Emerging Needs Of Sustainable Technology- Solar Pv Development In India

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Abstract—

Solar Power generation in India ranks within top five countries of world in Green energy revolution. Photovoltaic (PV) cells, or solar cells, are active photoelectric system converting sunlight to electricity. Small panels are constructed with semiconducting material based on photoelectric effect. The material, usually used comprises silicon with potentially other polycrystalline thin films, generating direct current when sunlight hits the panel. PV cells are successful in all regions of the world. Commercially available PV panels are about 22.5% efficient for conversion of sunlight into electricity under standard test conditions, but even in partially cloudy weather, they can operate at about 80% of their maximum output. In India Solar radiation available is more than 300 days amounting to about 3,000 hours of sunshine with power equivalent to 5,000 trillion kWh. India's economic growth has been hindered by shortage of electricity since transmission and distribution losses have been extremely high over the years due to urban theft. This reached a worst proportion of about 24.7% during 2010-11. Thus, use of solar needs to be commercialized for economic development in India.

Towards planetary mission, solar use is being promoted in applications like street–home lighting systems, solar Lanterns, PV power plants, water heaters, solar cookers, agro-photovoltaic pumps, large solar arrays, and solar powered portable lighting devices, rooftop panels, pedal powered classrooms, green parks, green cities, standalone and grid structures etc. The capital investment in establishment of solar unit is not too large since costs of land & building is not included. The machineries of the units are fabricated by suppliers or local engineering workshops. The plants can be installed in villages of small scale industry production catchment. Though India is the second largest rural agro industry in World, the Research and Development support is negligible towards use of solar in agro-systems designing, fabrication/ manufacturing, lay-out, installation, operationalization, maintenance of complete hard ware units as well as the product processes development, product manufacturing, product packaging, storage and marketing, etc.

Considerable research work has been done at ICAR Institutions by NISE, SEC, MHRD and NGOs in this direction. However, visible impacts are not seen on the real ground perhaps due to low risk capacity, limited internal resources and poor access to solar resources in areas of these entrepreneurs. In this presentation the present status and future needs for technovations and management skill in the areas of solar power extraction efficiency, improved fill factor, better MPP tracking, value added techniques with applications and overall modernization of solar PV processing, storage and marketing, etc have been mapped and discussed.

Index Terms — Photovoltaic's, Green energy revolution, agro-systems, solar power extraction efficiency, improved fill factor, MPP tracking.

1 INTRODUCTION

Sustainability is the core for developing and delivering payload energy systems in world. Sustainability refers to productivity inspite of challenges in social, economic and environment areas. The foundation stone of present sustainable structure is determined by use of RET's (Renewable Energy Technology) that plays an important role in global development. Sustainable in broad terms means living within the limits, understanding the interconnections among economy, society, and environment and having equitable distribution of resources and opportunities using renewable energy sources. Although there are number of RET's like Solar, Wind, Ocean, Geothermal, Biomass and waste energy, Solar being most abundant has vast energy potential. Solar appears to be largest contributor among RET's and its use is consistently increased by 20-25% in investment sector. The upcoming solar sustainability is marked by (1) Increasing efficiency of solar cells (2) Manufacturing technical improvements and (3) Economics of scale. Solar finds three main applications in areas of (1) Solar Thermal (ST), (2) Solar Photovoltaic's (PV) and (3) Solar Hydro (SH). Solar Thermal uses large solar collectors or evacuated tubes in capturing sunlight. It is used in domestic cooking and heating. Solar PV uses solar cell modules to absorb sunlight and emit photons for electricity generation. Solar Hydro uses perennial streams or water for electricity generation and heating. Since PV flexibility makes simpler technology with easy fabrication it is preferred on commercial scale. PV is used in standalone domestic structures requiring no battery storage and grid applications operating on battery banks.

PV systems are providing secure investments being environment friendly and emission free. Application areas of PV are not limited to agriculture and industry alone but personal and planetary sustainability too. Case studies reveal that immense solar potential is being harnessed for profitable energy ventures in India. Subsidized institutional tie-ups with Tata BP, BHEL, and NGO's have played role of catalyst in facilitating growth of solar PV. Jawaharlal National Solar Mission (JNNSM) introduces ample opportunities for PV developers in India. Specific drivers for PV in India include the country's rapidly rising primary energy and electricity needs, the persistent energy deficit situation, the country's overdependence on coal for electricity generation and on oil and gas imports (amounting to 7% of its GDP).

