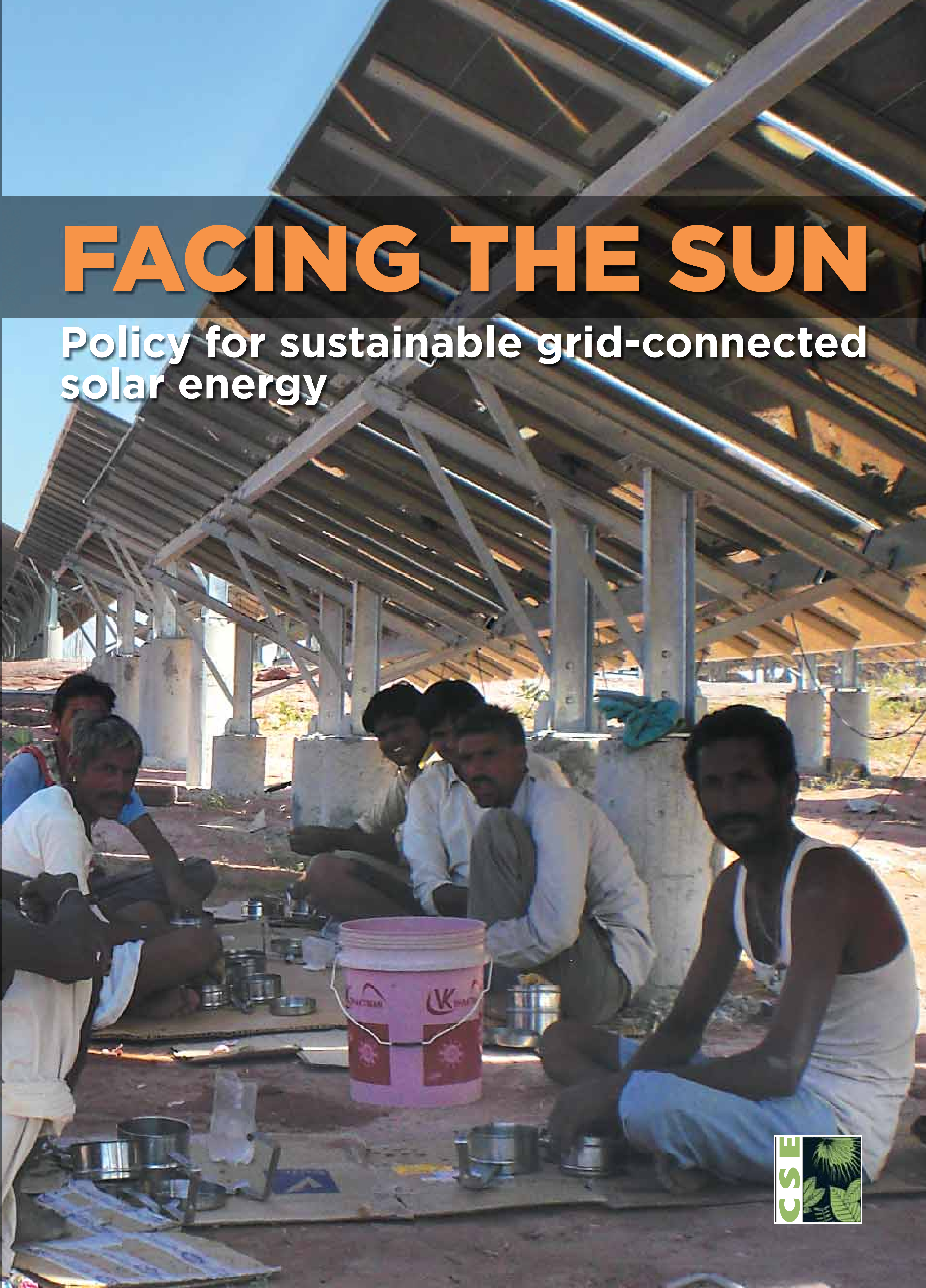
FACING THE SUN

Policy for sustainable grid-connected solar energy



CSE

FACING THE SUN

Policy for sustainable grid-connected solar energy

Centre for Science and Environment

Research director: **Chandra Bhushan**

Lead researcher: **Jonas Hamberg**

Contributor: **Kushal Pal Singh Yadav**

Editors: **Souparno Banerjee and Papia Samajdar**

Design and layout: **Surya Sen and Shri Krishan**

Production: **Rakesh Shrivastava and Gundhar Das**

Cover photo: **Jonas Hamberg**

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41 Tughlakabad Institutional Area
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Ph: 91-11-2995 6110, 2995 5124, 2995 6394, 2995 6499
Fax: 91-11-2995 5879, 2995 0870
Email: cse@cseindia.org **Website:** www.cseindia.org

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Foreword

Grid-connected solar power is a new and rapidly growing sector in India – from almost nil grid-connected solar power in 2009, if everything goes as per the plan, the country will have 2.5 gigawatts (GW) by 2014. It has already installed about 1.0 GW. The Union government plans to install 20 GW by 2022.

The speed of development in the sector has dazzled everyone. Most state governments are rushing to introduce solar energy policies; many have announced (or auctioned) megawatt-scale solar power plants. International and domestic consultancy agencies are regularly reporting on the market, technology or potential of grid-connected solar power. Hardly a month goes by when a major conference is not held on this sector.

But all this is just *noise*. There is hardly any independent research on how grid-connected projects are being implemented, what are the concerns of manufacturers, how are the government programmes performing, how are subsidies being utilised and most importantly, what positive or negative impacts – social, economic and environment – these projects have on the ground. On the clean energy stage, as we found to our surprise, most actors have clear interests: one is either a developer, a technology supplier, a consultant, an NGO implementing small-scale projects, a funding body, or a regulatory institution. But there are no institutions or bodies undertaking policy advocacy or performing a watchdog role.

It was precisely for this reason that we, at Centre for Science and Environment (CSE), decided to setup a small team to monitor and conduct policy research and advocacy on solar energy, including the implementation of the centrally-sponsored Jawaharlal Nehru National Solar Mission (JNNSM).

In the last one year, we have looked at all facets of the national grid-connected solar sector. The CSE team has visited solar projects comingup in Gujarat and Rajasthan – the key states where most grid-connected plants are being built. It has toured Tamil Nadu and Haryana to survey solar power plants. At every site,we have interacted with the project developers and the local community. We have met government officials at the local, state and national levels. This report is the outcome of the year-long research we have done to understand what is working and what is not working in grid-connected solar power.

What emerges is a fascinating picture of a sector that has captured the imagination of the private sector and the government alike. But what we also find is how, in the quest for rapid installation, some very important issues have been disregarded. These issues, if not addressed adequately, have the potential to stop this nascent sector in its tracks.

The very first of these issues is the institutional mechanism and processes through which grid-connected solar projects have been awarded under JNNSM and in other states. Our research on the first phase of JNNSM shows that the procedures for awarding and monitoring projects were questionable and non-transparent. This allowed a few companies to bend rules and corner the bulk of the projects under the first batch. The lesson: we must get our institutional structure and processes right for a transparent, vibrant and competitive solar sector. This lesson must be internalised by the Solar Energy Corporation of India, the institution being setup to implement JNNSM.

The second issue of concern is how to fund the next phase of solar power plants – the remaining 19 GW by 2022 under JNNSM as also the plants under the various state programmes. Despite falling prices, solar energy remains quite expensive compared to conventional energy.Our estimate is that the grid-parity can only be reached in the next 15 years or more. On top of it, most state electricity boards are facing bankruptcy; even a state like Gujarat, with a profitable electricity board, is not keen on allocating money for the next phase of its own solar programme. There are some domestic sources of funds, such as the National Clean Energy Fund ora cess on electricity generated from fossil fuels, like the Gujarat Green Cess or feed-in-tariff directly supported from the central exchequer. But these sources can at best provide a bridge, and will never be sufficient for an ambitious solar programme.

As far as international funding is concerned, it is too little and cumbersome. Clean Development Mechanism (CDM) cannot support even 10 per cent of the feed-intariff at the price at which carbon credits are being sold today. The Green Climate Fund (GCF) – worth US $100 billion by 2020 –is a possibility. But for that, countries will have to ensure GCF can support feed-intariff for solar energy in developing countries. What comes out from our research is that all sources of funds will be necessary – domestic as well as international – at least in the next 10-15 years for the expansion of solar power in India. In addition, any move to give capital subsidy (for instance, the proposal to give viability gap funding for the second phase of JNNSM) to the solar sector would be counter-productive; feed-intariff remains the best way for the growth of the sector in an efficient and transparent way.

The report has looked atthe domestic solar manufacturing sector and how it has been short-changed by market-distorting practices of American and Chinese companies. Webelieve that a strong domestic manufacturing sector is essential for a bright solar energy future of the country. The report, therefore, recommends supporting the domestic manufacturing sector, including public support for R&D in technology development and manufacturing.

We have spent a lot of time studying the environmental and social issues arising out of the installation of large-scale solar power plants. These issues have been completely disregarded or have escaped the attention of government and industry alike; this is probably because of the popular perception of solar energy being ‘clean’,with no social and environmental externalities. Our research, however, shows that solar power development does affect land and water.

Land, in fact, is at the centre of dispute at most major solar sites. While it has immense potential for upsetting the industry’s growth trajectory, it also provides an opportunity to redefine relationships between communities that own the land and solar power developers who want that land. Our slogan, therefore, is ‘Solar energy needs solar farmers’. But this slogan will not become a reality by just changing policy; it will require a change in mindsets. Our other recommendation is that we must start working on making solar energy more land and water efficient.

For India, solar energy is important not only because it is ‘clean’, but also because it has the potential to play a major role in achieving energy security for the country in future. Our aim is to influence policy and practices to create the best possible scenario for development of a truly clean solar sector. This book, we hope,would be the beginning.

– Chandra Bhushan

CHAPTER **1**

From zero to a gigawatt in three years

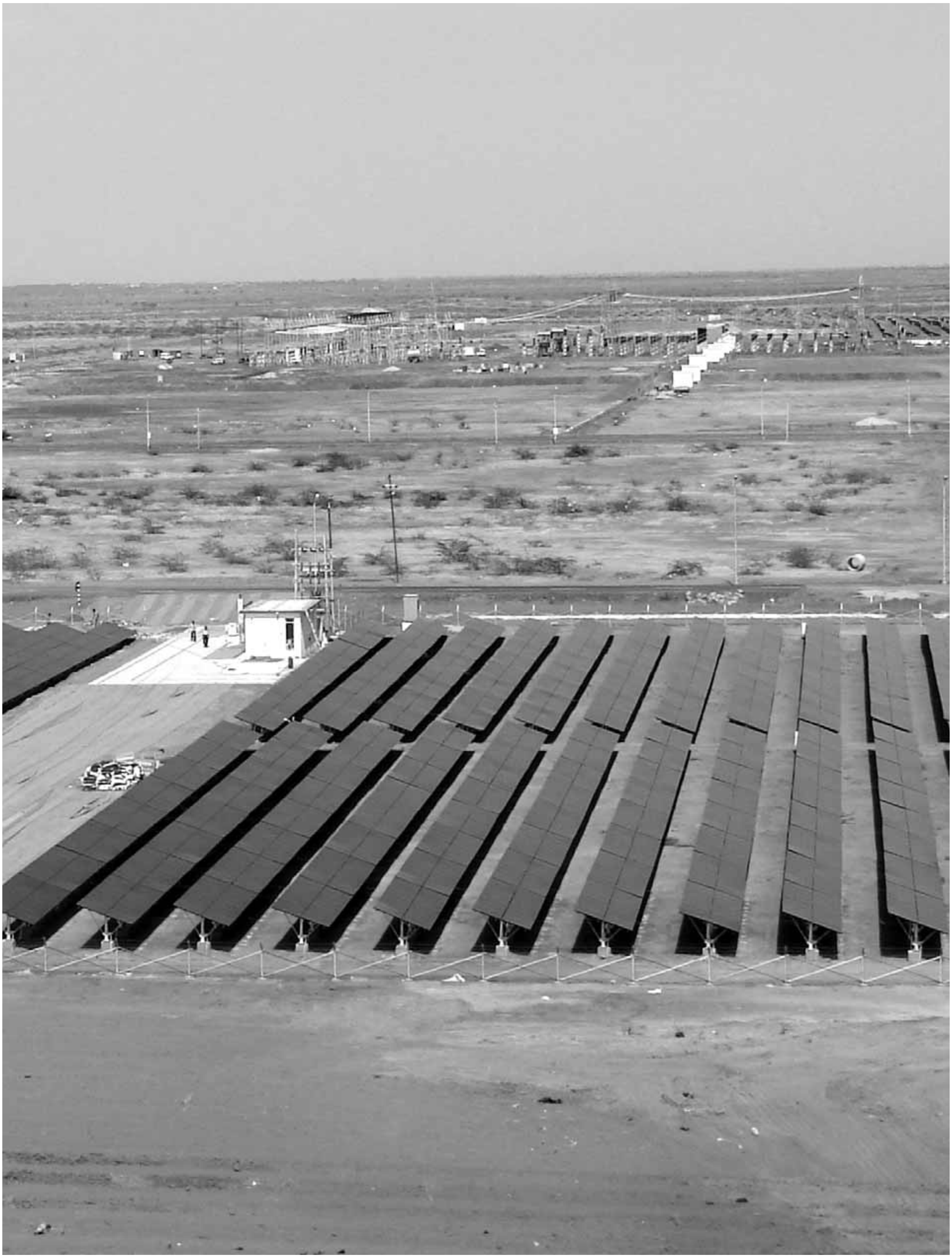
In June 2009, India did not have a single large-scale grid-connected solar power project[1]. By June 2012, the 1 gigawatt mark was all set to be breached – 979.4 megawatt of solar capacity had been commissioned in the country within just three years[2]

A large grid-connected solar PV project under construction

Before 2008, solar power was being used in India at a small scale, largely in off-grid lighting systems or research and demonstration work supported by the government and various international organisations. The government – through the Union ministry of new and renewable energy (MNRE) – had introduced schemes, most of which were geared towards supporting household-level applications. There were no schemes for aiding grid-scale solar projects. The Jawaharlal Nehru National Solar Mission (JNNSM) was the first programme in India to support megawatt-scale grid-connected solar power projects.

