Paving the Way for a Transformational Future

Lessons from Jawaharlal Nehru National Solar Mission Phase I

ESMAP
Energy Sector Management Assistance Program

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Abbreviations and Acronyms

ADB	Asian Development Bank
BG	Bank Guarantee
BNEF	Bloomberg New Energy Finance
BOOM	Build Own Operate Manage
BOOT	Build Own Operate Transfer
BoS	Balance of Systems
CdTe	Cadmium telluride
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CoD	Commercial Operation Date
CoE	Centre of Excellence
c-Si	Crystalline Silicon
CSP	Concentrating Solar Power or solar thermal
CSTP	Concentrated Solar Thermal Power
C-WET	Centre for Wind Energy Technology
DCR	Domestic Content Requirement
DIPP	Department of Industrial Policy and Promotion
Discom	Distribution company
DNI	Direct Normal Irradiance
EC	European Commission
EIB	European Investment Bank
EPC	Engineering Procurement and Construction
EPIA	European Photovoltaic Industry Association
EXIM	Export-Import
FICCI	Federation of Indian Chambers of Commerce and Industry
FiT	feed-in tariff
FSR	Financial Stability Report
FY	Financial Year
GBI	Generation based Incentive
GBS	Gross Budgetary Support
GDP	Gross Domestic Product
GEDA	Gujarat Energy Development Agency
GERC	Gujarat Electricity Regulatory Commission
GoI	Government of India
GPCL	Gujarat Power Corporation Ltd.
GW	gigawatt
HT	High Tension
IDFC	Infrastructure Development Finance Company
IFC	International Finance Corporation
IREDA	Indian Renewable Energy Development Agency
JNNSM	Jawaharlal Nehru National Solar Mission
kg	kilogram
kV	kilovolt
kWh	kilowatt hour
L&T	Larsen and Toubro
LC	Letter of Credit
LCR	Local Content Requirement
MNRE	Ministry of New and Renewable Energy
MoF	Ministry of Finance
MoP	Ministry of Power
MT	metric ton
MW	megawatt
NAPCC	National Action Plan for Climate Change
NBFC	Non-Banking Finance Company
NCEF	National Clean Energy Fund
NMCC	National Manufacturing Competitiveness Council
NOC	No Objection Certificate
NPA	Non-Performing Asset
NTPC	National Thermal Power Corporation
NVVN	NTPC Vidyut Vyapar Nigam
O&M	Operation and Maintenance
OPIC	Overseas Promotion and Investment Corporation
PBG	Performance Bank Guarantee
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PSA	Power Sale Agreement
PSS	Payment Security Scheme
PTC	Parabolic-trough collector
PV	Photovoltaic
R&D	Research and Development
RBI	Reserve Bank of India
REC	Renewable Energy Certificate
RFP	Request for Proposal
RfS	Request for Selection
RPO	Renewable Purchase Obligation
RPS	Renewable Portfolio Standard
RPSSGP	Rooftop PV and Small Solar Generation Programme
SCB	Scheduled Commercial Bank
SEC	Solar Energy Centre
SECI	Solar Energy Corporation of India
SEGS	Solar Energy Generating System
SNA	State Nodal Agency
SPO	Solar Purchase Obligation
SPSA	Solar Payment Security Account
STU	State Transmission Utility
sq m	square meter
SRRA	Solar Radiation Resource Assessment
T&D	Transmission and Distribution
TF	Thin Film
VGF	Viability Gap Funding
W	Watt
Wp	Watt peak
WTO	World Trade Organization

Currency Conversion: 1 US$ = INR 60

Acknowledgements

The preparation of this report—Paving the Way for a Transformational Future: Lessons from Jawaharlal Nehru National Solar Mission (JNNSM) Phase I—was led by Ashish Khanna (Lead Energy Specialist, SASDE) and Kanv Garg (Energy Analyst, SASDE), both from the World Bank's South Asia Sustainable Development Energy Unit.

At the request of the Ministry of New and Renewable Energy (MNRE), the World Bank has undertaken a study to document the experiences during the implementation of JNNSM and gather lessons for the implementation of the subsequent phases. The report draws from an underlying study prepared by the staff of Deloitte Touche Tohmatsu India Private Limited, who interacted with government agencies, solar power developers, financial institutions, and other stakeholders in the solar space in India to share data and firsthand experiences.

We especially wish to thank Vijay Iyer (Director, SEGEN) and Jyoti Shukla (Senior Manager, SASSD) for their support to the study. The team would also like to thank the peer reviewers—Nataliya Kulichenko (Senior Energy Specialist, AFTG1), Gabriela Elizondo Azuela (Senior Energy Specialist, SEGEN), Silvia Martinez Romero (Senior Renewable Energy Specialist, SEGES), Joerie Frederik de Wit (ET Consultant, SEGEN), Soumya Banerjee (Senior Investment Officer, IFC), Chandrasekeren Subramaniam (Senior Power Engineer, IFC), and Gaetan Tiberghien (Senior Investment Officer, IFC)—for their insightful inputs and assistance during the preparation of the study.

We gratefully acknowledge the cooperation and generous help rendered by officials and counterparts in MNRE—Mr. R.N. Watal, Mr. Tarun Kapoor, and Dr. Ashvini Kumar—who provided guidance and technical inputs through the assignment.

This team is grateful for the funding received from the Energy Sector Management Assistance Program (ESMAP) for the study.

Executive Summary

Renewable energy, especially solar power, has been garnering a lot of interest from governments, international development organizations, civil society, and the private sector for the last few years. There has been a huge surge in the popularity of this important energy source from various stakeholders in India as well.

In India, with rising levels of technology maturity, and cost competitiveness, solar power is attracting investments from the private sector. On the other hand, solar power presents a formidable option for addressing pertinent issues being faced in international geopolitical and national macro-economic arenas for the Government of India (GoI).

On the national front, firstly, solar power stands to partially address the issue of shortage of power for economic growth. There is an established positive correlation between energy requirement and Gross Domestic Product (GDP) growth. With energy shortages in excess of 10 percent and with more than 300 million people without access to energy, solar power can potentially address the shortage by both adding to the grid-connected electricity supply and providing a viable energy solution for off-grid areas. Secondly, closely related to the first point, solar power can foster energy security for India by reducing dependence on imported fuel. This will further help in reducing the current account deficit for the country. Grid-connected and off-grid solar power can partially replace the need for imported coal and diesel requirement to power the economy.

On the international front, firstly, India has already demonstrated that it is an industrial low-cost destination worldwide. It has the potential to capture cost reduction leadership for solar power as well. Domestic manufacturing and scale of implementation in India can cause a drastic fall in costs to bring solar power costs to grid parity sooner than other parts of the world. Secondly, cleaner energy production through solar power also contributes to India's international commitment in Copenhagen in 2009 to reduce the emissions per unit of its GDP by 20-25 percent by 2020 over 2005 levels. India is currently the world's seventh largest emitter of global warming pollution and fifth largest for emissions from fossil fuel combustion.[1]

Though the World Bank, India considers all market segments of solar power to be important; this report specifically looks at the utility-scale grid-connected segment of solar power in India.

Achievements of JNNSM Phase I

As one of the eight missions under India's National Action Plan for Climate Change (NAPCC), the Jawaharlal Nehru National Solar Mission (JNNSM) was launched in January 2010 with the aim of accelerating India's march toward grid parity in solar power. JNNSM envisages the achievement of grid parity through long-term and predictable policy, large-scale deployment, aggressive Research and Development (R&D), and domestic production of critical materials, components, and products along the value chain. Considering that India is blessed with immense solar potential, JNNSM can serve as a crucial element of India's response to the challenges of energy security and climate change.

Phase I (2010-13) of JNNSM, still under implementation, experienced enthusiastic

[1] http://www.nrdc.org/international/copenhagenaccords/

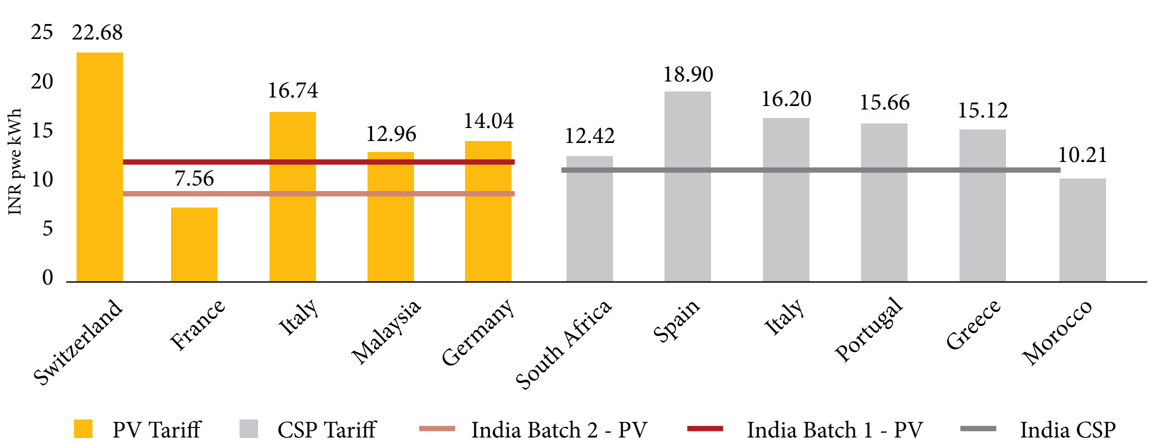
participation from Indian and international investors in the grid-connected segment with substantial discounts to the benchmark tariffs determined by the Central Electricity Regulatory Commission (CERC) for 500 megawatt (MW) each of solar thermal and solar Photovoltaic (PV) projects. Power from these solar projects is being bundled with conventional power from the unallocated quota of power from coal-based stations of the National Thermal Power Corporation (NTPC) on equal capacity basis. The bundling of solar power with cheaper conventional power reduces the tariff impact of solar power on the distribution utilities.

Another unique feature of JNNSM Phase I has been the adoption of a reverse auction method for awarding projects to qualified bidders. The bidding process has been able to fully realize the benefits of declining module prices in the global market and declining demand in key economies, leading to surplus supply in the international market. JNNSM has been instrumental in bringing the purchase price of both PV and Concentrating Solar Power (CSP) to a level that is competitive across the world. The levelized tariffs discovered through the competitive process have been far lower than the CERC benchmark tariffs. The average levelized tariffs have also declined between the two batches in Phase I, from INR 12.12 per kilowatt hour (kWh) (US$0.20 per kWh) to INR 8.77 per kWh (US$0.15 per kWh). This has made India amongst the lowest cost destinations for grid-connected solar PV in the world. Figure E1 illustrates the solar PV and CSP tariff in India compared to other leading countries worldwide.

In addition to the achievement of lower solar energy prices, the pace at which solar capacity additions have been accomplished also needs to be commended. In a span of three years, the total installed capacity of solar power has increased from around 30 MW to more than 2,000 MW with JNNSM contributing around 500 MW of that capacity.

The Government of India (GoI) took several proactive steps in Phase I of the mission, such as offering a bundling of solar power with unallocated coal-based power through the NTPC Vidyut Vyapar Nigam (NVVN), implementing a Renewable Purchase Obligation (RPO) for solar power, instituting a Payment Security Scheme (PSS), and undertaking certain measures

Figure E1:
PV and CSP Tariff Comparison Across Countries



Source: wind-works.org and author's research.

for promoting local manufacturing, which all combined to ensure the success of Phase I. Starting with the state of Gujarat and buoyed by the success of Phase I, several other states have also instituted state-level policies for encouraging solar energy. Gujarat has been a forerunner in solar capacity addition with Asia's largest solar park located in Charanka, constituting over 500 MW of multi-investor, multi-technology solar capacity addition at one location.

Amidst developments triggered by Phase I of JNNSM and the Gujarat Solar Policy, it is important to keep sight of JNNSM's overall objectives, which—apart from targeting a capacity of 20 gigawatt (GW) by 2022—aims at positioning India as a major power in solar manufacturing and R&D. Against this backdrop, the World Bank, in consultation with the Ministry of New and Renewable Energy (MNRE), instituted a study to identify the key barriers and constraints that could come in the way of scaling up the grid-connected solar program to levels envisaged in the subsequent phases of JNNSM.

The study, which culminated in the submission of this report, is based on consultations with key stakeholders and aims to provide an analytical lever to GoI in evaluating certain key policy debates that have emerged at this juncture.

Scaling up under JNNSM: Barriers and Challenges

Phase I of JNNSM, with a capacity target of 1 GW, was positioned to be a cautious beginning in India's ambitious journey toward 20 GW of capacity addition by the end of Phase III of JNNSM by 2022. Viewed in this context, it is essential to identify and address the key challenges faced by the stakeholders, which could prevent the program from reaching and, possibly exceeding, the scaled-up targets over subsequent phases of JNNSM.

Amongst the issues identified as critical by most stakeholders, which require closer attention and resolution, are the following:

1. Lack of adequate participation of Scheduled Commercial Banks in solar financing

Scheduled Commercial Banks (SCBs) mostly shied away from financing projects under Phase I of JNNSM, with export credit agencies, multilateral financial institutions, and some nonbanking financial institutions accounting for the bulk of debt financing over Phase I of JNNSM, as well as for projects under the Gujarat Solar Policy. Financing of most solar projects also happened on the basis of limited to full recourse.

Infrastructure lending in India, in the absence of an active debt market, has been led by SCBs, which account for more than 80 percent of such debt disbursements. Taking this financing landscape of Indian infrastructure into account, it is inconceivable for JNNSM to scale up to the levels envisaged under subsequent phases and beyond without the active participation of SCBs.

This remains the most significant concern for JNNSM. SCBs consulted during the study indicated several risks that they continue to perceive in lending to solar projects, particularly in the absence of any risk-reducing mechanisms. They also pointed out the crowding out effect of concessional sources of financing in the form of supplier's credit and direct lending by development banks, without the availability of concessional lines of credit for SCBs.

Phase II of JNNSM is likely to witness a huge scaling up of financing requirement with around US$4.1 billion required for building 3,600 MW of capacity under the central scheme. Another 6,400 MW is proposed to be developed under the state schemes which would further increase the financing requirement of the solar sector.

2. Bottlenecks in the enabling environment

Developers and financiers outline several key bottlenecks in the enabling environment, which have persisted despite significant efforts from MNRE and State Nodal Agencies (SNAs). These relate to land acquisition and converting land use designations, delays in approvals and clearances at the state level, limited field-level data availability on solar irradiation, nonavailability of support infrastructure pertaining to water and power evacuation, limited coordination between the central and state institutions, and the absence of a clear mapping of responsibilities of institutions in the public domain.

3. Payment security for future projects

The Phase I policy provided a robust commercial framework with the bundling of 1,000 MW of solar power with 1,000 MW of unallocated coal-based generation capacity from NVVN, which acted as the counterparty to all contracts, and the institution of a PSS, backed by budgetary support from GoI, which assisted in guarding the interests of developers against defaults by distribution utilities.

Bundling is no longer a major option, with limitations on unallocated power. As per JNNSM Phase II Batch I guidelines, the Solar Energy Corporation of India (SECI) shall set up a payment security mechanism to ensure timely payment to the developers. The rules to operate this fund will be framed by MNRE. Although the rapidly decreasing tariff scenario in solar power and increasing knowledge and exposure of all stakeholders shall reduce the need for PSS over time, payment security remains a concern for Phase II. This is because of the increasing concentration of solar projects in some states and the weak financials of distribution utilities in most states in India.

4. Unintended technology outcomes over Phase I

PV technology is broadly classified into Crystalline Silicon (c-Si) and Thin Film (TF). The latter, which emerged as a lower cost option in the era of rising polysilicon prices, has been steadily losing ground over the past few years as c-Si experienced a dramatic decline in prices. From a one-time high of about 30 percent market share, TF accounted for 11 percent of the global PV market at the end of 2011.

Compared with this global scenario, Phase I of JNNSM saw TF accounting for close to 70 percent of PV installations, due to a combination of two factors. First, a Domestic Content Requirement (DCR) under the Phase I policy required c-Si cells and modules to be mandatorily procured from domestic manufacturers over Batch 2, while waiving such requirement for TF owing to the low TF manufacturing base in India. Second, established TF suppliers based out of the United States were ready to supply competitively priced TF modules along with the provision of low-cost, long-tenor debt from the Export-Import (EXIM) Bank of the United States. Faced with an economically attractive option and supply from more established and proven U.S. suppliers compared with domestic manufacturers, developers opted widely for TF.

DCR, which was intended to promote local manufacturing, has thus not been able to provide adequate support to local manufacturers.

5. Beleaguered local solar manufacturing environment

An important objective of JNNSM is to develop India into a major force in low-cost, high-quality solar manufacturing. In Phase I, to provide support to domestic manufacturers, GoI included a DCR for both c-Si and solar thermal-based projects. As is now apparent, this measure did not contribute significantly to the revival of the domestic solar PV manufacturing industry, which continues to operate at an average capacity utilization of less than 50 percent.

Several solar PV manufacturers in India currently face issues related to lack of raw materials, nonavailability of low-cost financing, and an underdeveloped supply chain leading to high inventory costs. Problems faced by local PV manufacturers are multi-fold and have been summarized in the report. Without a comprehensive industrial policy to address all fundamental aspects of competitiveness, DCR alone is unlikely to revive Indian PV manufacturing.

Local manufacturing in solar thermal is complex, as the value chain is globally characterized by oligopolies with technology and product patents. India holds significant potential for emerging as a low-cost destination for solar thermal, as it can exploit the linkages this industry holds with more established industries in India, such as automotive, glass, metal, chemicals, power equipment, process heat, and construction. This, however, requires coordinated ecosystem development, with adequate technology partnerships to move existing industries to commit to such manufacturing.

6. Adequacy of the current approach to developing solar thermal projects

The framework for award of projects under Phase I of JNNSM, similar to that for solar PV, was a reverse auction, which awarded seven projects totaling 470 MW under Batch I. Solar thermal with less than 2.5 GW of installations globally is, however, far from commercially viable compared with solar PV with over 100 GW of installed capacity globally.

Solar thermal projects require a range of preparatory activities including several clearances and consents, detailed field studies as well as on-field Direct Normal Irradiance (DNI) measurement. In the above context and given the initial phase of development of solar thermal technologies in India, it is worth examining whether the existing framework for awarding projects is adequate or a different disposition is required.

7. Enforceability of RPOs and concerns around solar Renewable Energy Certificates

Although several State Electricity Regulatory Commissions have mandatory regulations specifying RPOs, they have so far been lenient in imposing penalties for noncompliance by distribution utilities. This threatens the very basis of JNNSM as well as other renewable energy programs in the country.

The pricing of solar Renewable Energy Certificates (RECs) is another matter of concern. The current REC framework has a base price range specified up to 2017, and in a rapidly declining solar tariff regime, there are genuine concerns that a purely short-term and market-based REC mechanism will not ensure cash flows to justify long-term investments. These issues are being examined seriously by MNRE and CERC and changes are likely in the near future.

JNNSM Phase II and Beyond: Essential Policy and Design Choices

1. Efficacy of public funding: "buying down" tariffs vis-à-vis addressing structural impediments to financing

Adequately structured public funding is essential to move the solar industry forward, given the evolutionary nature of solar PV and CSP technologies, their higher cost, and the risk perception amongst private investors and financiers in this segment.

Public funding is faced with a choice of two options of supporting the solar program under JNNSM:

- Buy-down the cost of solar generation by financing the incremental cost of solar. This is a direct, project-level involvement of the government, financed through instruments such as capital subsidy, Generation-Based Incentive (GBI) or Viability Gap Funding (VGF), and so on; and
- Address or cover risks that are impediments to investments or optimal financing of solar projects. This could be achieved through structured public debt, risk funds and guarantees to address specific barriers/risks perceived by the lending community.

Buying down the cost of solar power in the deployment phase, through direct public funding, leads to the GoI co-financing a large set of private projects. The criticism of this approach is that unless it justifies significant externalities, such funding simply translates to unintended (and not so useful) subsidies for the end consumers of electricity. Cost reduction by itself cannot be argued to accelerate the deployment of solar power, as RPO is the basic demand-pull for solar projects under the existing power sector policy and regulatory framework in India.

Capital subsidy, GBI or VGF are all, however, important funding instruments for technologies, which in the development life-cycle have not achieved the scale or viability to be deployed widely. Lack of public funding at this stage can simply impede deployment and diffusion, irrespective of the long-term economic benefits.

Given the capital intensive nature of the program and the lack of participation of SCBs in it so far, it is more desirable for public funding to address structural impediments to such financing, so that the sector transits to nonrecourse-based financing, which has been absent over Phase I. Transparent disbursements through bidding and penalties for not achieving defined performance parameters can be adopted to enhance the effectiveness of direct funding support.

Access to commercial financing and its pricing can be improved if risk-reducing instruments or financial innovations are implemented with adequate public funding to back such measures. This set of measures is collectively named "facilitating public funding" and the following measures are evaluated further in the report:

- Credit guarantee enhancement schemes;
- Risk guarantee schemes;
- Subordinated public finance to prolong tenor of debt financing; and
- Interest subvention or government-intermediated concessional lines of credit for financial institutions.

A comparative assessment of the impact of such funding mechanisms on government budgetary support indicates that, compared with direct public funding, facilitating public funding (with the exception of interest subvention) options have lower or zero budgetary requirements (although involving contingent exposure) and consequently offer higher leverage on limited public finance.

The National Clean Energy Fund (NCEF) is proposed to be used as a VGF measure of the last resort during JNNSM Phase II. In addition, there could be a case for the utilization of NCEF for the creation of a Non-Risk Guarantee Fund, which can take care of the payment risk to private utilities under the solar mission.

2. Promoting local manufacturing: DCR vis-à-vis comprehensive industrial policy actions

Recognizing the importance of solar manufacturing, the National Manufacturing Policy of 2011 (Department of Industrial Policy and Promotion (DIPP) 2011) identifies solar energy as among industries of strategic importance where national capabilities are envisaged to be developed to make the country a major force in the sector.

India's existing solar PV manufacturing capacity is, however, limited and does not straddle the high technology upstream segments of the industry, such as polysilicon, wafers and ingots. The solar PV manufacturing industry in India was historically export-led until 2011 but is beleaguered by the global demand-supply situation, and comparative disadvantages in sourcing and cost of raw materials vis-à-vis global players. Solar thermal manufacturing, on the other hand, will require substantial coordinated actions and technology partnerships to be able to take root locally.

Both solar PV and solar thermal offer potential economy-wide benefits such as job creation. As has been witnessed in the solar PV segment in

India, the Indian solar PV manufacturing industry provides jobs to more than 25,000 people, with a total installed capacity of 1,100 MW of cells and 1,800 MW of modules.[2] Similarly, solar thermal possesses immense potential; to have an installed capacity of 10,000 MW by 2022, the total manpower requirement is expected to be 96,000, with 44 percent of this linked with local manufacturing.[3]

In Phase I of JNNSM, GoI specified a DCR for cells and modules for c-Si PV projects and a 30 percent requirement for solar thermal projects. These were limited only to JNNSM, with most state government policies having no such requirements.

India's PV manufacturing industry is, however, confronted with several root cause issues straddling supply-side factors such as relative disadvantages in the cost of sourcing raw materials and resources, lack of access to technology, inverted duty structure for classes of equipment required for manufacturing, and cost and power.

It is essential that the industrial policy aspects are given due consideration since the DCR addresses demand-side actions and may not be sufficient to make local manufacturing self-sustainable and competitive in the long run. Promoting local manufacturing would require coordinated actions on the supply side, involving specific policy interventions.

For industrial policy to be effective, comprehensive actions as outlined under the National Manufacturing Policy 2011 are required to build on comparative local advantages, create adequate forward and backward linkages, and address specific input disadvantages faced by Indian manufacturers vis-à-vis their foreign counterparts.

Solar PV and CSP will solicit customized approaches in terms of an industrial policy action design which will need to consider the overall objectives of ensuring long-term energy security, ensuring cost effectiveness, and realizing economy-wide benefits. These objectives will need to be evaluated to arrive at a set of prioritized actions.

The policy design choices for solar PV and CSP will need to take cognizance of local capabilities, international market situation, and availability of domestic funds. Drawing up clear technology scenarios for solar (PV and CSP) generation and application would be a key requirement to enable a manufacturing roadmap to be finalized for India. There is a need for developing a shared understanding of a framework to design specific industrial policy actions for solar manufacturing.

DCR needs to be aligned with the technology roadmap and prioritized segments of the value chain (separately for solar PV and CSP) under a comprehensive industrial policy action. A phased approach (which reduces year on year) to DCR is essential to ensure that the domestic industry moves up the competitiveness curve and is globally competitive over a period. In the absence of a roadmap for the promotion of preferred technologies, the DCR should be applicable on the entire value chain (thereby giving the choice of least-cost technology path to the investors).

Without a mission mode focus on increasing domestic value-addition and technology depth, Indian manufacturing in solar is unlikely to progress far. A Task Force, with representation from other concerned government departments (for example, DIPP) and other relevant organizations (such as the National Manufacturing Competitiveness Council (NMCC) and Planning Commission) should be set up to identify specific and coordinated industrial policy actions required by GoI to enhance competitiveness of solar manufacturing in India. An example of such a mission mode approach can be seen in the

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[2] Source: Federation of Indian Chambers of Commerce and Industry (FICCI) Solar Energy Task Force Report on Securing the Supply Chain for Solar in India.
[3] World Bank Report - Development of Local Supply Chain: The Missing Link for Concentrated Solar Power Projects in India.

automobile sector, with the Department of Heavy Industries and Public Enterprises, GoI, formulating the Automotive Mission Plan 2006-16 in 2006.

3. Solar thermal: public private partnerships vis-à-vis private-led development

A probabilistic model of procurement followed for both solar thermal and solar PV projects is more suited for commercial technologies, where upfront costs are limited in establishing project feasibility, and knowledge and experience are well-established for developers and financiers.

Solar thermal projects challenged with varying technologies and significant upfront costs in establishing detailed feasibilities are unsuited for a Case 1[4] kind of probabilistic procurement.

Stakeholders consulted during the study agree that larger public sector involvement in identifying, scoping and undertaking preliminary activities is essential before inviting the participation of private players. This is more akin to the Case 2 mode of technology and site-specific participation by private players adopted for conventional power projects in India.

Given the importance and promise of solar thermal for India, a more hands-on and guided approach from the government is necessary to move the industry forward in the desired direction. The following pathway is envisaged for solar thermal under Phase II and beyond:

- SECI should focus, in Phase II, on developing demonstration projects with desirable technology features such as storage, air-cooled condensation, hybridization, and so on. Such projects are envisaged under JNNSM to be developed through public private partnerships;
- A detailed assessment is required of the manufacturing value chain along a framework of coordinated industrial policy actions and ecosystem development plans to indigenize production;
- Any further capacity development under Phase II should ideally be undertaken only under a deterministic model with site identification, preliminary activities, and techno-commercial feasibility completed by a public-sector entity such as SECI, before bidding it out with specific technical specifications through a Build Own Operate Transfer (BOOT) or Build Own Operate Maintain (BOOM) route;
- Gather lessons from Phase I projects to decide on the desirable technology standardization for solar thermal projects, which could be adopted into grid connectivity standards of the Central Electricity Authority; and
- Based on the success of Phase II, decide on a move to a fully private-led model of procuring power from such projects over Phase III of JNNSM.

4. Role of central government: facilitative coordination vis-à-vis central sector projects

The draft Phase II policy document of JNNSM presents a differentiated pathway for central and state sector projects, with most incentives and support mechanisms under the policy reserved only for central sector projects. Only about 3.6 GW of the 9 GW capacity to be added over Phase II is envisaged in the central sector.

It is important, in this regard, to revisit the role of public support mechanisms under JNNSM. It may be more desirable to reorient GoI's role to assume a larger and strategic focus of addressing sector-wide barriers and risks to enable a country-wide scale up of the program.

An alternative vision outlined in the report constitutes the following elements, which could be the focus of GoI:

[4] 'Case 1 Renewable Energy' procurement, where the location or technology of a renewable power project is not specified by the procurer; 'Case 2 Renewable Energy' procurement – location specific renewable, which the procurer intends to set up under a tariff-based bidding process.

- All solar thermal projects in Phase II to be developed through the Case 2 mode with the provision of facilitating financing schemes from GoI;
- GoI to play an active role in developing solar parks in coordination with state governments. It will ease infrastructure-related challenges faced by developers and ensure coordinated transmission planning and deployment of smart-grid related features at the transmission level. Policy should aim for all projects to be developed through such parks;
- Direct public funding[5] can be advanced to the solar parks to bring down the cost of such infrastructure for project developers. A standard, concessional charge for infrastructure could be specified for all solar park-based projects in Phase II; and
- All projects adhering to a robust and sufficiently improved standard Power Purchase Agreement (PPA) and set up in solar parks should be able to avail of facilitating public finance through GoI schemes, such as credit enhancements/ guarantees and/or subordinated public debt.

A mapping of institutional capabilities of public institutions under JNNSM Phase I points to several gaps in undertaking monitoring, evaluation and coordination activities. The incorporation of SECI is thus a welcome measure and it should be resourced adequately to play a coordination role, including:

- Develop demonstration solar thermal projects in its capacity as a nodal agency;
- Transit program management, monitoring and evaluation in a phased manner from NVVN;
- Coordinate R&D efforts and ecosystem development efforts;
- Coordinate the development of solar parks throughout the country; and
- Address solar integration issues and facilitate a comprehensive national plan that coordinates generation scale-up, Transmission and Distribution (T&D) expansion and dispatch systems, and draws up a vision for the implementation of storage systems.

