Government of India
Ministry of New and Renewable Energy
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Proposed Technology Configurations for Grid Connected Solar Power Demonstration Projects under Jawaharlal Nehru National Solar Mission

For comments and feedback by June 17, 2011

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1.0 BACKGROUND

1.1 Jawaharlal Nehru National Solar Mission (JNNSM) was launched by Prime Minister of India in January 2010 with an aim to promote ecologically sustainable growth while addressing India's energy security challenge. The National Action Plan on Climate Change recognized "India is a tropical country, where sunshine is available for longer hours per day and in great intensity. Solar energy, therefore, has great potential as future energy source." The objective of the JNNSM is to establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible. Implementation of the Mission is envisaged to adopt a 3-phase approach. Policy framework under Mission is to create the necessary environment to attract industry and project developers to invest in research, domestic manufacturing and development of solar power generation and thus create the critical mass for a domestic solar industry. During first phase, a target of 1000 MW capacity for grid connected solar power projects has been set by 2013.

1.2 Several policy initiatives have been taken with regard to setting up grid connected solar power projects and off-grid applications of solar energy. R&D efforts have been accelerated on different aspects of solar photovoltaics and solar thermal technologies, including multi disciplinary research, with the objective of improving the efficiency, systems performance and reducing the cost. Efforts are aimed at early indigenization of critical material and components and achieving cost reduction in a time bound manner.

1.3 Pilot demonstration projects for grid connected solar power, closely aligned with the R & D priorities, were envisaged under JNNSM with a view to address issues related to optimization, variability of solar resource and storage constraints and targetting space-intensity through the use of better technologies.

2.0 Relevance of CSP

2.1 Concentrating Solar Power (CSP) technologies use solar energy to produce high temperature by focusing solar radiation from a larger area on to a smaller area and then generating electricity by employing a prime mover, most commonly actuated by high pressure steam, but also using a external combustion engine (like Stirling engine) directly. CSP has capacity to store heat energy for short periods of time, and it can be increased by providing additional thermal storage, for continuing generation of electricity during periods of low sunshine as well as after sunset. The flexibility of CSP plants in combining with the conventional fuels enhances energy security.

2.2 CSP can provide a reliable source of electricity production in the regions with strong direct normal irradiance (DNI), *i.e.* strong sunshine and clear skies. IEA has envisaged that by 2050, with appropriate support, CSP could provide 11.3% of global electricity, with 9.6% from solar power and 1.7% from backup fuels (fossil fuels or biomass). In sunniest countries, CSP is tipped to become a competitive source of bulk power in peak and intermediate loads by 2020, and of base-load power by 2025 to 2030.

3.0 Global Scenario

3.1 CSP plants at commercial scale were set up during late eighties at Mojave desert, USA with aggregate capacity of 354.5 MW capacity for the nine plants. These plants are still operational. The present cumulative installed capacity of CSP plants has grown to 1265 MW, and is further rising as capacity of over 1,800 MW is reported under construction. Capacities over 15,000 MW have been announced in different parts of the world. As per information available from http://en.wikipedia.org/wiki/List_of_solar_thermal_power_stations and MNRE on May 16, 2011, the country-wise details of the capacities under operation and which are under construction are as given in Table 1; the capacities that have been announced by various countries are given in Table 2.

Table 1: Operational and under Construction capacities

Operational Capacity		**Capacity under Construction**	
Country	**Capacity (MW)**	**Country**	**Capacity (MW)**
Spain	732.4	Spain	1473.0
USA	507.5	USA	650.0
Iran	17.3	India	28.5
Italy	5.0	China	27.5
India	2.5	Algeria	25.0
Australia	2.0	Egypt	20.0
Germany	1.5	France	1.4
Total	**1268.2**	**Total**	**2225.4**

Table 2: The capacities that have been announced by various countries

Capacity under Announcement (MW)	
USA	7110
China	2000
Morocco	2000
Sudan	2000
Spain	1080
India	495
Australia	250
Israel	250
South Africa	100
UAE	100
France	12
Total	**15387**

3.2 Presently, USA and Spain represent for more than 90% of the market in terms of installed capacity and capacities under construction. As per announcements made, USA is far ahead while other countries, such as, China, Morocco, Sudan and India also have ambitious plans to set up CSP plants.

