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Utilisation of solar energy in India

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ABSTRACT

The demand for energy is rising exponentially all over the world with a doubling period of 5-7 years in underdeveloped countries, 7-10 years in developing countries and 10-15 years in advanced countries. There is an ever growing demand for energy to meet the growing needs for goods and services. On the other hand, there is a fast depletion of fossil fuels and the dangers of pollution hazards due to excessive burning of fossil fuel and nuclear waste. Due to the growing energy needs, fast depletion of fossil fuels and pollution hazards attendant with the fossil and nuclear fuels increasing attention is being paid to find out newer sources of energy that are inexhaustible, replenisable and would supply clean energy. Solar energy has all the requisite attributes and provides a viable solution. In this paper efforts have been made to summarize all points and aspects for use of different form of solar energy in India.

Keywords:*Fossil fuel,pollution,nuclear waste, solar energy, renewable energy.*

INTRODUCTION

The sun sustains life both directly and indirectly and is the ultimate source of energy known to man except the nuclear energy, figure (i) shows the sources of energy known to man and its way to be realized that except for the nuclear and geothermal energy, all other sources derive their energy from the sun.

Fossil fuels such as coal, oil, natural gas are perhaps next to nuclear energy, the most concentrated focus of energy. Solar energy fixed in plants through photosynthesis several centers ago is concentrated in the form of fossil fuel. The time required to produce these concentrated fossil fuels is very large. However our conception of these fossil fuels is very rapid. Indeed, we consume fossil fuels with several orders of magnitude faster than rate at which they are produced. When we burn fossil fuels like coal, oil and gas to generate electricity or power our cars, CO_2 isproduced which causes pollution in the atmosphere. Australians are big producers of CO_2 pollution compared to the rest of the world. Reducing the amount of electricity generated from coal and gas and increasing the amount of electricity from clean, renewable energy sources like solar and wind, means less carbon pollution is emitted. This is one of the main ways we can address global warming. [1]

Regarding the cost of coal, coal fired plants are currently the cheapest way to generate electricity. However that does not consider the external costs of coal fired plants. If coal fired plants were required to capture the CO_2 they emit into the atmosphere, it would cost 40% more to build and operate and the plants would produce 20% less electricity, according to an MIT study; the future of coal: options for a carbon constrained word.If these

costs were loaded into the effective cost of coal, then coal-generated electricity no longer looks so cheap and renewable electricity no longer looks so cheap and renewable electricity generated by solar and wind power becomes more economical by comparison. The solar energy utilization devices and processes follow, in general on of the three pathways namely (i) utilizing heat from the sun (ii) converting solar energy directly into electrical energy and (iii) using photosynthetic and biological processes.

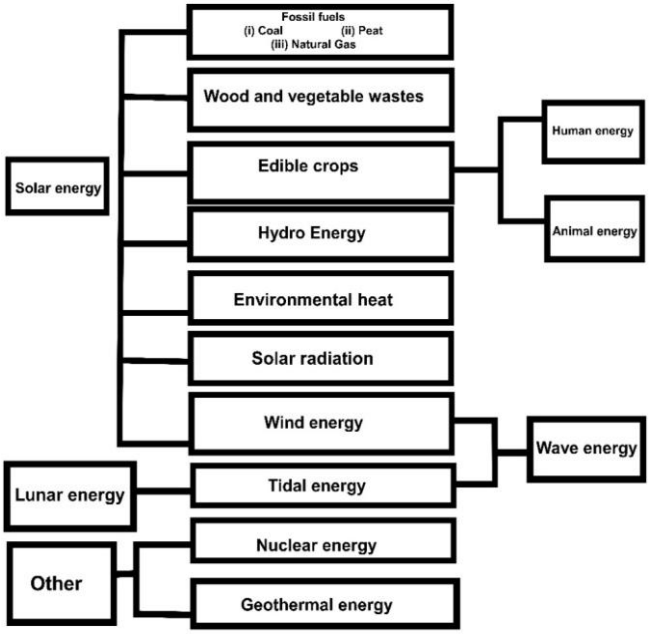

Fig. (i). The various ways in which solar energy can be used.

