

The Role of Jawaharlal Nehru National Solar Mission (JNNSM) in Promoting Solar Power in India



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Abstract

The National Action Plan on Climate Change (NAPCC) Was Released by the Prime Minister's Advisory Council on Climate Change in June 30, 2008, with an intention to serve as the first country wide framework on climate change. The Former Prime Minister of India, Dr. Manmohan Singh Stated that our Vision is to Make India's economic development energy-efficient. Over a period of time, we must pioneer 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 source of energy. The missions in the National Action Plan on Climate Change (NAPCC) were meant to map out long term and integrated strategies to achieve key national goals from the climate change. The National Solar Mission, later dubbed as the Jawaharlal Nehru National Solar Mission (JNNSM). JNNSM can serve as a crucial element of India's response to the challenge of energy security and climate change. The Jawaharlal Nehru National Solar Mission was launched on the 11th January, 2010 by the Former Prime Minister Dr. Manmohan Singh. The Mission has set the ambition target of deploying 20,000 MW of grid connected solar power (power projects based on wind power, biomass, small hydro and solar) by 2022 is aimed at reducing the cost of solar power generation in the country. The objective of the Jawaharlal Nehru National Solar Mission (JNNSM) under the brand 'Solar India' is to establish India as a global leader in solar energy. The Mission has set a target of 20,000 MW and stipulates implementation and achievement of the target in 3 phases (first phase upto 2012-13, second phase from 2013 to 2017 and the third phase from 2017 to 2022) for various components, including grid connected solar power. The successful implementation of the JNNSM requires the identification of resources to overcome the financial, investment, technology, institutional and other related barriers which confront solar power development in India. The penetration of solar power, therefore, requires substantial support. The policy framework of the Mission will facilitate the process of achieving grid parity by 2022. Aim of the mission is to focus on setting up an enabling environment for solar technology both at centralized and decentralized level.

Keywords: UNFCCC, Climate Change, Renewable Energy Economics, NAPCC, JNNSM.

Introduction

The Earth Summit 1992, India has been playing a very crucial and pivotal role in shaping global environmental policies. In 1972, at Stockholm conference, Indian Prime Minister Smt. Indira Gandhi had described "poverty as a greatest polluter" and thus underscored India's preference to the development to eradicate poverty. Thus, India's policy stand in international climate change regime has been articulated around the equal right of development for each individual. India had successfully negotiated during the making of United Nations Framework for Climate Change (UNFCCC) and the inclusion of "Common but Differentiated Responsibility" in article 7 of Rio Declaration can be marked as grand success for India and hence for all developing nations. The National Action Plan on Climate Change (NAPCC) Was Released by the Prime Minister's Advisory Council on Climate Change in June 30, 2008, with an intention to serve as the first country wide framework on climate change. The Former Prime Minister of India, Dr. Manmohan Singh Stated that our Vision is to Make India's economic development energy-efficient. Over a period of time, we must pioneer 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 source of energy. The following eight missions in the National Action Plan on Climate Change (NAPCC) were meant to map out long term and integrated strategies to achieve key national goals from the climate change perspective.

National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a Green, National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change

The National Solar Mission, later dubbed as the Jawaharlal Nehru National Solar Mission (JNNSM). JNNSM can serve as a crucial element of India's response to the challenge of energy security and climate change. The Jawaharlal Nehru National Solar Mission was launched on the 11th January, 2010 by the Former Prime minister Dr. Manmohan Singh. The Mission has set the ambitious target of deploying 20,000 MW of grid connected solar power (power projects based on wind power, biomass, small hydro and solar) by 2022 is aimed at reducing the cost of solar power generation in the country.

Aim of the Study

1. An analysis of the JNNSM in the Indian institutional context—in particular, in the context of the power sector reforms.
2. Study of the Policy and status of grid connected roof top PV system in Various States.
3. Study the twin impact of policy, technology management and their relationship on a focal firm's competitiveness.
4. Focus on setting up an enabling environment for solar technology both at centralized and decentralized level.
5. The performance of Phase 1 of the JNNSM and develops quantitative metrics to assess its effectiveness against stated targets.

