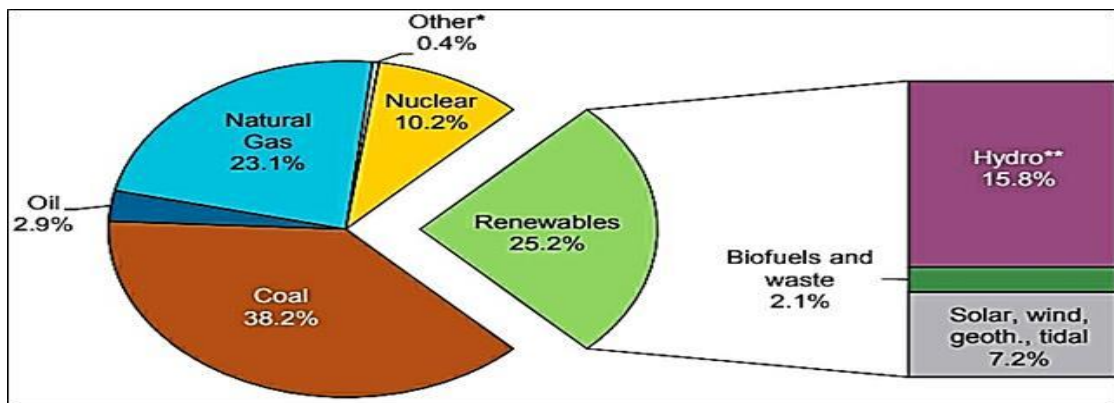


Fig1: Fuel share of world electricity production (2018)

Hydroelectricity provides almost all the electricity (renewable). It produces 15.8 percent of the world's total electricity and 62.9 percent of the world's total renewable energy. The other sources of energy like geothermal, tidal, solar, wind, all together contribute 7.2 percent to the total generation of renewable electrical energy although a sharp increase in contribution to 28.8 percent was observed in 2018. Other sources including biofuels, waste, etc. contribute in producing very less proportion of world's energy i.e., only 2.1 percent.[9]

World sectorial consumption of renewable (2018)

The largest contribution in generation of electricity in the world is of renewable resources. It was estimated in 2018 that renewable resources contribute around 25.2 percent to the total energy production. This has its position after coal, gas, nuclear fission and oil. The availability of natural gas and renewable sources is determined by various factors like weather conditions. There has been the formation of such policies which favors renewable

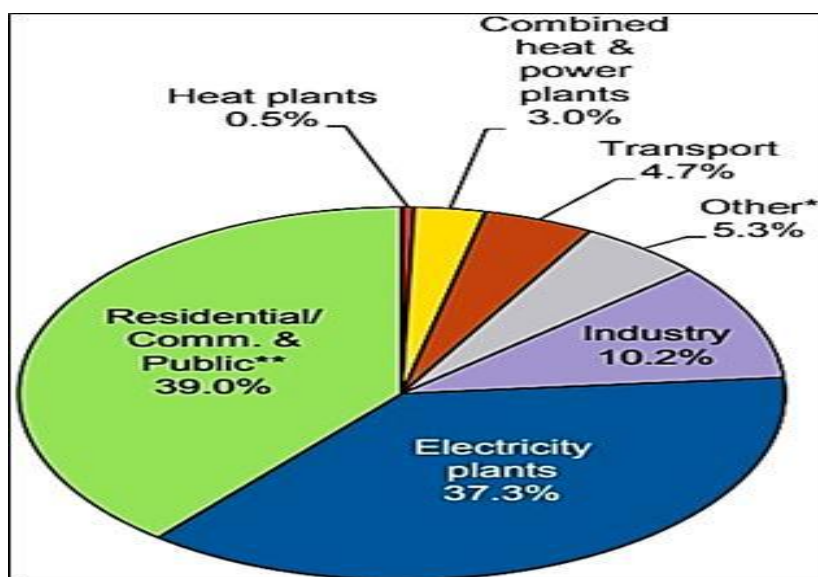


Fig2: Renewables consumption of world sectoral (2018)

energy sources over fossil fuels. This has also led to the increasing importance of renewable sources for electricity production in world.[10,11]