1. GROWTH OF SOLAR POWER IN INDIA

India is developing off-grid solar power for local energy needs in addition to its large scale grid converted solar PV initiative. The country had a poor rural electrification rate, in 2015 only 55% of all rural households had access to electricity and 85% of rural households depended on solid fuel for cooking. Solar products have increasingly helped to meet rural needs; by the end of 2015, just fewer than one million solar lanterns were sold in the country reducing the need for kerosene. India expanded its solar generation capacity 8 times from 2650 MW on 26th May 2014 to over 20 GW as on 31st Jan, 2018. The 20 GW capacity was initially targeted for 2022but the government achieved its target 4 years before the targeted period. While the global economy maintains its low level growth ,the Indian economy continues on to high growth trajectory .the year 2016-17 has been paradigm shift in the way indies economy will function by focusing on laying infrastructure for widespread inclusion of all economy activity on the digital platform. Power sector plays a vital role in the growth of Indian economyand it is growing at rapid pace. The installed capacity has reached to 310GW with generation mix of thermal (69.4%), hydro (13.9%) renewable (14.8%and nuclear 1.9%.it is evident that renewable power has solarsecured second position after thermal and is spreading its wing rapidly in India. Solar energy is abundant and offers a solution to fossil fuel emissions.Solar energy is the most nature inexhaustible renewable energy. To

the world's energy resources perspective, we have relied heavily on traditional energy stocks are already very limited. Storage capacity of the remaining oil can be used only forty-three years; natural gas storage capacity of the remainder can only be used thirteen years, these stocks will be growing as people increasingly exhausted to do extraction. In addition, carbon dioxide emissions from conventional energy sources are the main reason for the phenomenon of global warming. China's response to the global Framework Convention on Climate Change's international responsibilities, set to 2020 renewable energy will estimate the total generating capacity of 12% of the long-term goal, and actively promote the development and application of renewable energy, reducing the use of traditional fossil fuels and to play a accessibility of renewable energy, while promoting domestic energy diversification and the main nature.

India lies in sunny regions of the world. Most parts of India receive 4-7 kWh of solar radiation per square meter/day with 250-300 sunny days in a year. India has abundant solar resources, as it receives about 3000 hours of sunshine every year that is equivalent to over 500 trillion kWh. The Prime minister of India unveiled a National Climate Change action plane in June 2008. The plan has been implemented through eight majors with main focus on solar energy on the total energy win on the country.

The sun’s energy sent to earth is considerable, but only to its 22 billionth of outward radiation of energy, just from these energies, if the surface of the Earth's atmosphere to remove the reflection and absorption of energy, it will really reach the Earth the surface of solar energy, approximately equal to the world's current generation capacity of 20 million times. Solar energy received on Earth every day, equivalent to the entire world for one year the total energy consumed by 200 times. Only from these figures we can see a huge, really worthy of the sun's energy is an inexhaustible treasure house of mankind. The status of solar power in India has been given in the table which is the aspiration is to ensure large-scale deployment of solar generated power for gridconnected as well as distributed and decentralized off-grid provision of commercial energy services. The deployment across the application segments is envisaged as follows: [3, 4, and 5]

S. No.	**Application segment**	**Target for Phase I (2010- 13)**	**Target for Phase 2 (2013-17)**	**Target for Phase 3 (2017-22)**
1	Solar collectors	7 million sq meters	15 million sq meters	20 million sq meters
2	Off grid solar applications	200 MW	1000 MW	2000 MW
3	Utility grid power, including roof top	1,000-2000 MW	4000-10,000 MW	20000 MW

Table 1. Application segments.

The objective of the Mission is to create a policy and regulatory environment which provides a predictable incentive structure that enables rapid and large-scale capital investment in solar energy applications and

encourages technical innovation and lowering of costs.The solar radiation in India is equal to 4-7 KWh per square meter per day with an annual radiation ranging from 1200-2300 KWh/m^2. The average and clear sunny day in India is approximately 300 days. The sunshine hours/year is 2,300-3,200 hours. The land area to generate electricity of country need is 3000 km^2. The solar radiation of different places in India is given in the map [NASA].

