Solar Energy: Energy for the Future

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ABSTRACT
Energy crisis is the most controversial issue that is dragging the concern of the world. The speed by which fossil fuels are depleting and the way they contribute to the greenhouse effect, people are looking up for a renewable and green source of energy. It therefore stands the reason for the developing countries whose energy consumption rate is increasing very fast should not only invest but also investigate for newer renewable energy based system. Sun is an obvious source of energy that is not only inexhaustible but also do not pollute the environment. Solar energy has attracted interest of masses as a source of heat. Solar power is the process of conversion of sunlight into electricity either directly by using photovoltaic or indirectly using concentrated solar power. Dramatically, it has never lived up to the potential to which solar energy is claimed to be either because of the lack of technology or because of its weather dependency. Hence, the result countries like Germany and Spain are the only countries producing more than 1% of their total energy consumption with the help of solar energy.

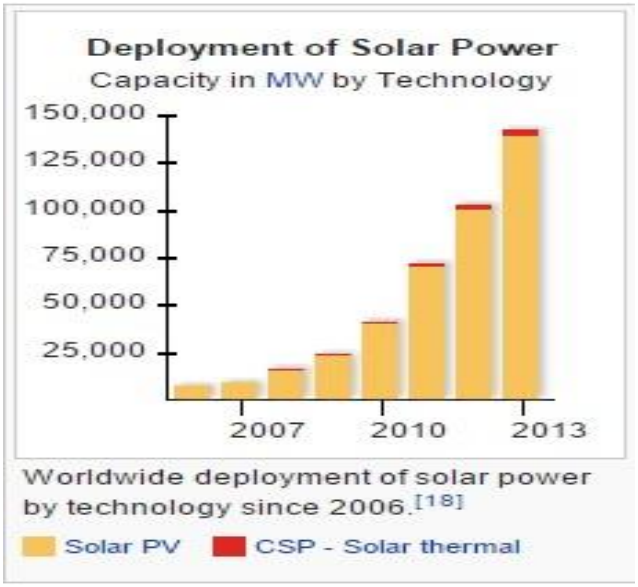
Keywors
Solar power; Solar power satellite (SPS); Photovoltaic(PV);Concentrated Solar Power(CSP)

Tabular representation of electricity generation by solar:

Electricity Generation from Solar		
Year	Energy (TWh)	% of Total
2004	2.6	0.01%
2005	3.7	0.02%
2006	5.0	0.03%
2007	6.8	0.03%
2008	11.4	0.06%
2009	19.3	0.10%
2010	31.4	0.15%
2011	60.6	0.27%
2012	96.7	0.43%
2013	134.5	0.58%
2014	185.9	0.79%
Source: BP-Statistical Review of World Energy, 2015[19][20]		

1. INTRODUCTION
The increasing importance of environmental concern, rapid depletion of conventional fossil fuel, fuel saving and unavailability of power have resulted in renewal of interest in renewable energies and their extensive use in electrical power generation. They do not pollute our environment but also are inexhaustible. Sources of renewable energy tend to be inconveniently unreliable, with with exceptions. Wind and wave energy are subject to the conditions of weather, and if we manage to find something that isn't weather dependent (like tidal flow), we can't rely on a continuous output of power. Energy received by the Earth from the Sun (with a rate of 174 PW in the upper atmosphere) is far way larger than the current world energy consumption and requirement. In view of the present crisis of the dominant energy resources, solar power emerges as a concrete alternative for a sustainable and environment friendly growth of the world energy supply.

Solar power is produced by collecting sunlight and then later on converting it into electricity with the help of solar panels, which are large flat panels that comprise up of many individual solar cells. Earlier, it was mostly used in remote locations, although it is also becoming more popular in urban areas too.



2. HISTORY
Idea of using sun as a source of energy is not new to mankind. Passive solar energy has been used as a form of heat and light since early times. In the 5th century B.C. the Greeks designed their homes to detain the sun's heat during winter. Later, the Romans enhanced on their solar architecture by converting south facing windows with materials such as mica or glass, preventing the run off of solar heat captured during the day.