One of the reasons why large-scale solar occupied a lower priority was that it was perceived as being too expensive to compete with other power generating technologies. In 2008, prices of solar photo-voltaic (SPV) had peaked at a steep US $4 per Watt-peak (Wp).[3] Post-2008, prices came down drastically, breaking the magic barrier of US $1/Wp and kickstarting growth in the Indian solar power sector.[4] The Indian solar industry really emerged as recently as in 2009: four grid-connected solar projects totalling 9 megawatt (MW) were installed in the second half of the year.

The first of these, a 1-MW SPV plant set up by the West Bengal Green Energy Development Corporation, was commissioned in August 2009. Two 3-MW projects by the Karnataka Power Corporation and a 2-MW project in Punjab by Azure Power, a solar power project developer, followed. The first and the only operating plant



A 1-MW solar PV thin-film project in Gujarat based on solar thermal technology was installed in May 2011 by Acme Telepower, in Rajasthan.

The coming of the Solar Mission

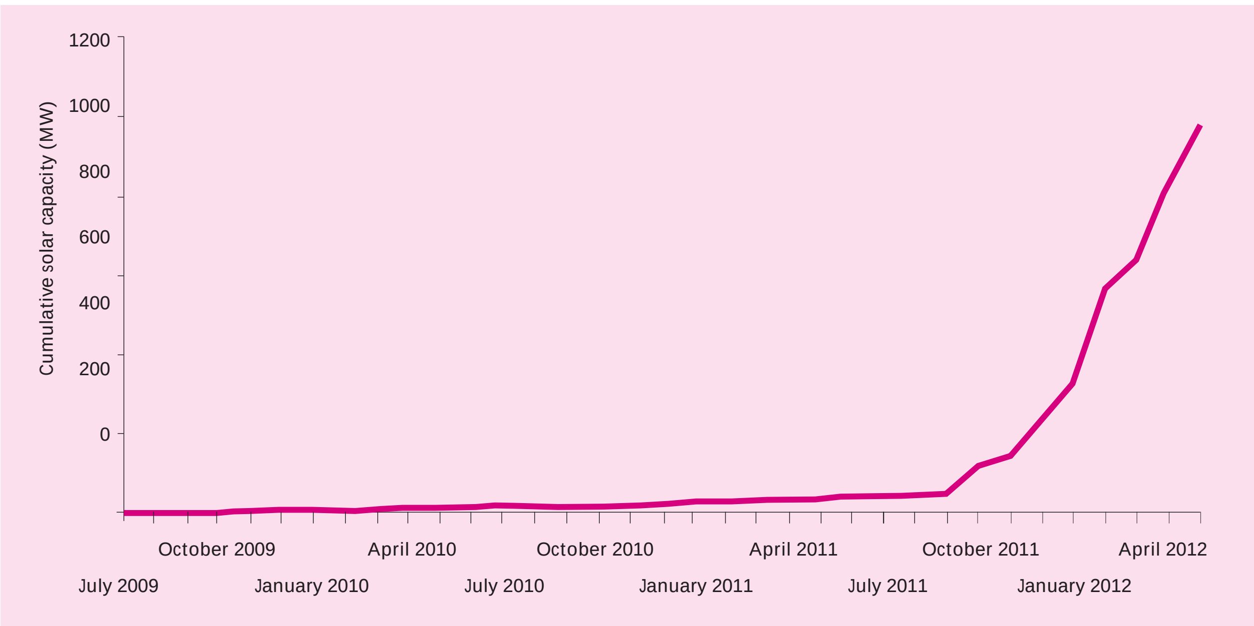
In June 2008, prime minister, Manmohan Singh launched the National Action Plan on Climate Change (NAPCC).[5] Eight 'missions' were part of the plan: increasing energy use from solar was one of them.[6] In January 2010, the government took the next step and announced the JNNSM – with the objective of making solar power affordable through its increased use and manufacturing.[7,8] The ambitious Mission aims for 22,000 MW of installed solar capacity by 2022.

Besides JNNSM, the Gujarat Solar Policy has contributed the most to the development of solar power in India. In fact, the Gujarat Solar Policy is the biggest programme for installed capacity as of now. Launched in 2009, this policy originally aimed to achieve 500 MW of grid-connected solar power by 2014 in the state, a goal that has already been reached.[9]

Since the launch of the Solar Mission, India has seen a remarkable growth in installed capacity of grid-connected solar power (see Graph 1.1: *Rapid increase*) – in spite of its share of roadblocks (land acquisition and capital, for instance, have proven to be hindrances). Other states (besides Gujarat) have now jumped into the fray – Maharashtra, Madhya Pradesh, Karnataka and Odisha have policies under which projects have been awarded to install grid-connected solar power. Among the states which have shown interest in formulating a solar policy for grid-connected projects, or which already have a solar policy but have not begun contracting include Rajasthan, Tamil Nadu, Andhra Pradesh and Kerala.

Prices, in the meantime, have continued their downward journey – the average price quoted for

Graph 1.1: Rapid increase



Note: Gujarat installation figures based on reports for December 2011 and February, March and May 2012

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ON CAPACITY, GENERATION AND UNITS

The solar power sector talks about the size of solar PV modules in Watt-peak (Wp), kilowatt-peak (kWp) or megawatt-peak (MWp), instead of Watt (W), kilowatt (kW) or megawatt (MW) used by conventional power plants. This is because electricity generation from a solar PV plant depends on many factors such as solar irradiance, temperature and air pressure. An identical solar PV module, therefore, can generate different quantities of electricity at two different locations.

To compare the efficiency of different solar PV modules, Wp/kWp/MWp is used to measure their nominal power under standard laboratory illumination conditions. The Standard Test Condition (STC) is defined as 1,000 Watt per square meter of solar irradiance at 25°C temperature – an approximate representation of noon near the spring and autumn equinoxes in continental United States with the modules aimed straight at the sun.[1] A 5-MWp solar PV module under STC should produce 5-megawatt hours (MWh) or 5,000 kWh of electricity.

Usually, in a conventional coal thermal plant, electricity production is 80-90 per cent of the plant capacity. With solar PV, the efficiency of electricity generation is approximately an average of 20 per cent. A 5-MW solar plant, therefore, on an average, produces only around 24 MWh per day.

The good news is electricity generation per MW is steadily increasing in solar technology, though there are wide variations with some organic PV having as low an efficiency as 4 per cent and some solar thermal tower constructions with a high efficiency of 40 per cent.[2]

solar PV modules in May 30, 2012 was US $0.835/Wp for silicon-based modules and US $0.732/Wp for thin-film modules.[10] With the demand for solar power falling in Europe and the over-supply in the entire manufacturing chain of solar PV – poly-silicon, wafers, cells and modules – the prices have dipped to historically low levels. This is getting reflected in the sharp discounts being offered by solar panel developers for supply of electricity to the grid.

In the second batch of the first phase of the grid-connected programme under JNNSM, the lowest bid came down to Rs 7.49 per kilowatt-hour (kWh) – about half of the Central Electricity Regulatory Commission's (CERC's) benchmark tariff of Rs 15.39 per kWh set for 2011-12.[11]

CHAPTER 2

India's solar programmes

The Jawaharlal Nehru National Solar Mission

Launched on January 11, 2010, the Mission aimed at achieving 22 gigawatts (GW) of installed solar capacity by 2022 – 20 GW grid-connected and 2 GW small off-grid applications. The JNNSM also aimed at creating a strong solar technology manufacturing base in India

The Mission – or JNNSM as it is referred to – is divided into three phases, which are further subdivided into batches. The first phase extends from 2010 till 2013, with the aim of installing at least 1,000 MW of grid-connected solar capacity. The second phase is from 2013 till 2017, and the third from 2017 to 2022 (see Table 2.1: *Phase-wise goals*).

The first phase has been split into two batches; the aim is to allow the second batch to learn from the first. Under the first batch of the first phase, concentrated solar power (CSP) or solar thermal projects totalling 470 MW and solar PV projects worth 150 MW were auctioned in November 2010. Under the second batch, 350 MW of solar PV projects were auctioned in December 2011.

Solar thermal power projects have a longer construction period; to ensure that they are up and running by 2013, all solar thermal projects were awarded in the first auction. About 30 MW of solar thermal projects had already been approved before JNNSM was launched – these are now being 'migrated into' (brought under) the Mission. Similarly, some PV projects that had already been contracted and were under construction have also been migrated into the Mission.[1]

A related programme under JNNSM – the Roof-top PV and Small Solar Power Generation Programme (RPSSGP) – has been initiated in this period to set up smaller 1-MW projects (see Box: *Roof-top PV and Small Solar Power Generation Programme*).

Table 2.1: Phase-wise goals

Application segment	Target for Phase 1 (2010-13)	Target for Phase 2 (2013-17)	Target for Phase 3 (2017-2022)
Solar collectors	7 million sq m	15 million sq m	20 million sq m
Off-grid solar applications	200 MW	1000 MW	2000 MW
Utility grid power, including roof top	1000 – 2000 MW	4000 – 10000 MW	20,000 MW

Source: Anon, 'Jawaharlal Nehru National Solar Mission - Towards Building SOLAR INDIA', india.gov.in/allimpfrms/alldocs/15657.pdf

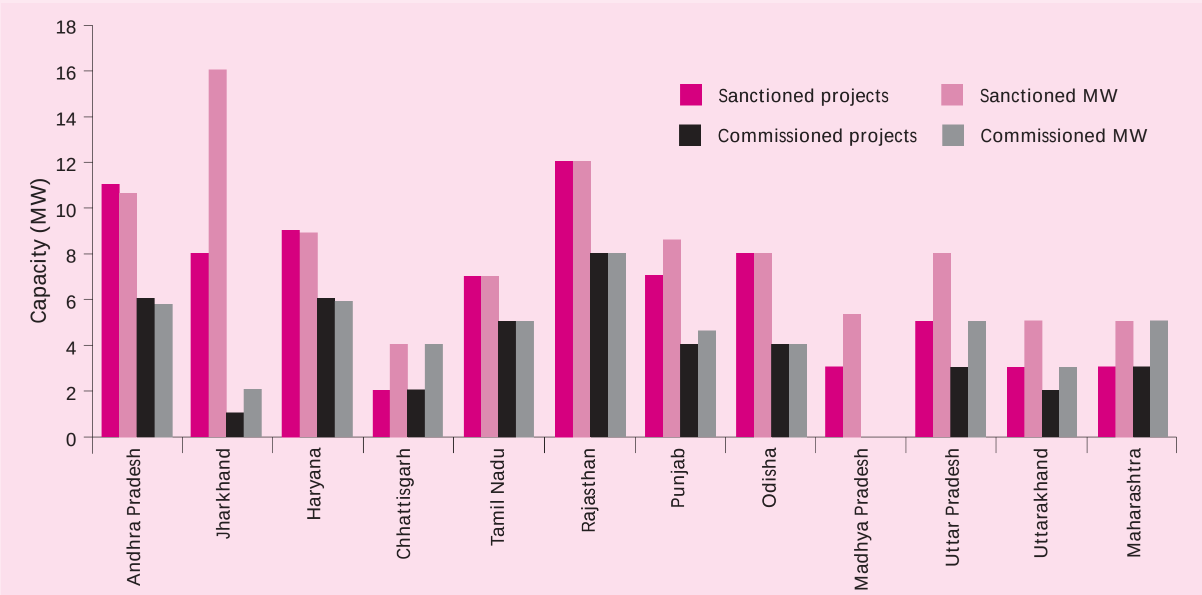
ROOF-TOP PV AND SMALL SOLAR POWER GENERATION PROGRAMME (RPSSGP)

The RPSSGP was set up under the Jawaharlal Nehru National Solar Mission (JNNSM) in order to meet the market demand for smaller 1-2 MW projects that could be set up on roof-tops. The Programme is administered by the Indian Renewable Energy Development Agency (IREDA), which is under the ministry of new and renewable energy.

