Solar Energy & Status in India

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Abstract:**Solar energy is the most readily available source of energy. It does not belong to anybody and is, therefore, free. It is also the most important of the non-conventional sources of energy because it is non-polluting and, therefore, helps in lessening the greenhouse effect. Solar energy has been used since prehistoric times, but in a most primitive manner.India is one of the few countries with long days and plenty of sunshine, especially in the Thardesert region. This zone, having abundant solar energy available, is suitable for harnessing solar energy for a number of applications. In areas with similar intensity of solar radiation, solar energy could be easily harnessed. Solar thermal energy is being used in India for heating water for both industrial and domestic purposes. A 140 MW integrated solar power plant is to be set up in Jodhpur but the initial expense incurred is still very high.**

Solar energy can also be used to meet our electricity requirements. Through Solar Photovoltaic (SPV) cells, solar radiation gets converted into DC electricity directly. This electricity can either be used as it is or can be stored in the battery. This stored electrical energy then can be used at night.

I. INTRODUCTION

Solar energy is radiant light and heat from the sun harnessed using a range of ever-evolving technologies such as solar heating, solar photovoltaics, solar thermal electricity, solar architecture and artificial photosynthesis

Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

The Earth receives 174 petawatts (PW) of incoming solar radiation (insolation) at the upper atmosphere. Approximately 30% is reflected back to space while the rest is absorbed by clouds, oceans and land masses. The spectrum of solar light at the Earth's surface is mostly spread across the visible and near-infrared ranges with a small part in the near-ultraviolet.

Earth's land surface, oceans and atmosphere absorb solar radiation, and this raises their temperature. Warm air containing evaporated water from the oceans rises, causing atmospheric circulation or convection. When the air reaches a high altitude, where the temperature is low, water vapor condenses into clouds, which rain onto the Earth's surface, completing the water cycle. The latent heat of water condensation amplifies convection, producing atmospheric phenomena such as wind, cyclones and anti-cyclones. Sunlight absorbed by the oceans and land masses keeps the surface at an average temperature of 14 °C. By photosynthesis green plants convert solar energy into chemical energy, which produces food, wood and the biomass from which fossil fuels are derived.

II. SOLAR POWER

Solar power is the conversion of sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP). Concentrated solar power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaics convert light into electric current using the photovoltaic effect.

Photovoltaics were initially, and still are, used to power small and medium-sized applications, from the calculator powered by a single solar cell to off-grid homes powered by a photovoltaic array. They are an important and relatively inexpensive source of electrical energy where grid power is inconvenient, unreasonably expensive to connect, or simply unavailable. However, as the cost of solar electricity is falling, solar power is also increasingly being used even in grid-connected situations as a way to feed low-carbon energy into the grid.

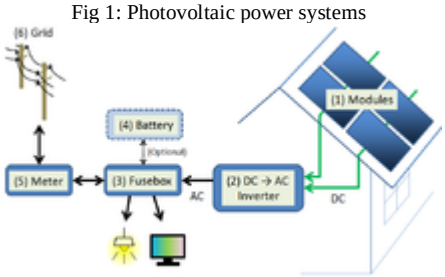
Commercial concentrated solar power plants were first developed in the 1980s. The 392 MW ISEGS CSP installation is the largest solar power plant in the world, located in the Mojave Desert of California. Other large CSP plants include the SEGS (354 MW) in the Mojave Desert of California, the Solnova Solar Power Station (150 MW) and the Andasol solar power station (150 MW), both in Spain. The 290 MW Agua Caliente Solar Project in the United States, and the 221 MW Charanka Solar Park in India, are the world's largest photovoltaic power stations.

III. PHOTOVOLTAICS

A solar cell, or photovoltaic cell (PV), is a device that converts light into electric current using the photovoltaic effect. The first solar cell was constructed by Charles Fritts in the 1880s. The German industrialist Ernst Werner von Siemens was among those who recognized the importance of this discovery. In 1931, the German engineer Bruno Lange developed a photo cell using silver selenide in place ofcopperoxide,although the prototype selenium cells converted less than 1% of incident light into electricity. Following the work ofRussellOhl in the 1940s, researchers Gerald Pearson, Calvin Fuller and Daryl Chapin created

the silicon solar cell in 1954. These early solar cells cost 286 USD/watt and reached efficiencies of 4.5–6%.