During 1760's the Swiss scientist Horace de Saussure constructed an insulated rectangular box with a glass cover that became the prototype for solar collectors used to heat water.

The enhancement of solar energy to be used as a commercial source turned out to be a lengthy process whose progress was basically shaped by the price and cost of alternative conventional energy source. Solar turned out to be most expensive and was especially vulnerable to the price of other competitor source of energy. Due to which visionary entrepreneurs, faced the problem that PV was technologically complex and required high capital investment. This led them seek investment from established firms and companies.

3. CONVERSION MECHANISM:

Solar power is the conversion of sunlight into electricity. This conversion can be carried out by two means:

[1] Directly by using **Photovoltaic**(PV)

[2] Indirectly by using **Concentrated solar power**(CSP)

In photovoltaic light is converted into an electric current using the Photovoltaic effect whereas in case of concentrated solar power systems lenses or mirror and tracking system are used. They focus a larger area of sunlight into a smaller and concentrated beam.

- Photovoltaic discovery provided a path to directly convert solar radiations to electricity. In this light can directly be converted into electricity with the help of photovoltaic effect. The first solar cells, made were only 1% efficient that was made of Gold-coated Selenium. It was in 1950s that PV cells with energy conversion efficiency of 6% were constructed in Bell laboratories by Chapin.
- Concentrated solar power (CSP) system uses lens or mirror and tracking system to focus a larger area sunlight into a smaller and concentrated beam. This concentrated heat is later on used as a heat source for conventional power plant. Various techniques are used to track down sun and concentrate the heat: the best are parabolic **trough**, **sterling dish** and **solar power tower.** A working fluid is heated that is later on used for power generation or energy storage.

Thermal storage allows 24 hour efficient electricity generation.

4. SOLAR BEFORE PHOTOVOLTAIC

In 1839, a French experimental physicist, Edmund Becquerel discovered the photovoltaic effect while experimenting with an electrolytic cell made up of two electrodes. He found that when certain materials are exposed to light they produce a small amount of current.

In 1878, August Mouchet a French Mathematician developed the first solar steam powered plant using parabolic dish collectors. This plant was the center of attraction of World Exposition in Paris in 1878.

It was another matter that at that time fossil fuels were cheap and widely available also the downside of their use was also not understood. During the 19th century entrepreneurs from U.S and Europe developed their own design of solar energy technologies that later on became the basis of modern designs.

It was in the developing world, rather than developed where ambitious schemes were launched. The greatest progress in the use of solar power was by the American Entrepreneur Frank Shuman who established a solar business. After year of lab experiment and failures in summer of 1907 he demonstrated a small scale solar motor. Later in 1910, on his compound a solar plant roughly 10 times the size of his demonstrated version was installed. It produced around 600 pounds of stream per hour generating 25 horsepower, enough to pump 3000 gallons of water per minute to height of 33 feet".

5. SPACE BASED SOLAR POWER SATELLITE

Researchers believe that to make solar energy the backbone of renewable energy economy is to avoid problematic earth entirely and head out into space. There we can get a continuous shining earth and no disturbance from the atmosphere even the need of large space for the installation can also be met. Being entirely different and more than a concept, solar power satellites (SPS) are an area of active research and continuous development. Japan Aerospace Exploration Agency (JAXA) prepared a 25 year technological development roadmap and believe that this technology can cultivate 1 gig watt of energy that will be send back to earth till 2030s.

The most difficult part of this from a technological perspective is recollecting the power on the earth which the satellite sent where we can efficiently use the generated power; and hence there's only one method to make it work by wireless power transmission mechanism. Efficient ways of transmitting power over a very long is either with LASER or Microwaves, but the problem with LASER it that it doesn't work through clouds. Microwave work even if the weather is bad and hence, researchers are planning to use Microwaves. With this technology a small satellite in outer space can transmit a power of several kilowatts back to earth via Microwaves.