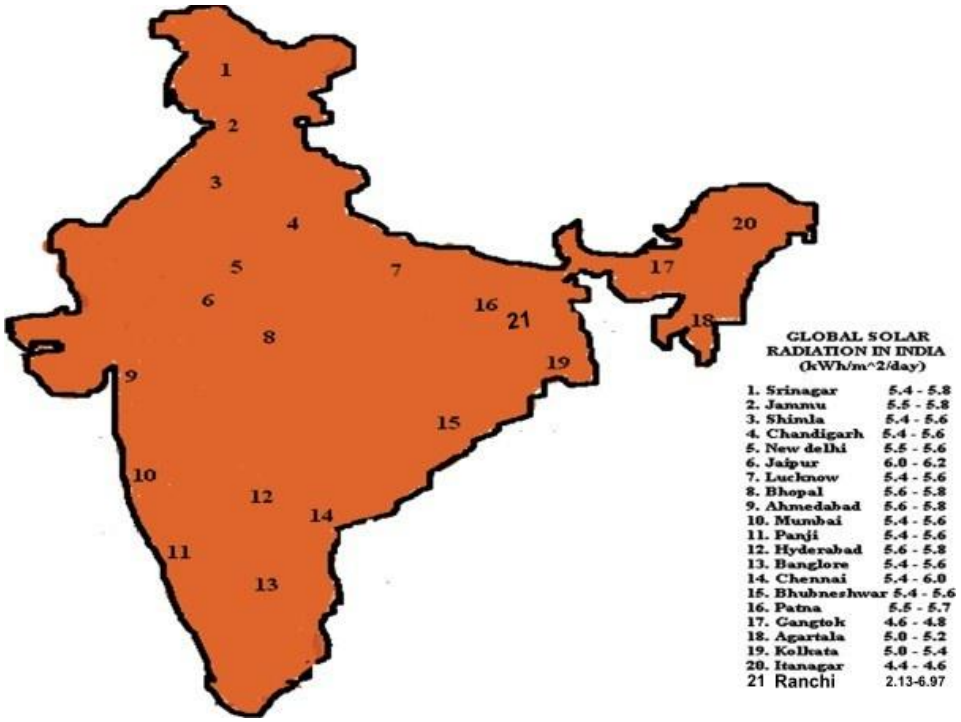

Fig. (ii) Solar radiation in India. [9].

The present status of solar power in India in different states has been given in the table[6].

S. no.	States/uts	Solar power(in MW)
1	Andhra Pradesh	38440
2	Arunachal Pradesh	8650
3	Assam	13760
4	Bihar	11200
5	Chhattisgarh	18270
6	Goa	880
7	Gujarat	35770
8	Haryana	4560
9	Himachal Pradesh	33840
10	Jammu Kashmir	111050
11	Jharkhand	18180

12	Karnataka	24700
13	Kerala	6110
14	Madhya Pradesh	61660
15	Maharashtra	64320
16	Manipur	10630
17	Meghalaya	5860
18	Mizoram	9090
19	Nagaland	7290
20	Orissa	25780
21	Punjab	2810
22	Rajasthan	142310
23	Sikkim	4940
24	Tamilnadu	17670
25	Telangana	20410
26	Tripura	2080
27	Uttar Pradesh	22830
28	Uttarakhand	16800
29	West Bengal	6260
30	Andaman and Nicobar	0
31	Chandigarh	0
32	Dadra and Nagar Haveli	0
33	Damanand Diu	0
34	Delhi	2050
35	Lakshadweep	0
36	Pondicherry	0
37	Others	790
	Total installed power	748990

Table.2. the status of solar power(in MW) in different states till 2016. [5]

Fig. (iii) A chart showing the status of solar power in different states till the year 2016.

Growth of solar energy utilization is given in the table. [4]

Types of energy	Growth rate (in %)
Solar	17%
Tidal& Wave	13.2%
Wind	11.7%
Geothermal	4.7%

Table 3.

Comparison of different energy sources according to their growth rate.

2. NEW INITIATIVES

In continuation of the new initiatives launched in the previous year, the government has taken up the following new projects/schemes during the current financial year.

2.1 Green energy corridor:

- A Rs. 38,000 crore Green Energy Corridor is being set up to ensure evacuation of Renewable Energy. Power Grid Corporation of India Limited (PGCIL) has sought a Loan assistance of US$ 1,000 million from the Asian Development Bank (ADB) comprising of Sovereign guaranteed loan of US$ 500 million and Non-sovereign loan of US$ 500 million. The loan would be utilized for funding of the following transmission projects including a project under Green Energy Corridor projects in next 3-4 years.

(i) HVDC(high voltage direct current) Bipole link between Western Region (Raigarh, Chhattisgarh) and Southern Region (Pugalur, Tamil Nadu) – North Trichur (Kerala) – Scheme 1: Raigarh – Pugalur 6000 MW HVDC System.

(ii) HVDC Bipole link between Western Region (Raigarh, Chhattisgarh) and Southern Region (Pugalur, Tamil Nadu) – North Trichur (Kerala) – Scheme 3: Pugalur – Trichur 2000 MW VSC based HVDC system.

