Present and Future Opportunities for Solar Power in the Indian Market: A Study

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ABSTRACT

In the ancient world, there was no fossil fuel, mineral oil and coal available for utilization. Renewable energy sources especially solar have very good potential in India and the world as well. The small (KW) at the micro grid/local grid level and the large (MW) Plants at the national/state grid level can produce the electricity. If the mineral oil and coal were not found as a fuel the solar/ renewable technology would have developed with its utmost potential. But this is the starting of the renewable technologies. The future is only for the renewable technologies where a lot of scope seems to be there with the points of the good business, good environment, good technologies, good research and developments, overall good livelihood. At present we see the adverse effects of the polluted environment as a result of the removal of the breeds of birds, animals, flies-mostly butterflies etc. Removal of the EM waves from the environment is essential to save the Ecological System on the earth. This could be achieved by sustainable and economic technological development for optimum utilization of the natural resources. Innovations in low Voltage Electricity Generation and proper channelization of the mini grid/micro grid/local grid interactive power system concept are desirable for the future aspects. Optimum utilization of Renewable Resources like the hybrid solar photovoltaic, biomass/biomass gas, biogas and wind Power Plants doesn't mean to be far away. Limited utilization of the high frequency related equipment and development of the low frequency utilization technologies is essentially required for the medical fitness of the humanity and to save the life expectancy for today. Emphasis in this paper is to achieve the highest growth and development in the solar technological innovations and suggestions. Commercial and deployment activities for the solar project's implementation may be the areas for developing EPC Solar NET Metering/Gross Metering. Rooftops/Ground Mounted for better business solutions. The government should take keen interest and initiatives to collect and provide funds for these projects. A transparent fit in tariff (FIT) should grow to build up the mass scale solar business.

Keywords - Renewable energy, solar, integrated, power cuts, Government. Solar policies.

1. INTRODUCTION

Despite the general economic crisis, India's energy demand is growing and continuously rising with the global warming and the disastrous consequences (IEA, 2020). The expected economic and population growth, together

with urbanization and industrialization, point towards continued growth in energy demand. The Energy demand is expected to increases 4.5 % annually by 2035 from 3.5 % which are previously projected demand during 2000 to 2017. The total use of electricity in India is 1,010 kWh, compared with a world average of 3,200 kWh (Bauner and Crago, 2015; DFAT, 2020; Jeffrey *et al.*, 2015). There is only one solution for this problem is to focus on renewable energy. India concentrates on renewable energy, have been projected to generate up to 84,000 MW of hydroelectric power at 60 percent load factors. The government mainly concentrated in the country's southern part and also preparing to accelerate a hydro-development programmed to install 50,000 MW of new capacity by 2026 (around the end of the 14th Five-Year Programmed) (Ulsrud *et al*., 2015; Bijarniya *et al*., 2016). Also revealed at the 2015 Paris Climate Summit was a "Solar Alliance," which seeks to increase its solar generating capacity to 175 GW by 2022. India is increasing its solar energy as the name implies, with aims to have 100 GW capacity by 2022 (Bauner and Crago, 2015).

India is the nation of villages and towns where the integrated approach to empower the people of the community is essential. Electricity is required to improve the healthcare, water & agriculture, education and enterprises facilities in the villages, towns and cities in the country. Lighting system in the villages as well as in the towns is very poor. People community especially in the villages and small towns of India are living in energy poverty. Newly announced 19th EPS projects with a demand for electricity of 1743 TWh (6.59% CAGR) from 2017 and a peak load of 299 GW (6.32% CAGR) by 2027.

Figure1: Projected Power scenario in India

2. GOVERNMENT PERSPECTIVES

The energy sector of India is exciting to transform and build a stable, scalable, productive and supportable network by 2027 to deliver people with reliable and good energy through the use of creative technology and guidelines to meet the desires and expectations of all, through active shareholder sharing (Zhang *et al*., 2015; MNRE, 2020; Invest India, 2020; Aichmayer *et al*., 2015). Technological transition makes it difficult to forecast of future mix energy of India, but even considering increased domestic supply energy and its higher energy efficiency, India's energy import dependence could grow from 36% to 55% by 2040.

