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Generation of Solar Energy Developed in Different States of India

P Sumaiah Naz
Assistant Professor, Department of EEE
Shri Shiridi College of Science & Engineering
Anantapur, India

***Abstract*— This paper presents the generation of electrical energy by solar through photovoltaic energy in India. Power is the main agenda of life. Demand of power is increasing day to day. So the method of generation of power and supply is increased. Photovoltaic energy power system take place as the most dominative source among renewable energy technologies. The most important reason is that it is infinite and neat energy of solar power system. Many studies show that photovoltaic power system will have an important share in electricity of future in India. In this study, to generate electricity from solar energy using photovoltaic systems have a leading position in some states of India like Rajasthan, Gujarat, Andhra Pradesh, Madhya Pradesh, Maharastra.The spectrum of solar energy is quite wide and its intensity varies according to the intensity of the day and geographic location. We review solar energy conversion into electricity with particular emphasis on photovoltaic systems, solar cells and how to store electricity.**

***Keywords*— Photovoltaic-thermal solar collector; Solar energy**

I. INTRODUCTION

Electricity is the key source for industrialization, urbanization, economic growth and improvement of quality of life in society From the beginning of time, people have been fascinated by sun. Ancient civilization worshiped sun as god (or) goddess historically, agriculture and agricultural crops have relied up on sun's rays to grow crops and sustain population. Recently, however, we have developed the ability to harness the sun's amazing power.as a result, renewable energy technologies are signs of stability in future.

II. SOLAR POWER

Solar energy harnessed from heat of sun's rays and power. it is renewable and green source of energy.

Fig.1. Photovoltaic Plates

A. How Does It Work

These panels take the sun's rays, gets heated up, and create energy, act as conductors. On a large scale, solar thermal power plants also furnish the power of sun to create energy. The plants use the sun's heat to boil water and in turn power steam turbines. These plants can supply power to thousands of people. Similar to wind power solar power is a virtually unlimited and inexhaustible resource. As technologies developed and the materials used in PV panels become "greener," the carbon footprint of solar power becomes smaller and smaller and the technique becomes more accessible to the masses.

B. Solar Power In India

Solar power is fast developing industry in India, with grid connected to solar power capacity of 8,062MW (8GW) as of 31 July 2016.the Indian government, expanded solar plants, in January 2015, targeting investing US$ 100 and 100 GW of power deployment began. However up to 2015 aim of India to see installing more than double achieved by world leaders china (or) Germany. The fast growth of solar power are recorded and updated in renewable energy website monthly by Indian government ministry.

Prime ministry of India shri narendramodi and franceMr Francois Hollande laid founding stone for head quarters of international solar Alliance(ISA) in Gwalpahori, Gurgaon in January 2016.ISA focus on developing solar energy and solar products for countries lying between tropic of cancer and tropic of Capricorn.

With insolation of 1700 to 1900 kilo watt hours per kilo watt peak(kwh/kwp), India ranked number one in terms of electricity production. On 16 may 2011, India's first solar power project was registered in sivagangai village, sivaganga district, tamilnadu. India saw a sudden rise in use of solar electricity by 3000MW per year and is set to increase yet further.

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III. INSTALLATIONS BY REGIONGROWTH OF SOLAR POWER IN INDIA

A. *Installations by region growth of solar power*

STATE	MW AS OF 31 MARCH 2015	MW AS OF 31 JULY 2016
BIHAR	0	5.1
Daman & Diu	0	4
Jammu and Kashmir		
Himachal Pradesh		
Mizoram		
Kerala	0.03	13.05
Arunachal Pradesh	0.03	0.27
Puducherry	0.2	0.2
Lakshadweep	0.75	0.75
Chandigarh	4.5	6.81
Uttarakhand	5	41.15
Tripura	5	5
Andaman & Nicobar	5.1	5.1
Delhi	5.47	14.28
West Bengal	7.21	7.77
Chhattisgarh	7.6	93.58
Haryana	12.8	15.39
Jharkhand	16	16.19
Odisha	31.76	66.92
Uttar Pradesh	71.26	143.5
Karnataka	77.22	145.46
Andhra Pradesh	137.85	572.97
Tamil Nadu	142.58	1,061.82
Telangana	167.05	527.84
Punjab	185.27	405.06
Maharashtra	360.75	385.76
Madhya Pradesh	558.58	776.37
Rajasthan	942.1	1,269.93
Gujarat	1,000.05	1,119.17
Others	0	58.311
Total	3,743.97	6,762.85