Fig 1: Photovoltaic power systems



Simplified schematics of a grid-connected residential PV power system

Solar cells produce direct current (DC) power which fluctuates with the sunlight's intensity. For practical use this usually requires conversion to certain desired voltages or alternating current (AC), through the use of inverters. Multiple solar cells are connected inside modules. Modules are wired together to form arrays, then tied to an inverter, which produces power at the desired voltage, and for AC, the desired frequency/phase.

Many residential systems are connected to the grid wherever available, especially in developed countries with large markets. In thesegrid-connected PV systems, use of energy storage is optional. In certain applications such as satellites, lighthouses, or in developing countries, batteries or additional power generators are often added as back-ups. Such stand-alone power systems permit operations at night and at other times of limited sunlight.

IV. SOLAR POWER IN INDIA

A. Economic Value: The generation of solar electricity coincides with the normal peak demand during daylight hours in most places, thus mitigating peak energy costs, brings total energy bills down, and obviates the need to build as much additional generation and transmission capacity as would be the case without PV.

B. Geographical Location: India being a tropical country receives adequate solar radiation for 300 days, amounting to 3,000 hours of sunshine equivalent to over 5,000 trillion kWh. Almost all the regions receive 4-7 kWh of solar radiation per sqmtrs with about 2,300–3,200 sunshine hours/year, depending upon the location. Potential areas for setting up solar power plant can be analyzed using Solar irradiation map of India. Our Statewise analysis of Solar resource, Business Opportunities and Latest trends in the states are discussed: Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Uttar Pradesh, West Bengal.

C. Power Shortage: Electricity losses in India during transmission and distribution have been extremely high over the years and this reached a worst proportion of about 24.7% during 2010-11. India is in a pressing need to tide over a peak power shortfall of 13% by reducing losses due to theft. Theft of electricity, common in most parts of urban India, amounts to 1.5% of India's GDP. Due to shortage of electricity, power cuts are common throughout India and this has adversely affected the country's economic growth.

Current Projects (includes both- installed and under installation projects)

S.No	State	PhotovoltaicCapacity (MW)	Solar ThermalCapacity (MW)
1.	Rajasthan	43	400
2.	Gujarat	722	45
3.	Maharashtra	133	-
4.	Karnataka	10	-
5.	Andhra Pradesh	20.5	-
6.	Uttarakhand	4	-
7.	Punjab	5	-
8.	Haryana	7.8	-
9.	Uttar Pradesh	11	-
10.	Jharkhand	16	-
11.	Chhattisgarh	4	-
12.	Madhya Pradesh	7.25	-
13.	Odisha	11	-
14.	Tamil Nadu	12	-
	TOTAL	**1006.55**	**445**

The country's biggest solar power plant was recently inaugurated in Madhya Pradesh by Narendra Modi. The solar power plant is located at Diken in Jwad area of Neemuch district of Madhya Pradesh.

V. ADVANTAGES AND DISADVANTAGES

A. Advantages of Solar Power

- Solar energy is a clean and renewable energy source.
- Once a solar panel is installed, solar energy can be produced free of charge.
- Solar energy will last forever whereas it is estimated that the world's oil reserves will last for 30 to 40 years.
- Solar energy causes no pollution.
- Solar cells make absolutely no noise at all. On the other hand, the giant machines utilized for pumping oil are extremely noisy and therefore very impractical.
- Very little maintenance is needed to keep solar cells running. There are no moving parts in a solar cell which makes it impossible to really damage them.
- In the long term, there can be a high return on investment due to the amount of free energy a solar panel can produce, it is estimated that the average household will see 50% of their energy coming in from solar panels.

B. Disadvantages of Solar Power

- Solar panels can be expensive to install resulting in a time-lag of many years for savings on energy bills to match initial investments.
- Electricity generation depends entirely on a countries exposure to sunlight; this could be limited by a countries climate.

- Solar power stations do not match the power output of similar sized conventional power stations; they can also be very expensive to build.
- Solar power is used to charge batteries so that solar powered devices can be used at night. The batteries can often be large and heavy, taking up space and needing to be replaced from time to time.

VI. APPLICATION

A. Residential Application

Use of solar energy for homes has number of advantages. The solar energy is used in residential homes for heating the water with the help of solar heater. The photovoltaic cell installed on the roof of the house collects the solar energy and is used to warm the water. Solar energy can also be used to generate electricity. Batteries store energy captured in day time and supply power throughout the day. The use of solar appliances is one of the best ways to cut the expenditure on energy.