Our Indian government should take the interest to improve the condition of the existing villages and towns and also should take keen interest in developing the smart and new cities for economic and industrial growth of India. Though the concept of developing smart cities is good enough for a long period progress of the nation but at the time the development in the villages and towns systems should be the first priority. Integrated approach of using Solar Energy Solutions with local grid concept at the sites is technically feasible to power the community lighting system. Such type of development model should be adopted where the people of India get their

enterprises, their production, their machineries and equipment powered by sufficient electricity, generate their economies, and achieve & avail all the facilities of a smart city. They get the qualitative educational facilities in the villages and small towns with new efficient computers, laptops, highly equipped labs etc. They get the water and agriculture, powered water wells, clean drinking water, drainage & roads, Pumps and year round crop irrigation systems powered by the Solar Photovoltaic systems. A good quality of transport and communication powered by the solar photo voltaic, medical & health facility with good quality of labs, diagnostic equipment and vaccine refrigerators will definitely improve the living standard of the gentry of our India and the country as well. They will definitely fully utilize & digitalize their skill with their strengths. The standard of the people in this way definitely will improve and the villages & towns will get smartness -in living, growth and development (Mileva *et al*., 2016; Nickerson *et al*., 2015; Askari *et al*., 2015; Shouman and Khattab, 2015; Som and Chakrobarty, 2014).

Villages should be selected & electrified under the remote rural development programs. The use of solar power must be intensified and independent off grid solar power projects should be launched on the basis of local/micro grid technology. Grid tied/hybrid solar power projects should be sanctioned as the mega solar projects to feed the Indian or national grid. For that the national/Indian/private integration, installation and commissioning companies/institutions should be funded. Good initiatives for the investors are also required to solve the monetary and funding problems. National/Indian/private banks and institutions may also be involved for the direct investment in building the solar park. A good qualitative and transparent funding scheme with clear bidirectional tariff policies should be introduced.

2.1 GOVERNMENT POLICIES AND REGULATIONS TO PROMOTE SOLAR ENERGY IN INDIA

1. 1982: Commission of Alternatives sources of energy was created
2. 2003: Electricity Act, 2003
3. 2005: National Electricity Policy, 2005
4. 2006: National Tariff Policy, 2006
5. 2006: National Rural Electrification Policies, NREP, 2006
6. 2007: Semiconductor Policy, 2007
7. 2008: National Action Plan on Climate change , NAPCC, 2008
8. 2009: Generation based Initiatives to encourage solar PV energy in India
9. 2010: Jawaharlal Nehru National Mission, JNNSM, 2010
10. 2011: Renewable Energy Certificates, RECs
11. State Level Initiatives
12. Research And Development Initiatives

2.2 NITI AAYOG'S NATIONAL ENERGY POLICY TO IMPROVE ENERGY SECTORS

Smart Grid has a very wide ranging vision of the forthcoming and is working enthusiastically towards achieving the targets and objectives propagated in the 13th and 14th, 5 year plans (Chang *et al*., 2015; Ondraczek, 2014; Hoppmann *et al*., 2014; Shah *et al*., 2015). Presently the government is working on 13th 5 year plan from 2017 to 2022 and focused the following targets:

1. Reduction of Transmission and Distribution losses to upto 10 % in all services

2. End of load shedding
3. Increase in Power Quality
4. Efficient Estimation and Shipment of Renewable Energy
5. Substructure and Requirements for EV
6. 1,200 KV ac network in operation
7. Requirements for DR preparation for energy efficiency and emission standards.
8. Distribute of smart grid goods to the abroad market.