5. Development through solar parks or cluster-based approach

Experiences from Phase I and the Gujarat State Solar Policy indicate the need for organized development of grid-connected projects. A deterministic approach to planning of shared infrastructure through the provision of solar parks is the way forward as it optimizes land, water and evacuation infrastructure, and paves the way for planning and developing transmission and grid management features in a coordinated manner. MNRE should consider making solar park-based development the baseline for large, grid-connected solar projects in Phase II of JNNSM. By providing public funding support for infrastructure development in solar parks, GoI can prompt states as well as private parties to adopt solar parks as the baseline for large, grid-connected solar power development, thus laying the foundation for orderly grid development with optimized use of resources.

Along with the significant achievements of JNNSM Phase I, there are noteworthy barriers in solar sector financing, developing a manufacturing base in the country, and so on, which need to be overcome to meet the long-term objectives of JNNSM. Proactive efforts by all stakeholders in facilitating public funding, creating an enabling environment for manufacturing, and focusing on cluster-based project development would go a long way in augmenting the outcomes of JNNSM during the subsequent phases.

[5] There is a strong economic rationale in advancing direct public financing to solar parks, with positive externalities such as optimization in infrastructure use, including land, water and evacuation facilities, and provision of scale to use smart-grid features in grid integration of solar power.

1. A New Sunshine: Achievements of a Grid-connected Solar Sector in India

1.1 Introduction

Solar power, due to its abundant and sustained availability across the globe, has emerged as a promising long-term option for meeting growing global energy demand while addressing the adverse environmental impacts of conventional fuels. India is blessed with abundant solar insolation and energy generation potential. Recognizing its importance, the Government of India (GoI) launched the Jawaharlal Nehru National Solar Mission (JNNSM or National Solar Mission) which targets 20 gigawatt (GW) of grid-connected solar capacity by 2022.

JNNSM Phase I (2010-13) implementation has witnessed appreciable scaling up of solar capacities in India within a short span of three years. Starting from a negligible base, the total grid-connected solar photovoltaic (PV) capacity base of the country had reached 2,079 megawatt (MW) by the end of September 2013 and the majority of Concentrating Solar Power (CSP) additions (around 500 MW) are also likely to happen by 2014.

Despite developments in the Indian solar energy space, it is critical to focus on the sector's long-term sustainability against mission objectives. Project developers and technology providers will be looking for sustained long-term market prospects, assured policy continuity from the government beyond the first phase, and availability of public financing support for subsequent phases. Planning for JNNSM Phase II (2013-17), therefore, becomes crucial and should be based on a sound analysis of lessons learnt from Phase I to provide the required contribution to policy design and support.

Several agencies have analyzed and documented the developments in Phase I of JNNSM. GoI, on its part, has taken steps to put forth options for supporting the program in a draft policy document for Phase II of the mission.

The World Bank, in consultation with the Ministry of New and Renewable Energy (MNRE), instituted a study to undertake a wide range of consultations with key stakeholders to identify the critical barriers to scaling up the grid-connected program in the subsequent phases of JNNSM, to provide an analytical basis for addressing some of the key policy debates that have emerged at this stage of the mission. This study is restricted to the large, grid-connected segment and does not address rooftop and off-grid segments, which are each important as subjects of separate studies in the future.

An extensive stakeholder consultation approach has been followed by conducting interviews with a diverse set of stakeholders, namely, developers, manufacturers, Engineering Procurement and Construction (EPC) players, financiers and industry bodies, besides GoI and industry experts (Annex 1). This was followed by two stakeholder workshops organized in Delhi and Mumbai in January 2013 and February 2013, respectively. Certain key public policy and regulatory options for the future were debated, aimed at arriving at a shared understanding of issues and possible approaches to resolving them.

This report aims to document the findings of this study and deliberations thereunder with the objective of providing an analytical lever to GoI in its challenging task of evolving guidelines and policy for subsequent phases of JNNSM.

1.2 Jawaharlal Nehru National Solar Mission: An Overview

1.2.1 Background

On June 30, 2008, the Prime Minister of India released the National Action Plan for Climate Change (NAPCC). It outlines a national strategy on climate change, to enhance India's ecological sustainability and encourage sustainable energy sources. As part of NAPCC, the JNSSM, launched in 2010, is a GoI initiative to promote the development of solar power in India.

JNNSM provides multi-pronged and long-term strategies for harnessing solar energy in India. Its implementation is based on a three-phase strategy outlined in Figure 1.

JNNSM targets to add around 20,000 MW of solar power generation capacity by 2022. The proposed roadmap for deploying solar power across application segments under the JNNSM is shown in Table 1.

1.2.2 JNNSM Phase I: Chronology of Events

Since the launch of JNNSM in January 2010, several initiatives were implemented during its first phase, which are depicted chronologically in Figure 2.

Table 1:
JNNSM Roadmap

Application Segment	Target for Phase I (2010-13)	Target for Phase II (2013-17)*	Target for Phase III (2017-22)*
Solar collectors	7 million square meters (sq m)	15 million sq m	20 million sq m
Off-grid solar applications	200 MW	1,000 MW	2,000 MW
Utility grid power, including roof top	1,000-2,000 MW	4,000-10,000 MW	20,000 MW

Source: JNNSM policy document.

* Cumulative targets

Figure 1:
JNNSM Objective & Strategy

Objective	Strategy	Targets
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	Adopt a three-phase approach: • Phase I (up to 2012-13) • Phase II (2013-17) • Phase III (2017-22) Review capacity and targets for subsequent phases at the end of each phase (corresponding to plan period during 12th & 13th plans), as well as conduct a mid-term evaluation based on emerging cost and technology trends, both domestic and global To protect the government from subsidy exposure in case expected cost reduction does not materialize or is more rapid than expected	• To create an *enabling policy framework* for the deployment of **20,000 MW** of solar power by 2022 • To ramp up capacity of grid-connected solar power generation to **1,000 MW** by 2013; an additional **3,000 MW** by 2017 through the mandatory use of Renewable Purchase Obligation **(RPO)** by utilities backed with a preferential tariff. This capacity can be more than doubled—reaching **10,000 MW** of installed power by 2017 or more—based on an enhanced and enabled international finance and technology transfer. The ambitious target for 2022 of 20,000 MW or more will be dependent on the *'learning' of the first two phases.* • To create favorable conditions for **solar manufacturing** capability, particularly *solar thermal, for indigenous production* and market leadership • To promote programs for **off-grid applications**, reaching **1,000 MW** by 2017 and **2,000 MW** by 2022 • To achieve 15 million square meters (sq m) of solar thermal collector area by 2017 and 20 million by 2022 • To deploy 20 million solar lighting systems for rural areas by 2022

Figure 2:
JNNSM Phase I Chronology of Events

Jan 2010	Feb 2010	Jun 2010	July 2010	Aug 2010
Launch of JNNSM	Benchmark tariffs - CERC	RPSSGP guidelines issued	Batch 1 guidelines issued	RfS for Phase 1 (Batch1)
Oct 2010	**Dec 2010**	**Jan 2011**	**Aug 2011**	**Nov 2011**
PPA for migration projects	Batch 1 bidding completed	Batch 1 PPAs signed	Batch 2 guidelines issued	RFP for Batch 2 issued
Dec 2011	**Jan 2012**	**Jan 2012**	**Feb 2013**	**May 2013**
Batch 2 bidding completed	Batch 2 PPAs signed	PV (Batch 1) target COD	PV (Batch 2) & CSP (migration) target COD	CSP (Batch 1) target COD

CERC: Central Electricity Regulatory Commission; RPSSGP: Rooftop PV and Small Solar Generation Programme; RfS: Request for Selection; PPA: Power Purchase Agreement; RFP: Request for Proposal; COD: Commercial Operation Deadline

1.2.3 Capacity Allocation Process in JNNSM Phase I

GoI undertook several proactive steps in Phase I, such as offering a bundling of solar power with unallocated coal-based power through the National Thermal Power Grid (NTPC) Vidyut Vyapar Nigam (NVVN), implementing a Renewable Purchase Obligation (RPO) for solar power, instituting a Payment Security Scheme (PSS), and undertaking measures for promoting local manufacture of solar power; these initiatives combined to ensure the success of Phase I.

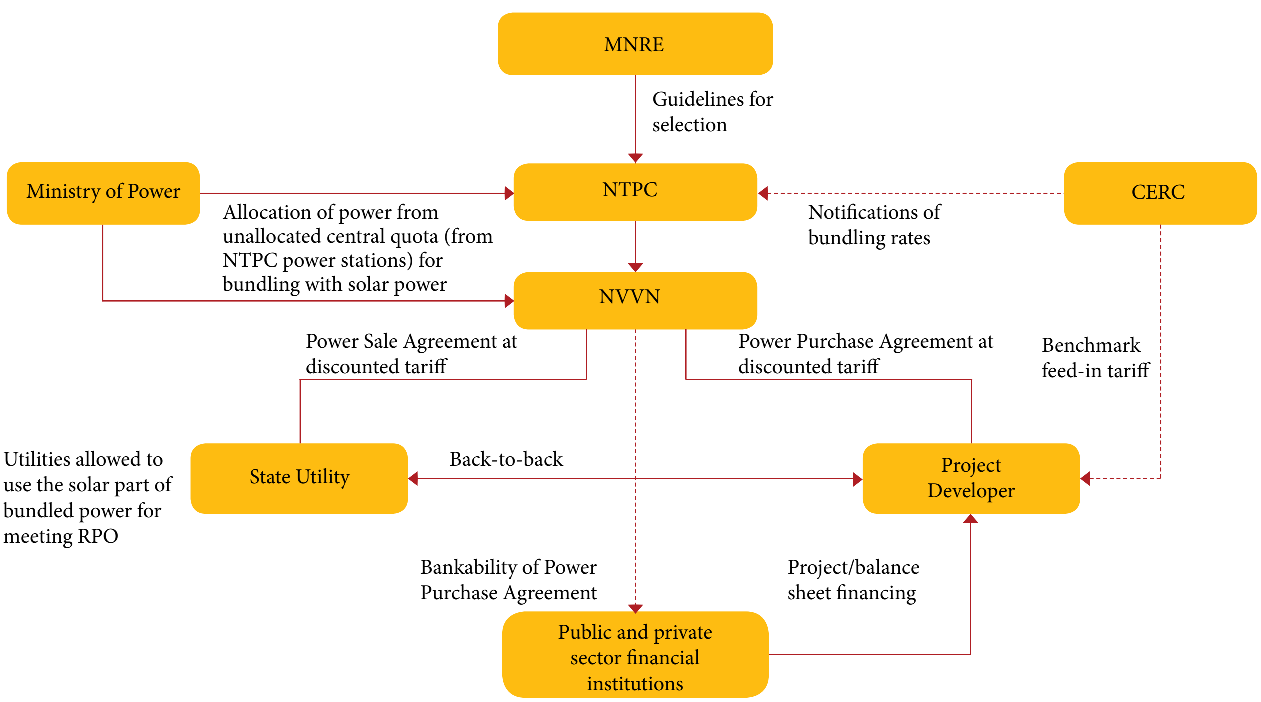
A summary of the key features of the capacity allocation process followed during JNNSM Phase I:

- Benchmark tariff fixed for each financial year by the Central Electricity Regulatory Commission (CERC), followed by competitive bidding (reverse auction) to allocate projects to a set of successful bidders with the lowest tariffs adding up to the quantum of capacity earmarked for each batch;
- Discount on a fixed tariff (set at the level of CERC determined tariffs) used as the evaluation criterion for selecting bidders; and
- Bundling of solar power with cheaper conventional thermal power to reduce the impact of higher solar tariff on utilities.

Figure 3 provides an overview of the capacity allocation process along with the key roles played by different stakeholders.

Phase I of JNNSM has witnessed active participation from the private sector in the grid-connected segment with substantial discounts to the benchmark tariffs determined by CERC for solar thermal and solar PV projects, respectively. MNRE played the crucial role of issuing JNNSM Phase I guidelines to select new solar power projects and providing the essential policy framework for the development of solar power projects under

Figure 3:
JNNSM Phase I Capacity Allocation Process



4 units of coal power bundled with 1 unit of solar power for sale to utilities

the bundling scheme for Phase I of JNNSM. The guidelines provided clarity on the bidding process as well as the technical and financial qualifying criteria for bidders to participate in the bidding process (Annex 2).

Bidding for solar thermal and solar PV projects was undertaken separately, with each having a clear target (of 500 MW each) under the JNNSM Phase I guidelines. NVVN, a company engaged in the business of trading of power, was designated as the nodal agency by the Ministry of Power (MoP) for entering into Power Purchase Agreements (PPAs) with solar power developers. The power from the solar power plants is being purchased by NVVN and sold to distribution companies (Discoms) after bundling with power from the unallocated quota of power (at MoP's disposal for allocation) from NTPC's coal-based stations on equal capacity basis, thus effectively reducing the average per unit cost of bundled power. Table 2 shows the average per unit cost of bundled power. It can be seen that, due to continuous reduction in PV prices, the cost of bundled power has also reduced.

1.3 Key Achievements of JNNSM Phase I

1.3.1 Capacity Additions under JNNSM

Capacity allocation under JNNSM Phase I was undertaken in two batches—projects under Batch 1 were awarded in January 2011 and those under Batch 2 in December 2011. These projects are in various stages of implementation, as shown in Figure 4.

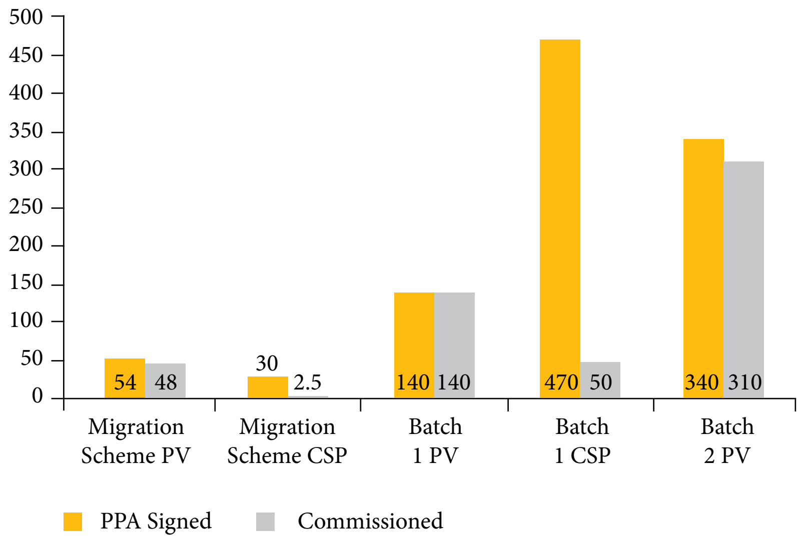
JNNSM Phase I implementation witnessed appreciable scaling up of solar capacities within a short span of three years. Starting from a negligible base, the total capacity reached 639.3 MW (including projects under the Rooftop PV and Small Solar Generation Programme (RPSSGP)) by the end of July 2013. CSP additions are likely to happen in 2014 (refer status of CSP projects and key players in Annex 3).

Table 2:
Cost of Bundled Power under JNNSM

JNNSM Scheme	Technology Type	CERC Tariff - INR/kWh (US$/kWh)	Discounted Tariff Range - INR/kWh (US$/kWh)	Weighted Average Tariff - INR/kWh (US$/kWh)	Bundled Power Tariff Range - INR/kWh (US$/kWh)
Migration scheme	PV	17.91 (0.299)	NA	–	5.40-5.72 (0.090-0.095)
	CSP	15.31 (0.255)	NA	–	5.31-5.62 (0.089-0.094)
Batch 1	PV	17.91 (0.299)	10.95-12.76 (0.183-0.213)	12.12 (0.202)	4.34-4.67 (0.072-0.078)
	CSP	15.31 (0.255)	10.49-12.24 (0.175-0.204)	11.48 (0.191)	4.49-4.81 (0.075-0.080)
Batch 2	PV	15.39 (0.257)	7.49-9.44 (0.125-0.157)	8.77 (0.146)	3.73-4.05 (0.062-0.068)

Source: NVVN. kWh: kilowatt hour; NA: not applicable.

Figure 4:
Status of JNNSM Capacity Additions—July 2013



Source: Authors' research.

1.3.2 Solar Tariff Trends in JNNSM Phase I

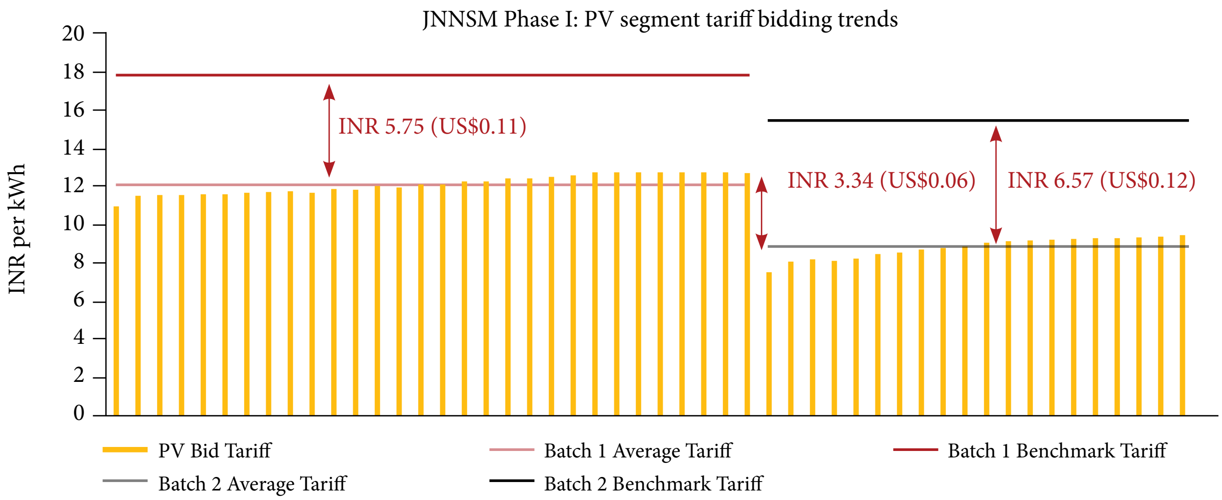
Solar PV bidding in Phase I was undertaken in two batches. With JNNSM adopting a reverse auction method for awarding projects to qualified bidders, weighted average levelized tariffs for selected solar PV projects declined sharply between the two batches in Phase1 from INR 12.12 per kilowatt hour (kWh) (22.4 cents per kWh) to INR 8.77 per kWh (16.24 cents per kWh), making India amongst the lowest cost destinations for grid-connected solar PV in the world. A snapshot of the bidding trends that emerged in the solar PV segment during JNNSM Phase I is shown in Figure 5.

There was a decline of around 27.6 percent in the weighted average tariff for the projects bid out in Batch 1 and those bid out in Batch 2. While the tariff range during Batch 1 bidding process was between INR 10.95 per kWh (18.3 cents per kWh) and INR 12.96 per kWh (21.6 cents per kWh), it came down to between INR 7.49 per kWh (12.5 cents per kWh) and INR 9.44 per kWh (15.7 cents per kWh) during the Batch 2 bidding process.

The weighted average bid price for CSP was also lower than the CERC benchmark CSP tariff. The range of bidding was between INR 10 per kWh (16.7 cents per kWh) to INR 12.5 per kWh (20.8 cents per kWh). A snapshot of the bidding trends that emerged in the solar thermal (CSP) segment during JNNSM Phase I is shown in Figure 6.

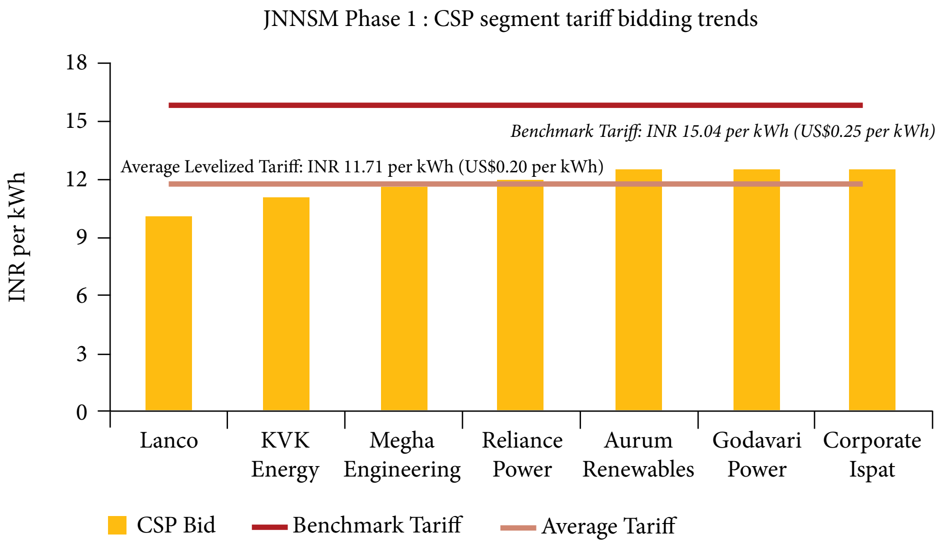
The open and transparent reverse tariff bidding process has demonstrated an appreciable reduction in the average tariffs for both PV and CSP projects. The weighted average tariff rate for Batch 1 PV projects is around 32 percent below the benchmark tariff set by CERC while the weighted average tariff rate for Batch 2 PV projects is 43 percent below the benchmark tariff set by CERC. For CSP projects, the weighted average bid tariff is around 25 percent below the CERC benchmark tariff (refer Annex 4 for chronology of reverse bidding process adopted and level of participation in JNNSM Phase I and the international experience for auctioning renewable energy-based power capacity).

Figure 5:
JNNSM Phase I Solar PV Tariff Trends



Source: NVVN report.

Figure 6:
JNNSM Phase I Solar Thermal Tariff Trends



Source: NVVN report.

The bidding process provided a transparent means of determining tariffs in a highly uncertain global solar PV market and, in the process, benefited from rapidly declining solar PV module prices in the global market, a result of cut backs in demand from several European economies, increased levels of competition on the supply side, and a resultant surplus in supply in the international market.

This has definitely helped India in driving down solar tariffs in the short term and moving closer to achieving grid parity in the long term.

JNNSM has been instrumental in bringing the purchase price of both PV and CSP to a globally competitive level. Figure 7 shows India's experience of very low bid out tariffs against feed-in tariffs (FiTs) across major countries in the world.

1.4 State Solar Policies

Several state governments in India have declared their state-level solar policies to promote solar generation. The following section provides an overview of the developments in various states.

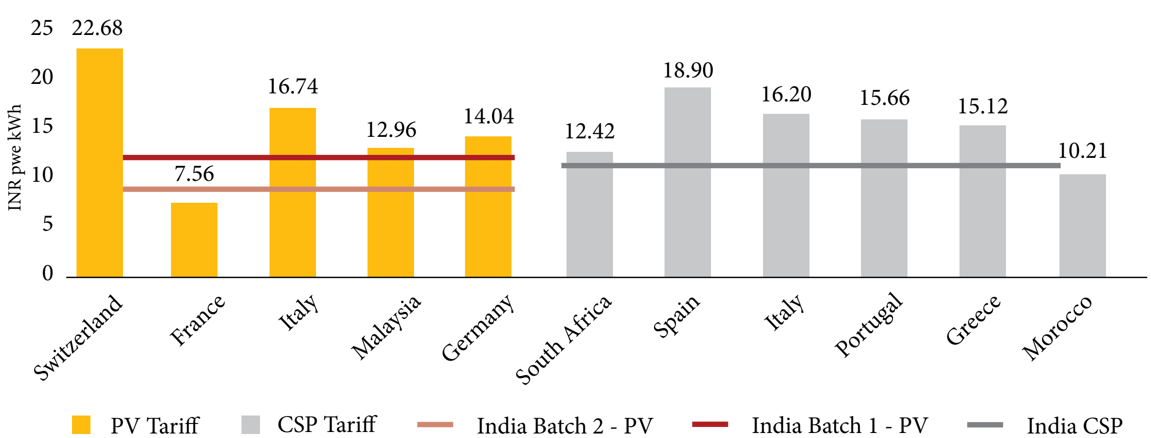
1.4.1 Gujarat

Gujarat has been at the forefront of solar development in India. It was the first state to declare a solar policy in 2009. It has also initiated the development of solar parks, with the provision of publicly developed associated infrastructure, leaving the private sector to focus only on solar project development.

The first solar park, developed in Charanka (Patan district), is currently the largest cluster of solar capacity in Asia. It provides developed land along with infrastructure, including power evacuation, roads and water for developers, thus ensuring a fast-track development of solar projects. The Gujarat Power Corporation Limited (GPCL) is the nodal agency mandated to develop, operate and maintain the solar park. The state has awarded projects on first-come-first-served basis at the FiT determined by the Gujarat Electricity Regulatory Commission (GERC).

Gujarat has also taken the lead in developing a grid-connected solar rooftop program based on gross metering with the rollout of the 5 MW Gandhinagar solar rooftop program in 2011. Developers have been selected through a competitive bidding process, and a Green Incentive of INR 3 per kWh (US$0.05 per kWh) has been provided to the rooftop owners.

Figure 7:
PV and CSP Tariff Comparison Across Countries



Source: wind-works.org and author's research.

1.4.2 Rajasthan

Rajasthan Solar Policy (2011) aims to develop the state as a global hub of solar power with around 10-12 GW of capacity to be developed over the next 10-12 years. Focus areas include grid interactive solar power projects, decentralized and off-grid solar applications, setting up of demonstration projects, developing solar parks, and promoting solar thermal collectors.

The allocation of generation projects of 100 MW capacity in Phase I of the state policy was completed recently and projects were awarded through a competitive bidding process along lines similar to those used under JNNSM.

1.4.3 Tamil Nadu

The Tamil Nadu Solar Policy (2012) has targeted a total of 3,000 MW by 2015. Of this, 500 MW is proposed to be achieved through the newly imposed Solar Purchase Obligations (SPOs) on consumers who receive power from Discoms at more than 11 kilovolt (kV).

Around 1,000 MW of grid-connected capacity addition is proposed through the competitive bidding process while another 350 MW would be generated through solar rooftop projects.

1.4.4 Karnataka

The Karnataka State Solar Power Policy (2011) has set the target of achieving 126 MW of solar power up to 2013-14, to meet the RPO imposed by the regulator, of 0.25 percent till 2013-14 from solar sources. A tariff-based competitive bidding process has been proposed for the selection of developers.

1.4.5 JNNSM and State Policies

JNNSM provided an overall national plan for solar power capacity addition which is implemented under the aegis of MNRE (GoI). The state-level policies are designed and implemented by the state governments and work in tandem with the JNNSM. Table 3 shows the capacity targets set under various state policies and a detailed comparison of criteria and processes followed is provided in Annex 2.

JNNSM, along with state solar policies, has led to the rapid augmentation of solar capacity in India within a period of three years. Table 4 shows the installed capacity (as on March 2013) under various initiatives across different states.

The successful implementation of projects under JNNSM Phase I and Gujarat State Solar Policy has firmly established the solar footprint in the

Table 3:
Solar Policy Capacity Targets and Status

Particulars	Gujarat	Karnataka	Rajasthan	Madhya Pradesh	Andhra Pradesh	Tamil Nadu
Period (FY)	**2010-14**	**2013-16**	**2013-17**	**2012-13**	**2013-17**	**2013-15**
Capacity targets	500 MW	250 MW	600 MW	200 MW	1,000 MW	3,000 MW
Capacity invited (up to March 2013)	972 MW	80 MW	100 MW	200 MW	1,000 MW	1,000 MW

Source: Authors' research.

Table 4:
Installed Solar Capacities (MW) under Various Schemes

State	State Policy	JNNSM	RPSSGP/GBI	REC Scheme	Other Projects	Total (MW)
Andhra Pradesh	-	11.40	9.75	-	2.00	**23.15**
Arunachal Pradesh	-	-	-	-	0.03	**0.03**
Chhattisgarh	-	-	4.00	-	-	**4.00**
Delhi	-	-	-	-	2.53	**2.53**
Goa & UTs[6]	-	-	-	-	1.69	**1.69**
Gujarat	824.09	-	-	-	-	**824.09**
Haryana	-	-	7.80	-	-	**7.80**
Jharkhand	-	-	16.00	-	-	**16.00**
Karnataka	-	5.00	-	-	9.00	**14.00**
Kerala	-	-	-	-	0.03	**0.03**
Madhya Pradesh	-	-	5.25	6.50	-	**11.75**
Maharashtra	-	16.00	5.00	9.50	4.00	**34.50**
Odisha	-	5.00	8.00	-	-	**13.00**
Punjab	-	2.00	6.00	-	1.33	**9.33**
Rajasthan	-	372.5	12.00	6.85	50.90	**442.25**
Tamil Nadu	-	5.00	6.00	1.055	5.00	**17.06**
Uttarakhand	-	-	5.00	-	0.05	**5.05**
Uttar Pradesh	-	5.00	7.00	-	0.38	**12.38**
West Bengal	-	-	-	-	2.00	**2.00**
Total	**824.09**	**421.9**	**91.80**	**23.91**	**78.91**	**1,440.6**

Source: MNRE website/reports.

