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A REVIEW ON INDIAN SOLAR ENERGY MISSION

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Abstract: The National Solar Mission is a major initiative by the Government of India and State Governments to endorse ecologically sustainable growth while addressing India's energy security challenge.Over a period of time, India must pioneer a graduated shift from economic activity based on fossil fuels to one based on non-fossil fuels and from reliance on non-renewable and depleting sources of energy to renewable sources of energy. This paper discusses a review about India's solar energy mission. It discusses about the objective of the mission, the phase-wise mission targets for 2022 and applications for solar power.

Key Words: Solar Energy, Solar Grid, Solar Collector, Solar PV (Photo Voltaic).

1. INTRODUCTION

1.1 The energy policy

Energy policy is the manner in which government has decided to address issues of energy development including energy production, distribution and consumption. The attributes of energy policy may include legislation, international treaties, incentives to investment, and guidelines for energy conservation, taxation and other public policy techniques. [1]

1.2 Advantage of solar energy

Solar energy is obviously environment friendly relative to any other energy source, and the key element of any sustainable development program. It does not deplete natural resources, does not cause CO_2 or other gaseous emission into air or generates liquid or solid waste products. Concerning sustainable development, the main advantages of solar energy are the following [3–6]:

- No emissions of greenhouse (mainly CO_2, NO_x) or toxic gasses (SO_2, particulates);
- Reclamation of degraded land;
- Reduction of transmission lines from electricity grids;
- Improvement of quality of water resources;
- Increase of regional/national energy independence;

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- Diversification and security of energy supply;
- Acceleration of rural electrification in developing countries.

1.3 Relevance and significance of solar energy for India

Cost

Although, the cost of installing a solar power plant is currently high compared to other sources of power such as coal, the objective of the Solar Mission is to rapid scale-up of capacity and technological innovation to drive down costs towards grid parity. The Mission anticipates achieving grid parity by 2022 and parity with coal-based thermal power by 2030.The cost projections vary – from 22% for every doubling of capacity to a reduction of only 60% with global deployment increasing 16 times the current level. Also there are a number of off-grid solar applications particularly for meeting rural energy needs, which are cost-effective and can rapidly expanded. [2]

Scalability

India is endowed with vast solar energy potential. About 5,000 trillion kWh per year energy is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day. Hence both technology routes for conversion of solar radiation into heat and electricity, namely, solar thermal and solar photovoltaics, can effectively be harnessed providing huge scalability for solar in India.[2] India can generate distributed power using Off-grid decentralization which would be advantageous for a rural electrification. Since the solar power is space exhaustive, this is a major check on scalability. In addition, effective storage capacity is required for solar electricity, particularly true in the monsoon season.

Environmental impact

Solar energy is environment friendly with no ecological hazards as it has zero emissions while generating electricity or heat.

Security of source

From an energy security perspective, solar is the most secure of all sources, since it is abundantly available. Theoretically, a small fraction of the total incident solar energy (if captured effectively) can meet the entire country's power requirements. [2]

This paper is organized as follows: Section II explains the solar mission objective and targets. In Section III is for mission strategy, Section IV shows proposed roadmap, Section V shows Research and development, Section VI focuses on human resource development, Section VII show international collaboration, Section VIII financing the mission activities and finally, the conclusion of this paper is provided in Section IX.

2. OBJECTIVES AND TARGETS

The objective of the National Solar Mission is to transform India as an international pioneer in solar energy. The Mission will adopt a 3-phase approach, spanning the remaining period of the 11th Plan and first year of the 12th Plan (up to 2012-13) as Phase 1, the remaining 4 years of the 12th Plan (2013-17) as Phase 2 and the 13th Plan (2017-22) as Phase 3. At the end of each plan, and during the midterm of 12th and 13th Plans, there will be an evaluation of progress, review of capacity and targets for subsequent phases, based on emerging cost and technology trends, both domestic and global. [2]

The first phase (up to 2013) will focus on the ground-level options in solar thermal; on promoting off-grid systems to serve populations without access to commercial energy and modest capacity addition in grid-based systems. In the second phase, after taking into account the experience of the initial years, capacity will be aggressively raised up to create conditions for up scaled and reasonable solar energy penetration in the country.

To achieve this, the Mission targets are [2]:

- To create a policy framework for the deployment of 20,000 MW of solar power by 2022.
- To rise up capacity of grid-connected solar power generation to 1000 MW within three years – by 2013; an additional 3000 MW by 2017 through the compulsory use of the renewable purchase duty by utilities. This capacity can be more than doubled – reaching 10,000 MW installed power by 2017 or more, based on the enhanced and enabled international finance and technology transfer.
- To create promising conditions for solar manufacturing competence, particularly solar thermal for indigenous production and market leadership.
- To promote programmes for off grid applications, reaching 1000 MW by 2017 and 2000 MW by 2022.
- To achieve 15 million sq. meters solar thermal collector area by 2017 and 20 million sq. meters by 2022.
- To deploy 20 million solar lighting systems for rural areas by 2022.