Table 1: Installations by Region Growth of Solar Power in India

B. *Installed Solar Pv On 31 March*

Year	Cumulative Capacity (in MW)
2010	161
2011	461
2012	1,205
2013	2,319
2014	2,632
2015	3,744
2016	6,763

Table 2 :Installed Solar Pv On 31 March

C. *Installed Solar Capacity In India*

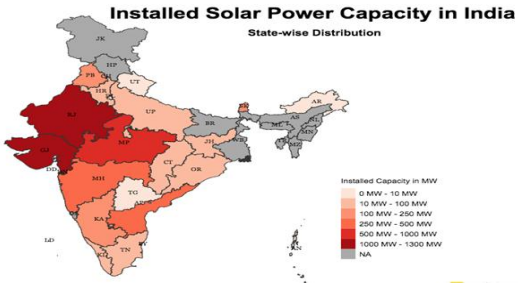

Fig. 2. Installed Solar Capacity in India

IV. SOLAR ENERGY DEVELOPMENT IN DIFFERENT STATES

A. *Rajasthan*

In India Rajasthan is most solar developed states.photovoltaic capacity has increased from 500 MW to 510.25 MW in year 2012-2013.district jodhpur leads 42 projects total 293 MW , followed by Jaisalmer and Bikaner. The asia largest CSP(concentrated solar power) engaged in constructing a 250 MW (CSP) group AREVA. In Rajasthan near Sāmbhar lake a ultra-mega green solar power (UMPP) project of 4000MW is being built.It is built in four phases, with the first phase likely to be completed by end of 2016 with 1000MW capacity, with total cost of 70 billion (US $ 1-0 billon), entire project expected to be completed in 7 years. After comp lection it would be the world's largest solar power plant.

B. *Gujarat*

Gujarat leader in generation of solar power in India, has commissioned Asia's largest solar park at charanka village generating 2 MW solar power of total planned capacity of 500 MW. The park is awarded for being the most innovative and environment friendly project CII(confederation of Indian industry).

The government has launched a roof top solar power generation scheme,which planes to generate 5MW of solar power by putting solar panels on about 50 state government buildings and 500 private buildings.the state has already commissioned 1 MW canal solar power project on branch of Narmada canal at chandrasan area of kaditalukamahesana district, which helps by stopping 90,000 liters of water/year of Narmada river from evaporating.

C. *Andhra Pradesh*

Power sector of Andhra Pradesh is divided into 4 power sectors. Namely regulationGeneration, Transmission and Distribution .regulation were AP electricity regulatory commission (APERC).Generation were electricity generated (APGENCO).transmission were electricity is transmitted by transmission co-operation(AP TRANSCO).distribution divided in to two category eastern power distribution company limited(EPDCL) and southern power distribution company limited(SPDCL).

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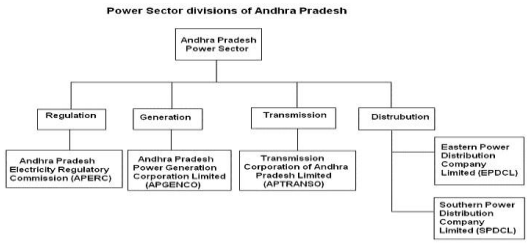

Table 3 : power sector division of Andhra pradesh

Solar Power In Andhra Pradesh

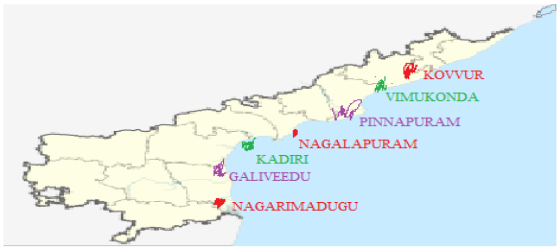

Fig.3. Solar Power in Andhra Pradesh

V. The State Has Total Installed Solar Power Capacity Of 793 Mw As Of 30 April 2016

Name	Operator	Location	District	Sector	Unit wise Capacity (MW)
MEIL-Green Power Limited	Megha Engineering & Infrastructures Limited	Nagalapuram	Ananta pur district	Private	1 × 50
Amruth-Solar Power Plant	AmritJal Ventures	Kadiri	Ananta pur district	Private	1 × 1

Table 4 : installed solar power capacity total

A. Maharashtra

Sakri solar plant is biggest solar plant in the state with 125 MW capacity. The shri sai baba sansthan trust worlds largest solar steam system constructed at shirdi shrine with estimated cost of 1.33 crore (US $ 200,000),58.4 lakh(US $ 87,000) was paid as subsidy by renewable energy ministry which is used to cook 50,000 meals per day pilgrims visiting with annual saving 100000kg of cooking gas, designed to generate steam for cooking even in absence of electricity to run the feed water pump for circulating water in system.