(iii) Real Time measurement / monitoring scheme.

(iv) Inter State Transmission System (ISTS) associated with Green Energy corridor as under:

(a) Ajmer (New) – Bikaner (New) 765 kV D/C

(b) Bikaner (New) – Moga (PG) 765kV D/C

(c) LILO(line in -line out) of one circuit of 400 kV Bhadla – Bikaner (RVPN) line at Bikaner (New)

(d) Establishment of 2x1500 MV A, 765/400 Kv S/s at Bikaner (New)

2.2 Renewable Purchase Obligation:

- Pursuant to the revised tariff policy, the Ministry of Power on 22nd July 2016 has notified the long term growth trajectory of RPO for solar and non-solar energy for next 3 years 2016-17, 2017-18 and 2018-19 as given in the table:

GROWTH TRAJECTORY OF RPOS			
LONG TERMTRAJECTORY	2016-17	2017-18	2018-19
NON SOLAR	8.75%	9.50%	10.25%
SOLAR	2.75%	4.75%	6.75%

Table 4. Growth trajectory of Renewable Purchase Obligation.

2.3 Net metering policy:

- The consistent follow-up by the Ministry resulted into the notification by State Electricity Regulatory Commissions (SERCs) of thirty four States on net-metering and feed-in-tariff to encourage rooftop solar plants. Net-metering scheme has been rolled out in all States / UTs which will help in meeting 40 GW rooftop grid connected solar projects. So far, 20 States namely Andhra Pradesh, Chhattisgarh, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Manipur, Punjab, Puducherry, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand and West Bengal have come out with Solar Policy supporting grid connected rooftop systems.

2.4 Solar rooftops

- All major sectors i.e. Railways, airports, hospitals, educational institutions, government buildings of central/state/PSUs are being targeted besides, the private sector.

- The ministry has tied up with ISRO for Geo tagging of all the rooftop plants using ISRO's VEDAS Portal.

2.5 Solar Tariffs Attaining Grid Parity:

- Solar tariffs have fallen to an unprecedented low of Rs. 4.34 / kWH(kilowatthour) through reverse auction for one of six projectors of 70 MW each to be put up in Rajasthan under the National Solar Mission. This trend is continuing and is moving towards grid parity.

2.6 Skill Development

- Surya Mitra Scheme has been launched for creating 50,000 trained solar photovoltaic technicians by March 2020. A total number of 7500 Surya Mitra's would be trained by 31.03.2017. A network of over 200 institutions, spread all over the country, has been created for implementing Surya Mitra scheme. In addition, short term training programs for small hydro, entrepreneurship development, operation & maintenance of solar energy devices and boiler operations in co-generation plants, have been organized.
- Govt. of India launched "Surya Mitra" mobile app at national workshop on rooftop Solar Power on 07.06.2016. The GPs based mobile app has been developed by the National institute of solar energy (NISE). The Surya Mitra Mobile App is currently available in Google play store, which can

be downloaded and used across India. This App is a high end technology platform which can handle thousands of calls simultaneously and can efficiently monitor all visits of Suryamitra's. The trained Suryamitra's who opts for entrepreneurship have joined in the Mobile app in several states. These Suryamitra's are once again sensitized by NISE on soft skills customer relations management, punctuality and are now ready to deliver the services.

3. QUALITY OF LIFE

Solar energy delivers environmental benefits. Many homeowners, businesses, and non-profits go solar because they are focused on minimizing environmental issues like climate change and health problems related to carbon emissions. According to the U.S. Environmental Protection Agency, the average household emits approximately 20 metric tons of carbon pollution each year. By installing a solar power system, a typical two-person household reduces their carbon emissions by three to four tons annually. [6]