5. Types of renewable energy

a.) Biomass energy

Biomass is basically generated by the organic matter that is the remains of dead animals and plants. It comprises all the vegetation and plants which are on land, also it includes sewage, waste of animals, agricultural wastes and specific types of wastes from industries. Biomass is a wonderful resource which is having carbon element, and of course it is not produced from any artificial process. This resource rapidly taking over on fossil fuels. Firstly the solar energy is utilized by plants to carry out the photosynthesis process then as the result of the complex processes that happens later, these organic compounds are converted into biomass. Then that biomass is transformed into biofuel and is utilized for heat energy. The operative working is required for this process and the heat energy is converted into electrical energy. Biomass provided us large amount of energy. In rural areas, fuelwood production and its marketing provide employment to nearly 2.5 million people in the world. In the rural Indian sector, 40% of the energy demand is met using fuelwood and 28% by crop residues and other biomass sources. Around 6000 MW power is produced from nearly 370 million tones of waste of agriculture. [12].

b) Hydropower

The kind of energy is also a typical form of renewable energy, it has complete dependency on the movement of water usually free fall from higher to lower surface of land which then produce the potential. There should be a conversion from this potential into the electrical energy, which can only happen if that moving water is able to transform this hydro into mechanical energy by a process of driving a hydraulic turbine. After that with the help of generator, the mechanical energy gives the electrical energy after conversion. There is a simultaneous process of conversion and consumption of electric energy from hydro energy. No doubt the hydro power has more advantages than thermal power in terms of production.[12]

In early 19th century, human used this energy from falling water as only mechanical energy but later than that the hydro energy started using in the form of electrical energy also. There are 150 countries which are generating hydro power, in fact hydro power acquires 15.8 percent of generation in the whole world for the year 2018. In comparison to thermal plants, the efficiency of hydro plant is very large, nearly around greater than twice.[13]

c) Geothermal energy

Geothermal means heat from earth, the generated steam and hot water inside the earth can be used for heating purposes or even produce electricity. Geothermal energy comes in the category of renewables, this is due to heat which is constantly generated inside the surface of earth. A geothermal plant which is used to withdraw the steam and hot water towards the surface. The steam which is produced from this hot water is further used to run the turbine, the turbine is connected with generator to produce electricity. The emissions through the geothermal plant are negligible, since there is no burning of anything. These plants clean the impurities in the steam like hydrogen sulphide from the scrubber system. After using the steam and hot water, they immediately given back to the

earth. There are 26 countries using Geothermal electricity and 70 countries which are using geothermal heating. In year 2019 geothermal power plants produced 13,930.58 MW of electricity^[14,15].

d) Wind energy

Wind energy is also an original and pure source of renewable energy due to the use of wind energy, the reliability on only fossil fuels is reduced. Wind is a kind of solar energy only as it gets renewed from the sun. This can be said that production of power is required when we are not using the turbine. These days the power stations of fossil fuels provide the back up or stored power for this. For producing wind energy, wind turbine including components as the blades of rotor and rotor itself, combination of hub, gearbox, the shaft, transmission, main frame, protection for over speed, nacelle, electric generator, drive of yaw tower is used. A wind turbine is not a self-sustainable power station. If we enhance the quantity of turbines, then more back up will be required, to maintain the electricity system. There are some obstructions for this because power stations would be able to give not much electricity in comparison to earlier. Though the importance of wind energy will always be there for the welfare of living beings because it is generated in a neat way without creating any kind of exhaustion and pollution after using the new technology tools.^[16]

e) Ocean energy

Mainly two kinds of energies are produced by ocean: The energy we get from the heat of sun and the energy we get from the high waves of ocean. Oceans can trap the sun rays at maximum since it covers 70 percent of the total area of earth. When the surface of oceans traps the rays of the sun, the temperature of surface rises with comparison to the deeper sea, this difference of temperature generates thermal energy. This little part of sun rays by the oceans, can be used worldwide. When this thermal energy is generated in the ocean is worldwide known as Ocean Thermal energy Conversion (OTEC). This technique uses this difference of heat at the upper surface and the deeper layers of the ocean to drive the engine and generate the electricity. There is lot of difference between the mechanical energy and thermal energy of ocean. Despite that the ocean activity is affected by sun, and the moon controls the tides by its gravitational force and the waves are responsible for the wind. So, this can be said that waves and tides are very fragmentary sources and the constant source of energy is ocean.^[16]