3.3 At present four variants of technologies form part of CSP family. These are Parabolic Trough; Tower; Linear Fresnel and Parabolic Dish technology. The technology distribution of these plants is shown in Figures 1 and 2. It is seen that parabolic troughs are the most favoured technology and represent over 90% of the capacity of the operational plants. Solar towers, however, seem to have getting much attention as is clear from the technology configurations for plants under construction. Reportedly, solar dish and Fresnel reflector technologies are also emerging as potential technologies for mass deployment; however, not much information is available in public domain on the proposed plants.

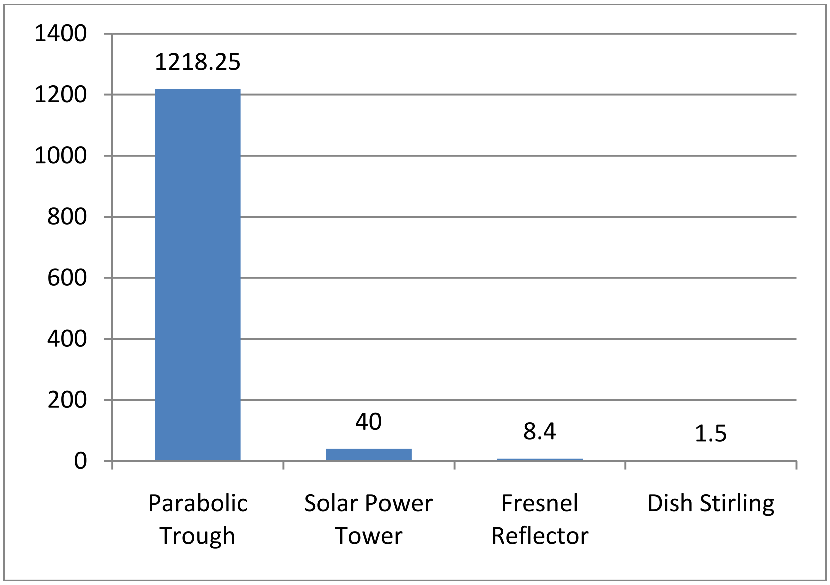

Figure 1: Technology distribution for operational plants

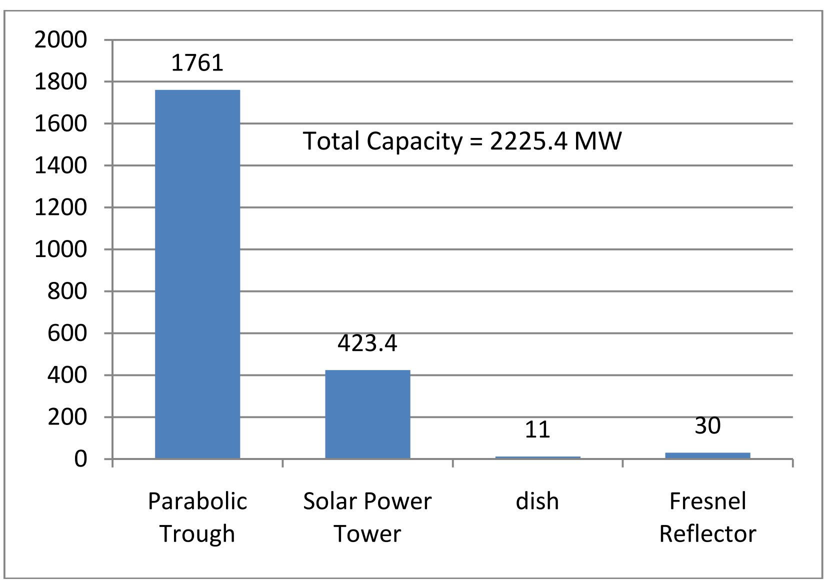

Figure 2: Technology distribution for plants under construction

4.0 Aim of the Demonstration Projects under JNNSM

4.1 Setting up <u>demonstration projects</u> using technologies that are not covered under commercial projects is one of the windows envisaged to achieve basic aim of the Mission to make solar power cost effective and achieve parity with grid power by 2022. For this, it is envisaged to have advanced technology configurations which could lead to cost reduction through higher efficiency and capacity utilization factor (CUF), and scale effect. The setting up of these demonstration grid connected solar power projects is visualized to enable solar project developers to plan projects in next phase of the JNNSM based on the learnings from these projects in terms of their performance.