The Road Map

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:

S. No.	Application Segment	Target Phase-I (2010-13)	Target Phase-II (2013-17)	Target Phase-III (2017-22)
1	Sollar Collector	7 Million Sq. Metres	15 Million Sq. Metres	20 Million Sq. Metres
2	Off Gridsollar	200MW	1000MW	200MW
3	Utility Grid Power	1000-2000MW	4000-10000MW	20000MW

Source: The MNRE, GOI, JNNSM, N. Delhi, P.7

Phase-L of JNNSM

The total aggregated capacity of the grid connected solar projects to be developed under bundling scheme in Phase-I of JNNSM shall be 1000 MW. The implementation of this phase is in hands of a subsidiary of National Thermal Power Corporation,

the largest power producer in India. The subsidiary, NTPC Vidyut Vyapar Nigam Ltd (NVVN) laid out guidelines for selection of developers for commissioning grid connected solar power projects in India. NVVN will sign power purchase agreements with the developers. Since NVVN is not a utility, it will sell purchased power to different state utilities via separate agreements. The Ministry of New and Renewable Energy (MNRE), in its new solar mission road map has converged state tariffs with central tariff for solar power. Across the country there will be uniform tariff for solar energy. The MNRE has appointed the NVVN Ltd. as a waypoint for the purchase of power produced by solar power plants which have availed of the JNNSM incentive scheme. The NVVN is a utility company which was originally created by NTPC as a purchaser of power which integrates it with the grid. The incentivized tariff payable as per the JNNSM will be therefore paid by NVVN Ltd. The NTPC Vidyut Vapayar Nigam Ltd (NVVNL), a wholly-owned trading arm of NTPC and the national nodal agency, has decided to procure solar power up to 1,000 MW by 2013.

Role of NTPC in JNNSM

The National Thermal Power Corporation (NTPC), a public sector company, has been selected to take the solar power mission of the country forward, keeping in mind the prospects of tapping solar energy in a big way in states like Rajasthan and Gujarat, said A K Singhal, Director (Finance), NTPC Limited. "The NTPC has a vision to make its impact in the world of solar energy." State-run NTPC, which is known as India's largest producer of power from coal, has decided to add around 301 mw of solar power by March 2014. Of the 301 MW, 190 MW will be through CSP and 111 MW will be solar PV generation. The director of operations said that though NTPC's solar capacity addition was not on account of the projects being allotted by the MNRE for the first phase of the national solar mission, "the MNRE is likely to take into account NTPC's solar power projects in its national solar mission target". For the near-term, the company has planned another 25 mw of solar thermal generation besides the 15 mw generation at Anta, and another 6 mw of solar PV generation at the Andaman and Nicobar islands.

Technologies

For Phase 1 projects, NVVN started with a proposal for 50:50 allocation towards solar PV and solar thermal. The latter is quite ambitious given India has no operational solar thermal projects and less than 10MW of solar PV projects. While growing at a rapid pace lately, solar thermal technologies are still evolving globally. The first batch of projects allotted for Phase 1 included 150MW of Solar PV and 500MW of Solar Thermal. A growing solar PV industry in India is hoping to take off by supplying equipment to power project developers. Well known equipment manufacturers started increasing their presence in India and may give competition to local Indian manufacturers. Due to generally high temperatures in India, crystalline silicon-based products are not the most ideal ones. Thin film technologies like

amorphous silicon, CIGS and CdTe could be more suitable for higher temperature situations.