f) Solar energy

The total energy of the sun which falls on the surface of earth is nearly equal to 173,000 terawatts which is a very huge amount of energy, nearly 10,000 times of the total consumption of energy in the world. The sunlight can be grabbed as a source of renewable energy and used in number of methods, it is indeed our future energy source. The sun, that is composed of 73.4% hydrogen and 25% helium gas and remaining 1.6% of other gases like carbon, neon, nitrogen, silicon, oxygen, iron and sulphur contribute for earth than giving light during the day, every photon which is basically a small element of sunlight that falls on our earth and giving energy like fuel. The solar radiations, our weather and all the sources of energy of the planet, there is one origin for all these, which is solar energy. In the duration of an hour, the amount of solar rays spread all over the earth is approximately equal to the energy requirements of the world for a whole year. Our sun is no doubt a master for nuclear reactions. A huge amount of energy is generated in the core of the sun due to nuclear fusion

reactions. Concentrated solar power and photovoltaic cells are used to process the solar energy into electricity. Therefore, these cells are indeed suitable for projects of electricity of low category. This concentrated solar power transformed the light of sun into heat energy and further into electrical energy. Therefore, electricity generation is the only use of this but in large scale through installation of solar devices^[17].

6. Conversion of solar energy to electricity

1. Photovoltaic cell

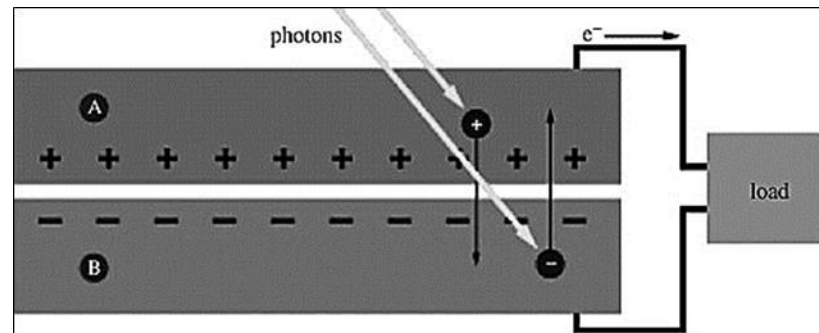


Fig3: Conventional photovoltaic device

The charge of mobile carrier is negative in the upper layer because of electrons and n-doping while the charge of mobile carrier is positive in the lower layer because of the holes present and p-doping. When two materials get in touch with each other then the n-doped silicon edge (A) becomes extra positively charged and the facing p-doped silicon edge (B) becomes extra negatively charged, this happens as a consequence of the shifting of electron and holes over the junction. The electric field thus generated has a crucial functioning in the photovoltaic energy conversion. The electron – hole pair can be produced with the assistance of sunlight as the absorption of sunlight give rise to the movement of electrons from valance band to the conduction band of the silicon. The n- type Si and p-type Si differ from each other in terms of the minority carriers, n-type Si possesses holes as the minority carrier and p-type Si possesses electrons as the minority carrier. The minority carriers integrate with the oppositely charged majority carriers in a very minute stretch of time hence their life span is also momentary. The solar photovoltaic arrangement is obtained by connecting the separated solar panels jointly in a series, which also help in assembling the electric charge. The fused array combiner is formed when numerous strings of solar photovoltaic array cables are brought to an end in an electrical box. The fuses are purposely made to safeguard and shield the module cables and links that supply energy to the inverter, and the fuses generally placed in combiner box. The DC(Direct Current) is produced in the inverter initially which is transformed into the AC(Alternating Current) for its utilization in work. The electric field show attractive interaction toward the minority carriers over the junction and as a result of its this property, electric field assist in accumulating photo induced carriers which produces a net photocurrent. Photocurrent needs the presence of field for its flow so the peak photo-voltage can be produced by the device which have the ability to equate the potential difference generated in the dark at p-n junction. The electricity flowing in two directions (towards and from the electricity projects) can be estimated by the net photocurrent meter. The electricity projects have a important role to play. They are executed on the rainy and cloudy days

or overnights when the solar cells and panels loose the capacity to catch required sunlight for generating electricity. The enough energy produced in day time by absorbing good amount of sunlight can be used in such cases.[18,19]