According to IREDA, as of April 17, 2012, 52.05 MW out of the total 98.05 MW (the total capacity of the sanctioned projects) has been commissioned. The projects are spread over 12 states, with the highest capacity awarded to Jharkhand and Rajasthan. By July 3, 2012, Jharkhand had commissioned one project while in Rajasthan, 10 projects have been commissioned (*see Graph: RPSSGP progress report).*

According to KS Popli, director technical at IREDA, contrary to the programme name, none of the projects that have been commissioned so far has actually been installed on roof-tops. All of the projects commissioned are erected on ground.

Graph: The RPSSGP progress report, April-May 2012



Source: Anon, 'Status of commissioned solar power projects under Rooftop PV & Small Solar Power Generation Programme (RPSSGP)', as on April 17, 2012 (updated daily on http://www.ireda.gov.in/)

PHOTOGRAPHS: JONAS HAMBERG / CSE

JNNSM phase I aims at installing at least 1,000 MW of grid-connected solar capacity

The agencies involved

The JNNSM's policy for large-scale grid-connected solar power has been formulated by the Union ministry of new and renewable energy (MNRE). The contracting, buying and selling of solar power, however, is handled by a nodal agency, as assigned by the Union ministry of power (MoP). Currently, this nodal agency is the National Thermal Power Corporation's Vidyut Vyapar Nigam (NVVN).

The NVVN is also the monitoring agency for assuring that the contracts are fulfilled. Ground-level monitoring, however, is done by state nodal agencies. Recently, the MNRE has set up the Solar Energy Corporation of India (SECI), which will take over the supervision of implementation and execution of the Solar Mission (see Boxes: *The Solar Energy Corporation of India* and *What SECI may do*).

The economics of it all

To achieve its targeted grid-connected solar capacity, the JNNSM has strategised on bringing the per unit prices down by developing a very competitive solar market.

For the first phase (funding for phases II and III have been left unspecified), the NVVN has been given a specific amount of MW capacity of 'unassigned' electricity from the NTPC's coal thermal plants; this amount corresponds to the capacity that is awarded in solar.[2] For example, if 1,000 MW of solar projects are awarded, the NVVN receives another 1,000 MW of power generated from coal-based thermal power projects. This is what happened in phase I. Since coal is more efficient per MW (around 70-80 per cent) compared to solar (around 20 per cent), this makes for about 4 kWh of coal per kWh of solar.

THE SOLAR ENERGY CORPORATION OF INDIA

The ministry of new and renewable energy (MNRE) has set up a private limited company owned by the government to take over the supervision of the implementation and execution of the Solar Mission. This company has been named the Solar Energy Corporation of India (SECI). The SECI will assume the responsibilities of the NVVN in the first phase.

Anil Kakodar, member of the Atomic Energy Commission, has been assigned to head the SECI.

Today, the authorised capital of SECI is stated to be Rs 2,000 crore with a total of two crore equity shares of Rs 1,000 each as per the information furnished to the ministry of corporate affairs. The subscribed capital of the "company" is stated to be Rs 600 crore with a total number of 10 lakh equity shares. Several officials of the MNRE are directors or nominated directors in the company. As and when the officials retire, they cease to be directors and new ones are appointed.

Despite being incorporated almost a year back, there is still no clarity on exactly what functions and specific responsibilities will the company fulfil. When a separate entity to govern solar energy in the country was envisioned a few years back, there were talks of an autonomous commission on the lines of the Atomic Energy Commission. However, what finally emerged was something absolutely different; a company incorporated under section 25 of the Companies Act, 1956. Therefore there is, till date, no clarity on the level of autonomy this company will get or whether the MNRE would be the parent body with the company under it.

Recently, the first board meeting of the company was held; going by the minutes of the meeting, SECI "may" do almost everything under the sun for the solar sector. From "setting up mini grid based on hybrid" to linking "up with housing developers to develop integrated architectural designs that incorporate water heating, air-conditioning and refrigeration as well as electricity systems based on solar power", from managing "security fund to provide support to the solar power project developers" to the almost ridiculous prospect of acting "as a wholeseller/distributer or devise some scheme so that solar products are available in the market net of subsidy". Is the purpose of an agency which was originally conceptualised to be an autonomous body to implement the solar schemes of the government, to be a wholeseller/distributor of solar products? Till date, the specific responsibilities and the level of autonomy of SECI continue to be a mystery.

WHAT SECI MAY DO

As per the minutes of the first Board Meeting of SECI, the corporation's work can cover the following areas:

Energy access through mini grids: Several villages and hamlets are without electricity. There are MNRE/government schemes supporting energy access. SECI can work for setting up mini grid based on hybrid (along with bio-digesters capable of using locally available bio-degradable waste) solar power.

Facilitate retail of solar products: A wide range of solar products are now being manufactured in the market. Subsidy is available through nodal agencies or through channel partners. It is not possible for a consumer to just go to the market and buy a product of his choice net of subsidy. SECI can act as a wholeseller/distributer or devise some scheme so that solar products are available in the market net of subsidy.

Turnkey projects for institutions: Several institutions, Industries and large builders are looking for agencies which can do a complete job of putting various types of solar systems in their premises. There is no such agency at the moment. The company shall tender technical assistance in finalizing a proposal for installing solar systems on government/private institutions and shall arrange for installation of the same. The company would also link up with housing developers to develop integrated architectural designs that incorporate water heating, air-conditioning and refrigeration as well as electricity systems based on solar power.

Solar park: While most of the solar parks will be set up and managed by state governments, SECI could set up and manage one or two large solar parks. The solar park should be in proximity of a large R&D centre that supports a comprehensive academic and research program related to solar energy. While the solar park may be managed by SECI, the R&D centre could be managed by one of the IITs in its campus.

Grid power scheme management: SECI will manage future GBI or other schemes on behalf of MNRE in order to encourage solar power projects.

Project financing: The company may provide loans to private developers. There are several international organizations which want to route funds for lending through a government organization. This can be done through SECI.

Pilot and mega scale projects: SECI may set up solar power generation projects by participating in various government schemes.

Security fund: SECI may set up and manage a security fund to provide support to the solar power project developers. Several national and international organizations could contribute to this fund.

Monitoring and consultancy: SECI may monitor NSM projects on behalf of MNRE and maintain a data centre to provide information about the solar sector. It could also provide expert technical advice to the government as and when required, as well as consultancy services.

The coal and solar units are then 'bundled' together by NVVN to create a package, which is sold to state utilities and other consumers for Rs 5.50 per kWh.[3] Though this is costlier than what utilities spend on buying electricity, they are legally bound to source at least 0.25 per cent of their electricity from solar as part of their Renewable Purchase Obligation (RPO). RPO is a mandatory scheme under which all utilities must purchase 0.25 per cent of all their electricity from solar sources.

Implementation – the bidding process

In the first phase, reverse bidding was used to select companies for implementing grid-connected solar power projects. Overseen by the MNRE, the bidding for the first batch of this phase was done in November 2010, while that for the second batch happened in December 2011.

To be eligible to participate in the bidding process, companies were required to show a net worth of Rs 3 crore per MW. The shortlisted companies had to be the controlling shareholder in the project for one year after its completion. In the first batch, this stipulation was interpreted as 26 per cent of the equity – this was later changed to 51 per cent of shareholding.

Before the bidding began, the Central Electricity Regulatory Commission (CERC) calculated a benchmark tariff of Rs 17.91/kWh giving the approximate costs and reasonable rate

JNNSM provided the necessary impetus to megawatt scale grid-connected projects

of return on the investment (this was reduced to Rs 15.39/kWh for the second batch for solar PV). Each project proponent who cleared the eligibility criteria was asked to give a closing bid – a discount on the benchmark tariff. The lowest bidder would get the first contract and so on, until the capacity auctioned off was completed.

For the first batch of projects, an indigenisation requirement was introduced: solar PV modules based on crystalline silicon technology had to be sourced domestically. In the second batch, both the modules and the cells had to be produced domestically. There was, however, no such requirement in the case of thin-film technology. For solar thermal projects, 30 per cent of the technology needs were to be sourced from India; this excluded the cost of the land.

In the first batch, each company was allowed to bid for only 5 MW (for PV) and 100 MW (for solar thermal) projects; the aim was to increase the number of players in the market. In the second batch, where only solar PV was auctioned, each company could bid for up to 50 MW.

To avoid low bidding and subsequent default by companies, each project proponent had to give a bid-bond – a sum of money which will be refunded after three months of the plant's operation. This bid-bond depends on the discount given – the larger the discount, the higher is the bid-bond. For the first batch of solar PV projects, a company bidding for a 5-MW project had to give a bid-bond of around Rs 10 crore (*see Box: Forfeiting bid-bonds*).

The bidding results

In the first batch, approximately 300 companies participated in the bidding process for solar PV projects; 30 applications were accepted. The lowest tariff bid was Rs 10.85/kWh, while the tariff cut-off was Rs 12.66/kWh (*see Table 2.2: Tariffs under the first phase of JNNSM*).

Sixty-six companies bid for solar thermal or CSP projects, and seven were accepted. The lowest bid was for Rs 10.49/kWh, and the cut-off stood at Rs 12.24/kWh.

FORFEITING BID BONDS

The JNNSM and the Gujarat Solar Policy levy fine on projects that are delayed. Ideally, no projects should be delayed; neither should penalties be seen as a steady source of funding.

Under the JNNSM, bid bonds had to be submitted at time of bidding; these bid bonds depended on the amount of rebate that the developers were willing to give and the capacity of the project (see Table: *Bid bond slabs for first phase of JNNSM*). The bid bond consists of three parts: earnest money deposit, performance bank guarantee and bid bond. The earnest money deposit (Rs 20 lakh per MW) and performance bank guarantee (Rs 30 lakh per MW) together account for Rs 50 lakh per MW.

The NVVN has provided a spreadsheet to calculate bid bond.[1] The first 20 per cent of the total bank guarantee is encashed if the project is delayed beyond deadline. A further 40 per cent is taken after one month and the last 20 per cent after a two-month delay. Beyond three months, Rs 100,000 per MW per day has to be paid as liquidated damages.[2]

In January 2012, 14 projects lost the initial 20 per cent of their bank guarantees. According to A K Maggu, general manager of the Power Trading Group at NVVN, a total of 19 projects have had some part of their bank guarantees encashed[3] (see Table: Bid bonds encashed from JNNSM phase I). Four projects have had their entire bank guarantees encashed: CCCL Infrastructure, Rithwik Projects Private Limited, Karnataka Power Corporation Limited and Camelot Enterprises Pvt Limited.[4]

The total amount received from the encashed guarantees amounts to Rs 86 crore. Although the amount is not enough to finance 100-200 MW plants, it is sufficient to build a 5-MW solar power project. A minor amount from this money could go into the fund for financing projects using Indian manufactured solar technology. Alternatively, it could fund R&D and testing facilities at the Solar Energy Centre to establish unbiased testing of different manufacturers' panels and their performance in Indian conditions.[5]

Table: Bid bond slabs for first phase of JNNSM

Discount offered on CERC approved tariff (%)	Bid bond applicable for every paise of the discount (Rs per MW)
Up to 10 or 10	10,000/-
More than 10 & up to 15	20,000/-
More than 15 & up to 20	30,000/-
More than 20 & up to 25	40,000/-
More than 25	50,000/-

Source: http://www.orierc.org/orders/2011/FINAL_RST_Order_DISCOM_fY (23.03.2012).pdf

Table: Bid bonds encashed from phase 1

Project	Amount enchashed (Rs)	Delay (in months)
DDE Renewable Energy	72789000	2
Electromech Maritech	24013000	1
Finehope Allied Engineering	23763000	1
Saidham Overseas	23263000	1
Vasavi Solar Power	23763000	1
Newton Solar	23513000	1
Khaya Solar Projects	24513000	1
Karnataka Power Corporation	117815000	3
Greentech Power	23513000	1
Alex Spectrum Radition	58689000	2
Indian Oil Corporation	19313000	1
Amrit Energy	18263000	1
Precision Technik	18213000	1
Camelot Enterprises	136315000	3
Rithwik Projects	110815000	3
Electrical Manufacturing	19563000	1
CCCL Infrastructure	92565000	3
Aftab Solar	18413000	1
Oswal Woolen Mills	18263000	1
Total	867357000	

Sources: 1. Interviews with A K Maggu, general manager, NVVN and Tarun Kapoor, joint secretary, MNRE in April 2012; 2. Anon, 'Status of Commissioning of 20 Solar PV Projects located in the State of Rajasthan under JNNSM Phase-I, Batch-I', NVVN, June 1, 2012, http://www.nvvn.co.in/Notice%20inviting%20Comments.pdf; 3. Anon, 'RfP opening on November 16, 2010 in descending order of discount offered,' -- The discounts offered in Batch 1 Phase 1 of JNNSM; 4. Anon, 'Bid Bond Calculator', NVVN, http://www.nvvn.co.in/ RfP%20 Documents.php; 5. MNRE, 'Jawaharlal Nehru National Solar Mission Building Solar India' - Guidelines for phase 1, batch 1 of JNNSM

Table 2.2: Tariffs under the first phase of JNNSM

Phase	Benchmark tariff of Central Electricity Regulatory Commission (in Rs per kilowatt hour)	Weighted average tariff after bidding (in Rs per kilowatt hour)
Phase I: Solar thermal	15.31	11.48
Phase I, Batch I: Solar PV	17.91	12.16
Phase I, Batch II: Solar PV	15.39	8.77 (Minimum and maximum tariff is 7.49 and 9.44 per unit)

Source: Union ministry of new and renewable energy

In the bidding for the second batch, around 130 companies bid for solar PV projects; 22 were successful. The lowest bid was at Rs 7.49/kWh and the cut-off was at Rs 9.44/kWh.[4]

In other words, reverse bidding did bring down the cost of solar power significantly. At the same time, evidence of corporate malpractices also emerged during the first phase (see Box: *Solar scam*).