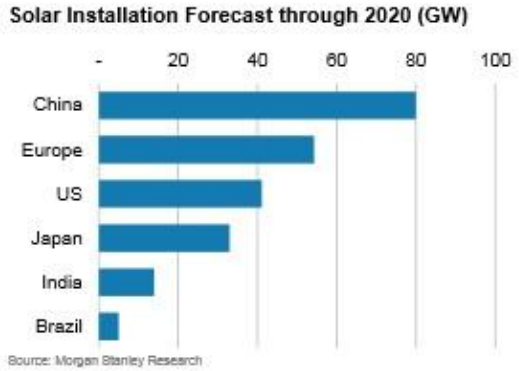
The obvious question here will be of efficiency. We are able to transmit large amount of energy but is it commercial viable. The conversion system from solar to DC to Microwave to DC and finally to AC is 80% efficient excluding the transmit loss. The transmission losses are also not consistent because various atmospheric conditions like humidity can affect the intensity of received beam. Researchers are using larger antennas with more emphasis on power over precision.

6. FORECAST ABOUT THE SOLAR POWER

[1] In 2010, the International Energy Agency formulated that global solar PV capacity will reach 3,000 GW or 11% of proposed electricity global generation by 2050- generating around 4,500 TWh of electricity.

[2] Later in 2014, the agency proposed that in this "high renewable" scenario, solar power will supply 27% of the world total electricity demand by 2050 (16% from PV and rest 11% from CSP).

[3] According to the model developed by MORGAN STANLEY that calculates solar economics around the world based on dynamics and solar conditions. Projected combined solar growth of China, India, Japan, Europe, U.S and Brazil of 39 GW per year by 2020 and global demand of 47 GW.



Annual Solar Photovoltaic Production by Country, 1995-2009

Year	China	Japan	Taiwan	Germany	United States	Others	Total
				Megawatts			
1995	n.a.	16	n.a.	n.a.	35	n.a.	78
1996	n.a.	21	n.a.	n.a.	39	n.a.	89
1997	n.a.	35	n.a.	n.a.	51	n.a.	126
1998	n.a.	49	n.a.	n.a.	54	n.a.	155
1999	n.a.	80	n.a.	n.a.	61	n.a.	201
2000	3	129	n.a.	23	75	48	277
2001	3	171	4	24	100	70	371
2002	10	251	8	55	121	97	542
2003	13	364	17	122	103	131	749
2004	40	602	39	193	139	186	1,199
2005	128	833	88	339	153	241	1,782
2006	342	926	170	469	178	374	2,459
2007	864	938	387	744	269	545	3,746
2008	2,013	1,268	813	1,334	401	1,261	7,089
2009	3,782	1,508	1,439	1,564	587	2,000	10,680

Notes: n.a. = data not available. Rows may not add to totals due to rounding.

Source: EPI, http://www.earth-policy.org/?/data_center/C23/, retrieved on April 27, 20

7. HOW IS SOFTWARE USED IN SOLAR PROJECTS

Application software have become important tools for improving the design, construction and applied operations on photovoltaic (PV) systems. From the very vast collection of software tools which exist for generating solar resource assessments, creating site-specific energy forecasts, optimizing design configurations and system layout, commissioning and testing system performance, managing and monitoring system health, executing control commands which are supposed to facilitate the integration of Photovoltaic systems to the utility grid in order to improve the effectiveness of operations and maintenance activities. The most used photovoltaic software applications analyze all data coming from the devices in the field like that of panels, trackers, inverters, environmental instrumentation, transformers and grid interface units at different intervals ,then it processes this information into actionable items through analytics and reporting tools for remote monitoring and asset management. Intelligent alarms highlight faults or variations that require attention, telling about it's cause as well as the severity and location of the problem such that guide field technicians and maintenance staff for faster effective troubleshooting.