3. MISSION STRATEGY (PHASE 1 AND 2)

The first phase will announce the comprehensive policy framework to achieve the objectives of the National Solar Mission by 2022. The policy declaration will produce the essential atmosphere to attract industry and project designers to invest in research, domestic manufacturing and development of solar power generation and thus create the critical mass for a domestic solar industry. The Mission will work closely with State Governments, Regulators, Power utilities and Local Self Government bodies to ensure that the activities and policy framework being laid out can be executed efficiently [2].

3.1 Utility connected applications: constructing the solar grid

The key driver for promoting solar power would be through a Renewable Purchase Obligation (RPO) mandated for power utilities, with a specific solar component. This will drive utility scale power generation, whether solar PV or solar thermal. The Solar Purchase Obligation will be progressively increased while the tariff fixed for solar power purchase will decline over time [2].

3.2 The below 80°C challenge – solar collectors

The Mission in its first two phases will promote solar heating systems. The Mission is setting an ambitious target for ensuring that applications, domestic and industrial, below 80°C are solarised. The key strategy of the Mission will be to make obligatory policy deviations to meet this objective [2]:

Firstly, make solar heaters mandatory, through building byelaws and incorporation in the National Building Code,

Secondly, ensure the introduction of effective mechanisms for certification and rating of manufacturers of solar thermal applications, Thirdly, facilitate measurement and promotion of these individual devices through local agencies and power utilities, and

Fourthly, support the upgrading of technologies and manufacturing capacities through soft loans, to achieve higher efficiencies and further cost reduction.

3.3 The off-grid opportunity - lighting homes of the power- deprived people

A key opportunity for solar power lies in decentralized and off-grid applications. In remote areas where grid penetration is neither realistic nor cost effective, solar energy applications are lucrative. It ensure that people with no access, currently, to light and power, adopt directly to solar, instead of knee-jerk fossil fuel trajectory of growth. The main problem is to find the optimum financial scheme to pay for the high-end initial costs in these applications through appropriate Government support.

The Government has promoted the use of decentralized applications through financial incentives and promotional schemes. While the Solar Mission has set a target of 1000 MW by 2017, which may appear small, but its reach will add up to bringing changes in millions of households. The Mission plans to [2]:

Provide solar lighting systems under the ongoing remote village electrification programme of MNRE to cover about 10,000 villages and hamlets. The use of solar lights for lighting purposes would be promoted in settlements without access to grid electricity and since most of these settlements are remote tribal settlements, 90% subsidy is provided. For other villages which are connected to grid solar lights would be promoted through market mode by enabling banks to offer low cost credit.

Set up standalone rural solar power plants in special category States and remote and difficult areas such as Lakshadweep, Andaman & Nicobar Islands, Ladakh region of J&K. Border areas would also be included.

Solar energy to power computers to assist learning in schools and hostels, Management Information System (MIS) to assist better management of forests in MP, powering milk chilling plants in Gujarat, empowering women Self Help Groups (SHGs) involved in tussar reeling in Jharkhand, cold chain management for Primary Health Centres (PHCs) are some examples of new areas, being tried successfully in the country.

The Mission would consider up to 30 per cent capital subsidy (which would gradually decline over time) for endorsing such inventive applications of solar energy.

In order to create a continual interest within the banking community, it is anticipated to provide a soft re-finance facility through Indian Renewable Energy Development Agency (IREDA) for which Government will provide budgetary support. IREDA would in turn provide refinance to NBFCs & banks with the condition that it is on-lend to the purchaser at rates of interest not more than 5 per cent.

The Mission would provide an annual share for the purpose which would be used for refinance operations for a period of ten years at the end of which the funds shall stand reassigned to IREDA as capital and revenue grants for on-lending to future renewable energy projects.

3.4 Manufacturing capabilities: innovate, expand and disseminate

Presently, India’s Solar PV industry is primarily dependent on imports of crucial raw materials – including silicon wafers. Transforming India into a solar energy hub would include a lead role in low-cost, high quality solar manufacturing. Active implementation of Special Incentive Package

(SIPs) policy, to stimulate PV manufacturing plants, including domestic manufacture of silicon material, would be required.

Although indigenous manufacturing of low temperature solar collectors is already existing, manufacturing capabilities for advanced solar collectors for low temperature and concentrating solar collectors and their components for medium and high temperature applications need to be built. An incentive package, similar to SIPS, could be considered for setting up manufacturing plants for solar thermal systems/ devices and components [2].

3.5 R&D for Solar India: creating conditions for research and application

A major R&D initiative to focus: firstly, on improvement of efficiencies in existing materials, devices and applications and on reducing costs of balance of systems; secondly, on developing cost-effective storage technologies targeting space intensity through the use of better concentrators, application of nanotechnology and use of better and improved materials.

A Solar Research Council will be set up to supervise the strategy, taking into account ongoing projects, availability of research competencies and resources and possibilities of international collaboration.