Some key concerns about the Mission

Ownership

In the first phase of the National Solar Mission's contract with power producers, there is a clause requiring a majority of shareholding to remain with the winning bidder up to one year after commissioning.[5] This is to ensure that the winning bidder will develop the project and by doing that, will improve its own experience and skills in the sector. Without this clause, there would be a risk of bidders applying only to get the contract and then selling it off without expanding the market of developers. Since the first phase was specifically designed to expand the market of solar power developers, this would not have been acceptable.[6]

There are, however, some concerns about how the clause was written and is interpreted. The initial clause merely stated that the winning bidder needed to hold on to a majority of voting rights – depending on how it was interpreted, it may have meant just 26 per cent of the voting rights. Shares not giving voting rights – preference shares – were not counted.[7] This loophole has been filled to an extent in the second batch of the first phase. The new request for selection document defines majority shareholder as one having 51 per cent of the voting rights; however, whether this includes preference shares or not remains unclear, as preference shares do not give voting rights.[8,9]

Under the Gujarat state policy (phase II), the original shareholders of a project need to continue to hold at least 51 per cent of the equity for five years after commissioning.[10] Under Karnataka's solar policy, the consortium or single entity bidder needs to retain 51 per cent of the equity share capital for three years after commissioning and then keep 26 per cent for the full 25 years of the agreement[11] – much longer than any other policy, thus in effect securing that the bidder stays with the project for the full time. This seems to be the best way to ensure responsible bidders.

The problem may, however, persist as companies bid through fronts. It may seem implausible that a few Hyderabad-based women own a large percentage of the projects under the first batch of the Solar Mission, but it is the truth.[12]

The other problem is that although shares may be held by a proper company, a few EPC (engineering, procurement and construction) contractors are doing all the work. There is little incentive for the winning bidders to do more than

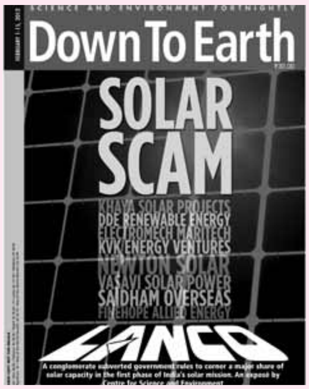
TECHNOLOGY CHOICES

Of the first batch of the first phase solar PV projects under JNSSM, half (about 70 MW) have opted for the thin-film technology (mostly CdTe), while the other half have gone for crystalline silicon. As for the first phase solar thermal projects, most companies are choosing to go for parabolic trough technology. Multiple reasons have been given for this – it is the most mature technology; and with a cap on the amount of electricity that can be sold from the plant, it may not pay to use the more efficient tower technology.

SOLAR SCAM

An investigation by Centre for Science and Environment (CSE) shows how a company used unfair practices to corner lucrative projects under the first phase of JNNSM

In July 2010, the Union ministry of new and renewable energy (MNRE) had issued guidelines for the selection of solar power projects. According to these, the ministry will accept only one application for one 5 MW solar PV project “per Company, including its Parent, Affiliate or Ultimate Parent or any Group Company…”. In the case of solar thermal projects, the guidelines specify “total capacity of solar thermal projects to be allocated to a Company… shall be limited to 100 MW”.



As per the guidelines, therefore, one company was allowed to bid for and win one 100 MW solar thermal and one 5 MW solar PV project. In totality, one company was eligible to get 105 MW worth of projects.

CSE investigations revealed that these guidelines were blatantly flouted by LANCO Infratech. This company floated front companies and grabbed no less than nine projects worth 235 MW. This is about 40 per cent of the 620 MW worth of projects auctioned by the government during the first batch of the first phase of the JNNSM. LANCO Infratech is the flagship company of the LANCO group.

The company has initiated work on these nine projects on 1,000 hectares at Askandara village in Jaisalmer, Rajasthan. In the winning bids for solar thermal projects, LANCO’s name appears only in the case of Diwakar Solar Projects, which has bagged a 100 MW solar thermal contract. Another LANCO subsidiary, Khaya Solar Projects, appears on the approved list of 5 MW solar PV project proponents.

CSE found that seven more companies had direct links with LANCO – some have LANCO employees and their family members as directors, while others have strong commercial ties to the company. LANCO’s own annual report indicates that all the seven are firmly in its control.

All seven companies had Rs 100,000 or Rs 1 million in equity, no assets or reserves from the past; all were created for the bidding process; all companies increased their authorised amount of shares and then issued preference shares on the same day (December 31, 2010); the shares did not go to LANCO directly, but show up in its annual report. Then LANCO and front companies bid for the PV projects in a unified fashion, quoting similar tariffs with Rs 0.05 jump between each bid.

The DPR of all projects are almost identical – word for word, page by page. Even the land that has been agreements for the legally distinct and differently owned projects has been signed by one person – a LANCO employee. LANCO bought compulsorily convertible preference shares of the front companies that will give it guaranteed ownership in future. This helps the company bypass the mission guidelines.

CSE investigators point out that LANCO could pull this off because neither the ministry, nor the NTPC Vidyut Vyapar Nigam (which is responsible for the contracting, buying and selling of solar power), have a mechanism to monitor the activities of companies that win a contract. The two agencies do not even provide the details of the projects and company addresses. The ministry’s non-transparent processes are responsible for the lapses in the renewable energy programme. This has resulted in LANCO winning the bids by unfair means. In doing so, LANCO throttled the competition and stopped genuine players from entering the market.

Source: *Down To Earth*, February 1-15, 2012

just hire an EPC contractor to take care of everything from finding and buying land, acquiring pollution control board clearances, choosing technology and constructing the plant. All the winning bidder needs to do is to sit back with the money, without gaining any experience.

Commissioning

Commissioning is another grey area. As the deadline for commissioning of the first batch of projects was reached, it became clear that the definition of commissioning in the power purchase agreement was not quite clear.[13] The joint secretary of the MNRE, Tarun Kapoor, said in an interview with CSE: "The PPA (power purchase agreement) was very faulty."[14] Commissioning had been defined in different ways in the PPA, in the guidelines and in the clarifications to the guidelines issued by MNRE or NVVN.

In the clarifications, it was made quite clear that equipment for 5 MW had to be constructed and electricity needed to flow from the project. However, developers sign just the PPA contract, in which the only clear definition was that electricity had to flow from the project; there was no mention of what amount, or how much equipment needed to be put up. According to the MNRE, this led the Rajasthan government to issue commissioning certificates to projects that were far from ready, but that had managed to feed a nominal amount of electricity into the grid. This way, projects which had not met the deadlines managed to avoid fines (*see Box: Solar trick*).

There has been some corrective action. The argument that the definition of commissioning was misunderstood has not been accepted by the MNRE or the government of Rajasthan. Four officials have been suspended[15] and projects have had their bid-bonds encashed.[16]

Deadlines had been established to ensure that construction happened on time and in turn, the Solar Mission goals could be met. One of the touted advantages of solar PV is the short time it takes to set up a plant – one year compared to four-six for a thermal coal power plant. But if a project is delayed, then this advantage is lost. Kapoor defended the tight schedule stating that without it developers may have dragged their feet.[17] Developers have been given extra time – 13 months instead of 12 – in the second batch of the first phase of JNNSM.[18]

Gujarat has no definition of commissioning in its PPA. A project needs a certificate of commissioning from GEDA to be considered as commissioned.[19]

This aside, it may be worth considering a somewhat longer commissioning time to enable the project to secure financing and to resolve any land dispute in a satisfactory manner.

Third party control

The JNNSM's power purchase agreement article 4.8 ('Third Party Verification') states: "*The third party may carry out checks for testing the CUF of the Power Project.*"[20] As projects feed their power into the grid which is monitored by the state utility, it may seem superfluous to have third party controls. However, since utilities have to pay an increased tariff for solar electricity it may not be in their interest to check that the projects are producing efficiently as the less power is produced, the lesser the utility has to pay. This has actually been evident in Rajasthan – according to the Rajasthan Renewable Energy Corporation Ltd (RREC), the government of Rajasthan does not care if projects are delayed as this only hurts the developers. An RREC official says, "Once the plant is commissioned, we do not bother to check if it is regularly feeding the grid. It is the company which will lose money because electricity will not be purchased from them."[21]

A third party, which is not connected to either the state utility, state nodal agency or the project developer, can be assigned to check that plants are living up to the efficiency they have promised. There has so far been no public discussion on who or what this third party would be. This discussion should happen now, before the second phase is implemented as well as for the monitoring of the first phase projects. It must be made very clear that third parties have the right to enter any plant at any time and perform inspection and that they are in no way financially connected to the projects (this will eliminate the conflict of interest and help avoid the 'CDM' situation of validators being paid by projects applying for CDM).

Ceiling on amount that can be sold

Under the JNNSM's power purchase agreement article 4.4 – 'Right to Contracted Capacity & Energy'[22] – the amount of energy that will be bought from each plant by NVVN is defined as generation of 21 per cent capacity utilisation factor (CUF) of the solar PV capacity (CUF is the actual generation of the project divided by the peak capacity of what the project is supposed to be able to produce under perfect conditions[23]). For solar thermal, the CUF has been put at 25 per cent while for 'advanced technologies', it will be the average CUF committed by the developer. However, the document does not clarify what it means by "advanced technologies".

Stating a 'maximum' amount of generation that NVVN will buy removes any incentive for developers to increase efficiency beyond that point through installation of equipment such as trackers or thermal storage or by upgrading

SOLAR TRICK

A number of solar mission projects are operational only on paper… Ankur Paliwal and Jonas Hamberg report in Down To Earth (March 15, 2012)

The government has decided to act tough with 14 companies which did not commission their solar power projects in time. NTPC Vidyut Vyapar Nigam Limited (NVVN), the power trading arm of the state-owned National Thermal Power Corporation, penalised them by encashing a part of their bank guarantees. These erring firms are among the 28 that were awarded solar photovoltaic projects under batch 1 of first phase of the Jawaharlal Nehru National Solar Mission (JNNSM). The date of commissioning of these plants was January 9.

Amrit Energy and Greentech Power are among the companies whose guarantees were encashed on February 16 to recover a total of Rs 30 crore (see table). But some project developers have managed to escape penalty by obtaining commissioning certificates from states without completing projects.

Lanco Infratech happens to be the engineering, procurement and construction (EPC) contractor for three of the companies that have been penalized — DDE Renewable Energy, Electromech Maritech and Finehope Allied Energy. A recent investigation by Centre for Science and Environment had shown that Lanco Infratech is in possession of seven projects, including the above three. All these projects are located in Askandra village in Nachna Teshil of Jaisalmer, Rajasthan.

In keeping with JNSSM guidelines, the companies were asked to submit bank guarantees of Rs 9 to Rs 12 crore at the time of signing power purchase agreements on January 9, 2011. It was agreed that if a project developer misses deadline, NVVN would start encashing the bank guarantee in parts over three months, after which the project would be fined Rs 5 lakh per day for another three months. If still incomplete, the project would stand cancelled.

In the present case, NVVN encashed bank guarantees because the 14 companies did not commission the projects in the given time. But many more may have escaped NVVN's notice.

