

# Solar Energy – The New Ray of Life & Hope for Mankind

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**Abstract - Ever since our forefathers inhabited the earth about 2,00,000 years ago, we have pillaged and plundered this once virgin planet with abundant flora and fauna and brought it to the brink of extinction with hardly a thought for posterity or how they will survive in this manmade barren wasteland. In the name of industrialization, and urbanization, we have plundered the forest wealth, fossil fuels, changed the course of rivers leading to severe water shortage, created giant industries and thermal power plants leading to steady global warming. The situation has now reached alarming proportions calling for immediate remedial measures. Switching over to renewable energy sources and a cutback in the use of fossil and nuclear fuels is now being done on a war footing with every country trying their best to bring down carbon emission. A progress shown by the major players are indeed highly encouraging and holds high promise for the future of our planet. By the year 2050, mother earth will be a better place to live in if every country meets the emission norms given in the Paris Agreement of 2015.**

**Keywords: Climate Change, Carbon Emission, Global Warming, Kyoto Protocol, Paris Agreement, Renewable Energy, Sustainable Development, Solar Energy, Solar Power**

## I. INTRODUCTION

Ever since the latter half of the twentieth century, scientists from various fields of science have been giving warning at regular intervals on the need cut down on carbon emissions and global warming but it largely fell on deaf ears. At this juncture, both China and the US were the biggest pollutants in that order. The urgency and desperate need to avert a certain manmade disaster in the making made the United Nations pass the Framework Convention on Climate Change. An international agreement linked to this, called the Kyoto Protocol was adopted in 1992 which commits the member countries for reduction in emission according to targets fixed in the agreement. 192 countries have ratified the agreement. Only Afghanistan, Sudan and USA have not signed it. The Paris agreement brought out by the United States in 2015 was to be a voluntary fixation of climate targets by countries both developing and developed. Since the agreement was a voluntary one, all the countries signatory to it, chose the minimum possible targets. Ironically, US, who piloted the agreement has since backed out of it, making a mockery of United Nations Framework Convention on Climate Change (UNFCCC).

## II. PRESENT SCENARIO

### CHINA

By the eighties the pollution was so severe in China that about 1.80 million people died every year due to respiratory ailments and organ failures. The public started to react vehemently to the heavy pollution and the Chinese Govt. which had been relying on thermal plants for electricity, started to go in for wind and solar energy in a big way. They also stopped their plan to add another 75 coal based power plants for their energy needs.

China is now the world leader in wind power generation with installed capacity of 174 GW as on 2018. The capacity is expected to touch 250 GW by the year 2020. The Chinese Govt. has set an ambitious target of 400 GW of wind power by 2030 and to reach 1000 GW by the year 2050. More importance is now being given to generation of solar energy. China has set itself a target of 1300 GW of solar energy generation by 2050. As on 2018 the world's largest solar power plant is in China with an installed capacity of 1547 MW. China is now experimenting with laying roads made of special solar panels to generate solar power without occupying additional space.

**UNITED STATES OF AMERICA**

United States is the second largest producer of solar power with annual installed capacity of 85.3 GW as at the end of 2018 including both Solar Photovoltaic Power (SPP) and Concentrated Solar Power (CSP). US was one of the first countries to conduct research on solar energy and ways to harness the power of the sun. Much research has also gone into the manufacture of photovoltaic and concentrated solar power (CSP). US has the oldest solar thermal power plant, the SEGS in California with an installed capacity of 354 MW. It also has the biggest solar thermal power plant in the world, the Ivanpah Solar Power Facility with installed capacity of 392 MW in California. The other major solar power plants in the US are:

1. 579 MW Solar Star in California
2. 550 MW Topaz Solar Farm in California
3. Copper Mountain Solar Facility with 552 MW installed capacity in Nevada
4. Desert Sunlight Solar Farm 550 MW in California
5. Solana Generating station with installed capacity of 280 MW in Arizona

There are several other smaller solar power plants scattered across the US apart from the fast growing rooftop solar plants of individual citizens and big businesses like Amazon.com, Macy’s, IKEA, General Growth Properties, Costco Wholesale, Kohl’s, Apple, Prologis, Walmart, and Target.

US refused to agree in principle to the KYOTO Protocol and was not a signatory to it. Even though the Paris Agreement of 2015, which was of its own making and a watered down version of the Kyoto Protocol, the US later walked out of the agreement along with Syria and Nicaragua. Both the latter countries later became signatories to it.

