Journal of Energy Research and Environmental Technology (JERET)
Print ISSN: 2394-1561; Online ISSN: 2394-157X; Volume 2, Number 4; April-June, 2015; pp. 333-336

http://www.krishisanskriti.org/jeret.html

Solar Technology: A Comprehensive State of Art of Technology, Achievements, Challenges and Suggestions: An Indian Perspectives

Madhulika Bhati[1], Rehan Ahmad[2] and Konchok Ishley[3]

[1,2,3]CSIR –National Institute of science Technology and Development studies, India
E-mail: [1]mahupratya@gmail.com; [2]madhulika.bhati@nistads.res.in; [3]visitrehan.ahmed@gmail.com

Abstract—*Green technologies are playing vital role to solve the challenges faces worldwide related to energy security and independency. Solar technologies are one of the emerging technologies. Developed as well as developing nations are spending substantial investment to promote this technology. This paper gives a comprehensive state of the art of solar technologies with special emphasis on solar Photovoltaic. It also draws insight about the policy environments to support this technology in China, a world leader in this technology. In this paper, we discuss the regulations, policy, strategies led by government as well as private stakeholder for the promotion of this technology. We also highlight the main barriers in adoption and successful implementation of this technology and suggested some ways so that this technology can provide a successful alternative to solve issues faces by using conventional energy sources.*

Keywords: *Solar PV, Green Technologies, Environment friendly, Sustainability.*

1. INTRODUCTION

Solar technologies use solar energy an inexhaustible clean energy that provides 99.98% energy for renewable energy. This most popular type of solar technologies are: solar Photovoltaic (PV) and concentrated Solar Power (CSP).This Paper is planned to give a comprehensive state- of- art solar technologies and provides the necessary technical knowledge for understanding of this technology in- depth analysis of policy environment as well strategies of world leader China to promote Solar PV technology and also highlights the policy environment of Solar PV in India and challenges and suggestions for its sustainable development.

Solar technology is considered as one of the best form of green technology across worldwide. It is environmentally advantageous relative to any other conventional technologies, it used sun light as energy source which is unlimited resources means, does not deplete, and does not cause greenhouse gas emission into air. Solar technologies are now the fulcrum of any serious sustainable development program, worldwide. Developed as well as developing nations are making significant investments to increase of regional/national energy independence as well as diversification and security of energy supply. Power generated by solar energy is not just relatively simpler but is also much more environmental friendly compared to power generation using non-renewable sources like coals and natural gas solar energy can be a feasible passage [1]. Solar energy can be exploited through the solar thermal and solar photovoltaic (PV) routes. It encompasses classification of solar PV technology and the manufacturing processes involved in various solar technology. Traditional solar cell technology such as single-crystal silicon technology as well as newer technologies has been described.

2. SOLAR TECHNOLOGY PRINCIPLES AND TYPES

Solar PV Technologies converts sunlight to energy this conversion happens directly through solar cells made up of various components that produces the photoelectric effect. Solar cell produces DC power, which fluctuates based on the sun's intensity. Solar cells are made by cutting a large segments of bulk semiconductor materials into wafer and processed these wafers to produce the cells, these cells are connected together to form module commonly known as solar panels. Modules are connected to form arrays, which would represent the aggregate of panels on a rooftop installation. Finally, in order to be connected to a grid, inverters convert the DC to alternating current (AC) [2]

3. GLOBAL OVERVIEW

The Top most solar PV capacity countries such as Germany, China, Italy, Japan, Spain, USA, France, had added new installed PV capacities by 3.3 GW, 12.9 GW, 0.2 GW, 6.9 GW, 0.2 GW, 4.8 GW, and 0.6 GW respectively[6]. Fig. 3 mainly shows the top 10 countries, generating electricity using Solar PV for the period from 2000-2013. The trend show that China is progressing aggressively in generation of electricity from solar sources. China surpasses many country counter parts and positioned itself in 2 positions (200% Annual increased in electricity generation during the year 2012-2013)

after Germany. Although India also show its visibility among top ten countries but large amount of energy potential is still untapped.

Therefore, existing successful solar energy policies of world's leaders like Germany, China, Italy can be a lesson for developed and developing countries. For these countries, the existence of solar energy policies managed to increase solar power generation significantly.