Take the case of seven solar photovoltaic projects of 5 MW each in Askandra village; Lanco is the EPC contractor for all of them. NVVN encashed the bank guarantee of three of them because they were commissioned a day after the deadline of January 9. The remaining four were commissioned between January 7 and 9, according to Rajasthan Renewable Energy Corporation (RREC). The Rajasthan Discoms Power Procurement Centre (RDPPC), the nodal agency for the state discoms, issues a commissioning certificate to a 5 MW plant "only when it is operational to feed the full 5 MW into the grid", says its chief engineer N M Chauhan. Going by RREC and RDPPC claims, all the seven solar projects in Askandra have been commissioned to produce a total of 35 MW.

But a closer look reveals a different picture. When *Down To Earth* (DTE) visited Askandra on February 12, a month after the commissioning deadline, it found that less than half the works seemed complete. It was past the second penalty period, meaning NVVN should have encashed the next part of the bank guarantees. These seven project sites are located cheek by jowl in an area of 49.5 hectares. There were no sign boards to distinguish one site from the other. Solar panels were fully installed and connected only at two sites. In the remaining five sites, they were either being connected to inverters or the inverters were being connected to transformers. Two sites had only metal poles sticking out of the ground. A site engineer said, "a lot of work remains. We are only feeding 10-20 per cent of the commissioned capacity of 35 MW."

Even the grid sub-station to which these seven projects are supposed to be connected is not complete. "Fifty per cent of the work remains," said Dheeraj Singh, engineer at the sub-station.

Vijendra Panchal, Lanco's site head at Askandra, said all the seven plants are operational and are feeding the 33 kv grid sub-station at Ajasar village, 8km away. A visit to Ajasar belied this claim. "No, they are not feeding our grid," said B R Vishnoi, assistant engineer of the Ajasar grid sub-station. DTE found that Lanco is feeding the sub-station at Chandsar village, 3 km from Ajasar. The meter reading taken from the 33 kv Chandsar grid sub-station confirmed how little power these seven sites are generating. "Lanco's seven plants in Askandra have fed only 65,385 kWh power in a month," said Vishnoi who also looks after Chandsar sub-station. This is only 1.3 per cent of the promised output, and just enough for 210 households. If the plants were functioning at full capacity they can meet the needs of 15,800 households. What's more, Lanco has taken 4,042 kWh from the grid station to power its site at night.

Then how is it that these seven plants obtained commissioning certificates? "Do not ask about commissioning. It is complicated. Besides, it is the job of RDPPC," said Anil Patni, project manager with RREC. "Once the plant is commissioned, we do not bother to check if they are regularly feeding the grid. It is the company which will lose money because electricity will not be purchased from them," said Patni. This attitude defeats the purpose of the ambitious solar mission. JNSSM aims to generate 20,000 MW by 2020.

There are around 20 projects under batch 1 of JNNSM in Rajasthan; 17 were commissioned by February 10. A visit to four more 5 MW commissioned solar plants in Phalodi tehsil in Jodhpur in Rajasthan and their readings noted from the Bap village grid sub-station showed they are transmitting sufficient power into the grid. For example, Mahindra Solar and Punj Lloyd were transmitting up to 30,000 and 23,000 kwh respectively a day.

So, while NVVN may have encashed bank guarantees of three of the seven projects in Askandra, the remaining four seem to have escaped because on paper they were commissioned before the deadline. "We encashed bank guarantees from the 14 firms because they were either not commissioned or were commissioned after the deadline. And for this data we depend on the state governments. We do not have mandate to go and check the sites," says A K Maggu, general manager with NVVN. But it clearly is a matter of investigation, he adds.

Ambiguity in interpretation

According to Tarun Kapoor, joint secretary, MNRE, such things happen because the word commissioning seems to be interpreted differently by the Centre and states. According to NVVN, a project is considered commissioned when the full 5-MW capacity is installed and is feeding the grid.

"The Rajasthan government has now written to us that many of their plants are partly commissioned," says Kapoor. "For MNRE, these projects are not commissioned. We are investigating the matter and if found guilty, bank guarantees will be encashed from them. We will soon release a clarification defining the word commissioning," he adds.

Table: 14 solar firms that were penalized

Bidder's name	Location of plant	Penalty (in Rs)
DDE Revewable Energy Pvt Ltd	Rajasthan	24,263,000
Electromech Maritech Pvt Ltd	Rajasthan	24,013,000
Finehope Allied Energy Pvt Ltd	Rajasthan	23,763,000
Karnataka Power Corporation Limited	Rajasthan	23,563,000
Greentech Power Pvt Ltd	Rajasthan	23,513,000
Alex Spectrum Radiation Pvt Ltd	Rajasthan	19,563,000
Indian Oil Corporation	Rajasthan	19,313,000
Amrit Energy Pvt Ltd	Rajasthan	18,263,000
Precision Technik Pvt Ltd	Rajasthan	18,213,000
Camelot Enterprises Pvt Ltd	Maharashtra	27,263,000
Rithwik Projects Pvt Ltd	Andhra Pradesh	22,163,000
Electrical Manufacturing Co Ltd	Uttar Pradesh	19,563,000
CCCL Infrastructure Ltd	Tamil Nadu	18,513,000
Aftab Solar Pvt Ltd	Odisha	18,413,000

Source: NTPC Vidyut Vyapar Nigam (NVVN)

One of the touted advantages of solar PV is the short time it takes to set up a plant – one year compared to four-six for a thermal coal power plant

panels to (for example) the more efficient mono-crystalline ones. Although the risk of heightened costs because of removal of this clause would be minimal (as few PV projects reach a CUF of 21 per cent while solar thermal projects hardly reach more than 40 per cent), it may help open up the market for R&D and innovation by developers.

Going solar in Gujarat

In February 2009, Gujarat set up a separate department of climate change, headed by the chief minister.[1] In 2009, this department announced the state solar policy, with the Gujarat Energy Development Agency (GEDA) and Gujarat Power Corporation (GPC) as joint nodal agencies

The Gujarat Solar Policy initially aimed at installing 500 MW by 2014[2], but some reports indicate that the state now aims at a total of 3,000 MW by 2014.[3] Till the end of 2011, the state had already allocated 968.5 MW[4] (*see Table 2.3: Capacity allotted in Gujarat by district*). It has now set a target of generating 20 per cent electricity from renewable sources by 2015.[5]

In fact, Gujarat is the only state in India where solar power plants have been commissioned under the state's solar policy. It is also the state with the maximum installed capacity (654.8 MW in May 2012).[6]

A backgrounder

Initially, like other states, Gujarat had concentrated its efforts on off-grid – specifically, on solar home lighting systems and solar cookers.[7] Problems with maintenance, however, marred the programme. As a result, solar began to be seen as 'unreliable'.

In 2009, the state announced its solar policy and decided on the investment model, where contracts for a fixed capacity were to be given to private developers. These project developers were to have a fixed feed-in tariff for 25 years. Unlike JNNSM, reverse bidding was not considered as the state government felt that there was a risk of developers underbidding and then not setting up plants.

The tariff in Gujarat is fixed by the Gujarat Electricity Regulatory Commission (GERC) and accelerated depreciation is allowed under the state's solar policy. This policy was launched with a tariff of Rs 13 per kWh for the first 12 years and Rs 3 per kWh for the following 13 years. Memorandums of understanding worth 5,000 MW were signed with project developers, and the government shortlisted solar projects with a total installed capacity of 736 MW – dividing it equally (50-50) between PV and solar thermal or CSP. Despite this, no developers signed power purchase agreements (PPAs).

Table 2.3: Capacity allocated in Gujarat by district

District	PPA signed (MW)
Ahmedabad	3
Amreli	10
Anand	16
Banaskantha	55
Bharuch	1
Gandhinagar	2
Jamnagar	25
Junagad	10
Kutch	217
Patan	76.5
Solar Park, Charanka	250
Porbandar	45
Rajkot	60
Sabarkantha	18
Surat	5
Surendranagar	168
Vadodara	10

Note: PPA = power purchase agreement
Source: Anon, 'Questions on Gujarat Solar Mission', Gujarat Energy Development Agency, communication through e-mail, May 4, 2012

In 2010, a tariff order issued by the GERC increased the price to Rs 15/kWh for the first 12 years and Rs 5/kWh for the remaining 13 years. Contracts worth 406.5 MW were signed with project developers – most of these developers opted for PV; CSP projects accounted for only 25 MW of the signed contracts.[8] These projects constituted what was the first phase of the work done under the Gujarat State Policy.[9]

For the second phase, the state received applications for developing 2,000 MW. Of this, applications for only 800 MW could show proper

Table 2.4: Tariffs in Gujarat

	PV	Solar thermal
Projects done by January 28, 2012	Rs 15 for 12 years, Rs 5 for next 13 years	Rs 11 for 12 years, Rs 4 for next 13 years
Projects done after January 28, 2012	Rs 9.98 for 12 years, Rs 7 for next 13 years	Rs. 11.55 for 25 years

Source: Anon, 'Determination of tariff for Procurement by the Distribution Licensees and others from Solar Energy Projects - Order 1, 2012', GERC, January 27, 2012, http://www.gercin.org/index.php?option=com_renewable&view=renewable&Itemid=83&lang=en

net worth; contracts worth 562 MW were signed, taking the total to 968.5 MW.[10]

The deadline for the projects under the first phase was extended, along with that of the second phase projects, to 2011-end. To get the Rs 15+5 tariff, the projects were required to be completed by January 28, 2012 – if the developer could not complete a project within this date, he would get the lower tariff (*see Table 2.4: Tariffs in Gujarat*). After January 1, 2012, penalties were to be imposed on unfinished projects at a rate of Rs 10,000 per MW per day.[11]

Project developers pleaded for more time, but the GERC rejected their pleas. There has not been a third phase so far.

By May 2012, 600 MW worth grid-connected solar power was commissioned or was 'ready to be commissioned' (this means that the plant is constructed, but is waiting for connection and synchronisation to the grid). Approximately 200 MW – all operational – is concentrated in the Charanka Solar Park in Patan district.[12]

Solar power plants have now started feeding the grid. In September 2011, a little over a million kWh of solar energy was generated in Gujarat. By April 2012, this had increased to 89 million kWh (*see Graph 2.1: Actual generation*).

Not keen to install more

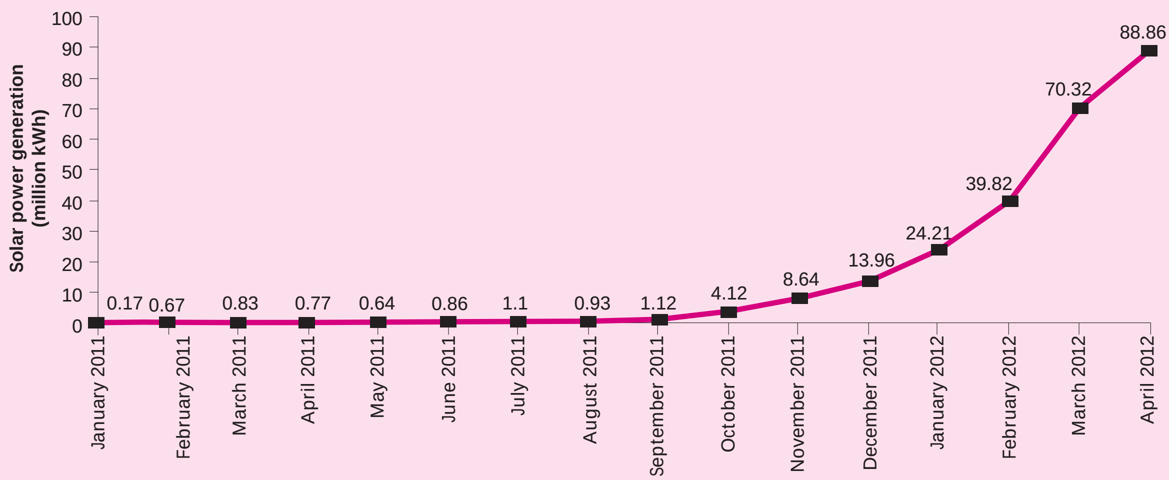
After the second phase of promotion policy for solar power in the state, the sector was anticipating announcements about a third phase at the India Solar Summit on April 21, 2012 in Gandhinagar. But it was not to be. D J Pandian, Gujarat's secretary for energy and petrochemicals, said during the summit that the Gujarat Urja Vikas Nigam Limited (GUVNL) has been resisting any further promotion policy, reasoning that "our years of efforts to become profitable has been ruined by this solar policy. We can't bundle power like in the JNNSM and profits from selling power to other states have already been earmarked for other purposes". The GUVNL has stated that the solar power will cost them about Rs 3,000 crore a year. According to an industry source (not willing to be named), there are not enough funds for the 1,000 MW that has already been approved by the state, and definitely no funds for further expansion.