NVNV Solar PV allotment process for Phase I

NVNV issued Request for Selection notice for allotment of capacity to Independent Power Producers (IPPs). 150MWs of Solar PV and 470MW

of Solar Thermal were up for allotment under the first batch of Phase 1 projects. Project size per IPP was fixed at 5MW for Solar PV and 100MW for Solar Thermal projects. State / UT wise status of PV projects commissioned under JNNSM Phase I (As on 31.01.2014)

S. No.	State	NVNV Batch-I (Capacity in MW)	NVNV Batch-I Solar thermal (Capacity in MW)	NVNV Batch-II (Capacity in MW)	RPSSGP (Capacity in MW)	Migration (Capacity in MW)	Total (Capacity in MW)
1	Andhra pradesh	15	0	20	9.75	0	44.75
2	Haryana	0	0	0	7.8	0	7.8
3	Jharkhand	0	0	0	16	0	16
4	Karnataka	5	0	0	0	0	5
5	Madhya Pradesh	0	0	0	5.25	0	5.25
6	Maharashtra	5	2.5	40	5	11	63.5
7	Orrisa	5	0	0	7	0	12
8	Punjab	0	0	0	6	2	8
9	Rajasthan	100	50	270	12	35	467
10	Tamil Nadu	5	0	0	6	0	11
11	Uttar Pradesh	5	0	0	7	0	12
12	Uttarakhand	0	0	0	5	0	5
13	Chhatisgarh	0	0	0	4	0	4
	Total	140	52.5	330	90.8	48	661.3

Sailent Features & Results

JNNSM Made impressive strides in adding capacity, and successfully reduced the costs of solar energy to around \$0.12 per kwh for solar photo voltaic and \$0.21 per kwh for concentrated solar power, making India amongst the lowest cost destination for grid connected solar power in the world.

- Bundling:** Since power from solar project has a higher cost to begin with, it is being bundled with coal based power from the national thermal power corporation's unallocated quota, through the NTPC Vidyut Vyapar Nigam, reducing the overall tariff impact on distribution utilities.
- Reverse Auctioning:** project were allotted to qualified bidders through attracting reverse bids, fully realising the benefits of declining price in the global market, and bringing the purchase price of both PV and CSP to competitive level, far lower than the central Electricity Regulatory Commission's benchmark tariffs.
- Implementation of a Renewable purchase obligation (RPO) for solar power and institution of a payment security scheme (PSS) were other features.

Challenges

Phase 1 has number of challenges and unintended consequences –

Unsuccessful Approach for Thermal

Every single solar thermal plant awarded under JNNSM Phase 1 was delayed, and target were not met. This may be due to lack of availability of solar resource data, complexities in land acquisition, provision of water supply, low feed in tariffs, and lack of loan guarantees, all of which could have been anticipated.

Local Manufacturing

The most controversial aspect of JNNSM has been the guidelines mandating components to be manufactured in India. In fact some of the critical components for CSP Project are practically unavailable in India.

Commercial Funding

Multilateral institutions and NBFCs financed many phase 1 projects, commercial banks stayed away. As the JNNSM program scales up, it is necessary to get these players into the fold to reach satisfactory levels of investment. This lack of funding is also experienced by local component manufacturers.

Challenges of Centralisation

JNNSM has focused centralized power generation, which, while lowering cost through economies of scale, leads to losses when sharing transmission and distribution facilities with electricity sourced from other modes.

Phase-II of JNNSM

The mission's phase 2 design continues trend of phase 1 using innovative policy mechanisms such as buying down the cost of solar generation by financing incremental cost through instruments such as capital subsidy, Generation based Incentive (GBI) and viability gap funding (VGF). JNNSM Phase-II shall comprise of various strategies for deploying solar power across the various States in India. As the target capacity addition is much higher in comparison to phase-I, it is proposed to spread Phase-II in two batches like phase-I. While devising implementation plan, it is envisaged that selection of project developers and award of contract would be taken up during initial two financial years through a bidding process so as to discover the true price of solar power. For phase-II, share of target capacity under VGF is kept higher in comparison to bundling due to

the fact that there is not enough unallocated power available with central govt. to cater the need of higher capacity under bundling with solar power. Bidding process for Solar thermal shall be undertaken during FY2014-15 so that sufficient learnings from implementation and operationalisation of solar thermal projects during Phase-I can be incorporated during Phase-II and sufficient time is available for installation of solar thermal projects by end 2017 during Phase-II.