Indian power sector. Gujarat State Policy received enthusiastic response and, amongst states, currently has the highest share of solar power installed capacity under state policies due to:

- Gujarat being the first state to award projects under its state solar policy even before projects were awarded under JNNSM;
- Projects allocation being based on the favorable FiT instead of competitive bidding;
- Availability of waste land and government support in acquiring this land; Gujarat had identified a land bank for solar power development (by developing solar parks) from wasteland areas available in the state;
- Gujarat being one of the few states with profitable electricity distribution utilities, offering high procurer creditworthiness; and

[6] Union Territories: Puducherry, Lakshadweep, Andaman & Nicobar Islands.

- Provision of a transmission evacuation facility by GETCO.

The launch of JNNSM provided an opportunity for states such as Rajasthan (with good solar radiation levels and wasteland availability) to procure solar power to meet their solar RPO compliance. The bundled power offered under JNNSM Phase I ensured a lower burden on state utilities, compared to the higher tariff levels of solar power. This has been followed by the separate solar power capacity allocation through state solar policies.

The announcement of JNNSM Phase II and state-level solar policies is likely to accelerate development of the solar sector in coming years. However, there are certain barriers and challenges which need to be addressed in the short to medium term. It is, thus, important, to evaluate the success of JNNSM Phase I, covering broader objectives and actions points rather than focusing only on capacity installations. The following chapters analyze the key barriers and challenges for the solar sector in India and provide the way forward to address them.

2. Scaling up under JNNSM: Barriers and Challenges

There is little doubt that the outcome of the large grid-connected solar PV program under JNNSM has been very encouraging. Most PV projects in Batch 1 were able to achieve financial closure and commissioning within the specified deadline. Projects in Batch 2 have also made good progress in meeting their commissioning schedule in 2013. JNNSM Phase I, despite its emphatic beginning, is modest in its capacity compared with the overall vision for solar energy under the mission. Factors such as creation of policy and a regulatory framework, manufacturing capacity, financing, and so on, are very important for meeting the long-term objectives of the solar mission. Thus, it is essential to view this program in the context of the overall targets under JNNSM. In order to gain a comprehensive understanding of various action points in JNNSM Phase I, the following key JNNSM objectives require a closer look:

- Creating a functional policy and a regulatory framework;
- Facilitating favorable conditions for solar power production/manufacturing; and
- Meeting capacity targets under each phase and preparing for the next phase.

These objectives have been qualitatively evaluated in terms of the key actions required to meet them and their outcome during JNNSM's Phase I implementation. Figure 8 shows the summary of our analysis.

Viewed in the context laid out in Figure 8, it is essential to identify and address the key challenges faced by stakeholders, which could prevent the program from reaching, and possibly exceeding, the target of 20 GW of grid-connected solar capacity in the country by 2022.

Among the various issues identified, the following need closer deliberation to help evolve solutions for subsequent phases of the mission:

- Lack of adequate participation of Scheduled Commercial Banks (SCBs) in solar financing;
- Bottlenecks in the enabling environment;
- Payment security for future projects;
- Unintended technology outcomes over Phase I;
- Beleaguered local solar manufacturing environment;
- Adequacy of the current approach to developing solar thermal projects; and

Figure 8:
Key Observations on Phase I of JNNSM

JNNSM Objectives	Actions	Results	Key Observations
Creation of functional policy and regulatory framework	Optimizing public investment utilization		Financing of solar projects is a challenge, CSP in particular is facing problems
	Acceptable risk sharing & reasonable competition		Risk sharing framework – project financing still some way off; long-term predictability on pricing is uncertain
	Transparency and nondiscriminatory allocation		Competitive bidding allowed achievement of transparency in bidding and nondiscrimination in project award and permitting
Facilitate favorable conditions for manufacturing	Solar manufacturing capacity additions during Phase I		Limited success in solar manufacturing capacity; global uncertainty in solar PV manufacturing
	Manufacturing policy for solar sector		Solar policies more focused on power generation; need for integrated industrial policy
	DCR		Under discussion
Meeting capacity targets under Phase I and preparedness for Phase II	Grid-based PV capacity additions		Solar PV has met its targets and witnessed huge participation from diverse players
	Grid-based CSP capacity additions		CSP – faced certain challenges during Phase I
	Developing framework for Phase II		Under discussion

Strong Weak

Source: Authors' research.

- Enforceability of RPOs and concerns around solar Renewable Energy Certificates (RECs).

This chapter presents these issues in brief as a background to the essential policy and design choices that are debated in the next chapter, and need to be resolved to ensure the success of the mission over subsequent phases.

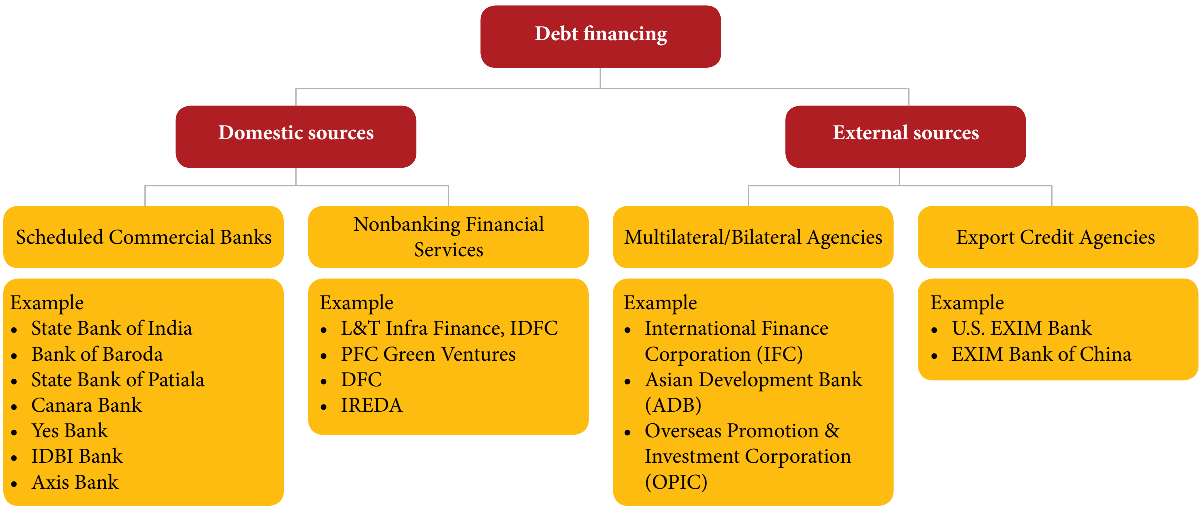
2.1 Lack of Participation of Scheduled Commercial Banks in Solar Financing

The financial institutions, which led debt financing to solar developers in Phase I, could be classified into four categories: SCBs; nonbanking financial services including infrastructure finance companies; bilateral/multilateral financial institutions including their private sector financing arms; and export credit agencies including EXIM banks.

2.1.1 Scheduled Commercial Banks

Several SCBs participated in solar projects in JNNSM Phase I and in projects under state policies. However, their cumulative market share was less than 25 percent and no single SCB featured among the leading lenders to solar projects. Such financing was also available only to established

Figure 9:
Types of Debt Financing Available to Solar Developers



corporates, with SCBs exercising discretion in qualifying borrowers for solar financing. SCBs also participated mostly through consortium lending routes, with even small projects of 5 MW being financed by a group of lenders, resulting in prolonged timelines for arranging finance.

2.1.2 Nonbanking financial services including infrastructure finance companies

In India, a Non-Banking Financial Company (NBFC) can either be an infrastructure debt fund, a dedicated power sector financing company, or an investment company. Select prominent NBFCs such as Larsen and Toubro (L&T) Infra Finance, Infrastructure Development Finance Company (IDFC) and PFC Green Ventures financed several Phase I projects.

2.1.3 Bilateral/multilateral financial institutions including their private sector financing arms

International Finance Corporation (IFC), Asian Development Bank (ADB) and Overseas Promotion and Investment Corporation (OPIC) are some prominent international financial institutions that have financed private solar projects in India. While financing by international financial institutions was a welcome feature of Phase I, it is limited in its availability for private projects or is tied in nature and cannot form the mainstay of financing for scaled up targets envisaged under subsequent phases of JNNSM.

2.1.4 Export credit agencies including EXIM banks

Equipment-linked financing through foreign EXIM banks had the highest share of debt in Phase I, led by U.S. EXIM bank. This type of funding was available for projects that imported equipment. Although they were technology neutral, a few suppliers emerged as primary beneficiaries of this financing. Projects under the Gujarat Solar Policy too benefitted significantly from low-cost, long-tenor financing available from export credit agencies, including, in particular, the U.S. EXIM bank, which was among the prominent lenders to solar projects in India.

Higher dependence on foreign financing creates mismatches in currency flows, as the revenues of the solar projects are all denominated in INR while overseas debt servicing is in foreign currency. The study also indicated limited or no hedging by developers which was always fraught with risk, as indicated by the unprecedented depreciation in INR in 2013. This will affect the future risk appetite for such structures. From this perspective too, participation of domestic banks becomes even more critical for the success of the program in the future.

The experience from infrastructure financing for private sector projects in India shows that SCBs have led from the front in the absence of a sufficiently active debt market, and account for more than 80 percent of such debt disbursements (ADB 2011). The importance of SCB financing to the power sector can also be ascertained from the fact that it showed a compounded annual growth of 42 percent over a six year period from FY2007-12 (Reserve Bank of India (RBI) Financial Stability Report, 2011 & 2012). It is in this context that the lack of active participation by SCBs in the Indian solar program is worrisome.

Phase II of JNNSM, in which 3,600 MW of capacity is proposed to be developed under central schemes, would require an investment of around US$5.8 billion (Annex 5) which, at 70:30 debt-equity ratio, translates into a financing requirement of around US$4.1 billion. Taking the financing landscape of Indian infrastructure into consideration, it is inconceivable for JNNSM to scale up to the levels envisaged in subsequent phases and beyond without the active participation of SCBs.

SCBs consulted during the study pointed to the following reasons for their lack of serious participation in Phase I of the program:

- Emerging nature of solar technologies and lack of SCBs' familiarity with the range of technologies deployed by developers led to a higher perception of risk. Lack of on-field irradiation data in Phase I added to the risk perception of lenders;
- Solar projects involving smaller ticket sizes are at a disadvantage when considered within the same sector limits applicable to conventional power projects;
- Concessional sources of financing in the form of suppliers' credit and direct lending by development banks effectively crowded out commercial financing from SCBs, particularly without the availability of any concessional lines of credit for SCBs in Phase I;
- SCBs expressed concerns with the bid-out tariffs on several projects, which were considered extremely aggressive and unviable with commercial finance even under P90 scenarios.[7] Collaterals and securities were not considered substitutes for debt serviceability, as defaults trigger debt restructuring and Non-Performing Assets (NPAs) that create regulatory issues for financiers, even if such defaults may be recoverable against securities;
- SCBs' evaluation of projects indicated several infrastructural bottlenecks, which were additional sources of risks. These included factors that are covered in a subsequent section in this chapter; and
- The PSS instituted by MNRE, although well received, was considered to have given substantial discretion to NVVN, leading to lack of clarity on its enforceability.

SCBs as well as other lenders, consulted during the study, raised certain issues with the standard PPA. These are briefly summarized in Annex 6.

2.2 Bottlenecks in the Enabling Environment

The promotion of solar power generation in JNNSM Phase I witnessed a number of key bottlenecks[8]

[7] P90 refers to a probabilistic scenario where irradiation profiles are assumed, on average, to be in the 90 percent confidence range.
[8] Bottlenecks identified based on the stakeholder consultation undertaken; PV and CSP supply chain issues not covered.

in the current enabling environment, spanning administrative and institutional readiness, knowledge and capacity of key stakeholders, and limited data availability. Some of the key bottlenecks are:

- **Land acquisition a cumbersome process:** Land acquisition is a major stumbling block for the development of solar power projects. According to developers, converting land use designations is extremely time-consuming (involving clearances from Gram Panchayats, Departments of Rural Development and Revenue, and so on) causing unnecessary delays;
- **Delays due to approvals and clearances:** The absence of a single window clearance mechanism under the state policy framework further delays solar project installation as there is limited coordination between different departments/ agencies. Frequent policy and guideline changes further complicate the process, leading to lack of clarity across different agencies/departments;
- **Limited data availability:** Limited availability of data on solar irradiation levels, land availability, water availability, grid loading and availability, and so on, were bottlenecks experienced by solar projects across regions. A number of financers have raised concerns about lack of ground-level technology performance data and its effectiveness in the Indian environment, especially related to CSP. MNRE, along with the Centre for Wind Energy Technology (C-WET), has initiated steps to overcome the issue related to solar irradiation levels by setting up Solar Radiation Resource Assessment (SRRA) stations;
- **Availability of support infrastructure (water/ power evacuation):** Timely availability of power evacuation continues to be a concern and has resulted in delays in commissioning of solar power projects, including in states that have identified land banks. Around seven solar PV projects in Batch 1 faced similar delays in commissioning because the State Transmission Utility (STU) had not made the transmission line ready. Many developers indicated that getting right of way for laying the water pipeline or power evacuation line is cumbersome and involves receiving consent from multiple parties; and
- **Limited state and center level coordination:** With no established framework for coordination between the state agencies and MNRE administered institutions such as SECI, the Solar Energy Center (SEC) and the Indian Renewable Energy Development Agency (IREDA), lack of clear mapping of responsibilities between the various agencies in the public domain, compels developers to navigate on their own. Although most clearances and consent must be obtained at the state level, it is worthwhile for MNRE to establish a procedural roadmap for solar development with a clear mapping of responsibilities of intervening public institutions, both at the state and the center.

2.3 Payment Security for Future Projects

JNNSM Phase I offered bundling of 1,000 MW of coal-based generation capacity from NTPC with solar power of 1,000 MW through NVVN and instituted a PSS. The combination of NVVN as a counterparty to all contracts in Phase I and PSS[9] as a security against defaults by Discoms was seen as a robust framework for a fledgling solar industry characterized by new, emerging players with limited financial strength.

The PSS is unique to solar[10] power and was instituted by GoI in recognition of the infancy of the solar industry, higher cost of solar with an associated higher risk perception of defaults, and lack of exposure of Indian financial institutions to solar power generation.

[9] Concerns were raised by financiers on the discretion accorded to NVVN in defining defaults and in assessing the Solar Payment Security Account (under the PSS).
[10] For instance, the successful wind energy program with over 18 GW of installed capacity in India was developed without any government financed payment security mechanism.

Over subsequent phases of JNNSM, however, bundling is no longer a major option because of limited availability of unallocated power and, therefore, the continuity of NVVN as the counterparty is in doubt.

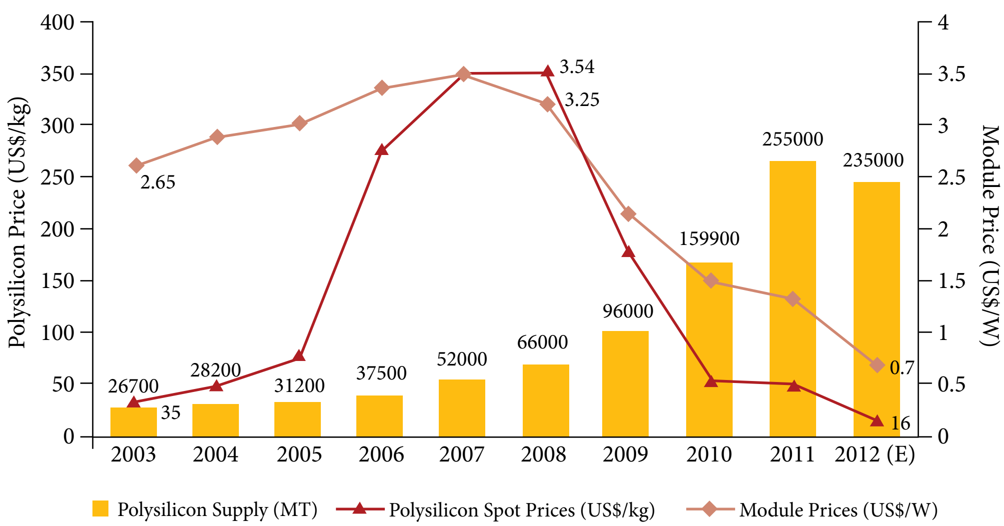
As per the JNNSM Phase II Batch I guidelines, SECI shall set up a payment security mechanism to ensure timely payment to the developers. This fund will have a corpus to cover three months' payment. The rules to operate this fund will be framed by MNRE. As per the draft Phase II policy document, the National Clean Energy Fund (NCEF)[11] is proposed to be used as a Viability Gap Funding (VGF) measure in the last resort, ensuring that the minimum possible NCEF funds are made available during the project cash-flow timelines to ensure project viability (refer Annex 7). In addition, there could be a case for utilization of NCEF for the creation of a Non-Risk Guarantee Fund, which can take care of the payment risk to private utilities under the solar mission.

With a rapidly decreasing tariff scenario in solar power and increasing knowledge and exposure of all stakeholders, the need for PSS may gradually dwindle. For Phase II, however, payment security shall remain a concern, particularly with the increasing concentration of solar projects in some states and the weak financials of distribution utilities in most states in India.

2.4 Unintended Technology Outcomes of Phase I of JNNSM

Phase I bidding took place in two batches[12] over August 2010 and August 2011—a period that witnessed the sharpest decline in module prices with cut backs in demand from some European countries, following the Eurozone recession. The global trend in polysilicon supply, polysilicon spot prices, and module prices over the last few years has been detailed in Figure 10.

Figure 10:
Global Solar PV Market Trends



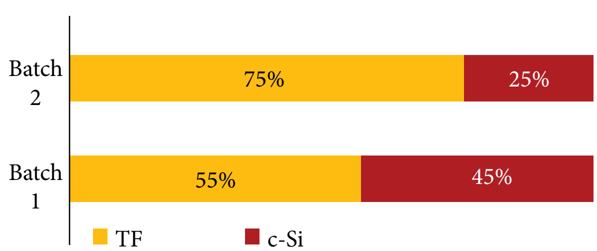
Source: EPIA, REC-SAGE, Bernreuter Research, BNEF, IHS iSuppli Module Price Index, authors' research.

[11] NCEF is expected to generate US$644 million in FY 2012-13.
[12] For solar PV technology only.

The consequent over-supply and build-up of inventory affected the prices of cells and modules, resulting in a consistent decline through 2011 and 2012. There has been an upward trend in the prices of key components during the first half of 2013. For example, the Bloomberg New Energy Finance (BNEF) Solar Spot Price Index showing average polysilicon prices just over US$17 per kilogram (kg), up from a low of US$16 per kg in December 2012. Module prices have also risen slightly, with Chinese modules from reputable suppliers widely commanding US$0.75 per watt (W) and international modules US$0.86 per W.[13]

Several suppliers the world over have struggled to be cost-competitive in this environment, and PV manufacturing continues to experience closures and consolidations. Globally, Thin Film (TF), which once accounted for 30 percent of the market, has been losing share steadily. With the dramatic decline in Crystalline Silicon (c-Si) prices, the value proposition of TF as a lower cost option has eroded over time, and it has continued to lose market share resulting in a long list of suppliers shutting down their manufacturing units. It accounted for only 11 percent of the global PV market at the end of 2011.

Figure 11:
JNNSM Phase I Solar PV Technologies Used



In India, on the contrary, the share of TF in overall PV installations over Phase I of JNNSM is close to 70 percent (Figure 11). This unintended outcome (refer Annex 8) is a result of two factors. First, the Domestic Content Requirement (DCR) for c-Si required cells and modules to be mandatorily procured from domestic manufacturers over Batch 2. Owing to a low TF manufacturing base in India, DCR was waived for TFs. Domestic manufacturers have struggled to be competitive in a volatile and rapidly declining price environment led by Chinese suppliers.

Second, established TF suppliers based out of the United States were ready to supply competitively priced TF modules along with the provision of low-cost, long-tenor debt[14] from U.S. EXIM. Faced with an economically attractive option and supply from more established and proven U.S. suppliers compared with domestic manufacturers, developers opted widely for TF.

Thus, DCR, which was intended to promote the local manufacturing industry, has actually resulted in a skewed technology choice and Indian manufacturers have derived minimal benefit from the program. Further, both c-Si and TF have relative pros and cons, as various international studies have shown, although TF has steadily lost global market share to c-Si. It is currently almost impossible to predict which technology will perform better in the Indian environment in the long run. This uncertainty, combined with the global preference for c-Si as against the preference for TF in India, might cause potential issues in the unforeseeable future for the rapidly growing Indian solar sector.

[13] Source: bnef/PressReleases/text/318 – August 2013.
[14] Foreign debt has been available for a tenor of 15 years and longer (IFC, OPIC, US EXIM); OPIC/overseas EXIM loans have been available at under 5 percent Fx denominated.

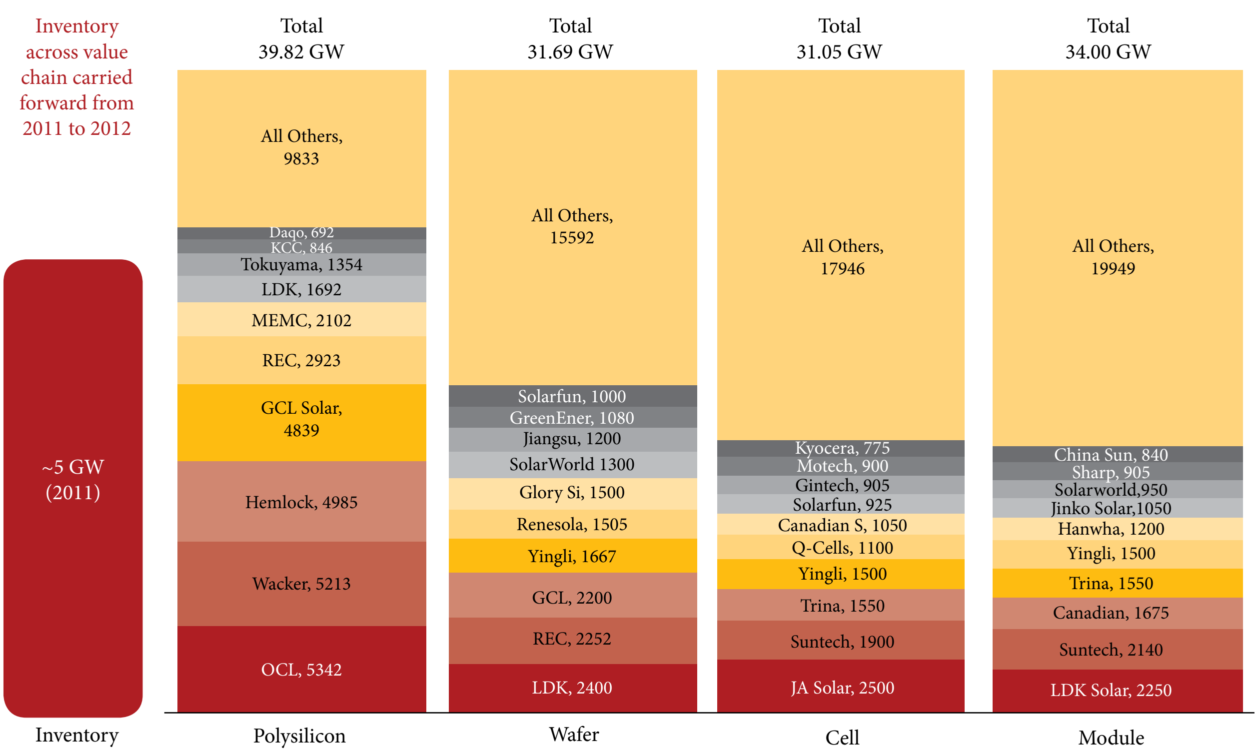
2.5 Beleaguered Local Solar Manufacturing Industry

JNNSM embodies the significant objective of developing India into a leader in high-quality, low-cost solar manufacturing. In Phase I, to provide support to domestic manufacturers, GoI included a DCR for both c-Si and solar thermal-based projects (refer Annex 9). As is apparent, not only did this measure not contribute to the expansion and development of the Indian manufacturing industry (the Indian solar PV manufacturing industry actually contracted in size during this period), but it also did not provide support for making the industry more competitive in the global solar PV market. The domestic solar PV manufacturing industry continues to operate at an average capacity utilization of less than 50 percent. On the other hand, lack of solar thermal manufacturing experience limits domestic technology supply options in the absence of critical locally manufactured components.

2.5.1 Solar PV

Globally the upstream segments in solar PV manufacturing are highly competitive, technology- and capital-intensive, and have followed a research-based learning curve. Only seven companies constitute up to 90 percent of the total polysilicon market and five companies provide up to 90 percent[15] of the total ingot production in the world. Figure 12 provides a broad overview of the global solar PV production.

Figure 12:
Global Solar PV Production Overview—2012 Beginning



Source: GTM research, polysilicon excludes production for semi industry.

[15] Exploring the effectiveness of local content requirements in promoting solar PV manufacturing in India, Deutsches Institut für Entwicklungspolitik (German Development Institute), 2013.

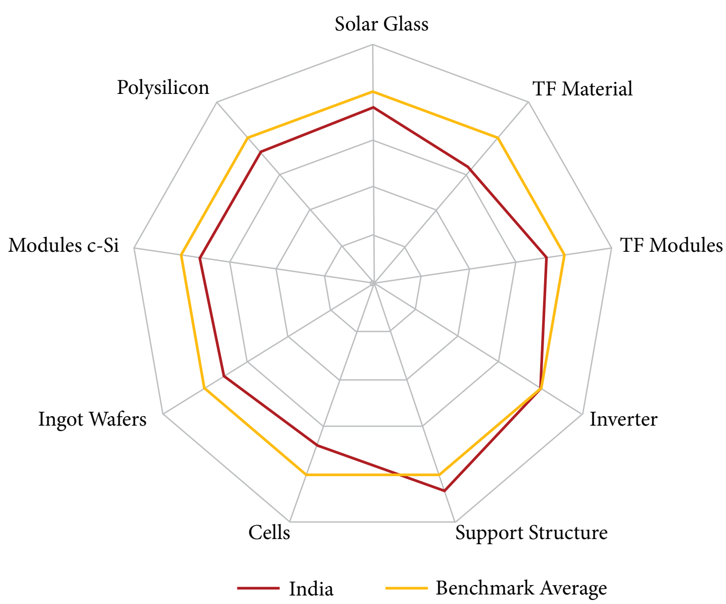
India's existing solar PV manufacturing capacity is, however, limited and does not straddle the high-end technology upstream segments of the industry, such as polysilicon, wafers and ingots. While there is no polysilicon manufacturing capability in India, technically around 15 MW of ingot and wafer manufacturing capacity exists, although this is a pilot unit which is not commercial in nature.[16] The Indian solar manufacturing segment is, thus, primarily represented by solar cell and module manufacturers, which are tail-end and lower value addition segments.

Figure 13 highlights the attractiveness of the Indian solar PV industries vis-à-vis international benchmarks.[17]

Indian solar PV manufacturing, restricted primarily to the lower value-added segments—namely cells and modules—of the c-Si value chain, has historically catered to exports. With Chinese and Taiwanese manufacturers cornering market share in c-Si solar PV globally through integrated operations and GW scale installations, Indian exports have declined significantly. Indian manufacturers have struggled to be price-competitive in the current environment, mainly due to high input costs of technology, power, and raw materials.

The PV manufacturing industry in India has also not been able to integrate backwards in the areas of wafer and polysilicon manufacturing, thus being substantially dependent on imports for raw materials and consumables. This has resulted in a significantly high cost at cell and module level for Indian manufacturers as compared to competition from Chinese and other Asian countries, as indicated in Figure 14.

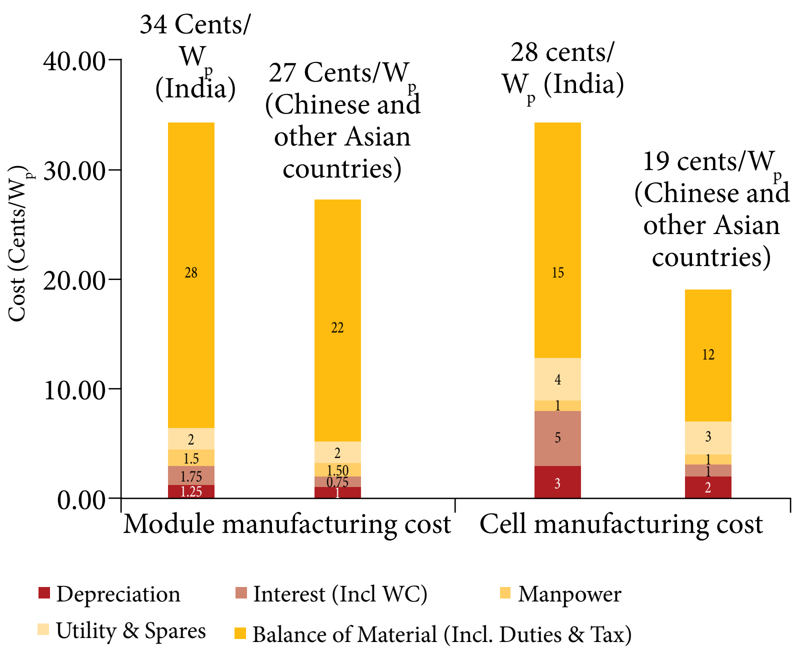
Figure 13:
Attractiveness of Solar PV Component Industries in India vis-à-vis International Benchmarks



Source: The World Bank report - Competitiveness Assessment of MENA countries to Develop a Local Solar Industry.