The future Plan of the government in the next fourteenth five years plan from 2022 to 2027 will investigate:

1. Economically possible services
2. Constant 24 x 7 electricity supply to all customer.
3. 33 percent or extra renewable in power system.
4. Electric Vehicle setup control as VPP
5. Transfer of Smart Grid goods, technologies and facility to abroad.
6. Clean cooking access through efficient and affordable gasoline.
7. Information Technology network and CRM system for electric utilities delivered to further service providers for example water and Gas delivery, land revenue collection

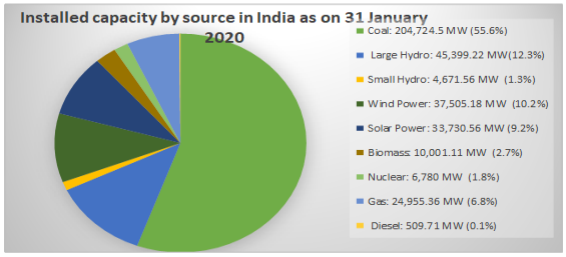

Figure 2: Installed Capacity by Sources in India [6]

3. SOLAR ENERGY

Solar energy has long been recognized as the green energy, ensures the energy security & the economic growth, renewable and carbon targets and is environment friendly. Wind power interpretation for the maximum at 46 percent (around 36 G W), after that solar with a stake of 36 percent (30 G W) share. Biomass captured the residual market at 12 percent (9 G W) and small hydro ventures at 6 percent catered for 5 GW. In India, wind energy capacity has risen 1.7 times in the last four years. In addition to this, last year record 100 bn+ renewable electricity generation units. Solar power has risen from 2.6 G W to 28.18 G W in March 2019 by more than 11 times in the last five years (Verma *et al*., 2017; Solarify, 2020; Kumar *et al*., 2014). The As of 29 February 2020, solar installed capacity in the country exceeded 34.404 GW. India has the lowest cost of capital per MW for building solar power plants globally (Som and Chakrobarty, 2014). In fig. 3 shows that solar energy give huge contribution in Indian Energy Consumption.

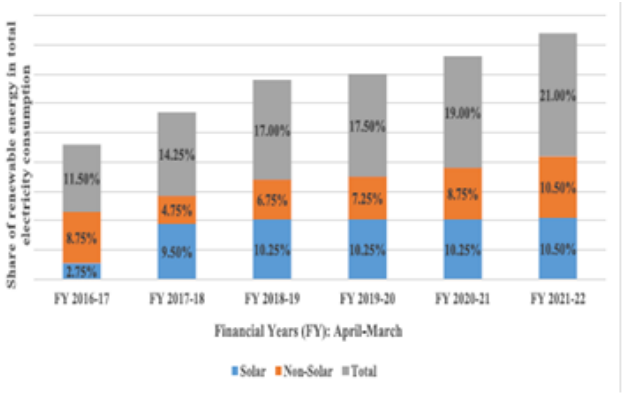

Figure 3: Share of Renewable Energy in India's Power Consumption

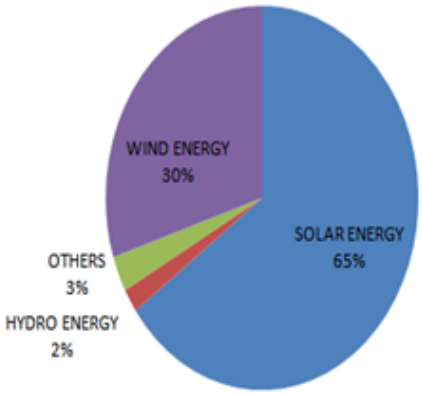

Figure 4: Source wise energy potential of India

3.1 BENEFITS OF SOLAR ENERGY

1. Power cuts management
2. Reduction in fuel and electricity consumption
3. No smoke, no noise, clean and green energy
4. Economic, efficient and environment friendly
5. Increased battery life and ensures energy efficiency and energy security concerns
6. Increased production and minimum cost of energy
7. Greater availability, reliability and maximum profitability
8. High societal impact and potential to commercialize

For rural electrification and development, many initiatives taken are given in Table 1 and Table 2.