Solar applications can be subdivided into many categories. As concerns electricity, power supply generation and distributions are most important. Small rooftop panels triggering power supply in homes to grid describing power utility over campuses all paralleled accommodated by solar. Water distillation used for domestic purification or pumps used in large farm lands spread over vast areas are watered using agricultural solo or Monedo solar pumps. Portability of panels makes domestic applications increased many times in consumer items. Electronic appliances in lighting systems and novel beautification handicrafts are another promoting feature. Solar panel integrated clothes, umbrellas, bags are interesting upcoming products in market. Be it east or west from hills to plains solar power is being harnessed in form of green houses to yield fresh vegetables throughout the year. Solar chargers, regulators, inverters, projectors and street lights form backbone in remote areas used in lighting fences or terrace lands. Solar cities and villages are bringing a direct link between energy and resources. Latest endeavors are being tested towards achieving set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022. Together with this, efforts for reduction in power generation cost through solar tariffs are upcoming area in R&D.

2 PRESENT STATUS AND CHALLANGES

In India, GDP high growth rate has resulted in great demand of energy, but the supply is unable to match the demand. India being amongst sunny regions of the world receives 4 to 7 KWhr of solar radiation per square meter per day with 250 - 300 sunny days in a year. Even though, solar energy constitutes just a miniscule part in India's installed power generation capacity 905 MW as on 31 March 2012 as shown in Fig. 1.

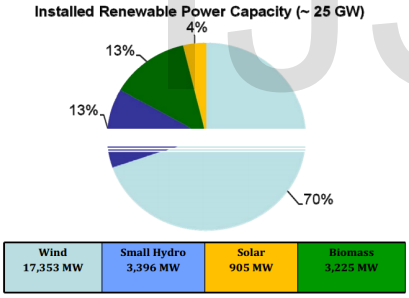

Fig. 1 Installed Renewable Energy Capacity

As indicated from above distribution that Solar although abundant in India is not being utilized effectively. The National Solar Mission as highlighted before is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth using solar addressing India's energy challenges. The major initiatives of JNNSM include promotion of solar energy technologies. The Mission aims to achieve grid tariff parity by 2022 through ¾ Large scale utilization, rapid diffusion and deployment at a scale which leads to cost reduction ¾ R&D, Pilot Projects and Technology Demonstration ¾ Local manufacturing and support infrastructure.

The roadmap planned by JNNSM to make photovoltaic's as most important components of country's energy mixture is given in Fig. 2.

Application Segment	Target for Phase I (2010-13)	Cumulative Target for Phase 2 (2013-17)	Cumulative Target for Phase 3 (2017-22)
Grid solar power (large plants, roof top & distribution grid plants)	1,100 MW	4,000 - 10,000 MW	20,000 MW
Off-grid solar applications	200 MW	1,000 MW	2,000 MW
Solar Thermal Collectors (SWHs, solar cooking/cooling, Industrial process heat applications etc.)	7 million sq meters	15 million sq meters	20 million sq meters
Solar Lighting System	5 million	10 million	20 million

Fig. 2 Road map for JNNSM

The execution of above plan has already been started using PV architectures suitable for India. Implementation results prior to 2013 statistics in India by about 1,114 MW installations, solar power installation rose to 2,319MW. Grid power PV area had provided 2,208.36 MW installations with OFF grid structures around 200MW by January 2014. Various application segments mentioned in above table are shown through implemented designs in Fig. 3-6.

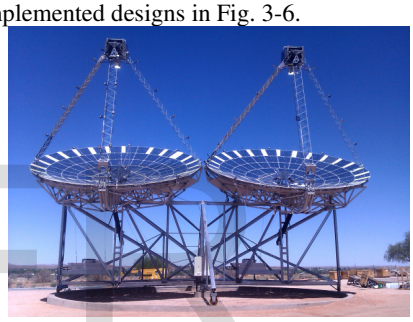

Fig. 3 Grid Solar Plant System

Fig. 4 Rooftop Building Management System

Fig. 5 Solar Thermal Collectors

Fig. 6 Solar Lighting Systems

All systems visualized above using PV panels are dependent on type of solar cells used in manufacturing panel. As in India, emerging trends describe to use thin film solar cells in PV panels whose wafer thickness, cell efficiency and more absorbing characteristics provide adaptive features in manufacturing processes. However, concerns of different category solar cells are given in Table 1. It summarizes various types of solar cells used in PV panel manufacturing and the challenges faced from them.

S.N.	CATEGORY	TYPE	CHALLENGE
1	Silicon	Single crystalline	Manufacturing, Quality improvement
		Polly crystalline	
		Amorphous	Junction Multiplication
2	Compound Thin Film	III-V (GaAsInP)	Band Gap control, Junction Multiplication
		II-VI (CdTe/CdS Cu_2S/CdS)	
3	Organic	Pentacene Phthalocyanine Merocyanine	Structure, development of the device, multi-junction.
4	Photochemical	Dye sensitized	Development of the materials
5	Inorganic	Quantum dots	Synthesis and preparation

Table1 Solar cells types and challenges

The manufacturing of solar cell panel is not sufficient. Terminology describing high efficiency of solar cell also needs to be justified. Various terms that need to be managed associated with solar cells are given in Table 2.