B. Madhya Pradesh

This is the largest solar producer and one of the top three companies in the renewable energy sector in india generate 130 MW solar power plant project at bhagwanpur in neemuch was launched by prime minister narendramodithe welspun solar Madhya Pradesh project the largest solar power plant in the state was set up at cost of 1,100 crore (US$ 160 Million) on 305 ha(3.05Km square) of land and will supply power at 8.05(12 US$)/kwh.

VI. List of Largest Photovoltaic Power Stations in India: India's Major Solar Power Production Facilities Are

Name of Plant	DC Peak Power (MW)	GW·h /year	Capacity factor
Abacus Holdings - Odessa	3		
Amruth Solar Power Plant - Kadiri, Andhra Pradesh	1		
Azure Power - Awan Photovoltaic Plant, Punjab	2		
Azure Power - Rajasthan Photovoltaic Plant, Rajasthan	35		
Azure Power - Rajasthan Photovoltaic Plant, Rajasthan	5		
Azure Power - Sabarkantha, Khadoda village, Gujarat	10		
B&G Solar Pvt Ltd - Mayiladuthurai, Tamil Nadu	1		
Bitta Solar Power Plant (Adani Power) - Bitta, Kutch District, Gujarat	40		
Charanka Solar Park - Charanka village, Patan district, Gujarat	221		
Citra and Sepset Power Plants, Katol, Maharashtra	4		
DhirubhaiAmbani Solar Park, Pokhran, Rajasthan	40		
Gandhinagar Solar Plant, Gujarat	1		
Green Energy Development Corporation Ltd (GEDCOL) -Odisha	50		
Green Energy Development Corporation Ltd (GEDCOL) -Odisha	48		
Green Energy Development Corporation Ltd (GEDCOL) -Odisha	20		
Green Infra Solar Energy Limited - Rajkot, Gujarat	10		
IIT Bombay - GwalPahari, Haryana	3		
IIT Delhi, Delhi	1		
Infosys complex, Hyderabad	7.2		
Itnal Photovoltaic Plant, Belgaum, Karnataka	3		
Jamuria Photovoltaic Plant, West Bengal	2		
Kadodiya Solar Park by Vivaan Solar - Madhya Pradesh	15		
Kamuthi Solar Power Project	360		
Kolar Photovoltaic Plant, Yalesandra, Kolar District, Karnatak	3		
KonarkKranti Energy - Odisha	5		
M G M Minerals - Odisha	1		
Mahindra & Mahindra Solar Plant, Jodhpur, Rajasthan	5		
Mithapur Solar Power Plant (Tata Power) - Mithapur, Gujarat	25		
Moser Baer - Patan, Gujarat	30		
NDPC Photovoltaic Plant, Delhi	1		
NTPC Limited - Odisha	10		
NTPC solar plants	110	160.8	16.64%
Numeric Power Systems, Coimbatore, Tamil Nadu	1		