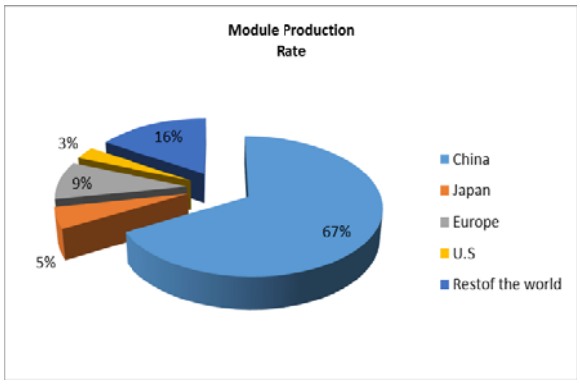

Fig. 1:Module Production rate[3-4]

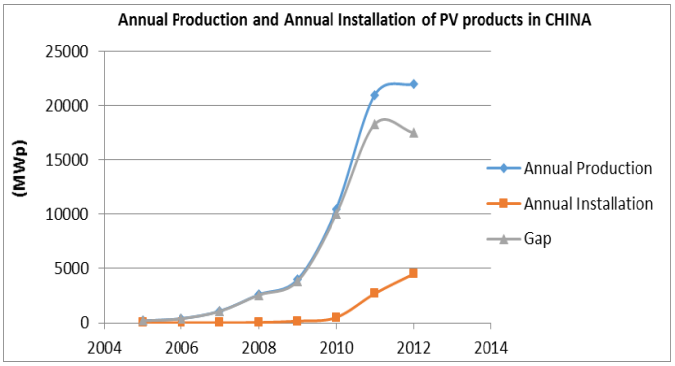

Fig. 2 : Annual Production and annual installation of PV Products in China[3-4]

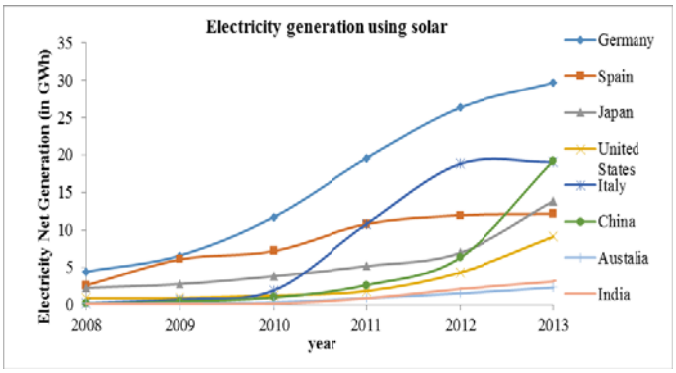

Fig. 3: Electricity generation using solar[5]

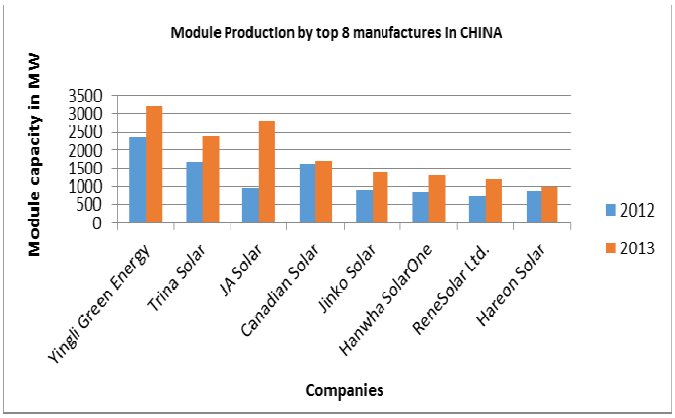

Fig. 4: Module production by Top 8 manufacturer in China[3-4]China Solar Status and Policy Environment

China PV sector showed tremendous development since mid-1990, particularly since the early 2000s. China PV module manufacturing capacity and output in China had reached 37 GW and 22 GW, representing 37% and 54% of the world total respectively (SEMI, 2013). Since 2007, China has become the largest producer of solar PV in the world the fig below shows the china's annual production and installation rate of PV in 2006 the production and installation rate is almost equal the deviation starts since 2008 as the annual production rate increase tremendously as compared to the installation rate, as since china become the largest PV module exporters, china can alone produce the 67% of the total module production

Table 1: China strategic goal for solar energy development [7-8]