Table 1: Perspective of solar schemes (on-Grid connected)

SCHEME	OBJECTIVES	FUNDING ASSISTANCE	TIME DURATION
Solar Based Park Creation & Ultra Mega Solar Power Projects	To improve the power from 20 KMW to 40 KMW.	Financial Assistance up to Rs. 25 lakh/ solar park DPR and Rs. 20 lakh per MW or 30 percent of the entire project price	Up to 2021-22
Founding of more than 5 KMW Grid Associated SPV	To boost grid power and distribute renewable energy projects	Up to Rs. 10000000 Per Mega Watt for open category and Rs.	Financial Year 2015-16 to 2018-

Power Projects beneath JNNSM PHASE-II	nationally, reducing transmission costs and losses	12500000 per Mega Watt for projects in Domestic category project.	19
Establishment of Scattered Grid Connected Solar PV Energy Projects at A & N and Lakshadweep Island.	Developing Pollution Free Islands by phasing out diesel usage for electricity production and contributing to the Iceland's NAPCC&G along with reducing power production costs.	CFA of up to 40% of the project Cost.	2016-17 to 2019-20
CPSU Scheme Phase-II for Setting up 12000 MW grid connected Solar PV Power.	To establish solar PV projects by Government to facilitate national energy security and environment sustainability for Government purpose.	VGF of up to Rs. 70 lakhs/ MW & 50% shareholding of Central / State Govt.	2019-20 to 2022-23
Grid Connected Solar PV Rooftop Scheme	For attaining collective capacity of 40 kMW from Rooftop Solar Scheme up to year 2022.	CFA to Residential sector up to 4 GW	Till 31.12.2022

Table 2: Perspective of solar schemes (off-Grid connected)

SCHEME	*OBJECTIVES*	*FUNDING ASSISTANCE*	*TIME DURATION*
Off grid and Dispersed Solar Photo Voltaic Application Scheme – under Phase II	Connection of an added off grid solar capability of 118 MW power by 2020 over ensuing application : • 3,00,000 solar street lights • 25,00,000 solar study lamps • 100 MW Power of off grid solar power plants	• CFA of 30% of the cost for solar street lights and solar power plants in developed States and CFA of 90% of the system in North Eastern States including Sikkim, J & K, HP, UK, Lakshadweep and Andaman & Nicobar Islands. • CFA provide 85% cost of the for Solar Study Lamps	Till 31.03.2020
PM KUSUM	To achieve 25,750 MW through renewable sources up to 2022 with total CF support of Rs. 34,4220000000/-	DISCOMs will purchase the produced renewable power at a feed-in tariff mandated by the respective State Electricity Regulatory Commission, SERC	Till 31.12.2022
Atal Jyoti Yojna (Ajay) Phase II	To installed 3,04,500 Solar Street Lights through Phase II	SSLs with a 12 W LED capacity will be installed in compliance with the MNRE description and 75 percent of the SSL device expense will be covered by the MNRE budget and the lasting 25 percent from the MPLADS fund.	Till 31.03.2021
Scaling up access to renewable energy for efficient use in rural areas	Improving the use of safe and affordable renewable energy for efficient rural usages / life and the usage of fossil fuels in underserved and under-served areas only for Assam, MP and Odisha	MNRE release will release up to 30 percent of CFA as advance and balance 70 percent based on progress	June, 2020
Off-grid and Open Solar Thermal Technologies (CST)	Promoting off-grid solar thermal systems applications to meet the goals set by the JNN Solar Program.	CFA will only be issued by each of the Regional Test Centers (RTCs) for reimbursement related inspection.	2017-18 to 2019-20

4. FUTURE PERSPECTIVES IN SOLAR POWER IN INDIA

For the better uses of solar power will contribute grow in GDP. So it is necessary to improve the solar power efficiency government should work on as following areas:

4.1 SEAMLESS AVAILABILITIES

The government should ensure the seamless solar projects implementation and should commit the challenges to be a forefront of the solar PV revolution underway in the Indian ensuring to achieve high energy efficiency and high energy yield. Our Indian government aim should be to take the initiatives to provide and deliver the cost competitive and affordable solar solutions for clean energy technologies with the following capabilities (Sharma *et al*., 2012; Kapoor *et al*., 2014; Tiewsoh *et al*., 2019):

1. Financial modelling and economic analysis
2. System design and engineering
3. Integration, installation, construction and commissioning
4. Complete project management, operation and maintenance
5. EPC Solutions for Grid Tied/Hybrid/Off Grid Power Plants
6. Real time monitoring and controlling facilities

Indian government should take the interest to improve the economics of manufacturing units of Solar panels, inverters, batteries, and other utility equipment's being used in solar energy systems to stop the imports of the cheap China solar products.