Targets for Phase II of JNNSM

National Solar Mission envisages installation of around 10 GW utility scale and 1 GW off-grid solar power projects by the end Phase-II. Twelfth five year plan (2012-17) also targets capacity addition of 10 GW of grid connected solar power in India. It is envisaged that out of this 10 GW target, 4 GW would be developed under central scheme and 6 GW under various State specific schemes.

Inter-technology Targets at Central and State Level:-

Item Description	Ratio	Central Schemes	State Schemes
Solar Photovoltaic	70%	40%	60%
Solar Thermal	30%	40%	60%

Proposed share of Target Capacity Mix (Solar PV & Solar thermal) & (Central/State) during Phase-II

Item Description	Capacity (MW)	Central Schemes (MW)	State Schemes (MW)
Solar Photovoltaic	6300	2520	3780
Solar Thermal	2700	1080	1620
Total	9000	3600	5400

Thrust Areas Phase-II

Scaling up of Grid Connected Projects

Phase –I was built aiming to ramp up grid connected solar energy to 1100 MW by 2013 with participation of both Solar PV and Solar Thermal technology. Capacity allocation was equal for both technology i.e. 500 MW each under Phase-I. Strategically development Phase-I has made India's grid-connected solar energy market grow tremendously, with an increased number of developers, lower prices, and participation from interested financial institutions. In Phase-II, it is necessary to build on the achievements of phase-I to ensure continued success of National Solar Mission. Large scale solar projects are going to play a huge role in phase-II and for the same reason, it has kept as one of the thrust area under Phase-II. Phase-II is targeting to bring cumulative solar capacity to 10 GW by 2017. Phase-II is not entirely dependent on bundling scheme to bring the costs down, as the target capacity under phase-II is high and without confirmation on availability of unallocated quota with central generating stations, Implementation of Phase-II will have to be reply upon combination of various schemes like Generation Based Incentive (GBI), Viability Gap Funding (VGF) and Bundling schemes. To make Phase-II another success story wider participation of States is required with development of transmission and distribution network to connect areas with high solar potential. Developing cluster of

Solar parks will help reduction in costs further and fair market play will prevail and help in development of various technologies used for achieving phase-II targets.

Objectives for Promotion of Grid Connected Solar Power during Phase-II are as under

1. To achieve Grid Parity at the earliest
2. To facilitate meeting of Solar RPO targets in line with Tariff Policy
3. To encourage wider participation of States in NSM
4. To facilitate increased connectivity & grid access for solar projects
5. To encourage Solar park cluster development
6. To promote technology agnostic approach
7. To develop domestic technology development capability
8. To Encourage large scale deployment of Grid connected rooftop solar
9. To encourage Captive and Third party sale of solar power to meet power shortages in Industry
10. To Encourage local Manufacturing and
11. To support focused R&D initiatives
12. Development of REC market
13. Development of Storage Systems

Rooftop PV Programme

Phase II would focus on deployment of both off-grid and grid connected rooftop PV systems in the country. Grid connected rooftop PV system shall be connected to the grid either of 11 KV three phase line or of 220 V single phase line depending on the system installed at institution/commercial establishment or residential complex. The off grid rooftop PV systems would be deployed at places which are not connected to the grid or not connected but getting electricity from the grid.