Manufacturing

Gujarat does not have an indigenisation policy for solar technology manufacturing. It has four manufacturers of modules – Waree (40 MW), Topsun (40 MW), JJ Solar (production capacity unknown) and Eurovision (under construction). CSE researchers have found that most of the panels at various sites were of Chinese or Malaysian origin, or were products of First Solar, a US-based solar PV company. "Whether it is made in Chhattisgarh or in Beijing, it doesn't make a difference to us. We are the Gujarat government, not the Indian government," said Pandian, referring to the differences in the Centre's and Gujarat's policies on indigenisation requirement for solar projects.[13]

Pandian, however, added that the state wanted to "synchronise" its policy with that of the Union government, and insisted that they were "no enemies of the Centre". This stems from the fact that the Union, and the states of Gujarat and Rajasthan have for some time been seen as competitors in the solar power business.[14] The situation is, though, coming to a thaw with Farooq Abdullah, minister in-charge at MNRE, recently commending Gujarat for the solar canal-top project saying that the state has "shown the way" (*see Box: Skip the land – canal-top projects*).[15]

Graph 2.1: Actual generation



Sources: State Load Dispatch Centre, Station-Wise Energy Generation and Auxilliary Consumption (monthly reports), http://www.sldcguj.com and GUVNL information board at the India Solar Summit in Gandhinagar on April 20, 2012

CASE STUDY

SKIP THE LAND – CANAL-TOP PROJECTS

Located in Sadan just outside Ahmedabad on top of the Sadan branch of the Narmada canal is the Gujarat Solar Canal Project. It is a 1 MW poly-crystalline project set up by Sun Edison with panels manufactured by US company MEMC in Malaysia. The project is run by Gujarat State Electricity Corporation (GSECL). The project is 750 meter long and is supposed to lower water losses by 9 million liters per year. The cost of the project was 17 crore which is high for 1 MW but the project required special steel structures and innovative R&D, if considered a pilot project the cost must be seen as quite cheap. According to the constructors, the water under the panels cool the panels giving higher efficiency as PV panels efficiency is lower at high temperatures.

The only possible drawback is that only so much of a canal can be covered as sunlight has important purifying properties on the water but even with 10% of the canals in Gujarat covered the capacity acquired would be in the 1000s of MW (5000MW according to one source but it varies). Apart from this there seems to be no negative side-effects so far of the projects.

One reason for choosing the Sadan stretch was that it ran in a north-south direction which is preferable for solar. Residents of Govindpura, a village only 5 minutes from the plant, had no issue with the project but had no idea what the project was before inauguration, there had been no contact from the government or company to explain the project to them. The village has electricity supply 24x7.

The Union minister in-charge for new and renewable energy, Farooq Abdullah, has said that the Sadan project will be replicated in the Damodar valley.[1]

Finance

Under the state's solar policy, the tariff is fixed by the GERC; the policy also allows accelerated depreciation to those developers who opt for it. Under this, the developers can write off a majority of their assets in the first year itself but are then not entitled to a higher tariff. The higher tariffs are paid for by GUVNL. There is no bundling of solar with coal thermal power as in JNNSM.

A quick calculation would give the price of 968.5 MW of power at an average tariff of Rs 12.54 per kWh as about Rs 2,000 crore per year.[16] Over 25 years, the cost would come to Rs 50,000 crore. According to the GUVNL's annual financial reports, it spent more than Rs 20,200 crore on buying power in 2010-11 (financial year). This means that the cost of solar would increase the cost of buying

CASE STUDY
CHARANKA SOLAR PARK

Hailed as Asia's largest solar park (beating the 200-MW Golmud Solar Park in China)[1], the Charanka Solar Park in Gujarat's Patan district reportedly has an operational capacity of 214 MW. However, according to a Gujarat Power Corporation Limited (GPCL) site engineer, only 198 MW was operational as of April 2012.[2]

Of the proposed area of 2,023 hectares, the total area planned for development is 1,998 hectares. About 1,080 hectares of the total is government land, and the rest is privately owned. Most of this private land has not yet been fully acquired.[3] When researchers from Centre for Science and Environment (CSE) visited the site, land acquisition was in progress.

The Park aims to install a total of 500 MW capacity onsite. According to a GPCL site engineer about 50 MW of this capacity is based on thin-film technology, with the rest being PV crystalline technology. However, another official report puts the figure of thin-film at 126 MW and PV crystalline at 130 MW (*see Table: Developers – Charanka Solar Park*).

Of the 21 developers that the Park harbours, projects of about 18 are complete. The GPCL provides the infrastructure and acts as a nodal agency for the Park. Water for the projects comes from a canal and a large human-made pond. During their site visit, CSE researchers found that only a few projects used trackers; most of the larger projects used fixed structures. Indigenous technologies were almost non-existent – Tata BP was the only visible Indian supplier of solar modules.

While the Gujarat government is planning a second such park, this one is facing trouble. Villagers from nearby Charanka are a deeply discontented lot.

Table: Developers – Charanka Solar Park

Name of the applicant	Tech-nology	Capacity (MW)
ZF Steering Gear (India) Ltd.	PV	5
NKG Infrastructure Ltd.	PV + TPV	10
Alex Astral Power Pvt. Ltd.	TPV	25
AES Solar Energy Gujarat Pvt. Ltd.	PV	15
Sun Edison	PV	25
GMR Gujarat Power Pvt. Ltd.	TPV	25
Corner Stone Energy	TPV	5
Kiran Energy Solar Power Pvt. Ltd.	TPV	20
E I Technologies Pvt. Ltd.	TPV	1
Emami Cement Ltd	PV	10
GPPC	PV	5
Roha Energy Pvt. Ltd.	PV	25
Surana Telecom & Power Ltd	PV	5
Avatar Solar.	PV	5
Saumya Construction Pvt. Ltd.	PV	2
Sun Clean	PV	6
Lanco Infratech Ltd.	TPV	15
Inspira Solar Energy Private Ltd.	PV	15
Yantra e Solar Pvt. Ltd.	TPV	5
GPCL	PV	5
Universal Solar System	PV	2

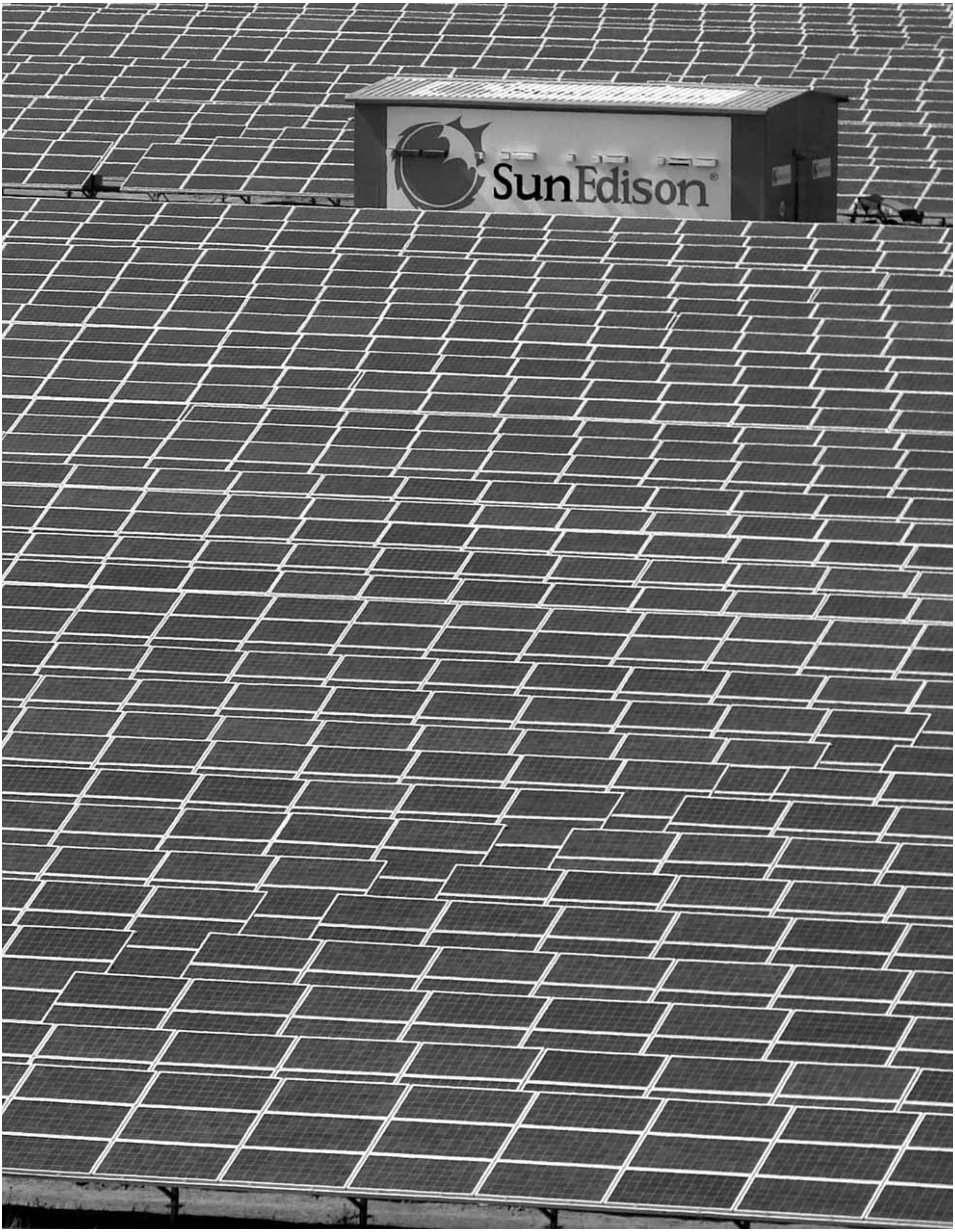
Note: One 10-MW plant is shown as PV crystalline + TPV (thin-film), We have assumed 5 MW of each technology
Source: Anon, 'Note on Charanka Solar Park: Developers within the Park', personal communication with the Resident Commissioner of Gujarat, May 4, 2012

CASE STUDY
GANDHINAGAR ROOF-TOP PROJECT

The contracts for what may become India's largest roof-top project were signed in April 2012, but the city of Gandhinagar had been steadily going solar way before that – small solar PV units and solar water heaters had been making their appearance since 2009, mainly on government buildings.

The contracts for the roof-top project were signed between Torrent Power – the electricity utility of Gandhinagar – and Sun Edison and Azure Power, two developers who are to set up 2.5 MW each of solar capacity on roof-tops in the city. Eighty per cent of this capacity is to come up on government buildings; private buildings will account for the remaining 20 per cent.

Azure and Sun Edison will get Rs 15/kWh as tariff; they will pay the roof-top owner Rs 3/kWh produced as a 'green incentive', a compensation for the use of the roof-top.[1]



Gujarat does not have an indigenisation policy for solar technology manufacturing

GUJARAT'S GREEN CESS

In a bid to draw in additional revenues, the government of Gujarat introduced the Gujarat green cess in April 2011.[1] The cess is levied on electricity generating companies, the exemptions being power companies with an installed capacity of less than 1,000 kW and power from renewable sources (hydro, solar, biogas, biomass and wind[2]).

The revenue extracted from this will contribute to the setting up of a 'Green Energy Fund', which will ultimately fund other renewable energy power plants. Targeting an installed capacity of 13,258 MW, the revenue is estimated to reach Rs 244 crore in 2011-12.[3]

The cess has not been well received by some of the major players in the state, including Essar Power, Reliance Industries and Tata Chemicals Ltd, who have filed individual petitions in the High Court against its implementation. Stating that under Entry 84 in List 1 of Schedule 7 of the Constitution of India, a state does not have the right to put a cess on production of power (only allowed to levy tax on consumption) and that it is under the privilege of the Centre, these petitioners have succeeded in halting any collection of the green cess till the next hearing.[4] If the green cess is struck down in the court at a state level, it can instead be introduced at a national level.[5]

The price hike for consumers, if any (because of the green cess), is yet to be decided upon by the Electricity Regulatory Commission.

Assuming all 1,000 MW contracted for was installed in 2011-12 and there was a 5.86 per cent rise in average power purchase cost, the cost of the Mission in total would be around Rs 5,000 crore.

ON PENALTIES

Delayed projects in Gujarat had to begin paying a penalty from January 1, 2012.[1] According to Article 4.3 of the Power Purchase Agreement (PPA) signed by developers, a fine of Rs 10,000 per day per MW for 60 days and Rs 15,000 for up to one year is levied, after which GUVNL has the right to cancel the contract. Under the Gujarat policy, it is GUVNL that accrues the penalties.[2]

On May 11, 2012, it was reported that 655 MW was installed in Gujarat. Assuming that an equal amount of capacity was installed each day, the total bid bond amount encashed would come to approximately Rs 100 crore.

If we assume a linear curve of installation in the state between December and May, then Gujarat installed an impressive 3.525 MW per day: more than the total installed capacity in the country before 2010.