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Omega Renk Bearings Pvt. Ltd. Solar Plant - Madhya Pradesh	1.5		
Orion Solar - Odisha	3		
Raajratna Energy Holdings - Bolangir Solar Power Project -Odisha	10		
Raajratna Energy Holdings - Odisha	1		
Rasna Marketing Services LLP, Ahmedabad, Gujarat	1		
Sakri solar plant- Maharashtra	125		
Sharda Construction - Latur, Maharashtra	10		
Sivaganga Photovoltaic Plant, Tamil Nadu	5		
SkygenInfrabuild - Odisha	5		
SkygenInfrabuild - Odisha	3		
Solid Solar by Gautam Polymers, Delhi, Haryana, UP, Tamil Nadu	1		
Sunark Solar - Odisha	10		
Sunark Solar - Odisha	3		
TAL Solar Power Plant - Barabanki, Uttar Pradesh	2		
Tata Patapur - Odisha	9		
Tata Power - Mulshi, Maharashtra	3		
Tata Power - Odisha	1		
Tata Power - Osmanabad, Maharashtra	1		
Tata Power Solar Systems Ltd (TPS) - 50 MW NTPC - Rajgarh,Madhya Pradesh	50		
Tata Power Solar- Murugan Textiles, Palladam, Tamil Nadu	2		
Thyagaraj stadium Plant - Delhi	1		
Urja Global Limited - Jharkhand, Delhi	1		
Ushodaya Project - Smarttrak Solar Systems, Midjil, Telangana	10		
Varroc Engineering Private Limited - Sakri, Maharashtra	5		
Waa Solar Power Plant (MadhavPower) - Surendranagar, Gujarat	10		
Welspun 34 MW, Bathinda, Punjab	34		
Welspun Energy 50MW Rajasthan Solar Project - Phalodhi, Rajasthan	50		
Welspun Solar MP project 151 MW Neemuch Solar Plant - Neemuch, Madhya Pradesh	151		
Zynergy, Vannankulam village, Peraiyur, Madurai district, Tamil Nadu	1		

Table 6 : largest photovoltaic power stations in India

A. Rural electrification

India's grid system is considerably under developed.as of 2004, 80,000 of india's village had not yet become electrified,where 18000 could not be electrified through conventional grid.a target of tenth national five year plan(2002-2007) has set electrifying 5000 villages, 2700 villages and hamlets has been electrified by solar photovoltaic system in 2004. India has been ranked the number one in asia for solar off grid product,with 1.2 Million solar home lighting and 3.2 Million solar lantern sold (or) distributed. Project includes 3000 villages in Orissa.

B. Solar lamps and lighting

A total of 4,60,000 solar lanterns and 861654 solar power home light have been installed in 2012.these replace kerosene lamps which can be purchased for the cost of few months worth of kerosene through a small loan.ministry of renewable energy is offering 30% to 40% subsidy by 2022 twenty Million solar lamps are expected.

C. Agricultural support

For irrigation and drinking water solar photovoltaic water pumping system is used. Pumps are fitted by a 200-300 watt motor powered with a 1800wppv array which can deliver 140,000liters of water/day from a head of 10 meters(33 ft).a total of 7068 solar photovoltaic water pumping system had been installed by 30september,7771 has been installed by march 2012. Solar driers are used to dry harvests before storage. Solar refrigeration and air conditioning

Thin film solar cells are more preferred and offer better performance in tropical hot and dusty conditions like India than crystalline silica solar panels. The deterioration is less in conversion efficiency and no partial shading effect with in ambient temperature. The thin film panels enhance the performance and reliability .In residential houses the maximum solar electricity generated during hot hours is used for air conditioning requirements rather than load requirements such as refrigeration, lighting, cooking water pumping etc.

D. Solar Thermal Processes

Electricity is generated through solar, bycoverting sun's energy in to high temperature heat using various mirror configurations, which is channeled to heat conversion technologies to make electricity. Solar plant consist of two parts, first collects solar energy and converts to heat, second converts heat to electricity.

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VII. FUTURE GROWTH OF SOLAR IN INDIA

A. *As demand for electricity*

As demand of electricity is increasing day to day, so fossil fuel and availability challenges and supportive environmental regulation increases solar power capacity to 50GW by 2022.market is seeing significant change in 2016.combination of lower solar cost with increasing price of grid power will convienceofftakers that solar power is economically viable. This shift will signal the start of growth phase. Solar capacity will increase rapidly to 35GW by 2020,as developers build capacity to meet both RPO requirements and demand from off takers seeking cost efficient to conventional power.

B. *Challenges and Constraints:Land Scarcity*

For generation of 20-60 mega watts(MW) of power the amount required is currently approximately one kilo meter square.in India architecture are more suitable for individual rooftop power generation system connected via local grid. Erecting does not enjpy economies of scale possible in most utility ,solar panel needs the market price of solar technology to decline, so that it attracts the average family size household consumer.it might be possible in future, as pv is projected to continue its present cost.

C. *Slow Progress*

World has progressed in production of basic silicon mono-crystalline photovoltaic cells, where India is short to achieve world wide momentum.in world wide photovoltaic (PV) cell production ,India is in 7th place and in solar thermal systems it is in 9th place with other countries like japan, china and US surrentlyranled far ahead.as seen during the past few years, solar is the fastest growing source of energy with annual average of 35%.