Off-Grid Schemes

The major thrust areas under JNNSM Phase II will be the areas where grid has not reached, or the areas where grid has reached but the electricity is not available. Phase II will also focus on Solar off grid generating systems, solar home lighting systems and various other forms of solar based heating/cooling/thermal applications. Phase II would focus on targets which will be product linked or enhances the income generation activities. It would also focus on various solar PV and solar thermal applications which will be used for heating and cooling requirements, drying purposes, etc. in domestic, commercial and industrial segments. This phase of the programme would also lay emphasis on different types of solar collectors such as flat plate, evacuated tube collectors and other concentrators for meeting the heating requirements.

Thrust Areas for Promotion of Off-grid Solar during Phase-II are as under

1. Improved Energy Access for remote areas
2. Heating/Cooling applications needs to be encouraged (such as Cooling, Cold Storage, water purification, Space Heating)
3. Replacement of diesel and kerosene
4. Distributed Generation : (e.g. rooftop PV applications)
5. Industrial process heat applications
6. Solar water irrigation pumping systems

Hybrid System

Phase-II is to bring development in hybrid technology, for this ministry shall be promoting systems based on hybrid technology with solar as one of the main or secondary source of energy.

Manufacturing

During Phase II, attention shall be given to solar manufacturing capacity building across the value chain covering silicon wafers, cells, modules, thin film modules, panels, balance of systems components such as inverters, power conditioning units, etc. Indigenous manufacturing of low temperature solar collectors is already available; however, manufacturing capacities for advanced solar collectors for low temperature and concentrating solar collectors and their components for medium and high temperature applications need to be built.

Thrust Areas for promotion of Solar Manufacturing Capability during phase-II are as under:

1. Development of complete value chain for both PV and thermal in India
2. Off-grid special products for rural applications
3. Manufacturing of solar grade mirrors and glasses
4. Developing capacity to develop components and Materials like
 - i. Heat Transfer Fluid (HTF)
 - ii. Thermal Storage systems
 - iii. Solar Concentrated Glasses
 - iv. Inverters
 - v. Permanent magnet and other motors for solar pumps

Focused Research & Development

Phase II of the mission a progressive and focused research infrastructure development has been planned. MNRE has constituted Solar Energy Research Advisory Council (SERAC) to analyze the existing research infrastructure in solar sector and then to set up a framework which would incubate a conducive environment for accelerating research and development activities in the country in alignment with the vision of JNNSM.

Thrust Areas for promotion of Research & Development initiatives during phase-II are as under:

1. Development of materials for solar thermal applications
2. Development of hybrid and storage technologies
3. Development Centers of Excellence for Solar Technologies
4. Identification of new areas of solar applications
5. Development of high temperature photovoltaic / Concentrated Photovoltaic (CPV)
6. Heat cycles for solar thermal with air as heat sink
7. R&D in Materials and Components – Receivers for parabolic technology, advanced power converter modules, self cleaning reflector surfaces, receiver modules for central tower, organic solar cells etc.

Solar Resource Monitoring and Assessment

Generation of any solar projects largely depends on solar irradiation of that place and hence assessment of solar potential is also considered as

one of the thrust areas for phase-II. Solar Data Sharing and Accessibility Policy 2012 ensures creation of a national level solar resource database. As a part of overall strategy, availability of accurate and reliable solar radiation data was considered a key element. Ministry of New and Renewable Energy decided to augment network of solar radiation monitoring stations in the country with a view to cover more areas, especially high potential areas. India Meteorological Department (IMD) of Ministry of Earth Sciences is a statutory body for measurement of weather parameters in the country which includes solar radiation also. At 45 of IMD stations, some facilities for measurement of solar radiations exist. In order to promote investor grade solar radiation data, MNRE sanctioned SRRA project for setting up 51 monitoring stations at sites having high potential of solar power in the country. The project is implemented by Centre for Wind Energy Technology (CWET) located at Chennai, which is an autonomous institution of the Ministry. SRRA project is being supported by Government of Germany through Solmap Project implemented by GIZ. Each of the SRRA stations is equipped with state-of-art equipments / sensors for measuring solar radiation and associated weather parameters. Configuration of these stations include monitoring of

1. Global solar irradiance
2. Direct normal incidence (DNI) solar irradiance
3. Diffused solar irradiance
4. Wind speed and direction
5. Ambient air temperature
6. Relative humidity
7. Atmospheric pressure and
8. Rainfall

Data is monitored at an interval of one second and averaged over a period of 01 minute. Average data is transmitted through GPRS to a Central Receiving Station set up at C-WET, Chennai.