[16] This was a testing unit which was made available purely for R&D purposes to an Indian solar facility.
[17] Benchmark based on average for eight countries: Chile, China, Germany, India, Japan, South Africa, Spain and the USA.

Figure 14:
Cost Comparison—Cell and Module (India, China and other Asian Countries)



Source: Securing the Supply Chain for Solar in India by FICCI Subgroup on Securing Solar Supply Chain (2013). W_p: Watt peak.

The development of an appropriate solar manufacturing ecosystem is the key to enhancing the competitiveness of Indian solar PV manufacturing. However, several solar PV manufacturers in India currently face issues related to lack of raw materials, nonavailability of low-cost financing, and an underdeveloped supply chain leading to high inventory costs. Lack of capital also impacts adoption of new technologies and ability to innovate to achieve higher efficiencies and competitive costs.

The status of Indian solar PV manufacturing and its declining exports have been summarized in Annex 10.

2.5.2 Solar Thermal

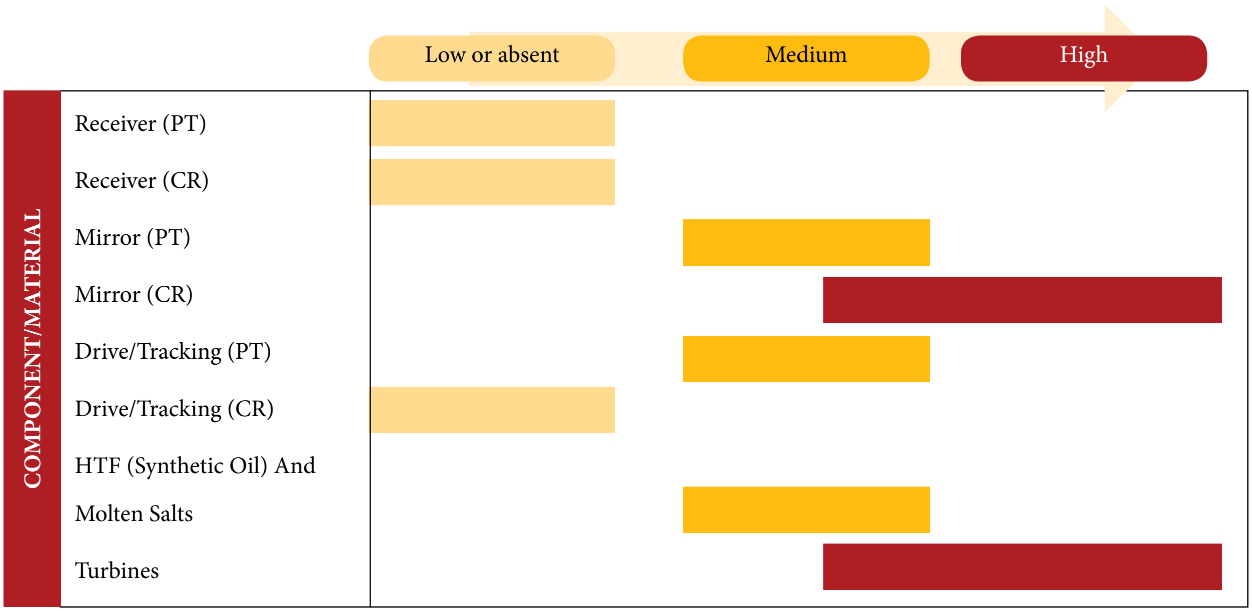
Local manufacturing in solar thermal is complex as technology suppliers are limited and their products patented. Despite the presence of large power sector manufacturing capacity within the country as well as availability of a skilled labor force, India has not been able to manufacture or produce some of the critical components for solar thermal projects such as receiver tubes and mirrors. In some cases, such as in the manufacture of reflecting surfaces, the lack of natural resources (low-iron sand, in this case) poses an impediment to indigenization. In other cases, such as in the manufacture of vacuum tubes, the obstacle is the lack of relevant technical know-how that is still proprietary and owned by a select few.

Figures 15 and 16 detail the present local manufacturing capability for CSP in India and attractiveness of CSP component industries vis-à-vis international benchmarks.[18]

It is well acknowledged that solar thermal products and equipment can be potentially manufactured in

[18] Benchmark based on average for eight countries: Chile, China, Germany, India, Japan, South Africa, Spain and the USA

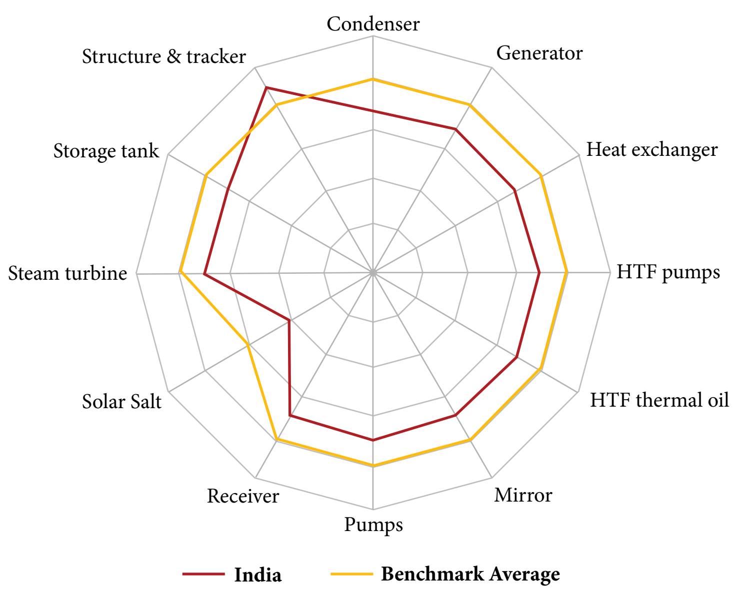
Figure 15:
Present Local CSP Manufacturing Capability in India



PT: Parabolic Trough, CR: Central Receiver

Source: The World Bank Report - Development of Local Supply Chain: A Critical Link for Concentrated Solar Power in India.

Figure 16:
Attractiveness of CSP Component Industries in India vis-à-vis International Benchmarks



Source: The World Bank report - Competitiveness Assessment of MENA Countries to Develop a Local Solar Industry.

synergy with other industries such as automotive, glass, metal, chemicals, power equipment, process heat, and construction. Given the presence of well-developed local players across most of these industries in India, the potential for indigenization and cost reduction in solar thermal technologies is very high —provided standardization in configurations, scale, and commercialization are accelerated, prompting investments along the value chain. It, however, requires a coordinated ecosystem development, with adequate technology partnerships to move existing industries to commit to such manufacturing.

The importance of developing a local competitive solar industry cannot be understated. It brings us to the important policy debate on the best set of actions to make Indian solar manufacturing truly global in character. To fully address the objective of making India a leader in solar manufacturing, GoI will need to critically evaluate current domestic strengths in solar manufacturing; international market situation and competitiveness; and availability of domestic funds. This subject is examined further in the next chapter.

2.6 Adequacy of the Current Approach to Developing Solar Thermal Projects

The framework for award of projects in Phase I of JNNSM, similar to that used for solar PV, was the reverse auction, through which seven projects totaling 470 MW were awarded under Batch 1.

Unlike solar PV, which has a range of fully commercial technologies with substantial scale of deployment (over 100 GW installed capacity) as well as manufacturing capacity, solar thermal or CSP with only 2.2 GW of installations globally is far from commercially applicable.

While solar PV bidders under JNNSM benefitted from a rapid post-bid decline in module and cell prices, solar thermal has not experienced any significant price reductions. Solar thermal technologies continue to suffer from immature manufacturing value chains and have not been able to achieve sufficient scale to drive down costs. The solar thermal industry is made up of oligopolies led by technology developers who also own significant portions of the supply chain. Most technology developers have created their unique, patented products and segments of the value chain with alternative uses,[19] and experience periodic capacity gaps and volatility in prices. The status and key action points for Indian solar thermal manufacturing have been summarized in Annex 11.

Solar thermal capacity additions the world over have also been developed with substantial public financing, as appreciation and experience of commercial financiers of such technologies is mostly nonexistent (refer Annex 12).

Solar thermal projects require a range of preparatory activities including clearances and consent as well as on-field Direct Normal Irradiance (DNI) measurement. Given the infancy of the solar market, the absence of on-field radiation data and a lack of familiarity amongst financial institutions when the projects were bid in 2010, JNNSM's schedule of 28 months for commercial operation date (COD) was ambitious. This is particularly so without a public funding roadmap under Phase I, which seems to be the norm globally for solar thermal projects. It is not surprising, therefore, to note that all solar thermal projects bid under JNNSM are running behind schedule.

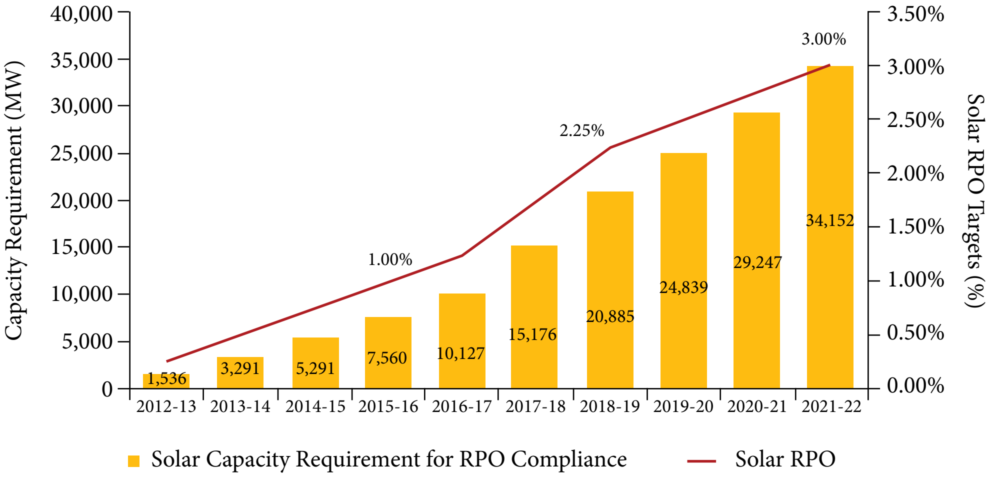
In the above context, and given the initial phase of development of solar thermal technologies in India, it is worth examining whether the existing framework for awarding projects is adequate or a different disposition is required.

2.7 Enforceability of RPOs and Concerns around Solar RECs

RPOs are the cornerstone of renewable energy capacity development in India, as envisaged under

[19] For example, heat transfer fluids were globally in short supply in 2012 resulting in a spurt in their prices.

Figure 17:
Solar RPO and Capacity Addition



Source: SECI Presentation: Achievements of JNNSM Phase I and Vision for Phase II (2013).

the Electricity Act, 2003 and the National Electricity Policy. They provide the necessary demand-pull by mandating distribution utilities and obligated entities to mandatorily procure a proportion of their power requirements from renewable sources, including a specific percentage from solar energy. MNRE estimates solar capacity addition requirement to be 34 GW to achieve the 3 percent solar RPO targeted by 2022 under the National Tariff Policy.

RPOs are enforced by the State Electricity Regulatory Commissions which have, so far, been lenient in imposing penalties in the event of noncompliance to RPO, although most have specific provisions in regulations for imposing such penalties.

The pricing of solar RECs remains a cause for concern in the medium to long term, given the uncertainty attached to the downward cost trends in the solar sector and the market-based pricing of RECs. Under the current REC framework, forbearance and base price range has been set only up to 2017, and there is likelihood of solar REC prices coming down drastically by the end of the current control period, that is, FY 2017. This is the key issue facing investment or financing of solar projects through the REC route, given the uncertainty of cash flows beyond 2017 and the likelihood of decreasing revenues beyond 2017, with the gap between average power procurement cost of utilities and solar tariffs narrowing with time. As a consequence, the installed capacity for the solar REC market remains negligible and due to demand-supply mismatch, the solar RECs have been trading close to the forbearance price of INR 13,400 per REC (US$223.33 per REC).

These issues have been highlighted by several stakeholders time and again, and our discussions with the government and regulators indicate that certain concerted measures are being formulated to address them. These include changes being contemplated in the framework of RECs by CERC for the period beyond 2017, and a recent petition before the Appellate Tribunal for Electricity seeking stricter enforcement of RPOs.


Fortum

3. JNNSM Phase II and Beyond: Essential Policy and Design Choices

3.1 Efficacy of Public Funding: Buying Down Tariffs vis-à-vis Addressing Structural Impediments to Financing

Investments worth approximately INR 100[20] billion (refer Annex 13) were deployed for Phase I of JNNSM and Phase II would require approximately INR 700 billion (US$11.67 billion). These requirements are likely to increase as the program is expected to expand exponentially over the subsequent phases. As public funding is limited, large amounts of private investments need to be mobilized to meet the mission targets; the private-led model adopted under JNNSM is thus appropriate and efficient.

Given the evolutionary nature of a range of solar PV and CSP technologies and comparatively higher tariffs, public funding in one form or the other has been found to be essential to leverage private investments (refer Annex 14 for key incentive/ instruments for solar power in India).

[20] INR 100 billion is approximately US$1.67 billion.

For public funding to support the solar program, a choice of the following fundamental options is available:

- Financing incremental costs of solar power, thus effectively "buying-down" the cost of solar generation. This is a direct, project-level involvement of the government, financed through instruments such as capital subsidy, Generation-Based Incentive (GBI) or VGF, and so on; or
- Addressing or covering risks, which are impediments to optimal financing of solar projects. This could be achieved through structured public debt, risk funds and guarantees to address specific barriers/risks perceived by the lending community.

3.1.1 "Buying down" Tariffs or Direct Funding of Solar Projects

In Phase I of JNNSM, GoI structured a bundling scheme through which 1,000 MW of coal-based thermal power from NTPC (from the unallocated quota, assignable at the government's discretion) was bundled with 1,000 MW of grid-connected solar projects and sold as "bundled" power to distribution utilities. This measure achieved two objectives: it brought down the cost of bundled power to around INR 5 per kWh (US$0.09 per kWh) and avoided any direct funding support from GoI for Phase I of the program. The program also benefitted immensely from the involvement of NVVN, the trading subsidiary of NTPC, which provided program management support for Phase I and was the counterparty to PPAs signed with all solar developers, on the one hand, and to Power Sale Agreements (PSAs) signed with all distribution utilities, on the other.

With very limited[21] unallocated power left for such bundling over subsequent phases, GoI is keen to substitute it with some form of direct funding to make solar power affordable for distribution utilities.

Before dwelling on the efficacy of instruments that are being discussed in this regard, it is important to highlight the policy and regulatory framework that exists in the power sector today for renewable energy. It is apparent that the basic policy and regulatory framework for promoting demand for renewables is focused on the RPO to be enforced upon distribution utilities with tariffs either preferentially set by the State Commission or competitively determined (refer Annex 15).

Given the potential of solar power in India and its importance in the long-term energy security of the country, there is a desire to fast track development without burdening the Discoms or end-consumers substantively. While this is an understandable goal, analysis indicates that the burden on end-consumers is negligible, since the targeted RPO under the National Tariff Policy is as low as 3 percent by 2022.

To achieve the 3 percent solar RPO targeted by 2022 under the National Tariff Policy, MNRE estimates the solar capacity addition requirement to be 34 GW.[22] Even if solar power were to achieve the 3 percent RPO target today, it would effectively translate to an average impact of not more than 15 paisa[23]/kWh in retail tariffs. This estimate is on the higher side as any such impact will narrow and possibly be bridged with the decline in solar tariffs over the period up to 2022, and a corresponding increase in the average cost of power procurement for distribution utilities, which is substantially dependent on fossil-fuel based sources.

Against this backdrop, "buying down" the cost of solar power through direct public funding translates into two outcomes. It leads to the government cofinancing a large set of projects under subsequent phases of JNNSM and to a lower cost of electricity from solar projects for distribution utilities and end-consumers, which reduces the risk of defaults.

The first outcome—unless it justifies significant externalities such as acceleration in deploying solar power with the attendant economic and strategic benefits envisaged under JNNSM, or addresses certain specific impediments that are hindering growth in the current environment—ends up simply as unintended (and not so useful) subsidies for the end consumers. Mandatory RPOs create the basic demand for solar power as they mandate distribution utilities to procure solar power, irrespective of the cost reductions that GoI is attempting to achieve. Thus, cost reduction cannot be argued to accelerate demand for solar power until the RPO targets are met. Since such direct public funding is intended (MNRE, 2012) only for

[21] The Phase II Draft Policy document for JNNSM estimates only1,650 MW of unallocated capacity for Phase II of the program.
[22] SECI Presentation: Achievements of JNNSM Phase I and Vision for Phase II (2013).
[23] Computed at an average power procurement cost of INR 3.50 per kWh and an average solar tariff of INR 7.00 per kWh with an assumed average distribution loss of 35 percent. The impact of 0.25 percent minimum solar RPO is thus less than 2 paisa per kWh.

projects selling power to distribution utilities, it also has a limited effect on demand from other segments for solar power.

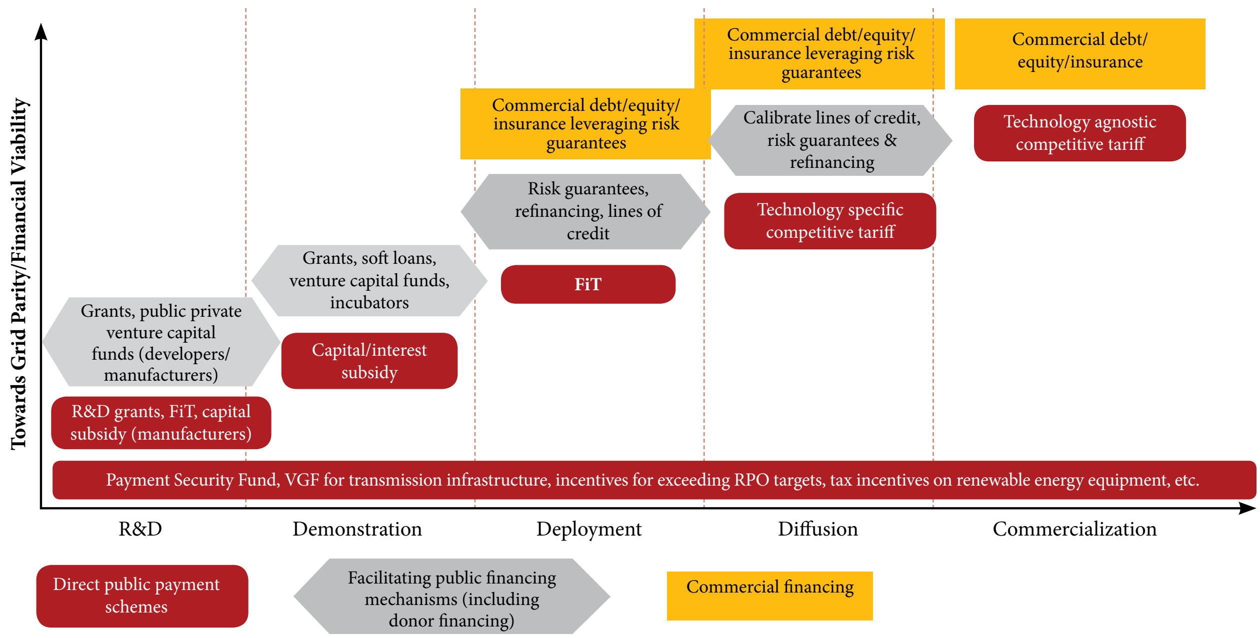
On the other hand, lower cost of solar power does tend to address certain risk perceptions. First, it ensures lower exposure of financiers to projects, assuming that public funding is utilized on a first charge to repay lenders. Second, it reduces the risk of defaults as cash-strapped distribution utilities are more likely to default to costlier producers of power. Third, lower priced solar power is likely to find third party buyers and is an additional security for investors and lenders. For the scale of the program envisaged, it is unlikely that GoI's intention is to swap part of the market debt with subsidy on commercial projects. On reducing risk of defaults and improving marketability of solar power, although apparently attractive to investors and lenders, direct subventions can be argued to be less efficient than risk-reducing tools in this regard. This is further addressed in the following section where the role of facilitating public funding in addressing structural financing impediments is analyzed.

Table 5 debates the pros and cons for each of the direct support instruments, which attempt to buy-down the cost of electricity. The options being considered here are those that have been proposed under the draft policy document for Phase II of JNNSM.

The choice of the public funding instrument should be viewed in the context of the life-cycle of solar development in the country, in particular, the distance the technology has to travel to be purely commercial in nature and to achieve grid parity, as this determines the extent of public funding support required over the entire program cycle.

Figure 18 indicates such a roadmap and outlines the role of public funding in this developmental life-cycle of a technology.

Figure 18:
Role of Public Funding in Developmental Life-cycle of Technology



Source: : Authors' research.

Table 5:
Direct Support Instruments

Public Funding Instrument	Pros	Cons
Capital subsidy	• One-time and easy to disburse for the government. • Investors and financiers find it attractive as it limits exposure of lenders and lowers tariff of projects – reduces risk of defaults and opens up option for third-party sale in case of defaults. • Projects, once funded, are no longer dependent on government budget in the future.	• Not linked to output and hence does not create a positive bias for performance. Not appropriate for commercial technologies. • Risk of compromises in Operation and Maintenance (O&M) and asset replacements. • Seen as going back in time, as the focus in other renewable segments (e.g., wind) has moved from capital-based incentives (accelerated depreciation) to GBIs.
Generation-based incentive	• Output linked; creates a bias for performance. • Incentivizes not only developers but also more efficient equipment suppliers.	• Outflow from GoI likely to be cumulatively higher than in the capital subsidy mode because of impact of taxes and time value considerations. • Dependent over a substantive period on government funding.
VGF in tranches up to one year post commissioning	• Front loaded public funding makes it easy to administer and disburse. • As in the case of capital subsidy, investors and financiers find it attractive as it limits exposure of lenders and lowers tariff of projects – reduces risk of defaults and opens up option for third-party sale in case of defaults.	• Not linked to output and hence does not create a positive bias for performance. • Risk of compromises in O&M and asset replacements. • VGF scheme in infrastructure was designed for economically necessary projects, which were not commercially affordable. Solar has already established itself in India to be commercially viable and tariffs reasonably acceptable

Source: Authors' research

Capital subsidy, interest subventions, and so on, make sense early in the life-cycle of a technology where the program's scale and viability are not completely established. Once the viability is established, market mechanisms should take over with public funding then switching to a role of facilitating access to private finance by addressing residual risks and barriers. This is the most economical basis for promoting market development of a renewable technology. Governments will also need to guard against excessive continuance of public funding in the commercial phase, as it tends to crowd out commercial sources of financing. Similarly, lack of public funding in the early stages of development of a technology can simply impede its deployment and diffusion, irrespective of the long-term economic benefits.

It is also important to realistically estimate the likely time a technology would take to achieve grid parity before designing direct public payment schemes, such as capital subsidy or VGF, as it can otherwise result in an open exposure of the government to technology-related risks, which should ideally be borne by the market functionaries.

3.1.2 Addressing Structural Impediments to Financing

It is now acknowledged that Phase I of the mission missed a roadmap for financing of solar projects, barring the provision of a payment security fund set up against payment defaults.

Given the capital-intensive nature of solar projects, improving access to commercial financing sources, and identifying and addressing structural impediments to such financing are imperatives for achieving the scale envisaged under subsequent phases of the program. At the very least, factors which enable nonrecourse financing have to be encouraged, without which private players will find it difficult to take on a large number of projects. The introduction of adequate risk-mitigating instruments can also lead to a reduction in tariffs by lowering the cost of financing.

In the course of the study, SCBs highlighted the following specific risks as barriers to financing solar projects:

- Risk of untried technologies in Indian conditions and lack of familiarity with such technologies amongst lenders;
- Risk of payment defaults on account of comparatively higher tariffs of solar power. This is exacerbated in the form of concentration of solar projects in a few states, most with distribution utilities in poor financial health;
- Instances of aggressive bidding by project developers, which render projects unviable without access to concessional sources of financing; and
- Risks in the development cycle including delays in obtaining clearances and consents and/or lack of interconnection facilities, and so on.

Solar projects with smaller ticket sizes are being considered part of the power sector for evaluating sector exposure limits. However, such projects are rarely financed by SCBs that prefer lending to conventional projects over several smaller solar projects. These concerns have reflected in the average cost of commercial finance for solar projects being available at 150-300 basis points more than average cost of financing conventional projects.

Besides risk perceptions, renewable energy projects in India suffer from the lack of sufficient long-tenor finance, which could have potentially reduced tariffs.

Access to commercial finance and its pricing can be improved if risk-reducing instruments are evaluated and implemented with adequate public funding to back such measures. Introducing innovations in financing mechanisms through an appropriate public financing source could also contribute towards addressing this structural inadequacy in financing solar projects. A range of initiatives can be proposed to address the structural bottlenecks and risks outlined above. These measures can collectively be called as “facilitating public funding” mechanisms and can include:

- Credit guarantee/enhancement schemes;
- Risk guarantee schemes;
- Subordinated public finance to prolong tenor of debt financing; and
- Interest subvention or government-intermediated concessional lines of credit for financial institutions.

Table 6 debates the pros and cons of each of these instruments.

Table 6:
Facilitating Public Funding Mechanisms

Public Funding Instrument	Pros	Cons
Credit guarantee/ enhancement scheme	• In the nature of a guarantee and hence more efficient than direct payment tools (e.g., FiTs, GBI, VGF, etc.), as they can leverage bank financing by using little or no public subsidies. • Credit enhancements can potentially improve the credit rating of debt instruments to be issued by borrowers, thus reducing the cost of financing. • Credit guarantees can lead to nonrecourse financing structures.	• Risk of free-riding and moral hazard, as commercial debt can effectively ride on the back of public guarantees. This can, however, be suitably minimized by structures such as partial guarantees, etc. • Can be an opening for transferring commercial risks to the government. This can again be minimized by specifying risk-related exclusions, e.g., on account of technology failures, which should ideally be borne by the developer (through a guarantee from the supplier).
Risk guarantee/ enhancement scheme	• Addresses specific risks such as payment defaults by distribution utilities and, thus, enhances bankability of projects. Alternatively, enhances the credit rating of the borrower through partial credit guarantees. • More efficient than direct payment tools (e.g., FiTs, GBI, VGF, etc.), as they can improve bankability by using little or no public subsidies. • Can be tailor-made for different phases of technology maturity.	• Transfers commercial risk to the government. Should ideally be linked back comprehensively to all forms of government support to distribution utilities to protect government against free-riding by distribution utilities.
Subordinated public finance to prolong tenor of debt financing	• More efficient than direct payment schemes as well as guarantees, as credit is recoverable. • Has significant impact on reducing the cost of borrowings and addresses the asset liability management-related issues of commercial banks. • Government benefits from the due diligence of commercial banks, which are the senior lenders to the project.	• Selective attempt to resolve a problem currently faced by all infrastructure projects in the country. • Requires substantially larger financial commitment from the government than guarantees (as it is in the nature of co financing projects with the private sector) to be effective. Can be raised from bi/multilateral development banks.
Interest subvention or government intermediated concessional lines of credit for financial institutions	• Directly reduces the cost of financing. • Dedicated lines of credit for solar projects can prompt commercial banks to lend to solar projects with a positive externality in building capacity of such institutions in appraising solar projects.	• Effectively a subsidy scheme attempting to "buy-down" the cost of solar generation. • Concessional finance is limited and unless leveraged properly, has the effect of simply crowding out commercial finance. There may also be the propensity of banks to stop lending when such lines of credit are exhausted.

Source: Authors' research.

3.1.3 Comparative Assessment

For GoI, it will be essential to analyze the extent of financial commitment that would be required for each of the above financial instruments (direct public funding and facilitating public funding) to be utilized over Phase II of the program.

A simple analytical framework was developed to assess the extent of budgetary support required for each instrument/mechanism operating in isolation. The assumptions underlying the analysis and its outcomes are presented in Table 7.

Not surprisingly, the options under direct public funding have the highest impact on budgetary support, while those under facilitating public funding have lower budgetary requirements (and are contingent in nature) while offering substantial leverage. It is essential, however, to appreciate that facilitating public finance or risk-reducing mechanisms play only a limited role in reducing costs/tariffs and their true potential lies in addressing specific long-term risks/barriers that the industry faces, thus paving the way for a market-driven and sustainable cost reduction over time.