Renewable Energy	Actual 2006 (GW)	Target 2010 (GW)	Target in 2020 (GW)
Solar Photovoltaic	0.08	0.3	1.8

4. RENEWABLE ENERGY LAW AND RELATED POLICIES

The Renewable Energy Law, which became effective on January 01, 2006 & was amended in 2009. It created for the first time a national framework for the Promotion of renewable energy in China .The Renewable Energy Law built renewable energy development funding sourced from user side electricity prices from 0.002RMB/kWh in 2006 to 0.015RMB/KWh in 2013[7] .As a result, the Renewable Energy Development funding will increase from 28 billion RMB in 2012 to 50 billion RMB after 2013[7]

5. R & D SUPPORTS

The Ministry of Science & Technology supported R&D in PV sector mostly through various programs 863 Programs concentrating on the PV power market application including on grid utility-scale PV in desert and thin film PV, while the key technologies of R&D programme focus on the upstream such as equipment manufacturing of crystalline silicon PV.

Recently in 2013, a key project of 863 program got initial results with funding capacity of($ 26.1943 million), in same year 2006 937 program for basic scientific research program for long term development is also initiated with the funding aid upto($ 4.9114 million) in 2009 a program for Innovation and investment of small high tech firms is planned with the funding capacity of ($3.2743 million)[8]

6. BRIGHTNESS AND TOWNSHIP ELECTRIFICATION PROGRAMS.

In 1996, Brightness Program aimed to provide this populace with average PV capacity of 100W per person, in 1996 the brightness program provides power for daily needs to the population of 23 million people in china who can't access the electricity with an aid of($ 1.637 billion),in 2002 the government launches the Township Electrification program to meet the power needs of public utilities and residents of un electrified town ship with the investment cost of ($0.4846 billion is provided by the government)[7-8]

The Rooftop Subsidy Program and Golden Sun Demonstration Program

Chinese government has rolled out measure to boost its domestic solar market. Two national solar subsidies program "The roof top subsidy Program" and the "golden sun Demonstration Program" has been initiated, the roof top subsidy is initiated to up scale the PV projects and to increase the PV efficiencies the efficiency of monosilicon PV products, Polysilicon PV products and amorphous silicon PV products exceed 16%,14%,and 6%, In July 2009 the golden sun demonstration program was started to limit the lower capacity of solar plant the size should not be less then (300KW) with a subsidy of 50% cost subsidy for on grid system and 70% of total cost for off grid system[7-8]

7. INDIAN SOLAR STATUS AND POLICIES ENVIRONMENT

Electricity Act 2003

The Section 86 (1) (e) and Section 61 (h) emphasis for promotion of renewable in India. This Acts bring the qualitative transformation in Electricity sector [9].

National Electricity Policy (2005)

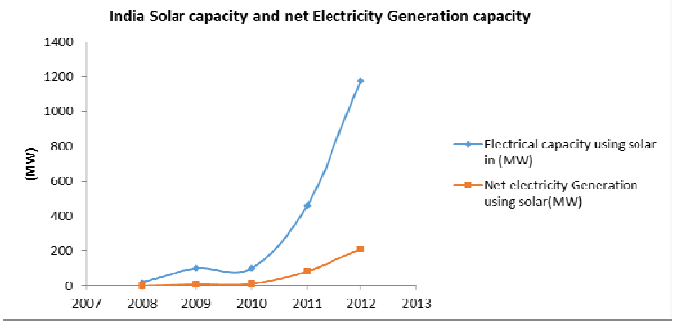

Fig. 5: India solar capacity and net electricity generation capacity[5]

The National electricity Policy (2005) is come into the existence in 2005 to stipulate progressively the share of electricity from non-conventional sources, power to be purchase by the distribution companies shall be through competitive bidding process, the commission may determine an appropriate deferential in prices to promote these technologies[14]

National Tariff Policies (2006)

As per the National Tariff Policy 2006 the State Electricity Regulatory Commissions (SCRC) to specify a Renewable energy Purchase Obligation (RPO/RPS) by distribution licensees in a time-bound manner