Rs 100 crore is a substantial amount of money, but it still is only a fraction of what the Gujarat Solar Policy (phases 1 and 2) will cost each year. The penalties could be used to fund R&D or to support better transmission infrastructure in the state to lower grid losses.

power by 8.4-9.6 per cent (depending on how many developers got a lower tariff after January 28). The GUVNL's earnings from selling power in 2010-11 was Rs 20,300.15 crore. The profits (before tax) have been given as Rs 107 crore.[17] The average tariff for electricity charged to consumers is Rs 4.05/kWh. This leaves a shortfall of at least Rs 8.49/kWh for every kWh of solar power sold. The net loss on solar would then come to Rs 1,300.65 crore per year. This would put GUNVL at a loss of Rs 1,200.58 crore per year (as per the 2010-11 balance sheet). To make up for this shortfall, there has to be an increase of Rs 0.25-0.30/kWh in average tariffs.

Gujarat has now introduced a 'green cess' of Rs 0.02 on each kWh of electricity produced from sources other than renewable (excluding generation companies with less than 1,000 MW of installed capacity). But this will not be sufficient to bridge the gap (*see Box: Gujarat's green cess*).

Making money on solar

A rough assumption would be that in 2011-12, Gujarat would need about 374 million kWh of solar electricity to fulfill its 0.5 per cent solar RPO target.[18] If this power was bought at the REC (Renewable Energy Certificate) floor price (Rs 9,300 per MWh), it would cost the state Rs 400.65 crore (compared to the current net loss of Rs 1,300 crore that the state is suffering). But Gujarat is estimated to produce 1.5 million MWh from the 968.5 MW solar power it has installed so far. It can sell the 'environmental part' (energy from renewable sources) of the remainder – about 1.2 million MWh. If this is sold at floor price to other states, it would generate an income of about Rs 1,100 crore – offsetting almost all of the losses.

In April 2012, Gujarat produced 88,860 MWh from solar installations. It is 18 times more than biomass energy production (4,942 MWh) in the state and almost 30 per cent of wind power production in the same month. In 2011-12, Gujarat's per capita consumption stood at about 1,600 kWh per annum. Keeping this figure in mind, solar power generation in Gujarat can supply electricity to 0.67 million people in the state.

Other state policies

While several states in India now have their own solar policies, only Gujarat and Rajasthan have commissioned solar power plants. At the time of going to press, Karnataka, Madhya Pradesh and Odisha had held bids, while other states were in different stages of policy formulation or project implementation. Existing state policies in Karnataka, Madhya Pradesh and Odisha have been synchronised with the Jawaharlal Nehru National Solar Mission (JNNSM), but with some differences

Odisha

Odisha announced its state solar policy in 2011. According to this policy, Odisha's solar programme will have a total capacity of 25 MW solar PV, which would be distributed through a competitive bidding process.

In line with this, the invitation for the request for selection (RfS) of companies was released by the Odisha Renewable Energy Development Agency (OREDA) in December 2011.[1] Bids were submitted, and the highest was placed at Rs 8.98/kWh by Azure Power, the New Delhi-based solar energy developer; the lowest – with a significant margin making it the lowest bid ever placed in the country — was quoted by Kolkata's Alex Green Energy at Rs 7/kWh.[2] Other bid prices included Rs 8.87/kWh by Welspun Renewable of New Delhi and Rs 8.6/kWh by Sudhir Energy of Hyderabad.

As per the policy guidelines, the lowest bidder was offered the entire 25 MW capacity: Alex Green has accepted the offer.[3] The deadline for reporting of project finance is 210 days from the signing of the PPA and the deadline for commissioning is 18 months from the signing of the PPA.[4] The company has to complete the project by August 2013.

Alex Green Energy is setting up the plant in Bolangir, keeping in mind the district's ample solar radiation supply. The estimated cost of the project is Rs 300 crore.[5]

Odisha has largely followed the JNNSM in planning for its solar capacity, except for one difference: its penalties for project implementation are less than those proposed under the Mission.

Andhra Pradesh

In November 2009, the then chief minister of the state, K Rosaiah, had announced that the government would formulate a solar policy that would "*complement*" the National Solar Mission, but no such commitment has taken shape.[6] The state has reportedly signed a contract in January 2012 for a 100-MW solar power plant with Welspun Pvt Ltd.[7] The Rs 950-crore project would be completed in 2013.

ALL INDIA STATUS OF SOLAR PLANTS

- Total amount of installed capacity of solar in India: 979.4 MW (as of June 2012; new capacity is being installed almost on a daily basis)
- This means an almost 26-fold increase in capacity from 35.5 MW in May 2011.
- Projects totalling to 350 MW under the second batch of the first phase of JNNSM have a deadline of February 2013, while 470 MW worth of solar thermal projects have to be completed by May 2013. Of these, 200 MW has been awarded in Madhya Pradesh, 80 MW in Karnataka, 125 MW in Maharashtra and 5 MW in Odisha; 34 MW is to be done by IREDA, or the Indian Renewable Energy Development Agency under the RPSSGP scheme.
- With projects already in different stages of contracting and construction, India is expected to reach an installed capacity of 2.5 GW.

Packaged solar panels for 5-MW plant in Tamil Nadu

JOEL KUMAR / CSE

Tamil Nadu

A 5-MW solar PV power plant under the Generation-Based Incentive (GBI) scheme of MNRE has been set up. The purchase price of electricity under the scheme has been fixed at Rs 15/kWh, of which the Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) will pay Rs 4.50/kWh and MNRE will pay Rs 10.50/kWh. The project, which is now operational, was awarded to New Delhi-based Sapphire Industrial Infrastructures Pvt Ltd.[8,9] The GBI scheme is a demonstration programme of the MNRE, and six grid-connected solar PV projects have been commissioned all over the country under it.

Tamil Nadu is currently in the process of drafting a solar policy that is expected to be released in the current or the next budget session – this was announced by the state's power minister, Natham Vishwanathan, in March 2012 during the two-day conference 'Renergy 2012' organised by the Tamil Nadu Energy Development Agency (TEDA).[10]

The draft proposals expected to be included in the policy are:

- **Installation of 3,000 MW of solar power by 2015-16** (the state suffers from a shortage of 3,000-4,000 MW)[11]: With projects expected to be completed by 2015-16, the state's electricity generation capacity is likely to match the demand. The state has approached the National Clean Energy Fund to provide financial assistance to achieve this goal.
- **1,000 MW solar power on buildings:** The state government will encourage residents to install roof-top solar panels on their houses. The option of selling excess power to the Tamil Nadu Electricity Board is also available to the consumers, where every kWh of power sold will bring in Rs 15. New constructions and all hotels are being considered for mandatory solar module installation.[12]

Madhya Pradesh

Madhya Pradesh announced its solar policy in February 2012. Under it, the state plans to construct 200 MW solar PV power plants.

The MP solar policy varies from other state policies in certain ways. It has not specified any geographical constraints on the location of the plants – developers can set up plants in any state they wish (land costs are cheaper in Gujarat and Rajasthan, and these states also receive more sunlight than Madhya Pradesh). But the minimum capacity of plants constructed outside the state has been fixed at 10 MW.

A plant is required to get an 'evacuation form' from the electricity board of the state in which it is being set up. This is a certification from the board that the power that the plant generates will be fed into the grid making sure it reaches Madhya Pradesh. If a plant fails to get this evacuation form, the cost of the transmission lines leading to the nearest Madhya Pradesh State Electricity Board (MPSEB) sub-station will have to be borne by the plant owner.[13]

There is no upper limit on the plant capacity for which any company can bid for. The deadlines for commissioning the plants have been specified depending upon the size of the project – 13 months for a project with a capacity of up to 25 MW and 24 months for one with 200 MW**.** The policy stipulates that except for thin film modules, which can be procured from international sources, crystalline PV cells and modules are to be sourced locally (as in JNNSM).

The penalty clauses for delays in project implementation are also similar to those in JNNSM: 20 per cent of the Performance Bank Guarantee (PBG) will be encashed after a delay of one month, 40 per cent after the second month and 100 per cent after the third.[14,15]

The benchmark tariffs for solar PV projects in the state are Rs 15.36/kWh, without the accelerated depreciation (AD) and Rs 13.94/kWh

RENEWABLE PURCHASE OBLIGATION AND RENEWABLE ENERGY CERTIFICATE

In India, every state has a Renewable Purchase Obligation (RPO), which is a fixed percentage of electricity that each utility or captive producer has to source (buy or produce) from renewable energy sources. This is one of the reasons why states are opting for solar projects. State commissions have been mandated through Section 86(1)(e) of the Electricity Act, 2003 to "*specify, for purchase of electricity from such sources [renewable], a percentage of the total consumption of electricity in the area of a distribution licence*".[1]

This has been further emphasised in the tariff order of 2006: *"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."*[2]

In January 2011, the tariff order was amended to accommodate the provisions of JNNSM to include a specific percentage as RPO for solar energy. The RPO, therefore, was split into two parts – solar and non-solar. Although the Centre mandates the existence of an RPO, it is the state's prerogative to set the level. As part of the tariff order amendment in January 2011, state electricity regulatory commissions (SERCs) are mandated to reserve a minimum of 0.25 per cent of electricity through solar energy by the end of 2012-13, with a rise to 3 per cent by 2022. Practically, this can mean a state can keep it at 0.25 per cent till 2021 and then hike it straight away to 3 per cent – but the idea has been to raise it incrementally.[3]

Gujarat has been the most progressive, mandating 0.5 per cent in 2011-12.[4] Delhi has only stated that it would announce a RPO policy specifying 0.1 per cent for solar in 2011-12, with the draft saying clearly that it will not reach 0.25 per cent until 2014-15.[5,6] Bihar has announced 0.25 per cent for 2012-13.[7]

To enhance solar energy production in India, it is crucial to ensure that utilities fulfil their solar RPOs. But state programmes argue that the RPO provision is being used by the Centre to punish them and that to fulfill this obligation, they would need financial

assistance. Odisha, when launching one of its 1-MW solar projects under RPSSGP, said that it needs a subsidy from the Centre so that consumers are not hit by higher tariffs.[8]

Maharashtra is one of the few states which releases its RPO data on the website of the Maharashtra Energy Development Agency. Its 2009-10 data shows that none of the utilities have achieved the 6 per cent non-solar RPO target which the state has set – with the Maharashtra State Electricity Distribution Company doing best at 5.22 per cent and Reliance Infratech managing a paltry 2.08 per cent.[9] This, in a state with ample resources for wind, solar and biomass.

The REC or Renewable Energy Certificate scheme was announced in January 2010.[10] The scheme certifies that a seller has produced 1 MWh electricity from a renewable source somewhere in India and is now willing to sell its environmental benefits. The seller gets a better price for producing clean electricity. The buyer, instead of buying power from renewable electricity producers directly, can fulfill its RPO by buying RECs.

To receive the REC, producers of renewable energy must forgo any preferential tariffs they get under JNNSM or state policies.[11] In theory, it is only the 'environmental benefit' of the energy produced that is sold in the REC, and not the total cost of producing that electricity. Hence, over and above the market price, the producer also receives a standardised energy price computed from the state's average pooled purchasing cost. There is, however, a risk of double-accounting if utilities receiving power from a solar plant that also sells RECs count that power towards fulfilling their RPO.[12]

The market for RECs (which are, in effect, electronic certificates) has a floor and forebearance price. This price was fixed by the CERC on August 23, 2011, and is applicable from financial year 2012-13 to 2016-17 (*see Table: REC price set by CERC*).[13] Entities obligated to fulfil their RPO will have to buy RECs at a forebearance price if they do not fulfil their RPO in time; however, if there is no availability of RECs they may be allowed to carry forward the lacking obligation to the next period.[14]

For non-solar RECs, the less than a year old market was worth Rs 30 crore by January 2012. The price for a non-solar REC of 1 MWh in January 2012 trading was Rs 2,950 – this is on top of whatever the producer of power can get for the electricity in the regular market.[15] In May 2012, the prices for non-solar RECs were between Rs 2,150 and Rs 2,400 with about 160,000 RECs (worth 1 MWh each) being traded.