Table 7:
Analytical Framework for Analyzing Financial Instruments/Mechanism

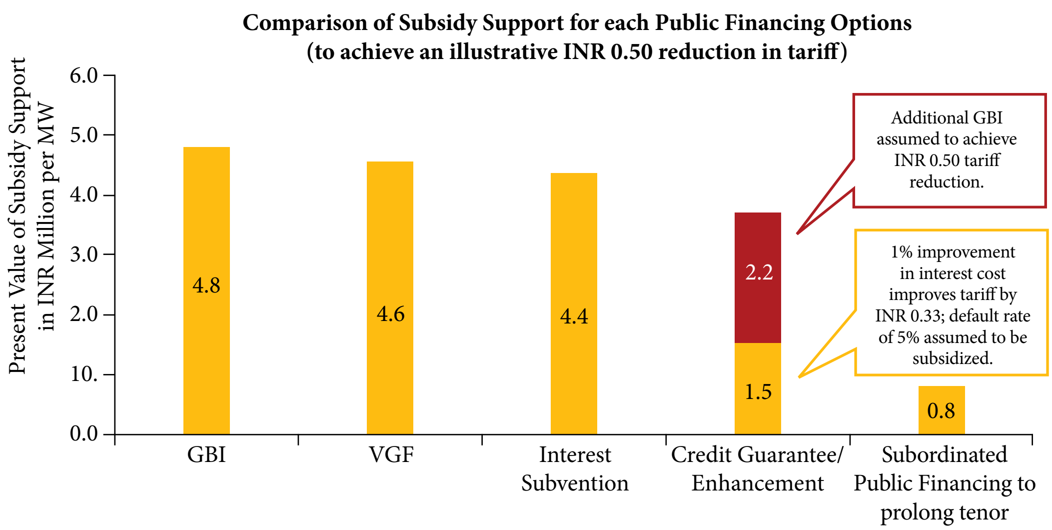
Funding Instrument/ Mechanism	Capital Subsidy/VGF	GBI	Interest Subvention	Subordinated Public Finance to Prolong Tenor	Credit Guarantee/ Enhancement
Extent of budgetary support on a per MW basis for achieving a 0.50 paisa reduction in tariff	INR 4.6 million (~US$76,700)	INR 4.8 million (~ US$80,000)	INR 4.4 million (~ US$73,333)	INR 0.8 million (US$13,333)[#] [#] *Based on the assumption of 5% NPA*	INR 3.7 million (US$61,667)[##] [##] *Consists of two components; 5% of NPA and additional GBI*
Key additional benefits	• Direct impact on tariff • Reduces capital exposure of lenders	Emphasis on performance	Draws commercial banks into lending	• In the nature of debt funds • Shall depend on the extent of commercial financing • Can be raised from multilateral development banks as sovereign loans • Not in the nature of a subsidy • Refundable capital support	• Contingent exposure • Can be raised from multilateral development banks as loans • Can leverage investments with zero or limited public funding
Key criticism	Not appropriate for commercial technologies: low emphasis on actual performance	Extends government support over the life-cycle of the project	• Concessional finance is limited • Effectively translates into subsidy	Attempts to solve a larger financing issue encountered on all infrastructure projects	Propensity for free-riding and moral hazard by financiers/ Discoms

Source: Authors' research.

Figure 19 shows the comparison of subsidy support required for the various public financing options.

Clearly, segments of JNNSM which are guided by considerations of affordability, such as off-grid

Figure 19:
Comparison of Subsidy Support for Public Financing Options



Source: Authors' analysis and assumptions based on authors' primary research.

Key Assumptions for Analysis:

- Capital cost at INR 75 million per MW (~ US$1.25 million per MW)
- Capacity utilization factor: 17% with annual degradation of 0.25%
- Debt considered at 70% of the overall project cost
- Interest on long-term loan at 11.50% with a tenor of 10 years and moratorium of 2 years
- All subsidy computations are in present value terms
- Subsidy in case of credit guarantee/enhancement and subordinated public financing options is assumed to finance 5% contingent defaults/NPAs
- Subordinated public financing results in prolonging the tenor to 18 years with moratorium of 2 years to achieve 50 paisa reduction in tariff
- All scenarios are computed to achieve identical internal rate of return for equity holders
- VGF has been considered as prescribed under the revised guidelines. However, the quantum of VGF has been considered just adequate to bring down the tariff scenario within comparable limits
- VGF, however, if considered as per the prescribed framework in the revised documents is capable of bringing down the tariff by INR 1.46 per kwh

Another scenario has been considered within the same framework of capital cost to analyze the quantum of support required to bring down the tariff to INR 5.45 per kwh. In this framework of analysis, it is observed that if a support of INR 33.3 million (US$0.56 million) per MW is considered, tariff can be brought down to INR 5.45 per kWh. In this analysis, the envisaged support of INR 33.3 million (US$0.56 million) is spread over a period of 6 years as envisaged under the revised framework.

applications, rooftop solar and demonstration CSP projects, will require some form of direct public funding support. The efficacy of direct funding support for promoting the bulk of the commercial program under solar PV needs, however, to be carefully evaluated by the government vis-à-vis other forms of public funding. Transparent disbursements through bidding, and penalties for not achieving defined performance parameters can be adopted to enhance the effectiveness of direct funding support. The extent of funding and mix of instruments/mechanisms will also fundamentally be determined by the availability of funds from sources such as NCEF.

Facilitating public financing schemes takes time in designing and monitoring, and the actual outcome is determined by the efficiencies of financial intermediaries. Nevertheless, they are fundamental in addressing key financial impediments and in moving solar development to a largely nonrecourse financing mode in India, critical to the scale of development under subsequent phases of JNNSM

3.2 Promoting Local Manufacturing: Exploring Customized Industrial Policy Actions

JNNSM outlines an ambition to transform India into a solar energy hub including establishing a "leadership role in low-cost, high-quality solar manufacturing, including balance of system components". Further, the country also desires human resource development and enhancement of Research and Development (R&D) capabilities in the solar energy space.

The desire to be relevant across the manufacturing value chain in both solar PV and solar thermal technologies is based on the following considerations:

- The large and predictable local solar generation capacity addition, envisaged under JNNSM, offers a significant captive market that can be leveraged to develop a local manufacturing base, thus contributing to manufacturing output and employment generation in the country; and
- A competitive local manufacturing industry is critical in the technology-intensive solar industry, as it enhances long-term energy security and creates an ecosystem for local innovation and adaptation.

Recognizing these aspects, the National Manufacturing Policy of 2011 (Department of Industrial Policy and Promotion (DIPP) 2011), identifies solar energy as amongst the industries of strategic importance where national capabilities are envisaged to be developed to make the country a major force.

To promote local manufacturing, Phase I of JNNSM specified DCRs in solar projects. These stipulations, however, were applicable only under JNNSM. Larger solar power generation capacities have been added under state solar policies which do not specify DCRs, and this is likely to be the case over JNNSM Phase II.

The unintended outcome of domestic content stipulations for solar PV projects in JNNSM has already been discussed in the earlier chapter. The form and continuance of domestic content over Phase II of JNNSM has since been keenly debated and evokes strong and contrary reactions from sections aligned on both sides of the debate. It is important, in this scenario, to view the role of DCR in the overall context of promoting local manufacturing in the country.

It is necessary that the industrial policy aspects are well considered in the current debate on the solar power being centric to the energy security policy in India. DCR thus addresses only one narrow segment of demand-side actions, which in itself may not be sufficient to make local manufacturing self-sustainable and address its competitiveness in the long term. Obvious industrial policy actions are supply and demand measures, as would happen for solar industry anywhere worldwide.

Box 1 indicates the range of demand- and supply-side actions that could be employed by the government in promoting local manufacturing.

Demand-side policy measures focus on providing captive demand and do not address competitiveness vis-à-vis global suppliers. Promoting local manufacturing would require coordinated actions on the supply side, which are fundamental and address the root of factors impacting long-range competitiveness of the manufacturing industry.

Demand-side policy measures such as price preference or DCR combined with price support mechanisms or subsidy from the government are also likely to be construed as "specific"[24] to the domestic industry and discriminating against imports, running the risk of challenges under the World Trade Organization (WTO). Tariff barriers on imports, on the other hand, may not be acceptable to state governments, whose policies do not distinguish between domestically manufactured products and imports.

In the above context, GoI will need to debate the form of policy actions it wishes to undertake to promote local manufacturing. Figure 20 highlights a broad framework to design specific industrial policy actions.

Box 1 :
Policy Actions for Promotion of Local Manufacturing

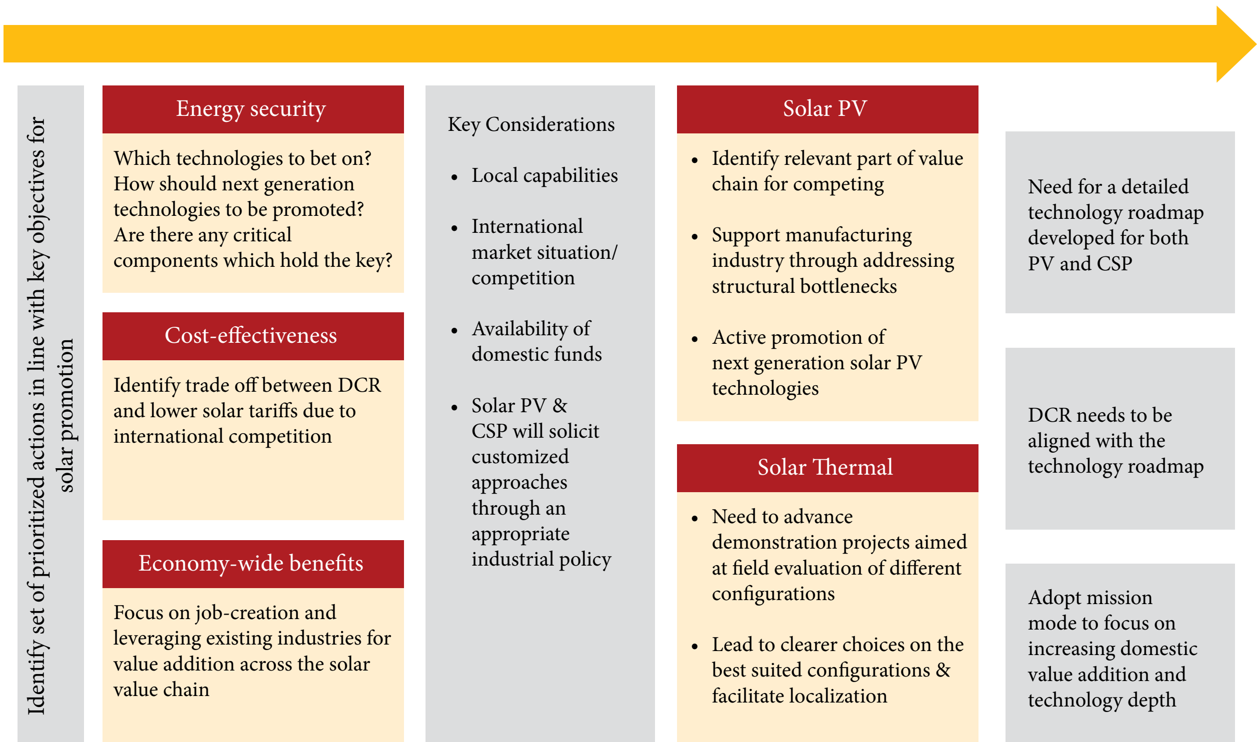
Possible Policy Actions

Demand Side
- Price preference/incentives for locally procured equipment
- DCR
- Mandatory local manufacturing facilities for a larger pipeline of "public projects"
- Tariff barriers for imports

Supply Side
- Rationalization and simplification of business regulations for manufacturing
- Financial/fiscal incentives for manufacturers
- Addressing backward linkages and input costs
- Clustering and aggregation through National Investment and Manufacturing Zones\and Special Economic Zones
- Export financial assistance and guarantees

[24] Agreement on Subsidies and Countervailing Measures under WTO defines "specificity" of subsidies, which are prohibited under the Agreement.

Figure 20:
Framework to Design Industrial Policy Actions



Source: Authors' research.

The design of an industrial policy action in this regard needs to consider the overall objectives of ensuring long-term energy security, assuring cost effectiveness, and realizing economy-wide benefits (for example, job creation, sustainable growth, and so on). Each of these objectives will need to be evaluated to arrive at a set of prioritized actions, as outlined in the example below.

- **Objective of energy security:** Active promotion of next generation solar PV technologies through R&D, international technology collaborations and incentives; roadmap for localization in the CSP value chain;
- **Objective of cost effectiveness:** Phased DCR to benefit from lower global prices while ensuring domestic uptake in manufacturing; focus on input-side factors to make domestic industry more competitive; and
- **Objective of deriving economy-wide benefits:** Focus on job creation and leveraging existing industries for value addition across the solar value chain. (For example, the Indian solar PV manufacturing industry provides jobs to more than 25,000 employees with a total installed capacity of 1,100 MW of cells and 1,800 MW of modules.[25] In case of solar thermal, for an installed capacity of 10,000 MW by 2022, the total manpower requirement is expected to be 96,000 and 44 percent of this would be linked with local manufacturing[26].)

[25] *Source:* FICCI Solar Energy Task Force Report on Securing the Supply Chain for Solar in India.
[26] World Bank Report - Development of Local Supply Chain: The Missing Link for Concentrated Solar Power Projects in India.

In this context, the country faces policy design choices in a framework of cognizance of local capabilities, international market situation, and availability of domestic funds. With solar PV and CSP requiring different manufacturing capabilities and investments, both technologies will require customized approaches from the government through an appropriate industrial policy. One of the key requirements shall be the drawing up of clear technology scenarios for solar (PV and CSP) generation and application to enable a manufacturing roadmap to be finalized for India.

Solar PV manufacturing needs to be seen from the perspective of current global market dynamics as well as the potential it holds in the future for India. The solar PV manufacturing segment has witnessed significant developments in the last few years, with a number of manufacturers announcing bankruptcies. There is also the emergence of technology advancements in the manufacturing procedures as well as use of materials for solar PV cells, including commercialization of measures such as single stage purification of silicon, vapor deposition, and so on, which are likely to lead the wave of next generation of technologies in manufacturing. In India too, MNRE and select public sector undertakings involved in PV manufacturing have been actively looking at the next generation of technologies, which are likely to lead the market. It is opportune time to create a detailed technology roadmap for both PV and CSP, which can lead to a more informed policy on manufacturing with an appropriate focus on next generation of technologies through R&D and appropriate international collaborations.

For a clearer technology roadmap to evolve in solar thermal, there is a need to advance the demonstration projects aimed at field evaluation of different configurations for obtaining feedback on performance, operability and costs of different technology streams. This will hopefully lead to clearer choices on the best suited configurations for the country, essential for local manufacturing and services to take root in India. Aspects related to the development approach for solar thermal are discussed further in the next section.

DCR needs to be aligned with the technology roadmap and prioritized segments of the value chain (separately for solar PV and CSP) in a comprehensive industrial policy action. This should be promoted in parallel with supply-side measures to achieve the goals. A detailed assessment of the impediments faced by the domestic manufacturing industry and a plan to localize manufacturing of critical components are essential to structure supply-side policy measures.

GoI started with DCR (a demand-side measure) as a policy action to promote manufacturing. A phased approach (which reduces year on year) to DCR is essential to ensure that the domestic industry moves up the competitiveness curve and is globally competitive over a period. In the absence of a roadmap for the promotion of preferred technologies, the DCR should be applicable to the entire value chain (thereby giving the choice of least-cost technology path to the investors).

Without a mission mode focus on increasing domestic value addition and technology depth, Indian manufacturing in solar is unlikely to progress far. A Task Force, with representation from other concerned government departments (for example, DIPP) and other relevant organizations (for example, the National Manufacturing Competitiveness Council (NMCC) and Planning Commission) should be set up to identify specific and coordinated industrial policy actions required by GoI to enhance the competitiveness of solar manufacturing in India. An example of such a mission mode approach can be seen in the automobile sector, with the Department of Heavy Industries and Public Enterprises, GoI, formulating the Automotive Mission Plan 2006-16 in 2006.

3.3 Solar Thermal: Public Private Partnerships (PPPs) vis-à-vis Private-led Development

Phase I of JNNSM adopted a reverse auction approach to project selection and development, which is akin to the Case 1 route followed in the power sector in India, to procure power from conventional power plants or through competitive bidding from renewable sources (refer Annex 16). This approach leaves all activities from project identification, choice of technology, design, development, commissioning and operation in the hands of the developer and focuses on the output, selecting developers based purely on the tariffs they quote.

A solar thermal developer is thus tasked with identifying suitable land, measuring on-site solar radiation, obtaining clearances and consents, arranging water linkage, and so on, before thinking of design, engineering and construction of the plant. Even if a developer undertakes all the initial activities to establish the feasibility of a solar thermal plant, there is no guarantee of emerging successful in a competitive environment under the reverse auction framework.

A probabilistic model of procurement such as this is more suited for fully commercial technologies, where upfront costs incurred in establishing feasibility are limited and the knowledge and experience of developers are well established. It is more appropriate where output or capacity addition is the focus, leaving the means to be determined by private players.

Solar thermal projects, on the other hand, use technologies that are varying and in the initial stages of commercialization, with inadequate experience and demonstration in the Indian environment. It is desirable for such project developers to invest more in establishing the techno-commercial feasibility before launching into design and development. A Case1 type of probabilistic model of procurement presupposes that a large number of developers have invested upfront in establishing project feasibility before bidding under a reverse auction, which holds only a probability of success. It leads to a scenario where either a large number of unsuccessful bidders will bear the upfront investment costs without economic gains, or the more undesirable prospect of bidders bidding without adequate preparation, which stands to jeopardize project development and the overall program.

When Phase I of JNNSM was bid out, information and on-field data were unavailable. Further, the reverse auction framework, unlike Case 1 in conventional power, did not require bidders to demonstrate land availability, technical competence, other preliminary activities, and consents and clearances for a project,[27] as a pre-qualification for bidding. It is thus not surprising to find that several of the solar thermal projects are currently encountering technical and site-related challenges, and are delayed.

Solar thermal is a promising technology for India, with its significant indigenization and cost-reduction potential and its technical ability to be hybridized and offer thermal storage. The most appropriate designs and standardizations in solar thermal are yet to be developed with respect to India's requirements and should, therefore, be the focus of early development work. Fundamentally, the understanding of solar thermal amongst financiers is, at best, limited and most such projects are not able to obtain financing without recourse to promoters or suppliers.

[27] Except for water availability, which was required under Clause 3.5D of the Guidelines for Selection of New Grid Connected Solar Power Projects for Phase 1 of JNNSM.

It is, thus, desirable to adopt a more deterministic model of development with larger public sector involvement than that achieved in Phase I of JNNSM. It is crucial for early developments in solar thermal to build in desirable technology features and to demonstrate on-field performance to evolve an acceptable pathway for large scale deployment. Given the significant preliminary efforts involved, it is desirable for the government to share such responsibility and play a facilitating role in tapping financing for such projects.

Stakeholders consulted during the study agree that larger public sector involvement in identifying, scoping and undertaking preliminary activities is essential before inviting participation of private players. This is more akin to the Case 2 mode of technology and site-specific participation by private players adopted for conventional power projects in India.

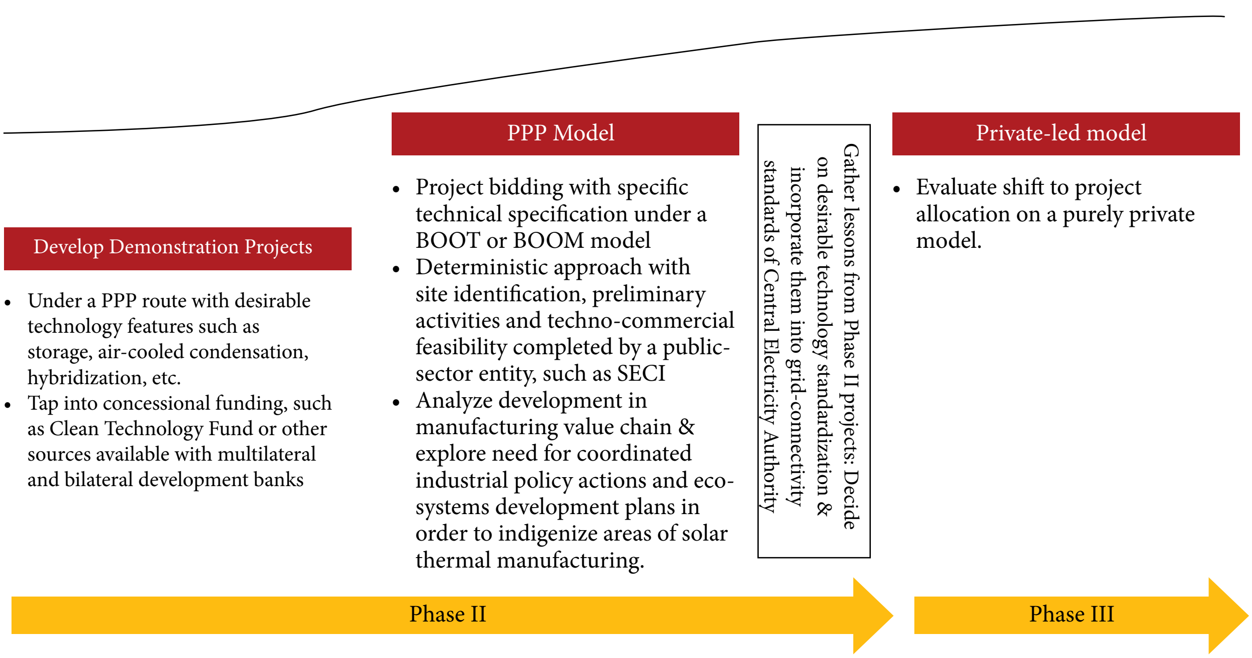
The approach to grid-connected solar thermal plants proposed for subsequent phases of JNNSM is depicted in Figure 21.

3.4 Role of Central Government: Co-development vis-à-vis Central Sector Projects

The draft JNNSM Phase II policy document outlines a differentiated pathway for central and state sector projects, with the policy covering incentives and support mechanisms only for central projects. Only 40 percent of the 9 GW of grid-connected capacity in Phase II is planned to be developed by the central government, with the remaining 5.4 GW to be developed by the states.

In the federal structure in India, it is fair to expect states with solar potential to develop their

Figure 21:
Proposed Solar Thermal Roadmap for Subsequent Phases of JNNSM



Source: Authors' research.

own policies to encourage investments in solar generation. Equally, state governments would welcome investments in the state facilitated by the central government through incentives or otherwise. There is, thus, no apparent conflict between instituting two parallel pathways in developing solar projects in the country, provided however that they are harmonized in some way. Unfortunately, most state governments pursuing solar policies may not have the fiscal space to match the central government with direct public financing mechanisms. In these circumstances, the country will have some 3.6 GW of projects under JNNSM Phase II benefitting from direct public funding schemes, and the remaining 5.4 GW without such an advantage. This will lead to a set of projects with varying tariffs and subsidies which will be consequently perceived quite differently by distribution utilities, financiers and suppliers.

In this regard, it is pertinent to enquire what the desirable role of MNRE should be under JNNSM and whether more harmonized development should be attempted through the central government policy framework.

As discussed earlier in this report, the primary policy/regulatory mechanism for creating the demand pull for grid-connected solar generation is the solar RPO. The route to capacity addition is also acknowledged as private-led. Public support mechanisms thus assume a larger and strategic role of addressing specific barriers and covering key risks in the way of solar development in the country. Viewed in this context, it is questionable whether JNNSM Phase II policies should limit focus only on creation of 3.6 GW of capacity, for which central support is available.

Despite the overwhelming response of the private sector to Phase I of JNNSM and the state solar policies, it is still early days in the life-cycle of solar development in this country. Progress on solar thermal projects is far from satisfactory, commercial nonrecourse financing has mostly eluded the sector, domestic manufacturing has struggled, and bottlenecks in an enabling environment need to be addressed to scale up the program. These are fundamental issues and need a coordinated, pan-Indian response. GoI, thus, has an important facilitating role in all solar projects, irrespective of their mode of development.

Instead of limiting itself to the 3.6 GW of projects under the central scheme, a better role for GoI could be to outline a coordinated vision of solar development for the entire country and to structure public funding to realize this vision. An alternative vision of this development could include the following elements:

- All solar thermal projects to be developed through the Case 2 mode with the provision of facilitating financing schemes from the central government;
- Central government to play an active role in developing solar parks in coordination with state governments and to promote organized development through these parks. This will ease infrastructure-related challenges faced by developers and ensure coordinated transmission planning and deployment of smart-grid related features at the transmission level. Policy to aim for all projects to be developed through such parks;
- Direct public funding[28] can be advanced to the solar parks to reduce the cost of such infrastructure for project developers. A standard, concessional charge for infrastructure could be specified for all solar park-based projects in Phase II; and
- All projects adhering to a robust and sufficiently improved standard PPA and set up in solar

[28] It is worth pointing out that there is a strong economic rationale in advancing direct public financing to solar parks, with positive externalities such as optimization in infrastructure use, including land, water and evacuation facilities, and provision of scale to use smart-grid features in grid integration of solar.

parks should be able to avail of facilitating public finance through central government schemes, such as credit enhancements/guarantees and/or subordinated public debt.

The existing public institutions and their role under the solar program are outlined in Annex 17. Table 8 summarizes the existing institutional roles under Phase I of the program and identifies significant gaps which need to be addressed over subsequent phases of the program.

The mapping (Table 8) shows substantial gaps in institutional capacity in MNRE and its institutions to play the roles expected of them under JNNSM.

The incorporation of the Solar Energy Corporation of India (SECI) is thus a welcome move and could provide the institutional support to undertake several of the roles outlined in Table 8. Strengthening of SECI with appropriate internal resources and external linkages is critical in this regard.

Some of the roles that SECI could play in line with the gaps identified after review of Phase I are:

- Develop CSP (and other semi-commercial technologies) demonstration projects through private and/or technology partnerships;
- Develop solar parks in association with states. Support state governments and SNAs in providing technical advisory and administrative support for solar parks;
- Transition program management, Monitoring and Evaluation (M&E) from NVVN in a phased manner;
- Incubate off-grid business models in partnership with SNAs and hand-hold SNAs to upscale and

Table 8:
Institutional Gaps

Function	Institutions under Phase I	Gaps
Program management, monitoring and evaluation	• MNRE (NVVN) for large projects • IREDA for RPSSGP	• Sustaining capacity developed in Phase I is a challenge, as substantive support from NVVN was received • Rooftop, off-grid and solar applications have not progressed much
Demonstration projects	• MNRE	• Limited CSP demonstration projects; no performance data available for CSP • Need an institution with earmarked resources for project development and operation
Resource assessment	• C-WET	• Satisfactory progress
Infrastructure development	• State agencies and developers in Phase I	• Land, right of way, water and interconnection have been significant bottlenecks; SNAs lack capacity • Provision of shared infrastructure necessary – need for dedicated central and state-level institutions to coordinate solar park development
Ecosystem development	• Center/state	• No institutional role identified for such development

Source: Authors' research.

replicate successful initiatives through private partnerships;
- Address solar PV integration issue and facilitate a comprehensive national plan that coordinates generation scale-up, T&D expansion plans, control and dispatch systems, and draws up a vision for implementing storage systems; and
- Besides the above, SECI could also play a coordination role in R&D efforts and in ecosystem development, provided internal capacities are built in this regard.

3.5 Development through Solar Parks (Cluster-based Approach)

Experiences from Phase I of JNNSM indicate a strong need for organized development of grid-connected solar projects. A more deterministic approach to planning of shared infrastructure through the provision of solar parks is the way forward to optimize land and water, enhancing grid-connectivity and evacuation infrastructure, and developing transmission in a coordinated manner as envisaged under the green corridor,[29] conceptualized by the MNRE. The successful implementation of the first solar park in Charanka, Gujarat (Annex 18), demonstrates the potential for future replication of such model across other states. The Government of Rajasthan has also laid (in August 2013) the foundation stone for a solar park in Bhadla of Jodhpur district of Rajasthan. The solar park with a proposed generation capacity of 3,000 MW would be commissioned in phased manner. In its first phase, the solar park will generate 1,000 MW.

Such development (public or private) could be promoted through positive incentives in the form of capital subsidy to partly fund the development of the infrastructure. Projects outside such parks may not be prohibited but could be structured to lose out on such incentives.

Solar parks also lend themselves to cluster development, where appropriate, with co-location of industries with forward and backward linkages.

As proposed in the earlier section, MNRE may consider making solar park-based development the baseline in Phase II of JNNSM. The alternative of developing large, grid-connected solar plants in a fragmented and decentralized mode is sub-optimal and damaging in the long run, and procedurally arduous and risky for developers. The provision of public funding for solar park development will prompt states to adopt solar parks as the baseline option and expend efforts in identifying and developing such infrastructure. SECI could provide advisory and administrative assistance in structuring solar parks.

[29] Report on the Green Energy Corridor prepared by the Power Grid Corporation of India Ltd. as part of a study commissioned by MNRE and FOR.

4. Way Forward

JNNSM has signaled a decisive start with strong interest from the private sector matched by bold policy support from GoI. This private-led development model, particularly for grid-connected solar PV, builds a strong base for scaling up the program over subsequent phases of JNNSM.

An evaluation of Phase I through wider stakeholder consultations, while indicating several positives, also points to certain barriers and challenges to scaling up the program to the levels envisaged under JNNSM and beyond. In this context, the report debated certain key policy options to address the existing constraints and to realize the overall benefits of JNNSM outlined in the mission objectives.