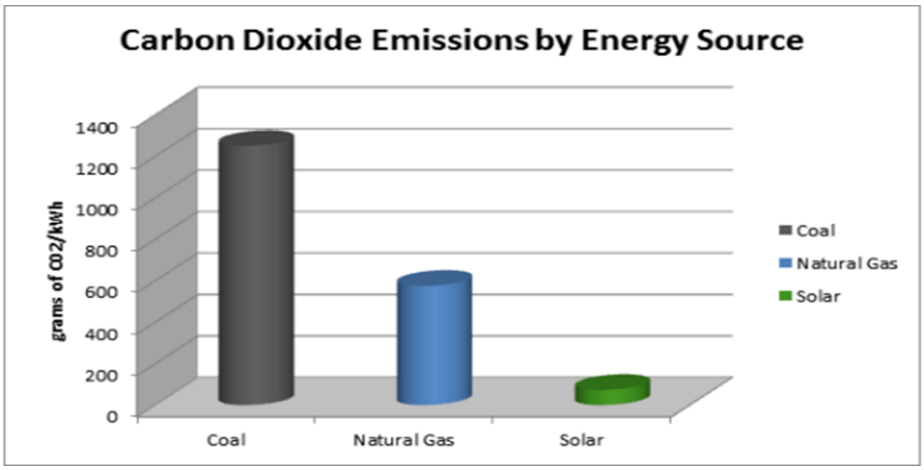

Fig. (iv). A graph showing the carbon dioxide emissions by different energy sources. [7]

3.1 Enhanced homestays

Today, solar-based electrification has helped the villagers improve the quality of locally manufactured products. "Copper-making is an ancient craft and the mainstay of our livelihood. With solar lighting people can work into the night," says Raghu Munda of Vishunpur, a village of Latehar district of Jharkhand state. Homestays, when trekkers stay overnight at villages, are also vital to the villagers' incomes. Now, more trekkers opt for and are willing to pay extra for electricity at a homestay that allows them to charge their tablet computers and mobile phones. Village children have a greater incentive to remain home during the winter vacations rather than migrate to city, where there is better infrastructure. Lighting the village had a profound personal impact on person, who helped GHE coordinate its 2015 expedition to light other remote villages. Through electrifying villages, he has taken on a leadership role in the local communities. The next stop was village Shingo. Here too, villagers were initially skeptical about the solar lighting initiative. "Sometimes the government takes years for such a development, so the villagers didn't think it was possible in a day," Dorjay explains. But after their houses were

illuminated at night for the very first time, the villagers had a large celebration, welcoming the expedition team with kathaks (traditional silk scarves) and delicious food.(Based on survey)

3.2 Transforming the village

The expedition members experienced one night of darkness in Shingo before setting up the solar micro-grids. Before dark, they sketched plans for the placement of light bulbs inside the houses and the monastery. The team worked closely with the head of one of the households, Jig met. She accompanied them to the various houses, suggesting the locations for light bulbs. The following morning the team leaders reviewed the lighting plans prior to installation. Some GHE members cemented solar panels to the roofs of two buildings, while the others wired and nailed light fixtures to the ceilings and the exteriors of the houses and monastery. An electrician completed the wiring and connected the solar

Panels to a solar charge controller, which prevents overload in the circuits. The power grid utilizes direct current (DC) because it is more efficient and safer than alternating current (AC) and can be easily maintained and extended by a local community. As part of the grid setup, GHE not only installs LED lights but also provides community lighting through LED-based solar street lights and a DC LED TV. However, the villagers can, if they wish, easily convert their power to AC in the future, for use in large appliances such as refrigerators.

LED lights are perhaps the most important aspect of electrification, as villagers are no longer confined by daylight hours, which vary from season to season. Working hours will increase in Shingo too and homestays will be more profitable. Shingo is also popular for sheep wool-based handicrafts; with grid-based lighting available, women in the village can work extra hours to make these handicrafts, which will fetch them additional income. The lighting will help Shingo retain its population and villagers will benefit more from farming too. “Especially during harvest, we need lights around the fields,” says Jigmet. According to Dorjay, Shingo is likely to become an important hub as it is located along a trekking route to the region’s main valley.

3.3 Shirdi gets world’s largest solar steam system

The Shirdi shrine has joined two other spiritual centers, Tirupati in Andhra Pradesh and Brahma Kumari Spiritual Trust in Rajasthan’s Mount Abu, where solar systems cook prasadam for devotees. The 73 parabolic antennas mounted atop the roof of the kitchen complex of Sri Sai Baba Sansthan in Shirdi constitute the world’s largest solar steam system that cooks food for 20,000 devotees daily. Though the antennas have been in place since January 8, the entire solar cooking system was inaugurated by Union Minister for New and Renewable Energy Farooq Abdullah on Thursday. Besides ushering in an environment-friendly power arrangement, the solar cooking system has added to the kitchen at Shirdi efficiency. The prasadam production for thousands of devotees saves Rs 10,500 per day on LPG, Shirdi officials told Deccan Herald. Annual saving since a backup stock of LPG is kept for the lean days, the annual savings translates to about 100,000 kg of LPG, which is nearly Rs 2,000,000 per year. The system exploits sunlight to generate 3500 kg of steam daily for cooking. While the antennas – each 16 sq. mt – were put up in January, the steam generator came alive in June, Shirdi officials said.