B. Industrial Application

Sun's thermal energy is used in office, warehouse and industry to supply power. Solar energy is used to power radio and TV stations. It is also used to supply power to lighthouse and warning light for aircraft.

C. Remote Application

Solar energy can be used for power generation in remotely situated places like schools, homes, clinics and buildings. Water pumps run on solar energy in remote areas. Large scale desalination plant also use power generated from solar energy instead of electricity.

D. Transportation

Solar energy is also used for public transportation such as trolleys, buses and light-rails.

REFERENCES

[1]. Agrafiotis, C.; Roeb, M.; Konstandopoulos, A.G.; Nalbandian, L.; Zaspalis, V.T.; Sattler, C.; Stobbe, P.; Steele, A.M. (2005). "Solar water splitting for hydrogen production with monolithic reactors". *Solar Energy* **79** (4): 409–421. Bibcode:2005SoEn...79..409A. doi:10.1016/j.solener.2005.02.026.

[2]. Anderson, Lorraine; Palkovic, Rick (1994). *Cooking with Sunshine (The Complete Guide to Solar Cuisine with 150 Easy Sun-Cooked Recipes)*. Marlowe & Company. ISBN 1-56924-300-X.

[3]. Balcomb, J. Douglas (1992). *Passive Solar Buildings*. Massachusetts Institute of Technology. ISBN 0-262-02341-5.

[4]. Bénard, C.; Gobin, D.; Gutierrez, M. (1981). "Experimental Results of a Latent-Heat Solar-Roof, Used for Breeding Chickens". *Solar Energy* **26** (4): 347–359.Bibcode:1981SoEn...26..347B. doi:10.1016/0038-092X(81)90181-X.

[5]. Bolton, James (1977). *Solar Power and Fuels*. Academic Press, Inc. ISBN 0-12-112350-2.

[6]. Bradford, Travis (2006). *Solar Revolution: The Economic Transformation of the Global Energy Industry*. MIT Press. ISBN 0-262-02604-X.

[7]. Butti, Ken; Perlin, John (1981). *A Golden Thread (2500 Years of Solar Architecture and Technology)*. Van Nostrand Reinhold. ISBN 0-442-24005-8.

[8]. Carr, Donald E. (1976). *Energy & the Earth Machine*. W. W. Norton & Company. ISBN 0-393-06407-7.

[9]. Hunt, V. Daniel (1979). *Energy Dictionary*. Van Nostrand Reinhold Company. ISBN 0-442-27395-9.

[10]. Karan, Kaul; Greer, Edith; Kasperbauer, Michael; Mahl, Catherine (2001). "Row Orientation Affects Fruit Yield in Field-Grown Okra". *Journal of Sustainable Agriculture* **17**(2/3): 169–174. doi:10.1300/J064v17n02_14.

[11]. Leon, M.; Kumar, S. (2007). "Mathematical modeling and thermal performance analysis of unglazed transpired solar collectors". *Solar Energy* **81** (1): 62–75.Bibcode:2007SoEn...81...62L. doi:10.1016/j.solener.2006.06.017.

[12]. Mills, David (2004). "Advances in solar thermal electricity technology". *Solar Energy* **76** (1-3): 19–31. Bibcode:2004SoEn...76...19M. doi:10.1016/S0038-092X(03)00102-6.

[13]. Müller, Reto; Steinfeld, A. (2007). "Band-approximated radiative heat transfer analysis of a solar chemical reactor for the thermal dissociation of zinc oxide". *Solar Energy* **81**(10): 1285–1294. Bibcode:2007SoEn...81.1285M. doi:10.1016/j.solener.2006.12.006.

[14]. Schittich, Christian (2003). *Solar Architecture (Strategies Visions Concepts)*. Architektur-Dokumentation GmbH & Co. KG. ISBN 3-7643-0747-1.

[15]. Smil, Vaclav (1991). *General Energetics: Energy in the Biosphere and Civilization*. Wiley. p. 369. ISBN 0-471-62905-7.

[16]. http://schooltutoring.com/help/solar-energy-and-its-applications/

[17]. http://www.processindustryforum.com/

[18]. http://economictimes.indiatimes.com/

[19]. http://www.eai.in/ref/ae/sol/sol.html

[20]. http://edugreen.teri.res.in/explore/renew/solar.htm