Key conclusions on the way forward are:

1. **Addressing structural impediments to commercial financing:** A sustained participation from commercial lenders is seen as critical for achieving the scale of capacity addition envisaged under subsequent phases of the National Solar Mission. The role of "facilitating public funding" in enabling implementation of risk-reducing instruments as well as innovations in financing is significant and comes across as an imperative for moving solar development to a largely nonrecourse financing mode in India. The efficacy of direct public funding in "buying-down" the cost of electricity for the bulk of the commercial program under solar PV needs to be carefully evaluated by GoI vis-à-vis other forms of facilitating public financing. Subordinated public finance to prolong tenor of debt as well as credit guarantee enhancement schemes ought to be structured and pursued over subsequent phases of JNNSM.

2. **Comprehensive industrial policy actions for promoting solar manufacturing:** GoI's National Manufacturing Policy 2011 recognizes solar manufacturing as a strategic industry requiring the development of national capacities. There is a need to analyze measures for domestic value

addition and technology depth to evaluate the segments of the value chain for domestic participation and, thus, customized industrial policy approaches will be required for solar PV and CSP. A shared understanding of a framework to design these specific industrial policy actions for solar manufacturing is solicited. A mission mode approach is essential to analyze and increase domestic value addition and technology depth through the creation of adequate forward and backward linkages, addressing specific input (raw materials and consumables, power, resources, technology, and so on) disadvantages faced by Indian manufacturers vis-à-vis their overseas counterparts.

As far as solar PV is concerned, currently there is immense uncertainty in the global market demand-supply situation. The focus is also beginning to shift towards the newer generation of technologies, which have the potential of cost reduction and/or improvement in efficiencies. It is appropriate for GoI to evaluate a technology roadmap for solar PV and focus on the next generation of technologies through active promotion of R&D and international collaborations. Further, in light of recent international experience, upstream capital intensive investments in polysilicon and solar cell manufacturing need careful analysis before being replicated in India. Downstream investments in modules and Balance of Systems (BoS), including applications, seem to promise a better future for business viability and creation of jobs.

Solar thermal, in particular, holds significant potential for India as it can leverage advanced manufacturing processes from conventional industries such as automotive, metals, power equipment manufacturing, and so on, and develop a local ecosystem for technology adaptation and cost reduction. For this to happen, though, a clearer technology roadmap needs to emerge for solar thermal as well in the country. It underlines the need for advancing the demonstration projects aimed at field evaluation of different configurations for obtaining feedback on performance, operability and costs. This, in turn, will lead to standardization in configurations, essential for local manufacturing to take root and for the government to commit to the development of local ecosystems for solar thermal manufacturing in India.

3. **Phased DCR:** Phase I of JNNSM saw demand-side actions, led by MNRE, such as DCRs or tariff barriers on specific imports. These measures have not led to the revival of the local industry and are subject to challenges under international trade regimes.

   DCR needs to be aligned with the technology roadmap, and prioritized segments of the value chain (separately for solar PV and CSP) under comprehensive industrial policy action. It may be advisable to adopt a gradually-tapered DCR, which reduces over time, to allow time for the domestic industry to come up to the scale and competitiveness of global competitors. Without a clear technology roadmap, DCR should be applicable to the entire supply chain, with developers allowed to make the choice of technology and components, which can be sourced locally to the extent specified by the government. The manufacturing industry is also better served with a more active mission mode focus on industrial policy actions, combining appropriate demand- and supply-side measures to make it internationally competitive.

4. **PPPs for solar thermal development:** Given the local manufacturing capability, dispatchability, possibility of hybrids and storage technologies, and cost reduction potential, CSP development holds promise for India. It should be ensured that, given the slow development of CSP projects in Phase I, the technology is not penalized

in Phase II. It is desirable to pursue a more deterministic model of development for solar thermal with larger public sector involvement in project preparation than that achieved under Phase I of JNNSM. There is a need for a more coordinated and guided approach from the government, in terms of more upfront project preparation before bidding, to move the industry forward in the desired direction. Further, sound technical due diligence of bidders should be undertaken as a pre-qualification exercise. The relatively long development time of the CSP projects in India stems in part from lack of expertise of the EPCs and lead members of the consortia. The following pathway is envisaged for solar thermal under Phase II and beyond:

- SECI should focus on developing demonstration projects with desirable technology features such as storage, air-cooled condensation, hybridization, and so on. Such projects are envisaged under JNNSM to be developed through PPPs;
- A detailed assessment is required of the manufacturing value chain along an outline of coordinated industrial policy actions and ecosystem development plans to indigenize production;
- Any further capacity development under Phase II should ideally be undertaken only within a deterministic model with site identification, preliminary activities, and techno-commercial feasibility completed by a public sector entity such as SECI, before bidding it out with specific technical specifications through a Build Own Operate Transfer (BOOT) or Build Own Operate Manage (BOOM) route;
- Gather lessons from Phase II projects to decide on the desirable technology standardization for solar thermal projects, which could be adopted in grid connectivity standards of the Central Electricity Authority; and
- Based on the success of Phase II, decide on the move to a fully private-led model of procuring power from such projects over Phase III of JNNSM.

5. **Large project development through solar parks:** MNRE should consider making solar park-based development the baseline for large, grid-connected solar projects in Phase II of JNNSM. By providing public funding support for infrastructure development in solar parks, GoI can prompt states as well as private parties to adopt solar parks as the baseline for large, grid-connected solar power development, thus paving the way for an orderly grid development with optimized use of resources.

6. **Enhancing institutional capacity through SECI:** The pan-Indian role of MNRE in ensuring a coordinated development of the solar industry is fundamental to JNNSM. It was argued that incentives and GoI support are better directed at measures which address fundamental structural and administrative barriers to development of large grid-connected solar projects in the country, rather than being reserved for a fraction of projects to be developed in Phase II of JNNSM. SECI could play a facilitative coordination role, encompassing several institutional roles relating to M&E of the programs under JNNSM, which were otherwise being pursued by MNRE. In addition to the M&E roles, SECI has important roles to play in the following aspects:

- Act as the nodal agency for developing demonstration CSP projects in JNNSM Phase II. These can be taken up through private/technology partnerships;
- Assist states in the development of solar parks across the country through the provision of administrative, advisory and financial support;
- Transition program management and M&E from NVVN for the grid-connected segment;
- Undertake enhanced reliable forecasting and scheduling of solar farms and work with the

Power Grid Corporation of India on the T&D expansion plans, and control and dispatching systems or storage implementation;
- Play a transformative role in off-grid solar through support for incubation of new business models in association with SNAs, and handhold SNAs in scaling up and replicating the successful initiatives through private partnerships; and
- Coordinate R&D efforts and ecosystem development.

The Indian solar sector has made commendable progress since the launch of the JNNSM in 2010. In the international arena, India has substantial learnings and experiences to share on institutional mechanisms, financing, technology, and manufacturing with the rest of the world. The steps taken by GoI in implementing institutional and financing measures to successfully meet the Phase II targets of installing 10 GW of solar power and letting the private sector roll independently in Phase III will be closely observed by the international community. Thus, it is imperative that the government act on measures to scale up the success already achieved in JNNSM Phase I while simultaneously addressing the structural issues which stand to impede the envisioned growth.

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5. Annexes

Annex 1: Consultative Workshop Details and Key Messages

(i) Participants in New Delhi Workshop

S No	Name	Organization	S No	Name	Organization
1	Mr. A.K. Magu	NVVN	14	Mr. Jatin P Singh	SBI Caps
2	Mr. Anil Mishra	GiZ	15	Mr. Michael Richards	Energy Unit Chief, US Embassy
3	Mr. Anudeep Yadav	IREDA	16	Mr. N. Venkataraman	IL&FS
4	Dr. Ashish Kulkarni	Nereus Capital	17	Mr. Peeyush Mohit	KPMG
5	Mr. Ashwini Aggarwal	AMat	18	Mr. Rajiv Jain	ISA
6	Mr. Balawant Joshi	ABPS	19	Mr. Rakesh Kumar	SECI
7	Mr. C. Kannan	SECI	20	Mr. Ravinder Raina	Astonfield
8	Mr. Deepak Gupta	Shakti Sustainable Energy	21	Ms. Ritika Goel	BHC
9	Mr. Gaetan Tiberghien	IFC	22	Mr. Salil Dutt	Thermax
10	Mr. Gopal Lal Somani	KVK Energy	23	Mr. Sandip Ghosh	Schneider Electric
11	Mr. Hemanshu Sugandhi	REC	24	Mr. Satyen Kumar	Lanco Solar
12	Mr. Hemant Bhatnagar	GIZ	25	Mr. Siddhartha Ghoshal	Areva
13	Mr. Girish Narang	Azure Power	26	Mr. Sourabh Kaura	PTC Financial

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S No	Name	Organization	S No	Name	Organization
27	Mr. Sudhir Kapoor	Country Strategy Business Consultant	35	Mr. P.K. Mahajan	NVVN
28	Mr. Sumit Pandey	Moser Baer	36	Mr. C. Subramaniam	The World Bank
29	Mr. T.C. Arora	Visa Ecotech	37	Mr. Rohit Tyagi	ABPS Infra
30	Mr. Usha Sunil	Energy Unit, US Embassy	38	Mr. Ankit Jain	SBI Caps
31	Mr. V.S. Sharma	Steag	39	Mr. B. Pandey	Cargo Infrastructure
32	Mr. Venkataramani	CEO, Indo Solar	40	Mr. Jonas Hamberg	CSE
33	Mr. Vimal	IREDA	41	Mr. Anurag Mishra	USAID/India
34	Mr. Vineeth Vijayaragahavan	Panchabuta			

Participants in Mumbai Workshop

S No	Name	Organization	S No	Name	Organization
1	Mr. A. Shreerang	Aurum Ventures	14	Mr. Mehul Desai	Yes Bank
2	Mr. Anand Jain	Kiran Energy	15	Mr. Pashupathy Gopalan	SunEdison
3	Ms. Anita Karnik	SBI Capital Markets	16	Mr. Rahul Sankhe	SunEdison
4	Mr. Ardeshir Contractor	Kiran Energy	17	Mr. Rajat Misra	SBI Capital Markets
5	Mr. Balwant Joshi	ABPS	18	Mr. Sachin S. Patel	Reliance ADAG
6	Mr. C. Kannan	SECI	19	Mr. Sanjeev Singhal	SBI
7	Mr. Chetan Krishna	IIT Delhi	20	Mr. Sanket Joshi	Electrotherm Immodo Solar
8	Mr. Dhananjay Yellurkar	L&T Infra Finance	21	Mr. Sunil Jain	Hero Future Energies
9	Ms. Eva D'Ambrosio	US Embassy	22	Mr. Swapnil Wankhede	Lauren CCL
10	Mr. Harsh Nanda	Goldman Sachs	23	Mr. Vimal Kumar	Cargo Infrastructure
11	Mr. Jis George	Lauren CCL	24	Mr. Vineeth Vijayaragahavan	Panchbuta
12	Ms. Jyoti Mistry	Welspun	25	Mr. Vish Iyer	Mahindra Cleantech
13	Mr. Ketan Shukla	GERC			

(ii) Key Messages from the Workshops held in Mumbai and Delhi

<table>
<tr><th colspan="2">Financing Session</th></tr>
<tr><td>Lenders' perspective</td><td>Financial Support Options

• Public financing support was seen as critical to addressing/balancing two objectives: (a) buying down the cost of electricity; and (b) addressing structural barriers and risks which impede the flow of commercial finance to the sector. Five different options were debated for their relative efficiency and efficacy in addressing these twin objectives:
  • Interest subvention
  • Provision of prolonging tenor of lending
  • Credit guarantee
  • VGF in tranches
  • GBI;
• VGF was seen as attractive in lowering the cost of electricity and thus improving the project economics and risk perception among lenders. Appropriate structuring of VGF and linking it to loan repayments, and so on, were seen as necessary to avoid misuse. It was acknowledged that the leverage of such an option in the hands of the government was minimal and overall cost of supporting the program may be higher for the government in such an option. VGF's lack of linkages with output and being interpreted as an obvious government subsidy for the project was acknowledged but was not seen as a lenders' issue;
• GBI, while being an attractive option, leaves lenders with generation risk. At this stage, SCBs are particularly concerned with generation risk since solar PV technology is new under Indian conditions with limited ground operating data;
• Asset liability mismatch and nonavailability of long-tenor debt were acknowledged by lenders. It was recognized that long-tenor debt would improve project economics substantially and such arrangements can also be optimal for the government compared with direct financial support which is envisaged in the other options. A combination of options from the government enabling long-tenor and lower-cost debt along with direct financial support through VGF/GBI was proposed;
• Counterparty risk for the projects was seen as most critical in lenders' assessment of solar projects, given the comparatively higher tariffs for solar and higher concentration of projects in a few states (which are not necessarily performing well in their distribution businesses). Improving the payment security mechanism and considering SECI as a counter party with back-to-back PSAs with Discoms were some of the suggestions made by lenders; and
• Guarantee products would be taken positively if they address commissioning risks and also cover the initial years of operation.

REC/RPOs
• REC may not be a bankable structure in its present forms for solar. In a market characterized by falling capital cost, newer projects would be comparatively better positioned in selling RECs than the older ones. As such, there is always a re-negotiation risk that older projects could face; and
• Stricter enforcement of RPO was absolutely essential. A recent case in the Appellate Tribunal to give more teeth to RPO enforcement.</td></tr>
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<table>
<tr><th colspan="2">Financing Session</th></tr>
<tr><td>Developers' perspective</td><td>Financing Structure

• VGF was not a panacea and fails to address systemic issues. It would make projects dependent on government budgetary support from year to year and could be risky. Since the pool is also limited, it may not be the most optimal structure;
• Interest subvention and long-tenor loans were better suited for projects;
• PPAs should be made uniform and robust all across, and should be comprehensive and bankable. Address issues of force majeure and termination payment, which are missing at the moment;
• No reason for construction period to be so aggressively prescribed by the government, if no support is being provided on preparatory activities; and
• Any financing structure should not lead to tying the developer to the project. Developers should be allowed to freely invest in and exit projects.

REC/RPOs
• RECs have limited takers in the long term. It would be wiser to invest in generating asset than to buy RECs; and
• RECs are not legal instruments and they always run regulatory pricing risks—regulators could always change the pricing structure.</td></tr>
<tr><th colspan="2">Technology Session</th></tr>
<tr><td>Lenders' perspective</td><td>• The appropriateness of the local content requirement provision was debated. The objective of JNNSM to promote local manufacturing for long-term energy security was acknowledged;
• Lenders had no bias for either locally manufactured or imported goods on projects. An important consideration, however, was the reliability/bankability of suppliers who are required to offer long-term warranties. The condition/reliability of Indian manufacturers in the current environment was far from good and a matter of concern;
• For local manufacturing, GoI needs to have an appropriate plan in place to enhance the competitiveness of the local industry. The local industry was established ahead of the Chinese industry and was catering to global needs until the JNNSM was initiated. Addressing fundamental input-side concerns of manufacturers was far more important than providing a captive market under JNNSM;
• Alternative structures were proposed for Local Content Requirement (LCR), if it has to be the way forward to avoid unintended outcomes such as higher penetration of TF in Phase I. The example of South Africa was discussed where a graded LCR of 30 percent was raised to 50 percent in two steps without specifying the category or kind of equipment to be locally sourced. This allowed enough flexibility for the developers to consider the area in which local value addition could be considered;
• A cluster-based approach for project development was highly recommended by the lenders and developers. GoI incentives for clusters were seen as a healthy way of promoting its stake in all projects across the country and signaling a clear preference for cluster-based development; and
• Federal structure-related issues were also discussed with a focus on the disparities between central and state sector policies in availability of incentives:
  – Given the fact that India has one central policy and multiple state policies, the aim should be to standardize the fiscal/support instruments to ensure a homogenous development of the sector. Projects fulfilling certain minimum criteria (such as cluster-based development, adherence to a standard model PPA, and so on) could then qualify for incentives from the central government irrespective of which policy they fall under.</td></tr>
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<table>
<tr><td>Developers' perspective</td><td>Issue of LCR
LCR was not successful in Phase I and had unintended outcomes. Hence, it may not be the correct instrument to promote local manufacturing. Also specifying LCR for modules and cells cannot address energy security considerations, which need investment in polysilicon. Small, largely unreliable players in cells and modules impede rather than aid the program;
LCR should not be enforced with developers, particularly when global prices have been on the decline and manufacturers are unlikely to invest in new capacities. Benefit from cost reduction globally should set up projects in India;
Adopt an ecosystem-based approach to manufacturing. The GoI should tap NCEF for developing an ecosystem for local manufacturing:
Provision of domestic financing using options such as NCEF (to compete with U.S. EXIM bank financing to encourage Indian manufacturers;
The definition of LCR should be revisited and can be made a percentage of the total value of a project rather than restricting it to the module and cell level. The BoS can be another area where India can develop competitiveness;
India can adopt Brazil's model in which local manufacturers are allocated solar projects for development:
Investors in domestic manufacturing in the approved phased manufacturing program should be granted special allocation for setting up solar plants with preferential tariff under JNNSM.
India needs to develop the ecosystem to make solar equipment manufacturing competitive:
GoI needs to revisit the strategy for enhancing solar manufacturing competitiveness. Manufacturing is the key to energy security, and India needs to learn from China which focused on the complete value chain with emphasis on polysilicon
Industrial policy is the key to enhancing manufacturing competitiveness and manufacturers need long-term clarity on the demand; and
Impact of LCR on financing
It would be difficult for multilateral agencies to support financing of projects where domestic content is mandatory.
CSP Requires Support
Governmental support is required for CSP development;
All CSP projects must include storage/hybridization as it will assist India in attaining its objective of energy security as well as grid parity;
CSP projects require high level of precision and quality, and it may not be desirable to include DCR in this. DCR may not work in the initial phase, but as the market develops, India can develop competence in the area;
Developers are not quite comfortable with the Global Horizontal Index data, however, DNI data are still a concern for CSP project developers; and
All CSP projects should be bid out as Case 2 projects with adequate preparation by government agencies upfront.
Government Involvement Key for Success of Cluster-based Approach
Land acquisition is a major issue, and the Government's role is crucial in this regard:
The state should identify the land and let institutions such as SECI/state institutions develop it and allocate it to private developers; and
The aim should be to develop small clusters close to electricity consumption areas.</td></tr>
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Policy/Regulatory Session	
	RPO Compliance Key for Growth • There is a need to enforce RPO stringently and bring credibility to the REC market. • Another option could be the Renewable Generation Obligation rather than a RPO which can be imposed on new generation capacities based on conventional fuels. **VGF Allocations Need to be Designed Properly** • VGF depends on year on year budgetary approval/sanction of the Central Ministry, which may create a problem: – VGF could take one time financial support from the NCEF to be passed on as a cash subsidy to developers – Import costs should be validated by an authority, as there can be a tendency to inflate cost to get a higher cash subsidy under VGF; there are also concerns around developers not investing adequate equity with upfront VGF – Need to clearly define stringent quality and performance criteria before allotment of VGF. It should be ensured that the developer operates the project for the complete life span; and • It is important to undertake a cost-benefit analysis of all the options proposed in JNNSM Phase II to determine the impact of these on the tariff as well as the overall economics/growth of the sector. **Other Options for Incentive Disbursement** • Instead of providing upfront subsidy/VGF to the developers in proposed stages, there could be a loan guarantee scheme, under which lenders get paid out from the VGF funds on the successful construction of project. **Database Creation** • Conventional power plant data is tracked by MoP and is available in the public domain, the same approach should be used for solar projects. **PPA Credibility is Important** • JNNSM was successful as the procurer of the power was NVVN. Had Discoms procured and signed the PPA, JNNSM would not have had the same credibility for financers.

Annex 2: Comparison of State Solar Policy Framework with JNNSM

Table A2 1:
Comparison of State Solar Policies with JNNSM

Description	JNNSM Phase I	State Policies
Financial criteria	Net worth • Up to 20 MW - INR 30 million/MW (US$0.50 million/MW) • For capacity > 20 MW - INR 20 million/MW (US$0.33 million/MW)	**Gujarat** • Internal resource generation: INR 12 million/MW (US$0.20 million/MW) computed as 5 times the maximum internal resources during past 5 years • Net worth: INR 20 million/MW (US$0.33 million/MW) • Annual turnover: INR 48 million/MW (US$0.80 million/MW) **Rajasthan & Karnataka** • Net worth: INR 30 million/MW (US$0.50 million/MW)
Technical criteria	Commercially established technology with at least 1 year of successful operation	**Gujarat:** Experience of developing any project in last 10 years with capital costs of not less than INR 30 million/MW (US$0.50 million/MW) with a minimum size of 1 project to be INR 5 million/MW (US$0.08 million/MW) **Rajasthan**: Same as JNNSM
Allocation process	Reverse bidding Discount to CERC's FiT	**Gujarat:** Projects allocated on first-come-first-served basis on GERC's FiT which provided certainty on revenue flows **Rajasthan, Karnataka, Madhya Pradesh, Tamil Nadu:** Followed/propose to follow tariff-based competitive bidding route
Security/ Performance Bank Guarantee (PBG)	INR 5 million per MW (US$0.08 million per MW)	**Gujarat:** PBG - INR 5 million per MW (US$0.08 million per MW) **Rajasthan:** Security – INR 0.5 million per MW (US$8,333 per MW); Bank Guarantee (BG): INR 2 million/MW (US$33,333 per MW)
Evacuation	Batch 1: STU's responsibility; Batch 2: project developer's responsibility	**Gujarat, Rajasthan:** Responsibility of the STU for timely completion of transmission line after the solar substation switchyard **Madhya Pradesh, Karnataka:** Responsibility of the developer to lay the line up to nearest STU/Discom sub-station
Equity lock-in	• No change in controlling shareholding & lead member for a period of 1 year after commencement • Controlling shareholding means at least 26% of the voting rights in the company	**Gujarat, Rajasthan:** Developer/consortium has to retain controlling shareholding (51% for first 3 years and 26% from thereafter) throughout the term of the agreement
Financial Closure	• 180 days for Batch 1 • 210 days for Batch 2	Same as JNNSM
Commissioning	• 12 months for PV & 28 months for CSP in Batch 1 • 13 months for PV in Batch	• **Karnataka:** PV - 12 months & CSP - 30 months • **Rajasthan:** PV - 12 months (for 5 MW) and 15 months (for 10 MW) & CSP - 28 months • **Madhya Pradesh:** PV - 12 months & CSP - 28 months

Source: Respective state solar policies, JNNSM guidelines, authors' research.

Annex 3: CSP Players and Status of Implementation

Details of CSP Players Selected in JNNSM Phase I, Capacity Allocated and Status of Implementation

Table A3 1:
CSP Projects and Implementation Status

S. No	Project Name	Promoter	Capacity (MW)	Location	Technology	Supplier/EPC Contractor**	Status*
1	Diwakar Solar	Lanco	100	Nachna, Rajasthan	PTC with storage	Siemens/Lanco Solar & Initec Energía	Under construction
2	KVK Energy Ventures	Lanco	100	Nachna, Rajasthan	PTC with storage	Siemens/Lanco Infratech	Under construction
3	Megha Engineering	Megha Engineering Ltd.	50	Anantpur, Andhra Pradesh	PTC	GE/MEIL Green Power Limited	Under construction
4	Rajasthan Suntechnique	Reliance	100	Bikaner, Rajasthan	Compact Linear Fresnel	Areva/Reliance Infrastructure	Under construction
5	Aurum Renewable	Aurum	20	Porbandar, Gujarat	Linear Fresnel	Sumitomo Shin Nippon/Indure	Under construction
6	Godawari Power	Hira Group	50	Pokaran, Rajasthan	PTC	Siemens, Schott Glass, Flabeg, Aalborg/Lauren, Jyoti Structures	Commissioned
7	Corporate Ispat	Abhijeet	50	Pokaran, Rajasthan	PTC	Siemens turbine & receivers/ Shriram EPC	Under construction

Source: "Concentrated Solar Power: Heating up India's Solar Thermal Market under the National Solar Mission", EEW/NRDC/Shakti Foundation, September 2012.
* Authors' research; ** Data collected from CSP World.

Annex 4: JNNSM Auction Process and International Experience

1. Chronology of JNNSM Phase I reverse bidding-based capacity auction process

Table A4 1:
JNNSM Phase I—Bidding Chronology

	Issue of Request for Selection	Submission of Response to Request for Selection	Shortlisting of Bidders and Decision on Tariff Discounting	Proposal Submission	Evaluation of Proposals and Issue of Letter of Intent	PPA Signing	Financial Closure of Projects	COD
Phase I Batch 1 Solar PV	August 2010	September 2010	October 2010	November 2010	December 2010	January 2011	April 2011	January 2012
Phase I Batch 2 Solar PV	August 2011	September 2011	October 2011	November 2011	December 2011	January 2012	September 2012	February 2013
Solar Thermal	August 2010	September 2010	October 2010	November 2010	December 2010	January 2011	April 2011	May 2013

Source: Authors' research.

2. Level of participation in JNNSM Phase I

Table A4 2:
Level of Participation—JNNSM Phase I

S. No	Batch/Technology	No. of Bids	No. of Projects Selected	Total Capacity
1	Batch 1 – PV	299	30	150 MW
2	Batch 2 – PV	183	26	350 MW
3	CSP	66	8	470 MW

Source: Draft JNNSM Phase II Policy Document, MNRE.

3. International experience: Capacity auction structure

Table A4 3:
Capacity Auction Structure—International Experience

Country	Type of Auction	Design of Auction	Penalties for Noncompliance	Domestic Content
India (JNNSM)	Reverse auction (ceiling price fixed by the regulator)	Technology specific	Clearly defined penalties Forego the PBG (for delays up to 3 months) Liquidated damages for delays beyond 3 months	For Batch 1 of Phase I, it will be mandatory for projects based on c-Si technology to use the modules manufactured in India. For Batch 2 of Phase I, all projects will have to use cells and modules manufactured in India
Brazil	Hybrid auction: First stage – reverse clock auction to determine ceiling price Second stage – sealed bid auction	Could be technology specific, alternate energy auction or technology specific Last auction was technology neutral	Flexible: A 4-year rule offers some flexibility by allowing producers to accumulate and carry over productions within some limits to make up for under production risks in future years Contract termination for delays greater than 1 year	60% of the cost of equipment spent locally
South Africa	Two stage bidding: First stage - bidders have to meet minimum criteria related to legal, financial, technical and environmental requirements Second stage - sealed bid auction 70% weightage to price and 30% to economic development including local content	Technology specific	Contracts will be terminated for bidders who fail to meet their commitment under the PPA	Weightage given to domestic content in the final evaluation of bids
Morocco	Two stage bidding: First stage – pre-qualification including experience, financial and technical capability Second stage - sealed bid auction	Technology specific	Penalties for delay and underperformance determined in PPA Guarantee paid at signature of PPA Termination of PPA as last resort	30% of the plant's capital cost (local equipment manufacturing, O&M, R&D)
China	Sealed bid auction	Technology specific (site specific as well)	No clear penalties for noncompliance	50% domestic content for wind in 2003, increased to 70% in 2005; abolished in 2009

Source: IRENA Report: Renewable Energy Auctions in Developing Countries (2013).

Annex 5: Funding Requirements for JNNSM Phase II

Solar lending is considered a part of power sector lending by commercial banks. The comparative transaction costs for smaller solar capacities are higher compared to those for large conventional power plants, and with concerns around few public sector banks reaching their sector caps, imposed by them in keeping with prudential norms, the availability of funding from domestic commercial banks becomes an issue.

JNNSM Phase II is envisaged to add higher capacity in comparison to Phase I. As per the draft JNNSM Phase II policy document, around 3,600 MW solar power capacity is proposed to be added under the central scheme.

Table A5 1 provides an indicative detail of funding requirement to support 3,600 MW of capacity.

Adding solar power capacity only under the central scheme would require around INR 340 billion (US$5.67 billion). At a debt: equity of 70:30, this is an estimated at INR 238 billion (US$3.97 billion) of debt financing.

Table A5 1:
Indicative Funding Requirement for Phase II (Central Scheme)

Type	Indicative Cost	Capacity	Funding Requirement
Rooftop & small solar PV	@ INR 80- 90 million (US$1.33 - 1.50 million) per MW	200	INR 16-18 billion (US$270 -300 million)
Ground-mounted solar PV	@ INR 70- 80 million (US$1.17-1.33 million) per MW	2,320	INR 162-186 billion (US$2.7- 3.1 billion)
Solar thermal	@ INR 120- 130 Million (US$2.00- 2.17 million) per MW	1,080	INR 130-140 billion (US$2.17- 2.33 billion)
Total		3,600	INR 308-344 billion (US$5.13-5.73 billion)

Source: Authors' research.

Annex 6: PPA under JNNSM Phase I – Key Concerns

1. Review of JNNSM Power Purchase Agreement

Under the JNNSM framework, selected developers have to enter a PPA with NVVN which, in turn, signs to a PSA with respective distribution utilities.

Developers and financiers expressed broad concerns with regard to the PPA in the following areas:

- Limitations on solar dispatch/assurance on power off-take;
- Conditions of liquidated damages and penalty;
- Performance guarantees;
- Creditworthiness of utilities;
- Payment security mechanism; and
- Termination and exit provisions.

These areas are summarized in Table A6 1.