National Rural Electrification policies (NREP), 2006

The main Aim of this policy To make India Self-sufficient in providing the electricity to all the household in a country with a minimum 'lifeline' level of consumption of 1 unit (kWh) per household per day The policy also mentions that off-grid solar PV solutions may be deployed where the supply of grid electricity is infeasible. The Jawaharlal Nehru National Solar Mission (JNNSM) 1 is India's flagship policy on renewable energy (MNRE, 2009) It is part of India's National Action Plan on Climate Change, which focuses on India's response to climate change, and addresses diverse policy issues, JNNSM prominent goals is the deployment of 20 GW of utility scale solar power by 2022[9-10] using solar photovoltaic (PV) and solar thermal technologies The JNNSM plans to achieve this target in three phases, with the first phase targeting 1 GW by 2013, the second 4–10 GW by 2017, and the third 20GW by 2022[10-11]

Semiconductor Policy (2007)

This policy come into existence in 2007 to promote the solar industries across the country the government offers a capital subsidy of 20% for manufacturing plants in Special Economic Zones and 25% for manufacturing plants outside of Special Economic Zones (SEZs).this subsidy is condition valid for if the net present value (NPV) of the investment is of worth 2crores or more[10].

Solar PV Generation based incentives

MNRE generation based incentives, Rs 12 Kwh to eligible projects (commissioned by December 31 2009) This scheme was limited to 5 MW per developer across India and a maximum of 10 MW[12] per state first started by the central government but various states also adopted the same scheme[11-13]

8. CHALLENGES

- Grid connectivity has become the major constrains in India as solar rich area are located far from electricity load centres so connecting solar power with main power grid requires significant investment
- India is technologically backward as compare to solar world leaders, in addition to this quality challenging issue with the local market compare to international

- The PV industries Produces the substantially toxic materials after manufacturing process such as flammable and explosive chemicals like lead, brominated flame retardants, cadmium, and chromium as by-product which has adverse effect on Human health
- Disposal of electronic waste has become the major challenging issue as Recycling of PV panel is currently not economically viable because waste volumes generated are too large

9. RECOMMENDATIONS

- Government should not only step forward to rapid installation of solar PV to generate electricity but also reduce the Transmission loses and achieved the grid parity through R&D
- The government run's the education programs at top universities at the undergraduate, graduate and postgraduate levels to helps the high-level engineers as well as skilled low- and mid-level vocational workers
- Should find an alternate materials through research and innovation which improve the PV efficiency and reduces the toxicity and environmental friendly.

10. ACKNOWLEDGEMENT

We are thankful to CSIR to fund this study in form of ISTIP Project. This paper represents a small part of our studies undertaken in our project "Green Technologies: revolution in green energy". Project output came in form of a report will published by CSIR-NISTADS (in press). Principal author of this report is Dr. Madhulika Bhati, Scientist, and CSIR-NISTADS.

REFERENCES

[1] Retrieved on 18-04-2015 www.sersc.org
[2] Philip G. Jordon (2014). The mechanics of Solar Power in Solar energy market Pg. 7-18
[3] Retrieved on 10-04-15 www.epia.org
[4] Reterived on 8-04-15 https://www.iea.org/.../TechnologyRoadmap**SolarPhotovoltaicEnergy**_2013
[5] Retrieved on 13-05-15 http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm
[6] Retrieved on 16-04-15 www.**ren21**.net/portals/0/.../gsr/.../gsr2014_full%20report_low%20res.**pdf**
[7] Zhang, S. and He, Y., (2013), Analysis on the development and policy of solar PV power in China. Renewable and Sustainable Energy Reviews.21, 393-401
[8] HUO, Mo-Lin and Wei, D., (2012).Lessons from photovoltaic policies in China for future development. Energy Policy,51,38-46
[9] Retrieved on 10-04-15 http://indianpowersector.com/home/electricity-regulation/
[10] Shrimali, G. and Sahoo, A. (2014).Has India's Solar Mission increased the deployment of domestically produced solar modules? Energy Policy, 69,501-509.
[11] Retrieved on 11-04-15 http://mnre.gov.in/file-manager/annual-report/2008-2009/EN/index.htm retrieved on 10-04-2015
[12] Sharma, N.K. (2012). Solar energy in India: Strategies, policies, perspectives and future potential. Renewable and Sustainable Energy Reviews. 16 933–941.
[13] Retrieved on 6-04-15 http://www.academia.edu/9505934/Solar_energy_in_India_Strategies_policies_perspectives_and_future_potential