However, it is heartening to note that though the US administration is not keen on carbon reduction, the nation as a whole is going ahead full steam with increasing use of solar energy. Apart from several advantages like carbon reduction, reducing global warming and preserving the

ecosystem for future generations, the solar power industry gives employment to thousands of people across the US. According to data published last year by Bloomberg, solar industry has employed more than 350,000 workers, more than twice the number working for coal and oil based power producers. Several other small and medium solar power plants are also in the pipe line and the total solar power production is expected to exceed 500 GW by the end of 2025.

**INDIA**

India, the third largest producer of solar energy was a slow starter but has more than made up for it with a vigorous effort in solar energy production since the second decade of the twenty first century. As on 2018 the total installed capacity in India was 67.4 GW. From 2650 MW as on 2014, there has been a 250% increase in solar energy capacity installed. The Central Government has announced a series of incentives and subsidies to encourage industries and private citizens to take up power generation at rooftop and ground levels. PV panels manufactured by various companies are offered for installation at a subsidized cost on turnkey basis by Govt. Agencies of various states. Thus both the Centre and the states are providing incentives for installing solar panels and other solar products like lanterns, cookers etc.

In 2015 almost one million solar lanterns were sold in India, thus reducing the need for costly kerosene. The same year 1.20 lac home lighting systems were installed and 1.40 million solar cookers were distributed. Under a national programme, almost 47000 street lighting installations were provided to various states to reduce the use of conventional energy. India is having tie up with major international agencies for promoting and developing solar energy and products with the latest available technologies to ensure reduction in production and development cost, thereby increasing the use of solar energy. States which have developed the use of solar energy based on their installed capacity in Mega Watts as on 31.03.2019 are:

Sl.No	State	As on 31.3. 2015	As on 31.3. 2016	As on 31.3.2017	As on 31.03.2018	As on 31.03.2019
1	Rajasthan	942.10	1269.93	1,812.93	2,310.46	3,226.79
2	Gujarat	1,000.05	1,119.17	1,249.37	1,344.69	2,440.13
3	Madhya Pradesh	558.58	776.37	857.04	1,210.11	1,840.16
4	Maharashtra	360.75	385.76	452.37	763.08	1,633.54
5	Tamil Nadu	142.58	1,061.82	1,691.83	1,819.42	2,575.22
6	Andhra Pradesh	137.85	572.97	1,867.23	2,165.21	3,085.68
7	Telangana	167.05	527.84	1,286.98	2,990.07	3,592.09
8	Uttar Pradesh	71.26	143.50	336.73	550.38	960.10
9	Karnataka	77.22	145.46	1,027.84	1,800.85	6,095.56
10	Punjab	185.27	405.06	793.95	905.64	905.62

Other states are also entering the solar team and are expected to contribute their mite in overall development of

solar energy in the country. The major solar power plants in the country are:

1. **Kamuthi Solar Power Project, Tamilnadu – 648 MW**
2. **Charanka Solar Park, Gujarat – 221 MW**
3. **Welspun Solar MP Project, Madhya Pradesh – 151 MW**
4. **ReNew Power, Telengana – 143 MW**
5. **Sakri Solar Plant, Maharashtra – 125 MW**

Some of the biggest solar parks in the world is being constructed in India and when completed India will be a solar force to reckon with. The Pavagada Solar Park in Karnataka with an installed capacity of 2000 MW will be the biggest in the world when completed. 14 more such parks are under various stage of construction. By the end of 2025 the installed capacity is expected to touch 275 GW. India has two major firsts to its credit. The first is the one and only airport, Cochin International Airport in Kochi, Kerala fully powered by solar energy. The second is the fully solar powered railway station in Guwahati, Assam. India's largest floating solar power plant was installed at Banasura Sagar Reservoir in Wayanad, Kerala.

### JAPAN

The next industrialized nation to take to renewable agency is Japan with 63.3 GW of installed solar power as on 2018. Japan has taken to solar energy in a big way since 1990 and the urgency has more than doubled since the Fukushima nuclear disaster of 2011 when all 50 nuclear plants in the country were shut down pending safety certification by Government Inspectors. Japan is now trying to increase solar power by giving subsidies and paying twice the standard electricity charges for on-grid solar power produced by house owners and businesses. Kyocera Corporation of Japan has installed the biggest off shore solar power plant in reclaimed land abutting Kagoshima bay in Japan and it is claimed to have the capacity to power almost 22,000 homes. Japan is also producing 45% of all Photovoltaic panels produced in the world.