Financing

For development of Grid connected projects, project financing and availability of long term funds is crucial. The fund requirements for the Phase-II would be met from the following sources or combinations:

1. Budgetary support for the activities under the National
2. Solar Mission established under the MNRE;
3. Viability Gap Funding Projects supported through finance from National Clean Energy Fund
4. International Funds under the UNFCCC framework, which would enable up scaling of Mission targets.
5. Apart from this other options could be explored as additional measures to assure financing of solar power projects during next phase of implementation of the Mission:
6. Raise equity of IREDA/SECI
7. Allow IREDA/Banks to raise tax-free bonds
8. specific exemption for solar power projects under exposure limits of banks for power sector
9. Facilitate international lines of credit
10. Involvement of banks/ financial institutes to extend loans to retail sector
11. Thrust on micro-financing of solar products

Human Resource Development

Development of Human resource has also been considered as one of the thrust area under phase-II. Some capacity already exists in the country, though precise numbers need to be established. However, it is envisaged that at the end of Mission period, solar industry will employ at least 100,000 trained and specialized personnel across the skill spectrum. These will include engineering management and R&D functions.

Development of Solar Parks

In order to harness the solar potential efficiently and to achieve the objectives of JNNSM, It is required to develop State level Infrastructure solely dedicated to promote solar power generation. One of the way of achieving this is by developing solar parks in a focused manner across different parts of the country. Solar Park is essentially a concentrated zone of solar development which may consist of a minimum of 250 MW generation capacities on a land area of over 600 hectare with minimum value of annual average global horizontal irradiance (GHI) greater than 5 kWh per sq.m. of area. The concerned State Government may designate and permit one or more blocks of land in close proximity as a Solar Park and prepare the transmission and other necessary infrastructure. Various blocks will be located within a radius of 10 km and such that no end points are separated more than 20 km. Private or public investors will lease the land and construct individual solar plants on the land in a clustered fashion and on a predictable timeline with an overall aim to reduce the development uncertainty through the sharing of common infrastructure including transmission. Solar Parks would include all required facilities for generation of solar power, which may include evacuation and transmission infrastructure, solar radiation monitoring station, water availability, access roads to the park, interior roads in the park, telecommunication facility, fire station, green belt and security. Other elements of the solar park could be manufacturing facilities, testing and characterization facilities, R&D and demonstration in accordance with the State policy in this regard.

Conclusion

1. The study concludes that JNNSM first phase could not perform up to the expectations, the state level policies have been doing well to fill the gap.
2. The JNNSM Phase II target composition of 3600 MW for central and 5400 MW for states are successfully achieved.

3. SPV technology which converts sunlight into electricity is workable option keeping in view the climate conditions.
4. Largest ever Wind Power capacity addition of 5502.39 MW in 2016-17 exceeding target by 38%. During 2017-18, a total 467.11 MW capacity has been added till 30.11.2017, making cumulative achievement 32746.87 MW. Now, in terms of wind power installed capacity India is globally placed at 4th position after China, USA and Germany.
5. Biggest ever Solar Power capacity addition of 5525.98 MW in 2017-18. During 2017-18, a total 4323.1 MW (including 207.92 MW Solar Roof Top) capacity has been added till 30.11.2017, making cumulative achievement 16611.73 MW (including 863.92 MW Solar Roof Top).
6. Biomass power includes installations from biomass combustion, biomass gasification and bagasse co-generation making a cumulative achievement to 8181.70 MW.

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