The system costs Rs 133 lakh out of which the Ministry provided a Rs 58.40 lakh subsidy. The temple had a smaller system of 40 dish antennas, which were found inadequate to deal with increasing pilgrim pressure. The first Indian institution to employ the solar cooking system was the Brahma Kumari Spiritual Trust at Mount Abu where the mechanics were employed in 1997 to cook food for 1,000 persons a day. Two years later, the system's capacity was increased to cater to 10,000 people. 46 Encouraged by the success, the Centre promoted larger solar cooking systems. There are similar systems in Tirupathi in Andhra Pradesh and Satyabama University in Chennai, each of which prepares food for 15,000 people daily. Steam cooking is clean, efficient and hygienic, especially when food is cooked for large numbers of people. The Shirdi system has been designed in a way so it can generate steam for cooking even in the absence of electricity to run the feed-water pump for circulating water in the system. The antennas concentrate solar rays to generate steam with temperature ranging between 550 and 600 degrees Celsius. With an automated tracking system, the dishes rotate continuously along with the movement of the sun, always concentrating the solar rays on the receivers. Every morning, the antennas are required to be turned manually in line with the position of the sun, a process which is completed when automatic tracking takes over. As the solar system is hooked up with boilers, it can take care of a few non-sunshine hours. But a backup is needed for prolonged spells of rainy and cloudy days. State wise allocation of canal-bank solar PV projects is given below[6,7,8]-

Sl. No.	State	Implementing Agency in the State	Capacity for which in-principle approval has been given (MW)	Commissioned as on 31.12.2017
1	Andhra Pradesh	New and Renewable Energy Development Corporation of Andhra Pradesh (NREDCAP)	1 MW canal-top	1 MW
2	Gujarat	SardarSarovar Narmada Nigam Limited (SSNNL)	10 MW canal-top	10 MW
3	Karnataka	Krishna BhagyaJala Nigam Limited (KBJNL)	10 MW canal-top	-
4	Kerala	Kerala State Electricity Board Limited (KSEB)	2 MW canal-top	2 MW
5	Punjab	Punjab Energy Development Agency (PEDA)	20 MW canal-top	5 MW
6	**Uttarakhand**	**UttarakhandJalVidyut Nigam Limited**	**1 MW canal-top**	**-**
7	**Uttar Pradesh**	**Uttar Pradesh Irrigation Department**	**6 MW canal-top**	**-**
	Total		**50 MW canal-top**	**18 MW**

Fig. (v) State-wise Allocation of 50 MW Canal-Bank Solar PV Projects. [6]

4. CONCLUSION

India is going to present an example to the world in solar energy production, the five biggest projects in the world by which 75000MW electricity will be generated; India will claim the first spot in solar energy production. Accordingto the report by Institute for Energy Economics, and FinancialAnalysis, India is going to launch a major project for solar energy which will be completed by 2020. At present, the ultra mega solar park – Kurnool (Andhra Pradesh) is at second position in the world for producing thousand megawatts of electricity and on the sixth position is AdaniKamuthi solar plant, located in Tamil Nadu of India whose capacity is 648 MW. The aim of India is to produce 100 GW electricity from solar power plants by 2022. Our government has

taken many steps for getting energy security and energy independence but it needs publicity and training programs at rural levels for awareness so that maximum people can use solar energy.

REFERENCES

1. E. Kyriaki, E. Giama, A. Papadopoulou, V. Drosou& A. M. Papadopoulos (2017). Energy and Environmental Performance of Solar Thermal Systems in Hotel Buildings. Procedia Environmental Sciences. (Volume 38, 2017) Pages 36 – 43.
2. Profiting from clean energy by Richard W. Asplund.
3. Solar India (http://www.solarindia.online)
4. The future of coal, MIT study. Retrieved from (http://web.mit.edu/coal/The_Future_of_Coal.pdf)
5. Jawaharlal Nehru National Solar Mission, Ministry of New and Renewable Energy (MNRE), Government of India, Annual Report 2015-16, 2016-17, 2017-18.
6. Annual report review2017-18. (www.mnregov.in)
7. International energy agency.
8. Ministry of power (www.powermin.nic.in)
9. VikasKhare, SavitaNema, PrashantBaredar (2013). Status of solar wind renewable energy in India. Renewable and Sustainable Energy Reviews. (Volume 27, 2013). Pages 1 – 10.