An aspiring human resource development program will be established. In Phase I, at least 1000 young scientists and engineers would be incentivized to get trained on different solar energy technologies as a part of the Mission’s long-term R&D and HRD plan. [2]

4. PROPOSED ROADMAP

The aspiration is to ensure large-scale deployment of solar generated power for grid connected as well as distributed and decentralized off-grid provision of commercial energy services. The deployment across the application segments is envisaged as follows [2]:

Table 1
Phase wise deployment for various application segments

S. No.	*Application segment*	*Target for Phase I (2010-13)*	*Target for Phase II (2013-17)*	*Target for Phase III (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

5. RESEARCH AND DEVELOPMENT

This Mission will launch a major R&D program in Solar Energy, which will focus on improving efficiency in existing applications, testing hybrid co-generation and addressing limitations of changeability, space-intensity and lack of convenient and cost-effective storage.

The R&D strategy would comprise dealing with five categories viz. i) Basic research having long term perspective for the development of innovative and new materials, processes and applications, ii) Applied research aimed at enhancement of the present processes, materials and the technology for improved performance, durability and cost effectiveness of the systems/ devices, iii) Technology authentication and demonstration projects aimed at field assessment of different configurations including hybrids with conventional power systems, iv) development of R&D infrastructure in PPP mode, and v) support for start-ups.

To support the R&D Strategy, the Mission may include the following [2]:

- Establishing a high level Research Council comprising eminent scientists, technical experts and representatives from academic and research institutions, industry, Government and Civil Society to guide the overall technology development strategy.
- A National Centre of Excellence (NCE) shall be established to implement the technology development plan formulated by the Research Council and serve as its Secretariat. It will coordinate the work of various R&D centres, validate research outcomes and serve as an apex centre for testing and certification and for developing standards and specifications for the solar industry.
- The Research Council, in synchronization with the National Centre of Excellence, inventories existing institutional capabilities for Solar R&D and encourage the setting up of a network of Centres of Excellence, each focusing on an R&D area of its proven competence.
- The NCE will be the main interface with international research institutions, research groups from foreign countries, high-tech start-up companies and multilateral programmes.
- The NCE will coordinate with the IMD (India Meteorological Department), ISRO and other concerned agencies, the detailed mapping of ground insulation, particularly in high potential solar regions of the country.

6. HUMAN RESOURCE DEVELOPMENT

The rapid and large-scale diffusion of Solar Energy will require a parallel increase in technically qualified manpower of international standard. It is envisioned that at the end of Mission period, solar industry will employ at least 100,000 trained and specialized personnel across the skill continuum. These will include engineering management and R&D functions.

The following steps may be required for Human Resource Development [2]:

- IITs and premier Engineering Colleges will be involved to design and develop specialized courses in Solar Energy, with financial assistance from Government. These courses will be at B. Tech, M. Tech and Ph. D level. Centres for Energy studies have been set up by some of the IITs and engineering colleges. In addition, a countrywide training programme and specialized courses for technicians will be taken up to meet the requirement of skilled manpower for field installations and after sales service network. The Directorate General of Education and Training under the Ministry of Labour has agreed to introduce training modules for course materials for technicians in order to create a skilled workforce which could service and maintain solar applications.
- A Government Fellowship programme to train 100 selected engineers / technologies and scientists in Solar Energy in world class institutions abroad will be taken up. Fellowships will be at two levels (i) research and (ii) higher degree (M. Tech) in solar energy. MNRE is already implementing a fellowship programme in this regard, which will be expanded to include students from a larger number of academic institutions.
- Establishing a National Centre for Photovoltaic Research and Education at IIT, Mumbai drawing upon its Department of Energy Science and Engineering and its Centre for Excellence in Nano-Electronics.

7. INTERNATIONAL COLLABORATION

Strategic international collaborations and partnerships intended at fulfilling the priorities set out under the Mission would be developed, along with significant technology transfer mechanisms and strong IPR protection.

DST has been supporting joint research with several countries under bilateral programs. More recently a research program is to be taken up by DST, in consultation with MNRE, with the European Union. MNRE is also implementing some bilateral projects under the Asia Pacific Partnership Programme with Japan and Australia. A project on solar radiation data collection is under implementation with USA.

8. FINANCING THE MISSION ACTIVITIES

The fund requirements for the Mission would be met from the following sources or combinations [2]:

Budgetary support for the activities under the National Solar Mission established under the MNRE;

International Funds under the UNFCCC framework, which would enable upscaling of Mission targets.

The funding requirements and arrangements for Phase II will be determined after a review of progress achieved at the end of the 11th Plan and an analysis of the effectiveness of the model adopted for capacity building of utility scale solar power.

9. CONCLUSION

Solar energy is the most promising renewable energy, consistent and is not considerably changeable to changes in seasonal weather patterns. Solar energy can be harnessed through the solar thermal and solar photovoltaic (PV) devices for various applications. Power generated by solar energy environment friendly compared to power generation using non-renewable sources like the fossil fuels and coals. As energy usage worldwide has been increasing throughout the years, switching to solar energy can be a worthwhile step.

In order to encourage and ensure the rapid and effective development of renewable energy, the Indian government has articulated a series of policies on renewable energy development, including laws, regulations, economic encouragement, technical research and development, industrialized support and renewable energy model projects, etc. These policies provide significant inspiration and awareness for the development and use of renewable energy expertise.

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