Table A6 1:
PPA under JNNSM Phase I—Key Concerns

S. No.	Particulars	Details
1.	**Limitations on solar dispatch**	Under the PPA, NVVN is not obligated to purchase any additional solar energy generated beyond the amount corresponding to 21% capability utilization factor from the PV project. Further, there is no compensation for the grid/procurer's inability to evacuate or transmit solar power, leading to its backing down. Given the lower capacity utilization factors of solar power plants, nonavailability of the grid can be a serious risk for such projects. This is particularly exacerbated by the fact that solar projects have been feeding into primarily rural areas of the state transmission and sub-transmission grid, which are known to suffer from maintenance and availability related issues in several states.
2.	**Liquidated damages & penalties**	Conditions for meeting the Scheduled Commissioning Date in the PPA are supplemented by liquidated damages and penalties to be paid by the developer in the event of delays. The developer is required to forego the PBG of INR 5 million per MW (US$83,333 per MW) submitted in the event of delay beyond 3 months. In case of further delay, the developer is required to submit INR 0.1 million (US$1,667) per day per MW as liquidated damages. Key hurdles in solar project development are land acquisition and laying down transmission lines for evacuation. As land acquisition is a state subject, the chances of projects getting delayed are higher. The bankability of PPA is marred by such stringent timelines coupled with serious monetary implications.
3.	**Performance guarantee**	Under the PPA, the developer is required to submit PBGs to the extent of INR 5 million per MW (USD$0.08 million per MW). This is perceived to be very high in a market characterized by falling project costs and with several smaller companies participating, since it locks in much higher amounts than equity in the project, as bankers insist on margins to extend such guarantees.

contd...

S. No.	Particulars	Details
4.	**Creditworthiness of utilities**	State utilities are the procurers of the solar power under JNNSM and are required to pay as per the provisions of the PSA. The creditworthiness of the state Discoms on timely payments for conventional power purchase has not been impressive so far and, therefore, the lenders view the payments from such utilities as a riskier proposition. The role of NVVN in Phase I had a beneficial effect, given the direct and indirect influence NTPC and NVVN have on distribution utilities. With bundling no longer a sustainable option, NVVN's role over Phase II is in doubt and raises issues on the creditworthiness of the overall program.
5.	**Payment security mechanism**	Under the PPA, the payment security mechanism is structured as a Letter of Credit backed by an Escrow mechanism. NVVN is albeit under no obligation to make payments to the developer in the event of default by the utilities. To mitigate such risks, the JNNSM framework identified a PSS by way of creation of a Solar Payment Security Account (SPSA). To this effect, MNRE has set aside budgetary support of INR 4,860 million (US$81 million) for the period of 2011-15. This third tier of payment security is a fall back arrangement in the event of exhaustion of the payment security as defined in the PPA. This mechanism, however, provides complete discretion to NVVN in terms of administering PSS and was pointed out by several lenders as ambiguous.
6.	**Termination payments and exit arrangements**	The PPA can be terminated by NVVN on account of the developer not meeting the conditions subsequent in the stipulated time period of 7 months from the effective date without giving any further extension. The PPA does not provide any exit arrangements for the developer or recovery of cost in the event of termination resulting in default by NVVN or the utilities, and is not on an equitable footing.
7.	**Charge on bundled power**	Banks have echoed concern that banks do not have a charge on the bundled power. There should be a scenario in some suitable form for recourse to the bundled power for the lenders to the solar project under the JNNSM.

Annex 7: Payment Security Scheme and NCEF

Payment Security Mechanism in JNNSM Phase I[30]

The core component of the PSS is to create a Solar Payment Security Account (SPSA) financed from the Gross Budgetary Support (GBS) to MNRE to ensure availability of adequate funds to address all possible payment-related risks in case of defaults by distribution utilities for the bundled power.

As per available provisions of the PPA, NVVN will raise a provisional bill on the last day of the month. Utilities would get 2 percent rebate if the payment is made on the next working day. The due date of payment would be 30 days from the date of billing. If payment is not made by the 30th day, NVVN can notify default and encash the amount from the Letter of Credit (LC). Utilities would open the LC for six month equivalent amount which would be backed by an escrow account. In addition to encashing the LC, NVVN has the right to divert and sell the bundled power in the spot/short-term market. In case the realized amount from the market is lower than the cost of bundled power, the difference is to be paid from SPSA, provided under the PSS. Alternatively, NVVN can continue to supply power to the utility since the LC has six months' equivalent amount. Even in case of diversion, the defaulting utility is not absolved of the liability to pay capacity charges.

A GBS of up to INR 4,860 million (US$81 million) will be provided to MNRE for the implementation of the PSS, which has been estimated for a default of 35 percent and based on capacity utilization factors on a normative basis.

The funds for each year shall be allocated by MNRE to SPSA which could be deployed in the approved liquid securities with the approval of the PSS Management Committee. However, resulting returns would be treated as accretion to the SPSA after taking into account the management fee of 1 percent of funds handling, to be provided to NVVN.

National Clean Energy Fund

Announced in the Union Budget of 2010-11, the NCEF is a nonlapsable corpus under the Public Accounts of India formed through the levy of a clean energy cess of INR 50 per ton (US$0.83 per ton) on coal produced domestically and imported to India. The cess came into effect from July 2010.

NCEF has collected revenues to the tune of INR 10,660 million (US$177.67 million) in FY 2010-11, an estimated INR 32,490 million (US$541.50 million) in FY 2011-12, and is expected to generate a further INR 38,640 million (US$644.00 million) in FY 2012-13.

[30] *Source:* Press Information Bureau of India,

Annex 8: Technology Factors in JNNSM Phase I

JNNSM Phase I has featured the following technology and price characteristics:

- Equal capacity distribution under Phase I of the mission for development of both PV and CSP;
- TF more desirable than c-Si in Phase I of the mission; and
- Aggressive price bids followed by the global glut in the solar market.

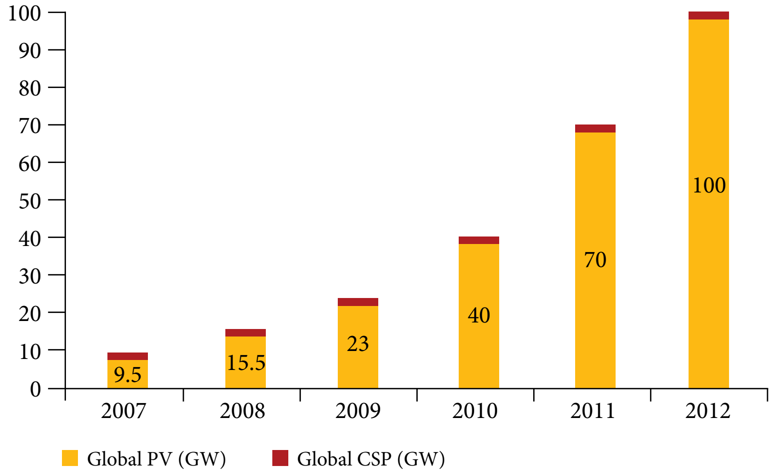
1. Equal capacity distribution under JNNSM Phase I for development of both PV and CSP

The grid-connected solar capacity under JNSSM Phase I was divided equally between PV and CSP (500 MW each), in contrast to the global share of CSP and PV technologies; the total installed capacity of solar PV is as high as 100 GW currently, compared with CSP at 2.2 GW. CSP projects have primarily been demonstration and semi-commercial projects with substantial public funding.

CSP refers to a range of technologies (parabolic trough, linear fresnel, solar tower, stirling dish, and so on), which are relatively less mature and currently more expensive than PV.

CSP, given its promising potential, including its ability to operate with thermal storage and be hybridized with other fuels, has been widely researched. Most developments so far have also been extensively supported by public financing sources and seen participation of public financiers and international development banks, including the European Commission (EC), European Investment Bank (EIB) and the World Bank.

Figure A8 1:
Global PV & CSP Capacity



Source: EPIA.

Box A8 1:
EC and EIB Support to CSP

EC's support for CSP started with the fourth EU Framework Program in 1994.

- **Fourth Framework Program (1994):** allocation of €29 million for development/implementation of CSP technologies.
- **Fifth Framework Program:** €15 million on three major full-scale MW size demonstration projects to:
  - PS10: 11 MW CR CSP in southern Spain
  - Andasol: 50 MW parabolic-trough collector (PTC) CSP with storage
  - SOLAR TRES: 15 MW CR CSP with salt storage
- **Seventh Framework Program:** looking for scaling up of promising CSP technologies. EIB has partnered EC with an investment of over €70 million between 2004 and 2012.

Source: European Commission.

Solar thermal has suffered globally through comparison with solar PV, the latter experiencing exponential growth between 2004 and 2009 due to the demand from rooftop solar programs in Japan and Germany, followed by a dramatic decline in prices thereafter. Since 2009, solar PV has seen a consistent decline in polysilicon and module prices due to substantial over-capacities across the manufacturing value chain and the emergence of large-scale, integrated and low-cost suppliers in China.

Solar thermal, on the other hand, has not reached a level where scale and competition can affect price reductions. CSP technologies are, at best, at the initial stages of commercialization with the dominance of a few suppliers who also own significant parts of the supply chain, restraining competition.

i. TF more desirable than c-Si in Phase I of the mission

Within PV technology, JNNSM Phase I has witnessed a higher demand for TF compared with c-Si. This is a contrast to the current global scenario. Globally, the share of TF in total PV installations has been declining in the last few years and was at 13 percent of all PV in 2011.

TF technology historic to current scenario

In the past, TF was considered a very promising technology with a lower efficiency than c-Si but with substantially lower cost. TF's market share was as high as 30 percent during the late 1980s but started declining thereafter with industry consolidations. Technological advancements returned the focus on TF after 2003; this phase lasted until 2008. However, with the dramatic decline in c-Si prices since 2009, the value proposition of TF has narrowed and it has continued to lose market share resulting in a long list of suppliers shutting down their manufacturing units.

Thin Film growth vis-à-vis polysilicon pricing

It may be argued that market share shifts or global interest in TF are cyclical in nature but the correlation between the decreasing cost of c-Si and decreasing growth of TF cannot be ignored. It can be seen in Figure A8 2 that year on year growth in TF also decreased as polysilicon spot prices decreased.

Figure A8 2:
TF Market Growth and Polysilicon Spot Prices

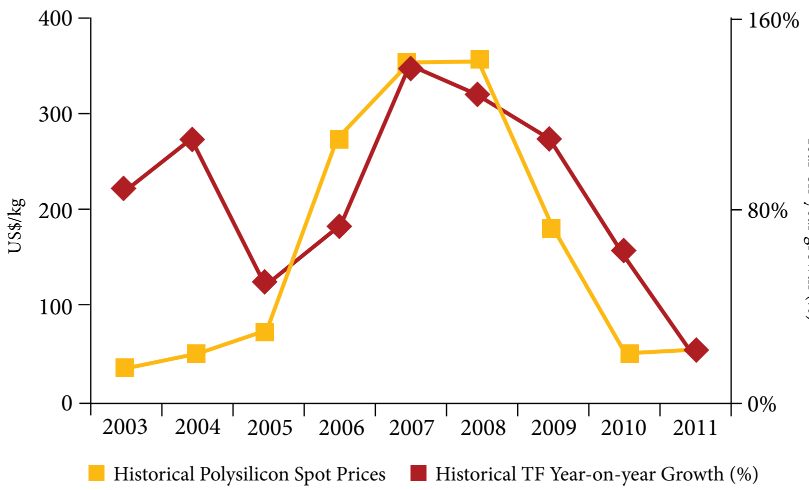


Table A8 1:
Comparison of PV and Thin Film Technologies

Modeled Data from PVSyst LA System	kWh/KW Performance	Performance vs Base	Assumed Efficiency	Efficiency Adjusted Penalty	Performance Adjusted Efficiency	Performance & Efficiency Adjusted Penalty
Poly c-Si (Base)	1,647	100.0%	**14.5%**	US$	14.5%	US$
Mono c-Si	1,696	103.0%	**15.0%**	US$ (0.02)	15.4%	US$ 0.05
a-Si	1,731	105.1%	**6.5%**	US$ 0.91	6.8%	US$ 0.83
CIGS	1,748	106.1%	**12.5%**	US$ 0.12	13.3%	US$ 0.07
Cadmium telluride (CdTe)	1,838	111.6%	**11.7%**	US$ 0.18	13.1%	US$ 0.08

Source: GTM research.

Decreasing cost competitiveness of TF

The decline in TF's share globally is a result of its decreasing cost competitiveness. As shown in Table A8 1, the performance and efficiency adjusted penalty is higher for TF because of larger area and BoS requirements with this technology. The overall advantage of TF being cheaper is not easily visible in the future, unless technological advancements drive down costs.

India, on the other hand, has a completely different scenario; the share of TF in PV is not only high but also increasing. As can be seen in Figure A8 3, the share of

TF between 2000 and 2011 was quite low globally but quite high in India under JNNSM Phase I. This was driven largely by the availability of low-cost financing from U.S. EXIM for U.S.-based TF supplies. Large U.S.-based suppliers with proven track records were also preferred by developers and lenders over relatively smaller suppliers of c-Si, which had to be domestic manufacturers on account of the DCR for c-Si.

ii. Aggressive price bids followed by global glut in solar market

The world has been experiencing a secular trend of decline in the cost of generation from solar technologies. The reverse bidding mechanism in JNNSM Phase I (Batch 1 in August 2010 and Batch 2 in August 2011) facilitated the emergence of price bids that are amongst the lowest globally. Access to low-cost financing and technology choice, which is usually a challenge with such tariffs, was facilitated by a few factors outlined below.

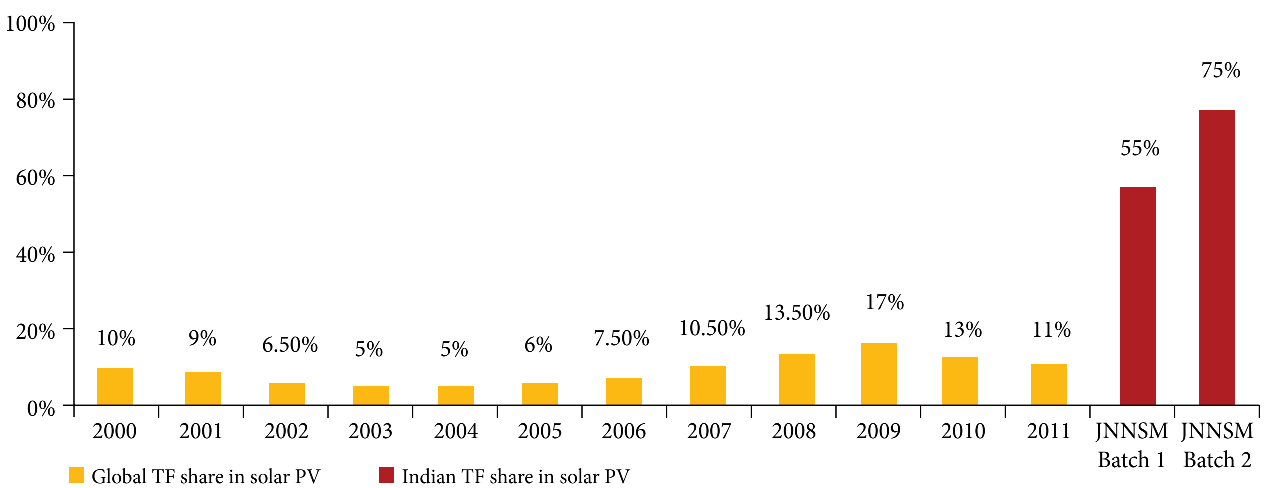
Glut in solar PV market

Solar PV has been witnessing a sharp drop on the back of heavy supply and inventories. Polysilicon makes up around one-third of the total cost of a solar PV cell. There have been huge investments in the polysilicon industry over the last five years, leading to over-capacity and build-up of inventories, resulting in a sharp decline in prices, thus pushing down the prices of solar PV modules. This price decline continued well into 2012 and the first few months of 2013.

Aggressive bids vis-à-vis DCR

Aggressive bid price demands availability of either cheaper solar modules and system equipment or low-cost financing. DCR under JNNSM requires developers to use locally manufactured cells and modules (for c-Si technology).

Figure A8 3:
Share of TF in Overall PV Installed Capacity



Source: Navigant consulting and authors' research.

The possibility of local modules being cheaper than imported modules is low considering the smaller scale of India's manufacturing capacity and fierce competition from Chinese modules. Even after paying import duty, the selling price of a Chinese cell is lower than an Indian one, because of the availability of low-cost local wafers and lower processing cost due to lower electricity and financing charges in China.

Compared with this domestic scenario, TF suppliers out of the United States were ready to offer competitively produced modules along with low-cost, long-tenor financing from the U.S. EXIM bank.

Substantially higher penetration of TF over c-Si is thus an unintended outcome of the DCR stipulation combined with the low-cost financing which accompanied U.S.-made TF products.

Annex 9: Domestic Content Requirement

The domestic/local content requirements under the power procurement contracts compel the renewable energy power developers to source a particular percentage of equipment from the local suppliers. The main aim of using the LCR criteria under the policy framework is to promote local manufacturing as well as attain tangible local economic benefits.

1. National Experience

Table A9 1:
National Experience, DCR

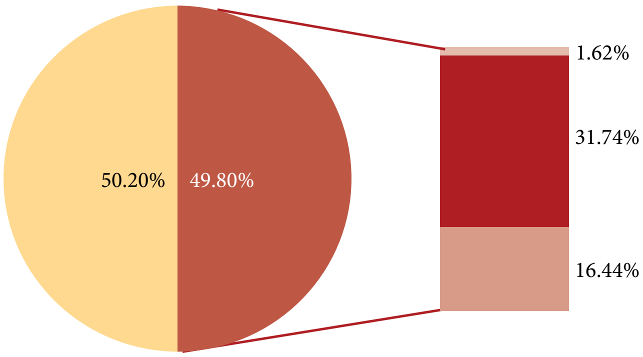
Description	JNNSM Phase I	State Policies
Domestic Content	**PV** • Batch 1 : c-Si - mandatory use of domestic modules • Batch 2: c-Si - mandatory use of domestic cells & modules • TF not under DCR purview **CSP** • 30% domestic content mandatory	**Gujarat** • No obligation on domestic content **Rajasthan** • No obligation on domestic content • Separate scheme for promoting local manufacturing: Solar producers under this scheme required to source solar PV modules from their own manufacturing units in Rajasthan - Target 200 MW power capacity & 500 MW manufacturing capacity (TF/c-Si) by 2013 - Selection through tariff-based bidding (not initiated) **Madhya Pradesh** • Domestic content clause (exception: TF modules) **Karnataka** • No obligation on domestic content

A review of the implementation of solar PV projects under the state policy of Gujarat (with no obligation on domestic content) indicates a TF share of close to 50 percent (for 492.61 MW capacity), in indicated in Figure A9 1.

2. International Experience

Table A9 2 provides brief overview of the international experience across select countries in the area of renewable energy with local content requirements:

Figure A9 1:
Solar PV Technology, Gujarat



Source: Sunrise in Gujarat (2013), RESolve Energy Consultants.

Table A9 2:
International Experience, DCR

Country	Experience
Ontario FiT Program[31]	The FiT Program was enabled by the Green Energy and Green Economy Act, 2009. The Ontario Power Authority is responsible for implementing the FiT Program. A price-based program, the FiT aims to attract renewable energy companies to the province by providing guaranteed pricing for certain forms of renewable energy projects. The FiT contract requires wind projects greater than 10 kW and all solar projects to include a minimum amount of goods and services that come from Ontario. The minimum requirements are: • 50% for wind projects greater than 10 kW; and • 60% for all solar projects.
Brazil - Wind[32]	In the first and second phase of the Program of Incentives for Alternative Electricity Sources, LCRs (so-called 'nationalization indices') were stipulated for equipment and services of 60% and 90%, respectively. Nevertheless, there are no similar measures to be found in the Portarias approving the guidelines on the tenders held in 2010, and no nationalization index is required to take part in the tender process. However, the nationalization index of 60% remains as a condition to access funding from the Brazilian development bank, and since its financing comes at a lower cost, this condition established a de facto LCR similar to the ones stipulated under the Program of Incentives for Alternative Electricity Sources and the Portarias or the wind-only auction.
China - Wind	Wind projects approved by China's National Development and Reform Commission from 1996 to 2000 were required to source at least 40% of their content from local manufacturers, which was increased to 50% in 2003, and then to 70% in 2004. The DCR was discontinued in 2009, as it was no longer needed as most turbines exceeded the DCRs.[33]

[31] *Source:* Report on FiT Program Overview - Ontario Power Authority, 2012.
[32] *Source:* Report - Analysis of the regulatory framework for wind power generation in Brazil (REEEP/GWEC).
[33] *Source:* Policy Brief - Sustainable Prosperity (2012).

Annex 10: Solar PV Manufacturing in India

Solar PV manufacturing in India constitutes an installed capacity of approximately 2,000 MW of modules and 1,000 MW of cells of which, as on date, only about 50 to 60 percent is operational. The manufacturing ecosystem for solar thermal generation is yet to develop and is mostly restricted to small Stirling dish engines for industrial applications. Manufacturing of power block equipment is well established in India for conventional power generation and can adapt itself to solar power generation.

1. Solar PV manufacturing in India

This section covers primarily the experience of solar PV manufacturing in India.

While there is no polysilicon manufacturing capability in India, technically 15 MW of ingot and wafer manufacturing capacity exists, although this is a pilot unit which is not commercial in nature.[34] The Indian solar manufacturing segment is thus primarily represented by solar cell and module manufacturers. A few projects have been announced to undertake manufacturing of other components in the value chain such as polysilicon, ingots and wafers; however, none of these have made progress on the ground on account of viability concerns in the current global pricing scenario.

While there has been marginal growth in the installed capacity for solar modules, the average

Box A10 1:
Indian Manufacturing Landscape

Polysilicon	Wafer
• India has no polysilicon manufacturing capacity • To sustain 20 GW of installation (including central and state policies), India would need an annual capacity of approximately 14,000 metric ton of polysilicon	• There is no significant wafer manufacturing capability in India • Around 2,000 MW per annum of wafer manufacturing capability would be required for sustaining 20 GW of installation
Cells	**Modules**
• Around 1,000 MW of cell manufacturing capability exists in India • Policy framework in place to push consumption of cells manufactured in India • Economically priced wafers would increase the prospects of domestic cells	• Around 2,000 MW of domestic module manufacturing capability exists • This capability could be ramped up depending on viable local availability of input materials

[34] This was a testing unit which was made available purely for R&D purposes to an Indian solar facility.

Installed Indian Solar Manufacturing Capacity
Ingots & Wafers: 15 MW
Solar PV Cells: 1,000 MW
Solar Modules: 2,000 MW

capacity utilization for the industry has decreased over the years and is currently at about 50 percent.

Historically, Indian solar PV manufacturers have relied on exports. The balance of payment for this segment until FY 2011 was positive. Exports, however, declined significantly over FY 2012 and continue to do so over FY 2013. This points to a significant erosion in the cost-competitiveness of Indian manufacturers in the face of rapid price competition from Chinese and Taiwanese manufacturers, in particular. On the other hand, domestic demand for solar products picked up over FY 2012 but has been catered to by imports, primarily in the TF segment.

The lack of integrated operations covering wafers and ingots and of GW scale manufacturing, adopted by Chinese competitors, has started eroding the cost-competitiveness of Indian manufacturers in the c-Si segment. Among the differentiating input side factors, which need to be addressed by GoI to make Indian PV manufacturing competitive, are the following:

- Capital subsidies available under Special Incentive Package Scheme of 20 percent in Special Economic Zones and 25 percent outside the zones are not at par with those provided by China and Taiwan, which are in the range of 50 percent of capital costs;
- Provision of reliable and uninterrupted power at concessional rates is critical to wafer and cell manufacturing. Most Indian manufacturers resort to the use of diesel/gas-based captive generators during production, as supply quality is poor, adding to the cost of production significantly. Co-location and provision of manufacturing with cheaper sources of generation have not been explored in the Indian environment;
- Most of the raw materials and consumables for cell and module manufacturing are imported. This includes all gases, silver paste, ethylene vinyl acetate, and so on. A domestic ecosystem needs to be developed which can make the most of locally accessible components, minimizing supply chain challenges and also exercising control over random price fluctuations; and
- While import of solar modules/cells does not attract duties, manufacturers claimed that import of certain key input material used for solar cell manufacturing attracts import duties. Further, where export-oriented units (such as Indo-solar) propose to sell their output in

Table A10 1:
Performance of Indian Solar PV Manufacturers

Commodity	Export (in US$ Million)				Import (in US$ Million)			
	2009-10	2010-11	2011-12	2012-13*	2009-10	2010-11	2011-12	2012-13*
Solar cells/PV cells whether or not assembled in module/panel	290.17	511.69	163.06	77.08	213.75	252.63	1,348.48	449.01
Other photo cells	31.72	37.85	11.76	3.80	22.48	11.19	73.53	53.10
Total	**321.89**	**549.54**	**174.82**	**80.88**	**236.23**	**263.82**	**1422.01**	**502.11**

*April- December; Source: Department of Commerce, Government of India.

the domestic market (domestic tariff area), manufacturers are required to pay excise duty which makes them less competitive vis-à-vis duty-free imports.

2. BoS manufacturing

Company	Capacity
Bonfiglioli	400 MW
ABB	500 MW
Schneider	400 MW
AEG	400 MW

With a rapid decline in the cost of solar PV modules, the proportion of BoS in the capital cost of solar PV plants has started rising and currently accounts for almost 40-50 percent of the total capital cost of installations. India has done well in localizing manufacturing in this segment, with several global solar inverter manufacturers setting up facilities in India in recent times. Structures, connectors and mountings are low value items and are usually locally procured by developers.

3. Solar PV market – Global and Indian

Table A10 2:
Solar PV Market—Global and Indian

Component	Global Market Competition	Indian Context
Polysilicon feedstock	90% of the total polysilicon market supplied by the top 7 companies	No polysilicon manufacturing capability in India
Ingots and wafers	The top 5 companies cater to 90% of the total market	Limited presence in the segment
Cells	Fragmented market. Top 10 producers produced 50% of the world demand in 2008	Heavily dependent on imports (nearly 100%), resulting in higher cost compared to Chinese and other Asian countries (28 cents/watt peak (W_P) in India, compared to 19 cents/W_P outside)
Module	Very fragmented market. Overlapping segment with cell manufacturers. Differentiating factor is the efficiency on the module	Very heavily dependent on imports (about 90% of the value is imported). Higher costs compared to Chinese and other Asian countries (34 cents/W_P as compared to 27 cents/W_P, respectively)
Inverters	Market dominated by a few global players. Economies of scale required to build a production line	Huge base of nonsolar inverter manufacturers in India (estimated at about 3,200 MW manufactured every year). With some technology back up, Indian inverter manufacturers will be able to easily manufacture solar PV inverters
Battery	Existing battery manufacturers will easily be able to supply solar PV batteries	High dependence on imports
Transformers	Mature and competitive market with room for growth	Mature market
System integration	Mature market	Need to develop a network of system integrators

Sources: FICCI Solar Energy Task Force Report on "Securing the Supply Chain for Solar in India" (2013), German Development Institute/Deutsches Institut für Entwicklungspolitik (DIE): "Exploring the effectiveness of local content requirements in promoting solar PV manufacturing in India"; Green Rhine Ltd., 2013; Fraunhofer ISE (2012, 11-12); IRENA (2011, 7-8), authors' research.

Annex 11: Solar Thermal Manufacturing in India

One of the biggest drivers of cost reduction in the solar energy space is the availability of scale across the complete solar manufacturing supply chain as well as the associated ecosystem. Scale of operations and the ability to source all components without price shocks will be the biggest drivers of solar cost reduction in the future. India lags behind in this regard.

The recent World Bank report titled *Development of Local Supply Chain: A Critical Link for Concentrated Solar Power in India* has mapped the current local manufacturing capability for CSP in India. There is an almost negligible presence in the production of the key components of the CSP supply chain. Some components such as the power block or evacuated tubes might be available in the Indian market (for example, power block components are available due to the presence of established players in thermal power generation but have not been custom-built for CSP). However, the Indian industry is definitely not geared to the development of a scaled up version of a CSP supply chain.

To realize the CSP potential in India, existing Indian industries must identify the opportunities and react proactively to participate significantly in supplying CSP components and systems. Many traditional industries such as glass, metal, automotive, power and process heat, machine tools and robotics, and chemical industries can play an active role in the development of the Indian CSP industry. Many only need a modest effort to adapt their manufacturing processes to the demands of the CSP industry.

The study also proposes an action plan to stimulate local manufacturing of CSP components in India as shown in Figure A11 1.

Figure A11 1:
Action Plan for Local Manufacturing of CSP Components (India)

Section	Action Plan	Supportive Responsibility	Y1	Y2	Y3	Y4	Y5
Long-term policy framework for CSTP development	Year-wise allocation for Concentrated Solar Thermal Power (CSTP) power projects	MNRE					
	Regulatory support & tariff mechanism for solar thermal hybrid projects	MNRE & CERC					
	Renewable energy certificate mechanism for solar thermal energy generation	CERC					
Planning for payment security	Adequate payment security mechanism using the coal cess funds	Ministry of Finance (MoF)/MNRE					
Low-cost financing	Enablement of low-cost financing for CSTP from banks & separate exposure limits for CSTP projects	MoF					
Financial planning of subsidies and incentives	Concessional customs duty and zero excise duties for materials and components used for manufacturing of solar systems	MoF					
	Fiscal incentives for sponsored research and in-house R&D expenditure	MoF					

contd...