4.2 INITIATIVES

The Indian government should take interest and initiatives in developing solar technologies and establish the labs/virtual labs to perform research and development in three major branches of solar energy

A. Photovoltaic (also called solar electric systems)
B. Solar thermal systems (Solar heating systems)
C. Solar cooling systems

The sustainability and the use of solar systems in aviation and medical fields persists high grade and efficient solar technological development. In this way the solar R&D cell might cover the full spectrum from fundamental studies to commercialization, systems development and integration to improve performance and reliability in the following research areas:

a) Research & development in solar cells & modules technologies.
b) Research & development in solar fields & radiations
c) Research & development in solar system installation & integration
d) Research& development in solar thermal
e) Research& development in solar heating
f) Research& development in solar cooling
g) Research & development in silicon materials and devices
h) Research &development in Polycrystalline thin-film materials and devices
i) Research & development in III-V multifunctional materials and devices

j) Research & development in new chemical and biological materials, devices and processes
k) Research & development in power electronics and energy efficient equipment's
l) Research & development in Solar Power Plants structures
m) Research & development in solar economics

4.3 ROLE OF INDUSTRIES & INSTITUTIONS

The institutions should go for R&D with planning with pilot project activities to work with local, Indian federal and state governments and private industries/ Institutions and organizations to deploy renewable energy technologies that are commercially available with energy efficiencies. The experts should plan to prepare the market for emerging technologies with the aim of project development, technical assistances and disaster resiliency and recovery by removing barriers to adoption and deployment resources to move the projects in forward directions. The researches with data preparation uniquely and continuously utilize the ideas along with academic institutions, industries, agencies, and laboratories. The data might be used for renewable energy, climate change studies, atmospheric research, conversion systems, carbon capture, technological development and testing etc. (Bijarniya *et al*., 2016).

4.4 METHODOLOGIES

Government should go for a firm planning, monitoring and developing the departments to offer the unique and the distinguished advantages in the fields of Solar Photovoltaic, Thermal and Electronic Projects mutually that may broadly be classified as:

A. Solar Photovoltaic Projects
   - Solar Photovoltaic Power Generating Systems
   - Grid Interfaced SPV System:
     a) Single Phase GISPV System with single stage or double stage
     b) Three Phase GISPV System with single stage or double stage
     c) Stand-alone SPV System with single stage or double stage: The capacity range is from 1Kw residential projects to Mw commercial projects.
     d) Solar Surface/Submersible Pumping Systems
     e) Solar Lanterns
     f) Solar Street Lighting

B. Solar Thermal Projects
   a) Solar Thermal Power Projects with Flat Plate Collectors
   b) Solar Thermal Power Projects with latest Evacuated Glass Tube technology
   c) Solar Chimney Power Plants