S.N	PARAMETER	DESCRIPTION
1	Solar power extraction Efficiency	The ratio of maximum power to the product of the input light irradiance and the solar cell surface area.
2	Fill Factor	The ratio of maximum power delivered by panel to standard power conditions.
3	MPP (Maximum Power Point)	The operating point under which solar cell generates maximum power.

Table2 Solar cells high efficiency managed parameters

Thus upcoming demand for PV to be considered as most appropriate exhaustless long-term source could be only when above three factors are managed and properly incorporated in solar cell panels. Research efforts are developing in stimulating solar cells to produce increased outputs at a lower cost. By identifying SWOT for PV industry remarkable results can be traced out.

3 SWOT ANALYSIS FOR PV INDUSTRY IN INDIA

The major challenge in successful completion of sustainable standard after surveying various Applications based on PV panel can be determined by value concerns through following four main industry segments. A SWOT survey for Indian PV industry is given below:

3.1 Strengths

1. Future of India poised to appear as major solar power. 2. Union Cabinet approves 25 solar projects for India's SunShot initiative. 3. JNNSM is accompanied with Ultra mega solar power plants in Budget 2014-15 in Rajasthan, Gujarat, Tamil Nadu and Ladhakh. 4. Sunlight availability is sufficient and adaptable to shade or no sun conditions. 5. Technology is proved, scalable with low operation and maintenance costs. 6. Availability of soft loans and government incentives for growth and expansion.

3.2 Weaknesses

1. Government incentives required to embark more facilities and subsidies for solar ventures. 2. High capital and space costs for establishment of grid utility plant. 3. Large business generally preferred due to capital intensive nature. 4. Distributed System designs cause base load difficulties. 5. Research and development projects simulation designs for shaded conditions are not up taken.

3.3 Opportunities

1. Ambitious targets of Government for solar projects. 2. PV Developers to get easy statutory and clearances on projects. 3. Thrust on grid connected Defense establishments. 4. Priority sector implementation of rooftop houses in remote areas with Government financing. 5. Formation of Association of Renewable Energy Agencies of States (AREAS) to continuously monitor watch of solar programmers. 6. High innovative Green jobs in market by The Council on Energy, Environment and Water (CEEW) research institution through

high-quality research by partnerships with public and private institutions.

3.4 Threats

1. High risks of obsolescence as novel technology. 2. Cash flow reduction in off season. 3. Searching professionally skilled persons for PV industries.

4 SOLAR MARKETING AREAS

4.1 ELECTRICITY GENERATION

PV uses mini grid or mega grid power plant to trap solar energy for conversion to electricity. It is subdivided into Rooftop or Grid distribution. Rooftop systems act as micro power plant to serve basic electric needs of building. For improving performance they are connected to Grid. Here, number of panels is used to determine wattage outputs of PV structures. This mode of electricity generation spread over a macro power grid can compete to provide electrification of village rather than a single solar home

4.2 ELECTRIC APPLIANCES

Appliances like batteries, regulators, inverters and chargers for mobile phones, laptops, e-readers, tubes, mini emergency lights and electronic items run using solar panels. The most common use of solar street lights, solar lanterns and CFL's can be used in day to day life. Modern Lighting in buildings mainly focus on Sox Lamps and Solar powered projectors. Advertising sites, billboards can be easily operated by these.

4.3 WATER SYSTEMS

The uncertainty of timely water supply in urban and non direct supply in rural areas creates concerns regarding water heating, cooling and drying purposes. Solar water heaters, water pumps and sprinkler sets serve best alternate to such conditions.

4.4 INDUSTRIAL SYSTEMS

Distilled water industry uses solar panels on top for water distillation purposes. Catering in canteens uses solar parabolic cookers for fooding, baking applications. Small scale packing industries requiring small supply use generator sets with motor driven by solar panels. Pedaled bicycles, solar panel e-vehicles are increasingly being developed. Green Schools and clean classrooms are being prepared on solar generated pedaled devices. Refrigeration in crop processing and vegetable industries is also based on solar panel technology.

4.5 COMMUNICATION TOWERS

Communication through land by telecom towers, naval ships in running, satellites for programme relay all use solar panels aligned in such a frame that energy captured by them is easily transported for use. In India presently Bharti Infratel has largest number of solar towers as compared to other simulation tools.

5 CONCLUSION

Clean and Green applications of solar energy with challenges and opportunities have been discussed. To revolutionize solar energy reliance threats identified need to be tracked appropriately. Global Pollution check and conservation of environment can be done by use of solar devices for balancing our lives.

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