2. Concentrated solar power

This plant transformed the solar energy into heat of enhanced temperature and generate electricity, by use of different mirror orientations. The heat is then channeled by a usual generator. The whole panel comprises of two parts: the first one accumulates sun's energy and transforms it into heat, and another one that transforms it into electric energy. The technologies mainly progressed globally are Parabolic trough systems, Solar dish systems, and Power Tower Systems, every system having different types of orientations. There is a complete dependence of the total quantity of processed power from a solar plant which is concentrated on the quantity of sunlight falling directly just same as intensive photovoltaic concentrator or concentrator. The condition for this technology is that the sunlight should be intense, instead of being scattered.^[20]

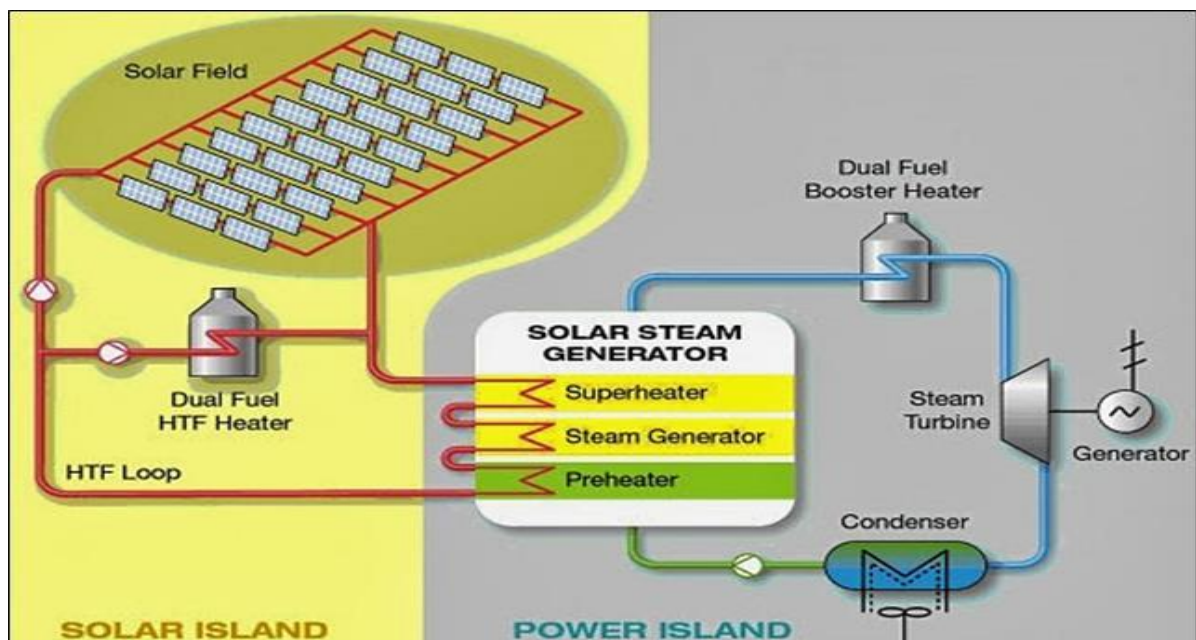
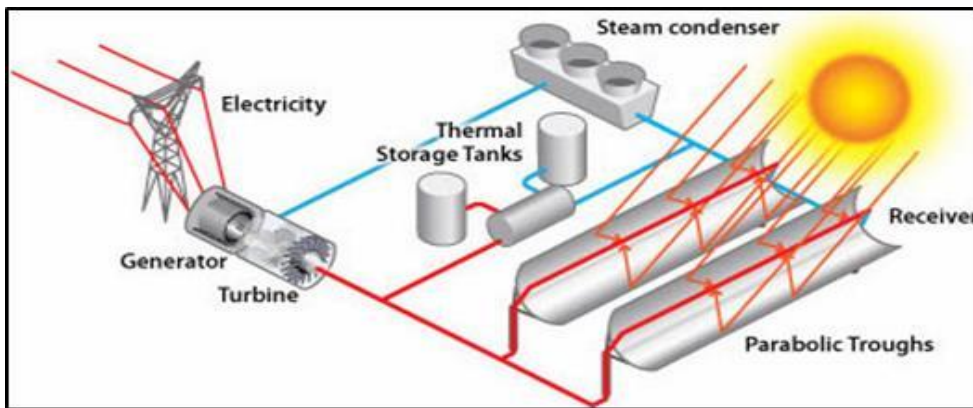