C. Solar electronic system
   a) LED lighting arrangement
   b) Solar street lighting system

D. Solar LED luminary

4.5 BEST FIT SOLUTIONS

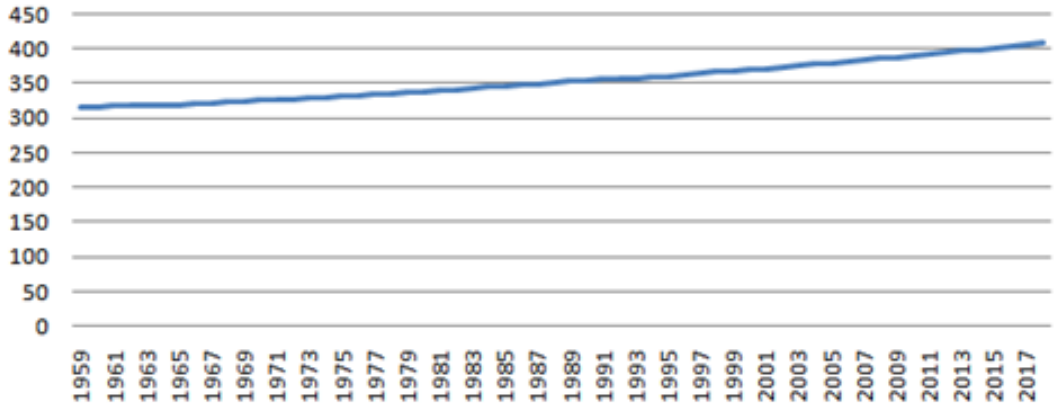

Figure 5: Global CO2 atmospheric emission in ppm

As it is seen from the data the rate of CO2 emissions are increasing every year with a rapid rate. Improving energy efficiencies is the key tool to reduce CO2 emissions. This requires the optimum utilization of clean and renewable energy to secure future generation. The Indian government can work /look/distribute the projects to the customers to fulfill the commercially viable requirements:

a) Energy efficient solutions
b) Energy savings & securities
c) Cleaner and reasonable alternative to diesel
d) Rooftop solutions for sustainability
e) Bilateral industry open access contracts
f) Off grid energy access opportunities
g) Grid interface SPV power generation opportunities
h) Achievement of green ratings for companies
i) Power transmission and distribution execution opportunities
j) Solar thermal Opportunities
k) Solar lighting Opportunities
l) Solar water heating Opportunities
m) Solar Water pumping Opportunities

4.6 GUIDELINES

For the projects the Indian government should issue the proper guidelines and the ratings for the commercial projects such as:

a) Quality and Engineering products
b) Challenges- always focus on cost effectiveness
c) Raise capability to utilize Solar Power
d) Up-gradation and innovation
e) Right amount
f) Reliability and optimum design considerations
g) International green and clean technology

h) Following IEC/NEC/REC/MNRE Standards
i) Meticulous spirit with strong commitment to meeting with all the requirements of esteemed customers
j) Design and development of High-level technology with high-precision and sustainability
k) Continuous innovative and managerial efforts in getting the balance between Environment, Economy and Efficiency

4.7 ACTIVITIES AND DEVELOPMENT

Commercial and deployment activities for the solar projects implementation may be the areas of the following with the efforts of developing EPC Solar, NET Metering/Gross Metering, and Rooftops/Ground Mounted for better business solutions:

a) Land in the villages/towns/cities
b) Grounds/Roofs of the houses, industries, institutes, hospitals, schools, colleges etc.
c) Government buildings
d) Patrol Pumps
e) Sides of the streets, rivers, canals etc.
f) Shadow free area in the Hotels, orchids, and resort centers patrol pumps etc.
g) Housing societies/townships

4.8 INTEREST

The government should take keen interest and initiatives to collect and provide funds for these projects. A transparent fit in tariff (FIT) should grow to build up the mass scale solar business. It can accelerate the investors to invest the money in such projects and form the public enterprises to provide the institutional support for the industries in setting up the commercial solar energy projects. Policies should be clear and supportive with financial subsidies and market strategies.

5. CONCLUSION

Solar power system can be the good alternative to produce electricity. The government should inculcate and develop the transparent policies for solar business in such a way that it should become the business of the masses. Most of the people should participate and grow this business as electricity is required for the growth and all round development of the country since development of any nation depends on per capita generation and utilization of the electricity. Optimization of hybrid renewable electricity model consisting of photovoltaic arrays, Battery bank and combined heat and power systems along with micro grid tools to deploy the off grid residential solutions can be coupled to fulfil the load demand in Indian rural. Fossil fuels, biomass, biomass gas, biogas based small scale CHP systems can be combined with the solar PV systems to improve the benefits of co-generation in getting electricity, space heating & cooling, water heating etc. Power management systems are to be proposed to cope up the micro grid to mitigate and suppress the disturbances due to the integration of renewable electricity in to such grids. Software algorithms should be designed and suggested to filter out the adverse effects of the power events and to improve the power smoothing index of the complex hybrid electrical network (grid) system.

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