5.0 Suggested Technology Configurations

5.1 The issue related to proposed technology configuration for the demonstration projects under JNNSM was discussed extensively during two formal meetings of the Core Group constituted for this purpose, and informally with various stakeholders including technology providers and experts..

5.2 The following technology configurations are proposed:

S. No.	Technology Configuration	Tentative number of projects	Requirements and other remarks
i)	Up to 50 MW capacity with air/ hybrid cooling; the minimum capacity would be 20 MW.	One	• Reduction in water consumption to 25% or less of the benchmark figure of 3000 litre per MWh. • Stand alone solar power plant with up to 10% energy from auxiliary source
ii)	50 MW capacity with up to 30% gas hybridization	One	• Total gas consumption in a year will not be more than 30% of the total generation of the plant based on total units of electricity generated in a year.
iii)	50 MW capacity having operating temperature over 500 C	One	• Stand alone solar power plant with up to 10% energy from auxiliary source
iv)	Solar Augmentation of the existing coal thermal power plant	To be decided	• Integration Strategy: Solar energy to be added to supply steam to the plant's cold reheat line and/ or the steam extraction lines for the plant's feed water heater. • Energy output of the solar plant to be monitored against declared performance. • May be considered under R&D programme to provide capital subsidy.
v)	Solar - biomass hybrid plant of 1- 3 MW capacity	Could be 4 - 5 projects.	• The turbine capacity to be maximized for solar radiation conditions. • Solar contribution to be over 25%. • The developer to have

			dedicated biomass supply chain for the project
vi)	Base load capacity solar stand alone plant of up to 10 MW capacity; the minimum capacity would be 3 MW.	One	• The project may have thermal storage for non-solar hours with up to 10% energy from auxiliary source

5.3 All projects, except the one related to solar augmentation of existing coal thermal power plants are proposed to be procured based on global tariff Case 1 bidding. The decision on the mode of procurement will be decided later based on the identification of coal plant where such augmentation could be carried out.

5.4 The following conditions could be considered for selection of projects:

a) Any of the Concentrated Solar Power (CSP) technology, such as, Parabolic Trough Collectors, Solar Dish Stirling (or any other prime mover), Linear Fresnel Reflector, Central Tower with heliostats, or their any other combination could be used.

b) Solar Power Developer must fulfil either of following requirements:

(i) Solar Power Developer is himself a technology provider who has **either** experience in design and engineering of at least 1 (one) MW capacity solar thermal power plant having been in operation for a period of at least one year on the specified cut off date, **or** obtained at least one financial closure of a solar thermal power plant of at least 50% of the proposed capacity based on the proposed technology.

(ii) Solar power Developer has a tie-up with a technology provider fulfilling technology requirements at S. No. (1) above.

(iii) Solar Power Developer is an EPC contractor/power generating company having experience in engineering, erection and commissioning of at least 100 MW capacity conventional thermal power plant **and** a tie-up with a technology provider fulfilling technology requirements at S. No. (1) above.

(iv) Solar power Developer has a tie-up with an EPC contractor having experience in engineering, erection and commissioning of at least 100 MW capacity conventional thermal power plant **and** a tie-up with a technology provider fulfilling technology requirements at S. No. (1) above.

(v) Solar Power Developer is an EPC contractor having experience in engineering, erection and commissioning of at least 1 (one) MW capacity solar thermal power plant **and** a tie-up with a technology provider fulfilling technology requirements at S. No. (1) above.

(vi) Solar Power Developer has a tie up with an EPC contractor having experience in engineering, erection and commissioning of at least 1 (one) MW capacity solar thermal power plant **and** a tie-up with a technology provider fulfilling technology requirements at S. No. (1) above.

c) The footprint area of the technology will form a criterion for selection of projects. This could be in the form of generation per unit area of the land.

d) In each case, the project developer will be required to indicate the performance benchmark/ baseline against which the plant has been configured. Key technical performance parameters of the plant will be required to be provided by the project developer for making this data available in public domain.