Shimizu Corporation of Japan has presented plans for the biggest ever solar power plant. They aim to erect solar panels encircling the moons equator and transmit the energy thus produced to earth via microwaves and lasers. The installed capacity as per the proposed plan is a mind boggling 13,000 terawatts of electricity per year, roughly more than 3 times what the US produces in a year. The added advantage is that they do not have to worry about cloudy days ever, but the cost of the project has not been mentioned so far. Meanwhile, In a small area which is densely populated and mountainous, Japanese are finding it difficult to find sufficient space to install photovoltaic panels. They are overcoming this problem by building small, medium and large solar installations offshore. This is to take care of the immediate energy needs till the 'lunar' power starts flowing.

### GERMANY

As on 2018, Germany is the fifth largest producer of solar energy in the world with 48.4 GW of installed capacity. It has been rightly called "The world's first major renewable energy economy." As early as 2014, Germany achieved an enviable national record by supplying 50% of its electricity requirement. Germany is also producing 4.85 GW from Bio-mass and 2.40 GW from hydro power. Germany has 1.7 million off grid solar systems all owned by its citizens. This in effect means that these households produce at least

75% of their annual power needs free of cost and pay only for the balance. At present, almost 60% of all energy needs of Germany are being met by renewable energy sources.

The ultimate target of the Government is to increase the level of renewable energy produced to 80% of total power generated by the year 2050. Germany is even now producing more electricity than it needs at times and the surplus is sold to neighboring countries. Germany exported a record surplus of 34 TWh in 2014. An added advantage for Germany is that the renewable industry has given rise to more than 3,70,000 employment particularly in small and medium industries. The renewable energy sector was benefited mainly by the Renewable Energy Sources Act with main focus on feed-in tariffs, a multi pronged incentive system for the producers, both citizens as well as businesses.

However, the main problem faced by Germany is that their PV panels are costlier as compared to Japan and US and therefore the cost per unit of electricity is also more. Attempts are now being made to enhance production with new technologies so as to bring down the cost of the panels and unit of electricity. They are however in no mood to give up the number one position they hold in the production of renewable energy in relation to total energy produced by them.

### ITALY

Italy is the sixth largest producer of solar energy in the world with total installed solar energy capacity of 22.6 GW. Previously the country used to meet its energy demand through imports, but by 2013 it produced 7% of its energy requirements through solar energy and stood first in the world. It was later overtaken by Germany in the matter solar energy produced in relation to total power production but was able to increase its own production by 8% during the period up to 2017. Italy has very favorable weather conditions for production of solar energy and the Government is planning to maximize utilization of this energy source in the days to come.

### UNITED KINGDOM

By encouraging commercial establishments, schools and homes to go in for solar energy, UK has emerged as an important player in the use of solar power. As on 2016, 3.4% of energy used by UK was produced by solar power and the Govt. hopes to increase this share to increase substantially by the year 2020. In fact 4 million homes are expected to use solar energy exclusively by next year. Govt. has also come out with a Feed-in-Tariff plan (FIT) by which the producer of solar energy is paid for producing and using solar energy. The FIT plan is expected to substantially boost solar power production to 22 GW by the end of year 2020. In the UK however, wind energy is the most significant contributor to renewable energy sources and solar energy is only second to it. It is for this reason that solar energy is developing slowly in UK. As the end of 2018, production of solar energy was to the tune of 14.2 GW.

### FRANCE

In 2016, both President of France and Prime Minister of India jointly laid the foundation stone at the headquarters of ISA (International Solar Alliance). This is an institution

working towards development of solar energy in the region lying between the Tropics of Cancer and Capricorn. France, with its thriving energy industry is fast becoming a leader in the field of solar energy production. By 2015 it had an installed capacity of 6.7 GW of solar energy and stood seventh in the world, a position it still occupies. France recently added 479 MW of solar power in the first half of 2018. During the year solar energy production grew by 59%. Installed solar power increased to 8.5 GW, and the self imposed target of 10.2 GW fixed for 2018 was exceeded by achieving 12.8 GW.

France and India have together pledged more than 2 billion US dollars for the development of solar power in the developing countries of South East Asia and Africa.

### AUSTRALIA

Australia has the highest solar radiation per square meter and as a result the solar industry is a fast growing one. Though slow to take off, it has an installed capacity of 12.2 GW of installed solar power by the end of 2018. Of this 3.35 GW was installed during the year 2017. From 2018 onwards Australia is adding 100 MW of solar power every month which is equal to adding 1 thermal power plant of 1200 MW every year. Another record to its credit is that it is going to be the first country to achieve the Solar Peak, a phenomena where the total power grid in the country is unable to distribute the solar power generated. The excess generated will go to waste if additional power grids are not established on a war footing.