Fig4: Concentrated solar power method

- a) **Parabolic trough systems:** The solar energy is focused through a curve like parabola, trough shaped reflectors on a host pipe fitting along the interior of that parabolic curve. From this generated energy, the oil gets heated which is flowing in the pipe and electric energy will be produced from that heat energy in traditional generator of steam.

Fig5:Parabolictroughsystem



An accumulator consists number of ducts in corresponding rows in the direction north to south. This orientation exhibits the one-axis ducts to follow the sun which is look like moving in the direction east to west in day time to confirm that receiver pipes should focus the sun. Individual duct system recently can produce around electricity of 80 megawatts. The design of ducts can edit the setting of thermal storage. Recently, all parabolic ducts plants are hybrids, it means in the shortage of sun rays, they use the fossil fuels. Basically, a steam boiler of gas is used, ducts can be combined with contemporary coal-fired plants.[20]

b) Power tower systems: The power tower set up transforms sun rays into neat electric energy for electricity grids of world. This technology uses number of mirrors which are capable to track the sun rays to concentrate an acceptor at upmost of the tower. A liquid which transfers heat in receiver is used to produce steam is used to make traditional generation of turbine to produce the electricity.[20]

c) Solar dishsystems:This dish of parabolic shape comprises of a point which is also has a shape of parabola towards the concentrator in some type of dish which reflects the solar rays at receiver placed at the point of focus. This type of concentrators are placed on a skeleton with a bi-axis tracking system to catch the sun. ^[20].



Fig6:Parabolicdish

This accumulated heat is basically used as it is by heat engine placed on the host commutingthrough the dish skeleton. For power conversion Brayton and Stirling engines are recently used. Projects of customizablesystems have been realized with overall capacities up to 5MW energy. 30 percent

overall efficiencies have been accomplished by the modules with maximum sizes^[21]:

1st Generation photovoltaic cell

This cell is having a huge area, a crystal, a p-n junction diode, which is able to producing efficient electric energy from sources of light with the sunlight's wavelength. The technique of diffusion process is used with silicon wafers. This technology which is silicon wafer based is a huge technology in industrial generation of solar cells, greater than 80 percent of the solar market comprises of this.^[21]

2nd Generation photovoltaic cell

This type of cells is reliable on the use of a sleek multilayer depositions of semiconductors on wafers which is matching of the lattice. There are two types of multilayered photovoltaics-terrestrial and open land. The AM0 efficiency are higher in space cells but costly on basis of per watt. The part of thin film has been flourished by the use of less cost processes, the only thing is they have low efficiency (AM0) i.e. only 7-9 percent. There are some technologies like micro-crystalline, amorphous silicon, cadmium telluride etc. Since it is having reduced mass, so it permits segments materials which are flexible. These days the solar cells which are of second generation comprises of a small sector of market of photovoltaics in terrestrial field and huge amount i.e.90 percent of market in space.^[21]

3rd Generation photovoltaics' cell

These cells are considered extremely different from the other devices because they are not depending on old p-n junction to separation of charge carriers which are photogenerated. For applications in space the devices of quantum well like quantum ropes etc. and the set-up which editing Nanotubes of carbon are investigated by a potential till 45 percent AM0 efficiency of production. For the innovations of terrestrial purpose, the new set ups including photo electrochemical cells, Nanocrystal solar cells, polymer solar cells and even Dye sensitized solar cells are quite the area of good research. [22].