D. *Latent Potential*

Since being thickly populated region in sunny tropical belt, India should adopt a policy of developing solar power as dominant renewable energy mix, subcontinent has the ideal combination of both high solar insolation and big potential source like solar the back bone of its economy by 2050.

E. *Government Support*

India government is promoting various strategies for the development of solar energy.in 2010-11,government of India announced an allocation of 10 billion towards the Jawaharlal Nehru national solar mission and development of clean energy fund. This is an increase of 3.8 billion from previous budget. Also this budget has encouraged private solar companies by reducing custom duty on solar panels by 5% and exempting excise duty on solar photovoltaic panels.by this roof-top solar panel installation is reduced to 15-20%.

VIII. PROBLEMS AND SUGGESTIONS

A. *Standalone EPC players will cater to ISPPs and corporations*

Due to lack of internal expertise above scenario will increase demand for engineering procurement and construction (EPC) players, as developers opt to outsource turnkey project. By 2017 EPC players can look forward to 3$ Billion in annual sector revenues, thanks to a wide client base of utilities, small independents and niche players.

B. *The EPC market will remain fragmented*

Small and medium sized players will have few constraints competing against larger national and international ones with project size typically ranging from 10 to 25 MW.scale driven procurement efficiencies will vanish as faster declining costs and improving technology options inhibit the long term frame work agreements that characterize conventional energy procurement structure.

C. *Manufacturing space will still be dominated by imports*

By local regulation one area of solar market won't be dominated by small local companies; manufacturing of modules, given global over capacity in this segment, module manufacturing facilities likely will not be built in India unless mandated. The lower cost economics a of India manufactures could delay grid parity by two to three years if this happens .A trend players have to continue nonetheless global players have already started setting up base for balance of system(BOS) in India.

D. *Suggestions*

As more players achieve scale and become adept to it, globally procurement is likely to remain a differentiator. Therefore creating value in Indian market requires efficient execution financing and localization.

E. *Execution*

Managing power projects in India is tough-projects are often slowed by infrastructure issues and unreliable local vendors even under the most suitable conditions.in addition, stake holder management at the national, state and local levels often stands in the way of ensuring efficient project execution and sustained operation. Building a team of talented project managers and experienced trouble shooters will be crucial.

F. *Financing*

For project developers innovative means of financing will create win=win situations for all stake holders and drive significant upfront value.Japan-differentiated models could include teaming with technology providers from low-cost financing countries. For example-or with consumers seeking sustainability benefits(or) tax credits.A pool of low cost project equity developed from retail (or) other cost source can add up to a distinct advantage**.**

G. *Localization*

In India's solar market local design and engineering will play a major role. Global markets can generate significant benefits, inverter and balance of system design that incorporate local requirements and eliminate unnecessary elements that are geared more towards global markets. For the Indian market, eventually, global players will see the benefits of manufacturing locally. Competitions from local players could father drive down system costs.

H. *An Open Market*

Its currently open to global players as well although India's solar market appears well suited for local players. At the same time, local players can bridge capability gaps by

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striking appropriate alliances, or by recruiting strong teams(or) individuals. A partnership of foreign technology and local EPC can help both parties climb up the steep learning curve fast, but mechanisms will need to be put in place to ensure that the risks and up sides are shared equally. Both parties involved will need a long term view of the market, with lessons learned from initial projects built into subsequent ones.

IX. CONCLUSIONS

A. *India's solar market could be worth billions of dollars over the next decade*

Over the next decade, India's solar potential is real enough, and the support environrnent is improving fast enough, to forecast a 6$ billion to 7$billions capital-equipment market and close to 4$billion in annual revenues for grid connected solar generators.

B. *Project execution, financing, and localization are crucial*

Procurement effectiveness will become a requirement as the number of projects and players increase. Efficiently executed projects, low cost financing and localization will come from longer term value. A frugal cost base will be at the core of successful Indian solar ventures. Local players will dominate the downstream solar industry-The project development, installation and distribution includes in contrast to the global nature of the upstream industry, we expect local, or at least well-localized players to dominate the downstream side in the initial years will be able to prosper global players entering India for the first time, given sufficient time to fine-tune their business models. For both local and global players entering and learning the rope will be important success in solar energy will require a long term commitment and a sound understanding of local dynamics.

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