### PAKISTAN

Pakistan was one of the late entrants to the production solar power, but economic troubles and stiff foreign competition saw the country stagnating in the production of solar power. However, at the end of 2013, it could boast of producing more than 3% of all power produced in the country through solar energy. During the next two years addition was made to the installed solar power in fits and starts. Though Pakistan is one of the Asian countries receiving the maximum sunshine, it could not be converted to solar power due to severe financial constraints and political upheavals. However through sheer determination to reduce carbon emission Pakistan is now trying to make up for the lost years to be able to compete with the rest of the world leaders in solar power production and utilization. As at the end of 2018 Pakistan boasted of 10.0 GW of solar energy production.

### III. FINDING

Though scientists, environmentalists and the United Nations have been warning major developed and developing countries of the world for almost half a century regarding the very high level of pollution being created by them, it largely fell on deaf ears. The seriousness of the problem was realized by all countries only by the last decade of the twentieth century. It is found that

1. Pollution exists in all countries in varying degrees based on their level of development.
2. Fossil fuels now being used extensively are fast depleting.
3. Serious health issues are now being reported from major metros due to heavy pollution of air and water.

4. Plastic waste pollution is another serious problem in the cities that is gaining gigantic proportions.
5. During natural disasters, solar energy is better suited to withstand the ravages than conventional energy because it is scattered over a large area like roof tops of buildings. Solar energy generation is also done from comparatively smaller power plants.
6. Last but not the least is the fact that though US is a major polluter of the earth they have backed out of the Paris Agreement of 2015 though the agreement itself was mooted by them.

### IV. SUGGESTIONS

1. Alternative sources of non-polluting and renewable energy must be harnessed to provide the necessary impetus for overall growth.
2. Since solar energy is available in abundance it can easily replace fossil and nuclear fuels.
3. Solar energy is seen to be the cheapest and cleanest for adoption by all countries. Solar energy has unlimited usages. The potential is so vast that no other form of energy is required to run a country.
4. Every industrial, commercial and domestic activity can be powered economically by solar energy.
5. An initiative should be taken by the Government in promoting the use of solar powered vehicles like car, bikes and also buses to bring down the high pollution levels in metropolitan cities.

### V. CONCLUSION

The rapid pace at which countries both big and small have embarked on installing and utilizing solar and other renewable energy is a welcome and hopeful sign for the future wellbeing of mankind. In most of the developed and developing countries the air and water are heavily polluted. Some major cities like Delhi in India have provided oxygen masks at regular intervals on the wayside to enable commuters and pedestrians to breathe fresh air. Carbon emission has reached a peak about a decade ago. However, sensible and timely action by the UN and world leaders have produced the Kyoto Protocol of 1992 and subsequently the Paris Agreement of 2015 under the aegis of UNFCCC which ensures that each country reduces its carbon emission as per undertaking given in the agreement. It is pertinent in this context to mention the case of Iceland, a country which runs totally on renewable energy, though not solar since there is hardly any sunshine. Instead they use hydropower (73%) and geothermal power (23%). They do not face any of the problems of pollution faced by rest of the world. Avenues for development and utilization of solar energy are unlimited. Any country receiving at least 200 days of sunshine a year can adopt solar energy in a big way. Wind energy can make up for any deficiency in power production. In a country like India, which receives sunshine almost throughout the year self dependency in the matter of solar energy is just a matter of determination. Govt. buildings, schools, colleges, factories, warehouses, commercial buildings, rivers, lakes, rooftops of houses, buses, trains, the list is endless. We only need to put our mind to the task to ensure that we achieve self sustainability in renewable energy by the year 2050. We can also use wind energy to augment our total renewable energy supply. The development of "Inkjet" solar panels by Polish scientist

Olga Malinkiewicz is about to revolutionize the solar power industry since it is far cheaper than the regular solar cells, can be fixed to almost any surface, is very inexpensive, and comes in various colors and degrees of transparency. Most of all it is capable of producing electricity in the shade or even indoors. Continuous R & D will bring down the cost of solar panels and components and thereby cost of power generated. The possibilities are therefore unlimited. Let the world unite in transforming the universe from the brink of destruction to a pollution free ecosystem where future generations can live happily.

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