4th Generation photovoltaic cell

The theoretical production of the solar cells comprises of a technology which is blended type, in this polymer having Nano-particles are combined to generate one layer of multi spectra. After that a sleek layer of multi spectra are combined to build a solar cell of multi spectra having low cost and much efficient in quality, which makes kit a high technology device which is multifunctional. NASA and mission of Mars also used this technology. The coating that transforms different types of light is first, then another layer for the light that passes and last is an infrared spectrum layer for the cell- thus converting some of the heat for an overall solar cell composite. Following is the history of major innovations in the field of solar energy is available in tabular form^[22]:

6. Advantages and disadvantages of solar energy:

Table 1-Solar energy: Advantages and disadvantages

Advantages	Disadvantages
It's a source of renewable energy	Comparatively higher costing
Deprivation in electricity bills	Reliability on weather
Vast in applications	Storage is also expensive
Low Maintenance Costs	Occupies a Lot of Space

6.1 Merits of solar energy

1. Renewable energy source

- If we look for the advantages of the panels for the solar energy, the most important thing is that solar energy is a truly renewable energy source. Renewable Energy often referred to us clean energy comes from the natural sources or processed that are constantly replenished. There are many renewable sources of energy. One which is most common is Solar Energy. It can be generated almost every part of the world and even we cannot run out the solar energy, as it has been predicted by the scientists that solar energy is with us at least for 5 billion years. [23]

2. Reduces electricity bills

For living all need Electricity and cost at which we all use receiving electricity is high. So, this solar energy which will hemmers Electricity will reduce our heavy bills and will even make us self-dependent. There is also a possibility to receive payments for the surplus energy that we export back to grid [22].

3. Diverse applications

The Energy generated can be used in the following ways –

- To produce Electricity in rural areas.
- To distill watering region with linked water supply.
- To power satellite in space.
- It can be integrated into the material used for building.

Sharp interdiction to transparent solar energy windows [23].

4. Low maintenance costs

Maintenance cost is low, as it is based on one-time investment fact, only cleaning of the ponds is required. They have high working potential and can work for 25-30 years. No wear and tear of panels is seen. Only inverse is there which heads to be changes after 5-10 years. So, considering the beginning charges they require very minimal maintenance cost [23]

5. Technology development

With the advancement of technology, there are many improvements in this field. Innovations and developments have been made in the field of quantum mechanics has appreciably enhanced the effectiveness of solar panels to generate double or even triple amount of electric energy [22].

6.2 Demerits of solar energy

1. Cost

The starting set up cost of solar panel system is too much. This is having some materials like solar panels, batteries, inverter, wire system, and the process of installation. No doubt, these technologies are developing regularly, so it can be expected that the costing should turn low in the coming time [23].

2. Weather dependent

Even though we are able to collect the energy in cloudy weather also but the efficiency of the energy will not that much satisfactory. So, these panels have a kind of dependency on the weather. Thus,

some cloudy weather can impact the system of this energy. It is also not possible to collect the solar rays at night. Looking at the other way, if we also need our water heating solution to work at night or during wintertime, thermodynamic panels can be considered as a substitute [23].

3. Solar energy storage is expensive

It requires continuous production and usage i.e. it cannot be stored easily. For the proper storage, heavy batteries are required and the batteries having high power are too much costly. It is a blessing to us that during the day only we are able to collect the required energy so well [23].

4. Uses a lot of space

As our energy requirements are higher so we need more panels to install on the roofs but there is a limited space on our roofs. This is suggested that installation should be done in the yards also, so there must be proper availability of sun rays at the yards also. If the proper space will not be available then we have to manage with the restricted amount of energy [22].

5. Associated with pollution

As all know that from the generation of solar energy, there is negligible pollution and harmful effects are there in comparison to other energy sources. But in the generation of photovoltaic cell panels there are some negative impacts in terms of pollution. Some harmful substances are released during the process of making these panels still solar energy is far better than other resources in terms of harmful effects.^[22]

7. Conclusion

Renewable energies stand first in terms of giving energy to living beings. The initial technologies are not so much flourished so that they can fulfill the energy needs. No doubt, industrialization do wonders in this matter, so that the generation and production of energy become at high levels like coal and other fuels. The proportion of usage of renewable energy is growing nowadays. Hydropower and the traditional biomass usage already productive factors in the combination of energy in the world, concerning the whole energy needs, although the renewable energy is working independently in the field of energy need in all over the world.

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