Section	Action Plan	Supportive Responsibility	Y1	Y2	Y3	Y4	Y5
Mechanism for promotion of R&D and innovation	Development and maintenance of a public repository of knowledge	MNRE					
	Development of quality and specification standards	MNRE					
	Establishment of an R&D framework on a public-private partnership basis	MNRE					
	Development of solar energy courses	MNRE					
	Sponsored research projects in educational institutions	MNRE					

Source: Development of Local Supply Chain: A Critical Link for Concentrated Solar Power in India.

Annex 12: International Experience in CSP Projects

Two major markets of CSP, the U.S. and Spain, have been growing with broadly similar approaches of initially applying technology push instruments such as demonstration projects, public financing, R&D, and so on, and thereafter (after proving the technology) utilizing market or demand pull instruments such as FiT, Renewable Portfolio Standard (RPS), and so on, to facilitate the deployment of commercial projects. The difference in approach, however, exists in terms of choice of market instruments. The U.S. is using the RPS mechanism whereas the FiT instrument is being utilized in Spain. Table A12 1 highlights the details of incentives available in Spain and the U.S. for development of CSP.

Also realizing that CSP technology has still a long way to go to match the commercial scale of operation enjoyed by PV technology, both countries use public funding or federal incentives to facilitate development of projects.

1. Development of CSP in Spain

Figure A12 1 shows the chronology of events in shaping Spain as a market for CSP. It has been shown that, initially, public funding was utilized on research and demonstration projects and, subsequently, FiT was introduced to upscale the market with commercial and private projects. The R&D projects[35] were implemented to proof the technology and push the supply chain into the market. Later, government-funded demonstration projects were commissioned.

Public funding for CSP development in Europe: Since 1994 (Fourth Framework Program of EC), the EC has spent some €29 million on the development and implementation of CSP technologies. An additional €15 million has been spent on supporting three major full-scale MW size demonstration projects under the Fifth Framework Program (1998-2002):

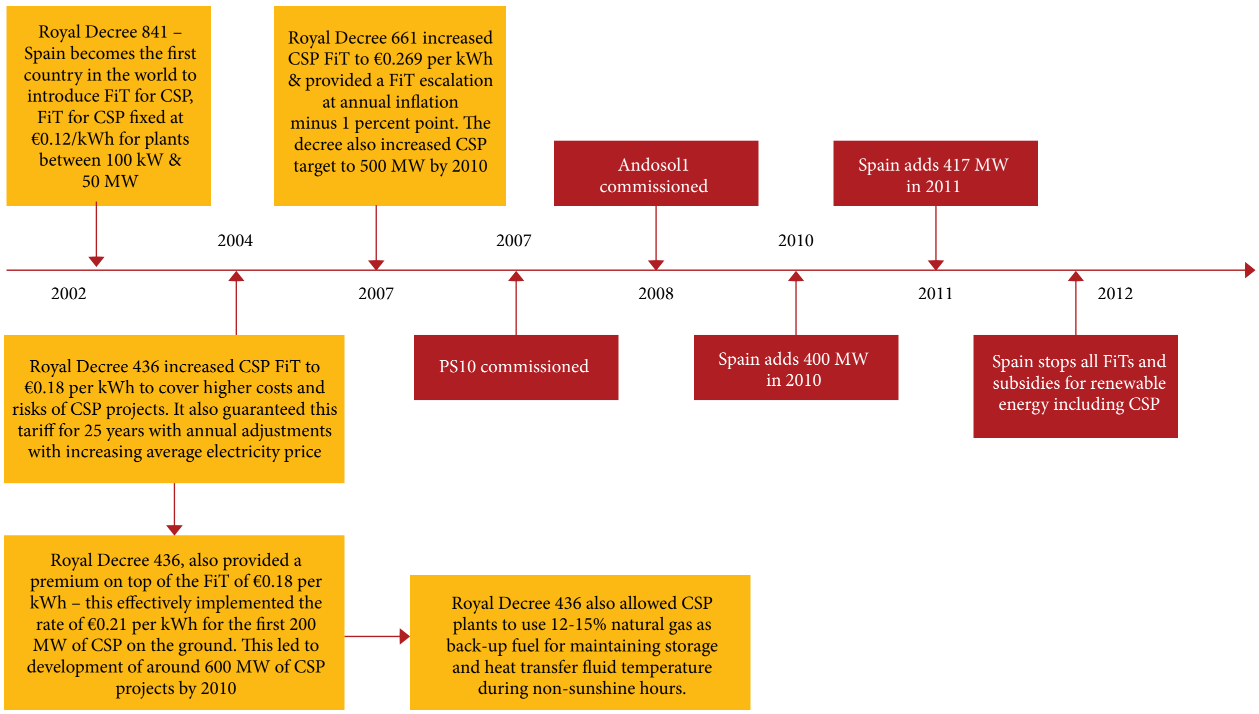
Table A12 1:
International Experience, CSP Projects

S No	Country/State	Supply or Technology Push Instruments	Demand or Market Pull Instruments and Federal Incentives
1	Spain	• Several R&D projects funded by EC • EC funding for development of MW scale projects – PS 10, Andasol	• FiT
2	U.S. Total	• Government funding for demonstration projects • Institutional and private risk capital investments backed by government energy procurement	• Accelerated depreciation • Investment tax credit • Federal loan guarantees • Clean energy renewable bond
3	U.S. California	NA	• RPS 33% by 2020 • Tax credit/property tax exemption

Sources: OECD Environment Directorate 2004, The World Bank report on CSP in developing countries, European Commission.

[35] List of EC funded R&D projects can be accessed at http://ec.europa.eu/research/energy/eu/index_en.cfm?pg=projects#results

Figure A12 1:
Development of CSP, Spain



Source: CSP Today, USA 2012.

- PS10: 11 MW solar thermal power plant in southern Spain;
- Andasol: 50 MW parabolic trough plant with thermal storage; and
- SOLAR TRES: 15 MW solar tower with molten salt storage.

In addition to the applicable FiT regime in Spain, CSP research is one of the priorities of the Seventh Framework Program (FP7, 2007-2013) of the EC. The EC is committed to continue supporting the scaling up of promising CSP technologies from research, development and demonstration scale to a pre-commercial feasibility phase in the multi-MW range.

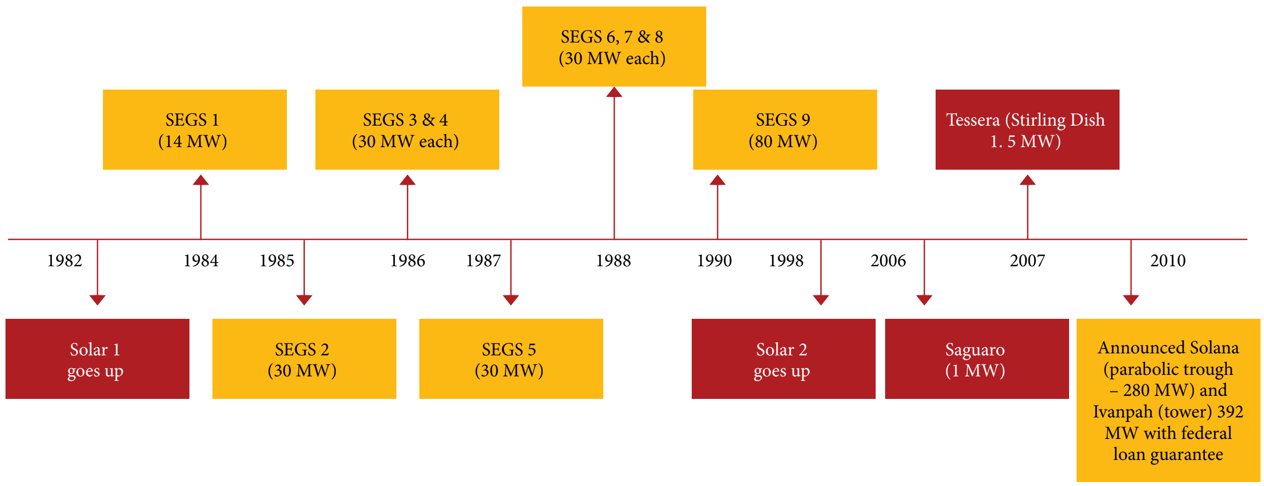
2. Development of CSP in the U.S.

The Solar 1 CSP plant was designed with funding provided by the Department of Energy in the late 1970s and early 1980s. A consortium of government, national labs, and industry built this 10 MW steam power tower project (1982) for demonstration purposes.

Thereafter, Luz International Ltd. built a series of nine solar electric generating systems, from 1984 to 1990 in the Californian Mojave desert, ranging from 14 to 80 MW electric unit capacities and totalling 354 MW electric of grid electricity.

The US$1.2 billion was raised for these plants from private risk capital investors and institutional investors (notably subsidiaries of East Cost utilities). These ventures were significantly aided by federal and state tax incentives (from 35 percent in 1984-86 to 10 percent in 1989) as well as attractive long-term power purchase contracts. With no further R&D in the technology, the development of the market was stalled for more than a decade.

Figure A12 2:
Development of CSP, U.S.



Source: CSP today, U.S. 2012.
SEGS: Solar Energy Generating Systems.

Continued R&D and demonstration projects: Recognizing that the industry could not establish CSP projects for more than a year, the U.S. Government decided to continue to install demonstration projects. Projects such as Saguaro (1 MW) and Tessera (Stirling Dish 1.5 MW) were demonstrated.

Federal loan guarantee in the U.S.: A majority of project developers in the U.S. found it difficult to achieve nonrecourse financing for their CSP projects under the prevalent RPS mechanism. The federal loan guarantee scheme (with a corpus of US$10 billion for renewable energy efficiency and other segments) has enabled projects of Brightsource Energy and Abengoa to achieve financing.

Annex 13: Overall Funds Requirement for JNNSM Phase I

JNNSM Phase I (Batch 1 and Batch 2) developers would need over INR 110 billion (US$1.83 billion) to implement the conceived 480 MW of solar PV and 470 MW of solar thermal. At a debt: equity of 70:30, this is an estimated INR 76 billion (US$1.27 billion) of debt financing.

This is in addition to about 970 MW of solar projects that have signed PPAs and are under development in Gujarat and several other states that have come up later with their own policies.

Table A13 1:
Overall Funding Requirement for JNNSM Phase I

Category	Indicative Cost	Capacity	Funding Requirement
Solar PV	• @ INR 110 million (US$1.83 million) per MW (Batch 1) • @ INR 100 million (US$1.67 million) per MW (Batch 2)	• Batch 1: 140 MW • Batch 2: 340 MW	• INR 15.4 billion (US$260 million) • INR 34 billion (US$570 million)
Solar thermal (without storage; parabolic trough)	@ INR 120 million (US$2.00 million) per MW	Batch 1: 470 MW	INR 56.4 billion (US$940 million)
Total			INR 105.8 billion (US$1.77 billion)

Sources: Authors' research.

Annex 14: Key Incentives/Instruments for Solar Promotion in India

Table A14 1:
Key Incentives for Solar Promotion in India

S No	Scheme Name	Details
1.	GBI[36]	• A GBI of INR 12.41 per kWh is provided to the state utility, on a first-come-first-served basis (the first 100 MW of capacity will be eligible) • Eligibility criteria – rooftop and small ground mounted (100 kW to 2 MW) connected to High Tension (HT) 33 kV and below lines (provided under JNNSM Phase I)
2.	Various tax exemptions[37]	• No customs and excise duty on cells and modules but some raw materials required to manufacture cells and modules attract 5% customs duty and countervailing duties • Import of plant and machinery for the setting up of solar power projects is exempted from additional custom duty and the total custom duty leviable has come down from 9.35% to 5.15% • Goods required for manufacturing of solar cells and modules have been exempted from additional custom duty and the total custom duty leviable has come down to 9.35%.
3.	Accelerated depreciation	• Accelerated depreciation of as high as 80% of the asset value
4.	VGF[38] (draft for discussion)	• Tariff fixed at INR 5.45/kWh (INR 4.95/kWh for projects not availing of accelerated depreciation). • A VGF of 30% of project cost subject to a maximum of INR 25 million/MW will be provided by MNRE • Developer needs to put in his equity of at INR 11.5 million/MW • VGF will be released in three phases: 25% at time of delivery; 50% at the time of commissioning; and 25% after one year of successful and satisfactory operation
5.	REC	• CERC has fixed a solar REC price band of INR 9,300 to INR 13,400 till FY 2017 • Solar REC not issued to solar power developers having PPAs with distribution utility at preferential tariff or at a tariff determined under section 62 or adopted under section 63 of the Act by the Appropriate Commission

Sources: Author's research.

[36] Press Information Bureau of India release, dated December 16, 2011.
[37] MNRE presentation: Grid Connected Solar Power in India.
[38] MNRE Policy document for Phase II of JNNSM.

Annex 15: Regulatory and Policy Provisions for Renewable Energy

Electricity Act, 2003	**Section 86 1(e)** "promote cogeneration and generation of electricity from renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any person, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licence"
National Electricity Policy	**Section 5.12.2** "……Such percentage for purchase of power from non-conventional sources should be made applicable for the tariffs to be determined by the SERCs at the earliest. Progressively the share of electricity from non-conventional sources would need to be increased as prescribed by State Electricity Regulatory Commissions. Such purchase by distribution companies shall be through competitive bidding process. Considering the fact that it will take some time before non-conventional technologies compete, in terms of cost, with conventional sources, the Commission may determine an appropriate differential in prices to promote these technologies."
National Tariff Policy	**Section 6.4 (1)** "Pursuant to provisions of section 86(1)(e) of the Act, the Appropriate Commission shall fix a minimum percentage for purchase of energy from such sources taking into account availability of such resources in the region and its impact on retail tariffs. Such percentage for purchase of energy should be made applicable for the tariffs to be determined by the SERCs latest by April 1, 2006. It will take some time before non-conventional technologies can compete with conventional sources in terms of cost of electricity. Therefore, procurement by distribution companies shall be done at preferential tariffs determined by the Appropriate Commission." ***The National Tariff Policy was amended in January 2011 to prescribe solar-specific RPO be increased from a minimum of 0.25 percent in 2012 to 3 percent by 2022.***

Annex 16: Competitive Bidding for Renewable Energy Projects

Guidelines for tariff-based competitive bidding process for grid-connected power projects based on renewable energy sources, December 2012

1. Case I: renewable energy procurement, where the location or technology of the renewable power project is not specified by the procurer

To ensure serious participation in the bidding process and timely commencement of the supply of power, the bidder, in case the supply is proposed from a power station to be set up, should be required to submit along with the bid, documents in support of having completed specific actions for project preparatory activities in respect of matters mentioned below:

i) **Site identification and land acquisition:** The requirement of land would be considered as indicated in the proposal filed with the competent authority for issuing the No Objection Certificate (NOC) for the project. In case of land is to be acquired under the Land Acquisition Act 1894 or its equivalent, the bidder shall submit copy of the notification issued for such land under Section 6 of the Land Acquisition Act 1894 or its equivalent. In all other cases, the bidder shall furnish documentary evidence in the form of certificates by concerned and competent revenue/registration authority for allotment of the land;

ii) **Environmental clearance for the power station:** The proposal for obtaining NOC should have been submitted to the competent authority responsible for providing final approval at the time of submission of the Request for Proposal (RFP) bid;

iii) **Forest clearance (if applicable) for the land for the power station:** The bidder should have submitted the requisite proposal to the concerned administrative authority responsible for according final approval in the central/state government, as the case may be;

iv) **Water linkage:** For solar thermal and hybrid power projects, the bidder shall have acquired approval from the concerned State Irrigation Department or any other relevant authority for the quantity of water required for the power station; and

v) **Technology tie-up:** The bidder shall be required to provide proof of the technology tie-up for the renewable power project.

2. CASE II: renewable energy procurement for the location-specific renewable, which the procurer intends to set up under a tariff-based bidding process

To ensure timely commencement of supply of electricity being procured and to convince the bidders about the irrevocable intention of the procurer, it is necessary that various project preparatory activities are completed in time. For long-term procurement for projects for which pre-identified sites are to be utilized, the following project preparatory activities should be completed by the procurer or an authorized representative of the procurer, simultaneously with the bidding process adhering to the milestones indicated below:

i) **Site identification and land acquisition:** If the land is required to be acquired for the power station, the notification under section 6 of the Land Acquisition Act, 1894 or its equivalent should have been issued before the publication of RFP. If the provisions of section 17 of the Land Acquisition Act, 1894 or its equivalent regarding an emergency have not been applied, the award under the Land Acquisition Act or its equivalent should have been declared before the PPA becomes effective;

ii) **Environmental clearance for the power station:** The application to the competent authority for grant of NOC should have been submitted before issuing the RFP and the NOC should be in place before the PPA becomes effective;

iii) **Forest clearance (if applicable) for the land for the power station:** The requisite proposal for forest clearance should have been submitted before the concerned administrative authority responsible for according the final approval in the central/state government, as the case may be, before the issue of the RFP;

iv) **Water linkage:** For solar thermal and hybrid power projects, approval from the concerned State Irrigation Department or any other relevant authority for the quantity of water required for the power station should have been obtained; and

v) **Requisite solar radiation, hydrological, geological, meteorological and seismological data necessary for the preparation of the Detailed Project Report, where applicable:** The data should be made available to the bidders during the RFP stage, that is, at least 30 days prior to the submission of the RFP bid. The bidder shall be free to verify geological data through its own sources, as the geological risk would lie with the project developer.

Annex 17: Institutional Framework for the Solar Sector

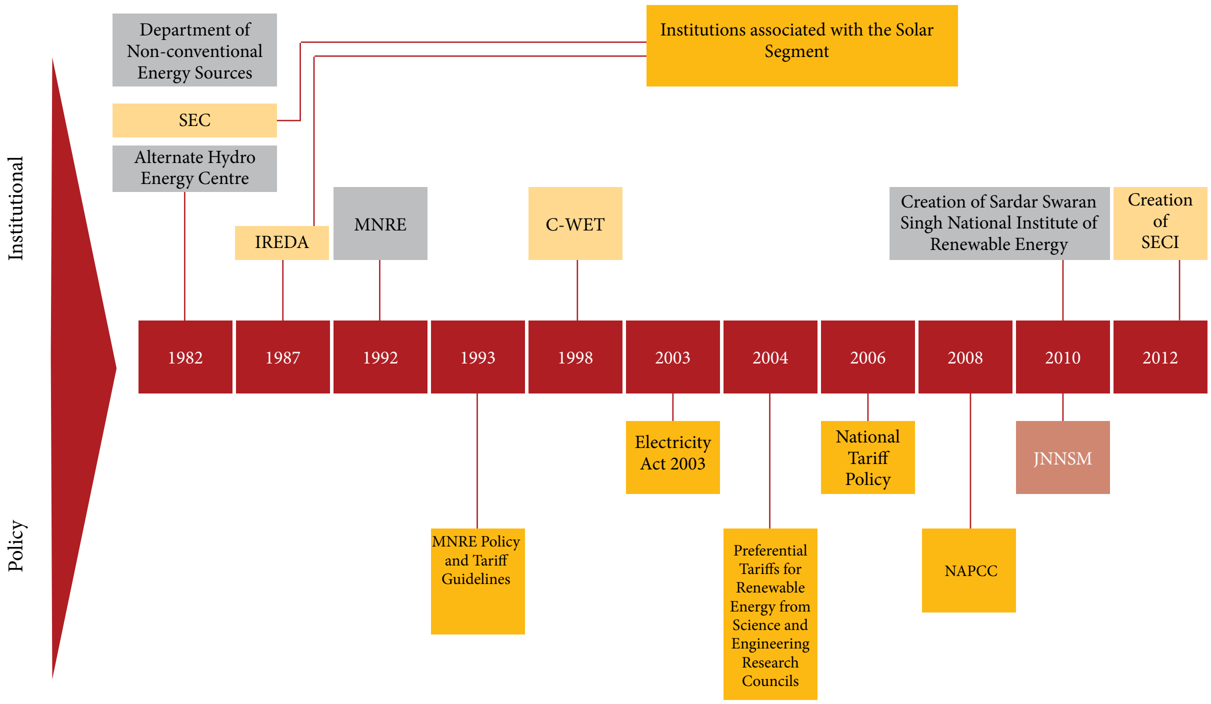
Key Areas of Institutional Interventions

- **Program implementation**
  The MNRE undertakes various solar energy specific programs. The SNAs act as the program implementation agencies at the state level. However, at central level, MNRE has been directly overseeing program implementation until now. The SECI has been recently formed to assist MNRE in undertaking solar programs.

- **Monitoring and evaluation**
  M&E of the rural solar energy programs has been an area of concern. Issues related to lack of O&M expertise and equipment availability are faced by the rural solar programs. SNAs, due to their limited capabilities/resources, are not able to overcome these issues on a sustainable basis. Institutional intervention at the central level is required to overcome these issues, with to establish a well-coordinated arrangement with SNAs.

- **Coordination arrangement**
  State and center coordination: There is no established framework for coordination between the SNAs and the MNRE's administered institutions such as SEC, SECI and IREDA. There are a number of solar energy programs which are undertaken and coordination is limited to the specific programs. Institutional intervention at the central level can facilitate in establishing a framework to facilitate state and center coordination aimed at solar sector development, to leverage synergies across different programs;

Figure A17 1 :
Central Institutions with Solar Sector



Source: Authors' research.

Coordination among MNRE institutions: SECI has been mandated to undertake program implementation and set up projects in the area of solar energy. In this respect, it will need support from other MNRE institutions such as SEC, IREDA and C-WET on areas like solar radiation data, site attractiveness, technology attractiveness, and financing which will form a major factor in implementation of solar programs (grid and off-grid).

Institutional intervention is required from MNRE administered institutions on aspects related to planning/implementation of evacuation infrastructure in regions (high potential), facilitating approval and clearances for strategic projects. Most issues are related to state-specific implementation. However, the involvement of central-level institution can be crucial in the success of solar projects strategic to sector development.

The solar energy segment has an adequate number of institutions to undertake the mandates required for the growth of the sector:

- SEC and C-WET to focus on technology demonstration, resource assessment;
- SEC to assist MNRE in implementation of solar programs (grid as well as off-grid);
- State level implementation by the SNAs; and
- IREDA to facilitate financing.

Role of SEC

The SEC is the primary entity for undertaking activities in the area of technology R&D, testing, evaluation and standards:

- The JNNSM envisages that the MNRE-administered SEC will become part of the National Center of Excellence. It is expected that, increasingly, SEC will need to move towards being adequately autonomous in its decision-making and flexible in adopting processes and systems to meet its own requirement;
- The SEC will have multiple roles to execute, namely, of being a premier center for technology R&D, support the GoI in its solar testing, calibration and benchmarking initiatives, offer knowledge services and, in the long run, facilitate technology commercialization initiatives; and
- Currently, SEC is organized as a division of MNRE. However, SEC being a division (directly) under MNRE may pose a challenge for SEC in undertaking substantive multi-institutional participation (having diverse contractual arrangements, especially with the private sector) and establishing itself as a self-sustainable and accountable institution.

Role of SECI

- A newly formed organization with a focus on solar technologies;
- Established as a Section 25 company which provides for institutional autonomy; GoI is expected to hold a 100 percent equity stake in the company;
- Roles and responsibilities:
  - To function as a solar development implementation institution and assist the MNRE as an executing arm for meeting goals
  - Only institution in the renewable energy sector with a large scope of mandate to implement solar projects in grid as well as off-grid setup (under program administration as well as project management
  - SECI to play an active role in the implementation of power evacuation arrangements;
- Expected to be a stepping stone for overcoming issues related to program implementation at the central level and other related implementation aspects; and
- SECI is expected to tackle issues pertaining to planning, management and implementation with a professional and holistic approach. Other MNRE institutions such as SEC, C-WET and IREDA are expected to support SECI in the achievement of JNNSM and other sector requirements.

Role of IREDA

IREDA is a public limited government company established in 1987, under the administrative control of MNRE, to promote, develop and extend financial assistance for renewable energy and energy efficiency/conservation projects.

It has developed norms to undertake its lending functions covering aspects such as loan application registration, project appraisal, sanction of loan, security creation, and disbursement and recovery of loan. In the solar energy segment, IREDA has also played the role of program administrator for the GBI under the RPSSGP scheme in JNNSM Phase I and is responsible for project allotment and disbursement of GBI.

Role of State Nodal Agencies

SNAs play an important role in the implementation of central as well as state-level policies/programs for renewable energy including solar energy in the state. SNAs are responsible for grid as well as off-grid solar power project/program implementation.

The main roles and responsibilities of the SNAs in the area of solar energy include:

- **Policy formulation support:** Advocacy of policies, legislation and enforcement mechanisms for promotion of solar energy;
- **Implementation:** Project registration, facilitation in approval and clearances, coordination with state and central departments;
- **M&E:** Supervision, monitoring and evaluation of the solar energy programs;
- **Resource assessment:** Survey and mapping of resource potential and subsequent dissemination to encourage project installation; and
- **Awareness generation and capacity building:** Undertake activities to raise public awareness and disseminate information related to solar energy.

Annex 18: Gujarat Solar Park—A Case Study

Gujarat Solar Park is the world's first multi-developer, multi-facility, multi-technology and multi-beneficiary solar park; it is located in Charanka village, district Patan, Gujarat. It was implemented speedily with the entire park becoming operational in one year, starting with land acquisition to commissioning of 214 MW solar projects.

Background

In September 2009, the Clinton Climate Initiative signed a Memorandum of Understanding with the Government of Gujarat for setting up of solar parks. The implementation of the solar park concept was proposed in several phases with the aim to make Gujarat a hub for solar power generation and also to bring in manufacturing and R&D facilities to support this goal.

The initial solar projects in Gujarat had faced problems in terms of private land acquisition leading to legal issues and procedural delays, conversion of agricultural land, transmission connectivity issues, procedural delays due to multiplicity of the agencies, and so on. Considering all these difficulties, the solar park was conceptualized with the purpose of:

- Developing a concentrated zone for solar project activities; and
- Providing all the primary infrastructure such as land allotment, roads, power evacuation network, water supply system, and so on, for ease of operation and rapid development of the solar project at a single location.

The Charanka site in Patan district was identified for the development of first such solar park focused on generation, the foundation stone was laid in December 2010, and 214 MW was commissioned by January 2012.

Figure A18 A:
Gujarat Solar Park Layout Plan

GPCL was appointed as the nodal solar park development agency for the execution of solar parks in Gujarat. It has played a crucial role in ensuring the implementation and operations of the Charanka solar park.

Key Features

The solar park presents a plug and play model for potential investors, by designating and developing one or more blocks of land as a concentrated zone for solar development. Individual solar plants share common power evacuation facilities, reducing costs. The major interest in these concentrated hubs has been due to their ability to achieve economies of scale by developing shared infrastructure facilities for each business located in the zone. In addition, they reduce unforeseen risks for investors by acting as a single-window clearance agency and providing certainty with respect to investment and relevant policy, regulatory and incentive frameworks. These zones also serve as centers for targeted social development by virtue of their location in underdeveloped/backward regions. In this manner, these parks provide economic and employment opportunities for specific regions.

Gujarat Solar Park has large concentration of solar power generating units in a single location in Asia. It has a capacity potential of more than 500 MW, covering a land area of 2,024 hectares, comprising government land (1,080 hectares) and private land (944 hectares).

The park has been able to attract more than 21 developers from India and abroad with varied capacities ranging from 1 MW to 25 MW. The park comprises a mix of technologies, ranging from TF PV, c-Si, tracker-based, and so on.

The park provides a multi-facility infrastructure to the developers, including:

- Requisite size plot allotment;
- Approach and access roads;
- Smart power evacuation network up to the project premises; and
- Water supply system.

The solar park provides infrastructure facilities such as roads, water pipeline, water and sewage treatment plant, helipad, fencing, leveled land, fire station, telecom network, 400/220/66 KV sub-station and 66 kV auxiliary sub-station. The within park distribution network development cost for infrastructure and land in the solar park is around INR 5,500 million (US$91.67 million). The land allotment has been done by the nodal agency (GPCL) through a transparent process. The developers have to pay processing fees, allotment fees, security deposit and a development charge based on the area occupied.

Key Benefits

The park has been able to benefit various stakeholders such as government agencies, private developers, financial institutions and the society at large. Some of the benefits include:

- Savings in terms of clustered infrastructure development instead of segregated development for individual projects as well as cost savings due to sharing of common infrastructure cost;
- Overall emission reduction and avoidance of Right of Way issues for transmission evacuation;
- Single window clearance ease for developers;
- Due diligence assistance for financial institutions;
- Unique smart grid features incorporated in the design;
- Development of government wasteland;
- Social uplift around solar park site and local employment generation; and
- Intangible benefits in terms of increase in vegetation cover and water conservation.

The successful implementation of the solar park concept in Gujarat is likely to pave the way for the development of bigger and better infrastructure facilities for solar projects in other parts of India. MNRE is already working on a plan to set up five ultra-mega renewable energy parks across different states. These solar parks are likely to come up in Rajasthan, Gujarat and Jammu & Kashmir. The first ultra-mega solar park of 4 GW capacity is being set up in Sambhar, Rajasthan.

Notes

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