8. PHOTOVOLTAIC SOFTWARE and its UTILITY IN THE RECENT TIMES

These photovoltaic software are basically designed to get an accurate evaluation of solar photovoltaic total energy output below given is list of present software available in recent days**.**

8.1 INSEL

It's a integrated modular stimulation environment, a software which helps in understanding, planning, monitoring and visualizing energy systems. It can be understood as a general purpose programming language, which can be used to solve any kind of computer stimulation related problems. Its major applications can be seen in fields of solar irradiance stimulations, photovoltaic and solar thermal applications. INSEL models are written in programming languages like C/C++ and Fortan in descriptive codes.

8.2 PV Designer Solmetric

It enables and allow users to quickly draw a roof outline, specify set-backs and keep-out regions, incorporate SunEye shade measurements at specific locations on the roof, drag-and-drop modules, size strings, check inverter limits, and calculate the AC energy generation for our system with minimum time and maximum ease.

This software is designed for residential and small commercial type systems

8.3 Photo Voltaic F CHART

It is a comprehensive photovoltaic system analysis and design program for calculating monthly-average performance estimate for each hour of the day.

8.4 Easy Solar Apps

It is an application which increases the possibility of design preparations and customization of professional offers within minutes. Due to this technology solar professionals can work in one go and can easily manage their sales just by the use of mobile devices. It helps in creating better communication among the team members. Few examples of such applications are:

8.5 Solar checker

It can estimates annual and lifetime energy production.

8.6 Solar meter

It can specify array size in terms of the number of modules and peak power output per module.

8.7 PV Test

It can calculate what should be the instantaneous power output at the given the time of day.

8.8 Solar Pane

It can calculate how many panels one needs to produce a given amount of energy per year.

8.9 BlueSol

Software for the design of photovoltaic systems present in every corner of the world. It can perform the entire process for designing a PV system. BlueSol has been made through standard Microsoft interface.

8.10 Helioscope

Photovoltaic sizing software programs for grid connected systems

8.11 Solar Pro

It can calculate the amount of electricity produced on the basis of latitudes, longitudes, and the weather conditions of the installation site. It also calculates I-V curve of solar modules exactly and quickly based on the electric characteristic of each product.

8.12 RET Screen 4

It's actually an Excel-based energy project analyzing software tool which has the ability to help decision makers to quickly determine the technical and financial viability of potential renewable energy, energy efficiency and cogeneration.

8.13 Hybrid2

The Hybrid2 software packages are user friendly tool to perform economic analysis on a wide range of hybrid power systems.

9. ADVANTAGES OF USING SOLAR POWER

1. Renewable source of energy
2. Most of the spacecraft operating in the inner solar system are usually solar powered. They use solar panels to derive electricity from sunlight.
3. Space based solar power uses high efficient multi junction photovoltaic cells.
4. Green and ecofriendly source of energy.
5. Sustainable for energy consumption and increasing need.

10. DISADVANTAGES OF USING SOLAR POWER

1. Less efficient
2. Weather and sunlight dependent
3. Installation cost of panels by which solar power is generated is very high.
4. Differential spatial availability of sunlight throughout the world.

Typical PV system prices in 2013 in selected countries (USD)

USD/W	Australia	China	France	Germany
Residential	1.8	1.5	4.1	2.4
Commercial	1.7	1.4	2.7	1.8
Utility-scale	2.0	1.4	2.2	1.4

11. CONCLUSION

In each and every generation the "energy from the sun" attracted many visionary entrepreneurs. The major problem which they faced was its high cost and hence they looked up for financial investment. The sun shines throughout the world but spatial differential availability of sunlight is also a major drawback for the installation and use of solar power. The cost of installation of solar panel is very high but once installed it will provide a clean and free source of energy throughout its lifetime. Research work is carried out continuously in this field to increase the efficiency of devices from 7-8% to 15-20% and it is also claimed that technological advancement will also bring down the cost of solar energy.

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