Solar RECs were traded for the first time on May 30, 2012: 10 RECs were traded by the first certified solar REC seller, M&B Switchgear, a 2-MW project based in Madhya Pradesh.[16] The project was awarded 249 RECs during registration, but it perhaps wanted to test the market cautiously. The price for the 10 RECs was Rs 13,000 per REC or Rs 13/kWh, close to the forebearance price.[17]

Besides M&B Switchgear, other projects are coming up which will generate solar power and sell the RECs to utilities (see Table: REC projects). Projects have also been set up specifically to fulfil RPO demands of utilities. The 40-MW Dhanu PV plant set up in Rajasthan by Reliance Power is all set to sell RECs directly to the Maharashtra utility (which is also owned by Reliance) through a long-term power purchase agreement.[18] Maharashtra's generation utility, Mahagenco, has initiated a 125-MW project to fulfill its RPO requirements; the project is still in the land acquisition stage. Initially, the project was under the joint partnership of German solar manufacturer Juwi and the Indian developer Lanco, but Juwi is no longer a part of the project.[19]

Table: REC price set by CERC

	Solar REC (Rs/MWh)	Non-solar REC (Rs/MWh)
Forebearance price	13400	3300
Floor Price	9300	1500

Source: Anon, 'Determination of Forbearance and Floor Price for the REC framework to be applicable from 1st April 2012,' CERC, August 23, 2011

Table: REC projects

State	Technology	Project company	Capacity (MW)	Registered by	Accredited by
Maharashtra	Solar PV	Jaibalaji Business Corporation	1	06/06/12	Not yet accredited
Madhya Pradesh	Solar PV	Gupta Sons	0.5	09/05/12	22/05/12
Madhya Pradesh	Solar PV	Omega Renk Bearings	0.105	09/05/12 accredited	Not yet
Rajasthan	Solar PV	Kanoria Chemicals & Industries	5	28/03/12	20/04/12
Tamil Nadu	Solar PV	Numeric Power Systems	1.055	20/02/12	10/04/12
Madhya Pradesh	Solar PV	M&B Switchgears	2	03/02/12	04/04/12
Maharashtra	Solar PV	Jain Irrigation Systems	8.5	20/10/11	22/05/12

Source: Anon, 'Registered RE Generators', Renewable Energy Certificate Registry of India, https://www.recregistryindia.in/index.php/general/publics/registered_regens, as seen on June 8, 2012

Table 2.5: **Madhya Pradesh: bid winners and their bids**

Company	Capacity won (MW)
Bidding	
Alfa Infraprop	20
Welspun	105
MOUs	
Moserbaer	25
Acme Telepower	25
Welspun	25

Note: Allocations are yet to be confirmed as of May 2012, just as the bids came out.
Source: Anon, 'Only two companies walk away with MP Solar Allocation of 125MW', Nature World, May 12, 2012 http://natgrp.wordpress.com/2012/05/12/only-two-companies-walk-away-with-mp-solar-allocation-of-125mw/

with AD. Tariffs declared for solar thermal are Rs 13.94/kWh without AD and Rs 11.26/kWh with AD[16] (*see Table 2.5: Madhya Pradesh: bid winners and their bids*). With 130 MW, Welspun Solar has been awarded the highest capacity any Indian company has received so far. The company will set up two projects in the state, in Mandsaur and Neemuch districts, by 2014[17].

Rajasthan

The state wants to sell solar power directly to discoms, and is aiming to do this through a two-phase approach. In phase 1, a total installed capacity of 200 MW – evenly divided between SPV and CSP – is targeted by 2013. In phase 2, which will be in operation till 2017, a total of 400 MW capacity will be installed.

In Rajasthan, two 5 MW solar PV plants have been planned under the generation-based incentive scheme of the MNRE

The selection of solar projects will be done through a tariff-based competitive bidding process. The benchmark tariffs for solar PV plants commissioned by March 31, 2014 have been set at Rs 10.12/kWh (without AD) and Rs 8.85/kWh (with AD). Each bidder would be allowed to place bids for either a 5-MW or a 10-MW PV. In the case of a consortium, each company would have to submit a separate RfS – request for selection – for the desired capacity.[18]

The deadline for final bid submission has undergone several revamps. The initial date was February 17, 2012. It was pushed back till May 18, 2012, and then postponed again till further notice.[19,20] The most obvious reason behind this indecisiveness, say industry watchers and power distributors, is the state's inability to pay for the power. Anil Patni, project manager at Rajasthan Renewable Energy Corporation Ltd (RREC), had a different take when CSE researchers approached him: "It [the bidding] has been stopped because there was some confusion regarding the bidding procedure. As it is a new process, we were following the conventional system of bidding. But the RERC asked us to stop while they reviewed the entire procedure. The policy has never been finalised so there are no interested parties. They [RERC] have returned the policy so we are now looking into the details. Maybe in a month we can start with the registrations."

Two 5-MW solar PV plants were to be set up under the generation-based incentive scheme of the MNRE.[21] Reliance Industries Ltd (RIL) and Par Solar Ltd were shortlisted for setting up one plant each.[22] Of these, the 35-acre RIL plant has come up in Nagaur district; it has an average capacity utilisation factor of 19.5 per cent and annual generation of 7.5 million kWh/year.[23] Par Solar, which plans to set up its plant in Osiyan in Jodhpur district, has not made much headway due to lack of funds.[24]

Another target that the policy has is sanctioning of solar power projects worth 66 MW; these projects had been migrated to JNNSM in compliance with the RREC's orders and are now being funded under the Central government scheme.[25] Originally, these projects had been developed by 11 private sector developers to meet the RPO demands of the discoms in Rajasthan. Of these, seven solar PV projects of 5-MW capacity each have been commissioned, while 31-MW of solar thermal plants are facing issues of funding.

West Bengal

In 2009, West Bengal lost more than Rs 500 crore in investments in the renewable energy sector, when it had to turn away companies like Astonfield Renewable Resources, Videocon and Reliance Power. These companies had approached the state government to set up projects ranging from 5 to 10 MW – but the state did not have a solar power policy.[26]

The state has learnt its lesson from this missed opportunity. It has come up with a draft policy, which was prepared by an expert committee headed by S P Gon Chaudhuri, a former advisor to the state government's power department. The policy preparation process was funded by the DFID, or Department of International Development.[27] In April this year, the draft was sent to the state power minister Manish Gupta for approval.[28] After acquiring the minister's approval, the policy will be forwarded to chief minister Mamta Banerjee and her cabinet for their assent, before being implemented.

Various means of producing electricity have been proposed under the policy, including grid-connected large plants as well as small roof-top plants from where excess power can be supplied to the grid.[29] The tariffs for selling the solar energy are yet to be decided.

Karnataka

Karnataka's Solar Policy 2011-16 was announced on May 2, 2011, with a target of setting up 200 MW capacity by 2016 (including projects under JNNSM).[30] The policy was introduced as the state's current RPO (0.25 per cent of the total electricity supplied in the state) will go up to 3 per cent by 2022. One 5-MW project has so far been awarded to Karnataka under the Mission's first phase. The state's total targeted capacity of 200 MW has been divided into five 'slots' of 40 MW each for the years between 2011 and 2016.[31]

State-level bidding was first planned in 2011, but was delayed as the Karnataka government wanted to see the outcome of the bidding for the second phase of JNNSM.[32] There was a further delay in February 2012, when bidding was halted as the bidders were found avoiding the on-line system that was mandated for tendering in the state.

For the year 2011-12, Karnataka opened bidding for 50 MW of PV and 30 MW of solar

Table 2.6: Karnataka: bid winners, their bids and the capacity won

Company	Capacity (MW)	Discount (Rs/unit)	Actual tariff (Rs/unit)	Capacity to be allotted (MW)
Helena Power Private Limited	10	656	7.94	10
Jindal Aluminium Limited	10	625	8.25	10
ESSEL Infrastructure Limited – Gulbarga	5	613	8.37	5
ESSEL Infrastructure Limited – Badami	5	604	8.46	5
GKC Project Limited	10	604	8.46	10
United Telecoms Limited	3	604	8.46	3
Sai Sudhi Energy Limited	10	601	8.49	10
Welspun Solar AP Private limited	10	600	8.50	7
Neelanchal Infra Tech Private Limited	5	559	8.91	0
Archita Indra Project Private Limited	3	552	8.98	0
Mangalam Energy Development Company Limited	10	550	9.00	0
SNC Power Corporation (P) Limited	5	500	9.50	0
Bhoruka Power Corporation Limited	5	485	9.65	0
TVS Energy Limited	5	481	9.69	0
SEW Infrastructure Limited	10	460	9.90	0
Posh Chemicals Private Limited	3	415	10.35	0
Jampana Construction Limited	5	265	11.85	0
Tata Power Renewable Energy Limited	3	201	12.49	0

Source: Pothan, Ritish, 'Karnataka solar bids now out', http://natgrp.wordpress.com/2012/04/20/karnataka-solar-bids-now-out/, April 20, 2012

In Karnataka, 80 MW is under development

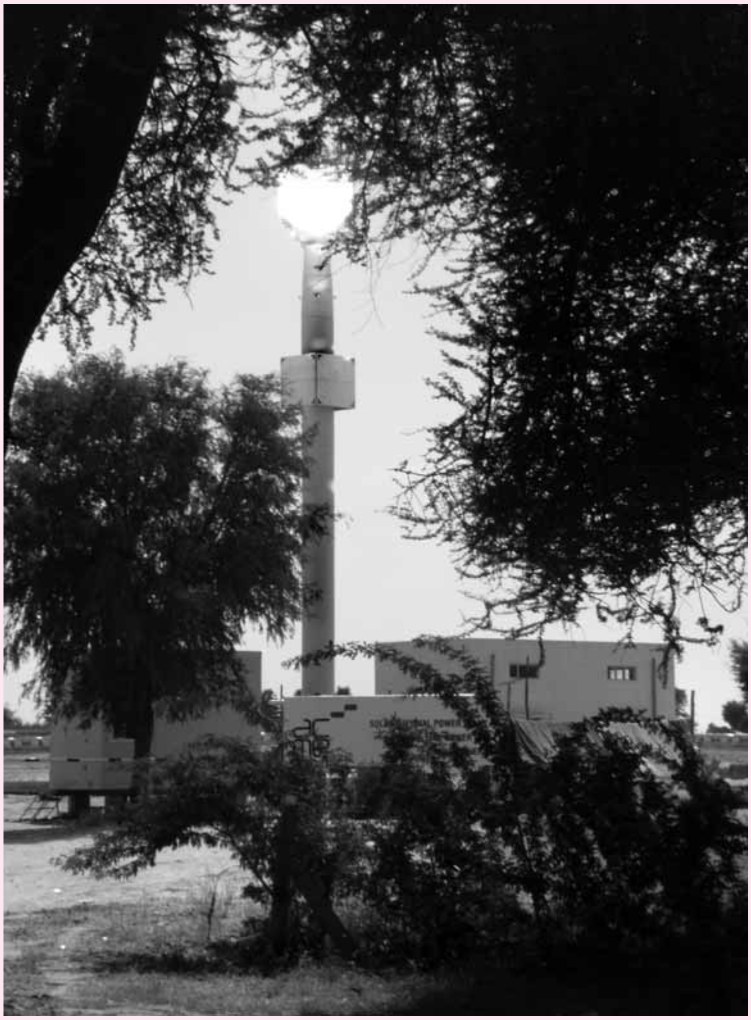
thermal. The benchmark tariffs declared by the Karnataka Electricity Regulatory Commission (KERC) were set at Rs 14.50/kWh for PV and Rs 11.35/kWh for solar thermal, for projects that are to be commissioned by March 31, 2013.[33]

As there were only two bidders offering 20 MW of solar thermal, the remaining 10 MW was transferred to the PV. Of the 22 companies that participated in the bidding, eight will set up solar PV plants worth a total of 60 MW. The only two bidders for solar thermal – Sunborne Energy of (bidding tariff of Rs 10.94/kWh) and Atria Power Corporation (bidding tariff of Rs 11.32/kWh)) were awarded a 10-MW solar thermal project each.[34] Thus, so far, 80 MW have been awarded through bidding in Karnataka. (*see Table 2.6: Karnataka: bid winners, their bids and the capacity won*).[35]

THE WOES OF SOLAR THERMAL

When the first phase of the National Solar Mission was being planned, the cost of the two technologies – PV and solar thermal – was about equal. A CERC calculation which set the base price for the first phase bidding predicted a lower price for solar thermal.[1] The MNRE, therefore, went on to split the first phase 50:50 in capacity. Bidding led to prices dropping heavily both for PV and solar thermal. PV bidders were lucky to see prices of modules fall in the international market, making their gamble profitable. Solar thermal developers, however, were not as lucky. An Indian representative of one of the largest developers in solar thermal in the world, Abengoa, said that the company chose not to invest in India at the moment as it found the tariffs unsustainable.[2]

It is, however, difficult to fix a price for solar thermal as the market is still small and is dependent on government subsidy. Solar PV has a big advantage – it preceded solar thermal in the field by a year and a half with new plants being commissioned every month or new technologies being developed.



India's only operational solar thermal plant in Rajasthan

Solar thermal projects under JNNSM phase I are placing orders and constructing their plants (*see Table: Solar thermal projects in India*), which indicates that they believe they can make a profit out of the project, or at least recoup their investments. The Karnataka Solar Policy included a section on solar thermal: it had a provision for 30 MW of solar thermal projects, but the state could get bids for only 20 MW at around Rs 11 per unit – the same price as the bids more than a year ago.[3] Hence, it does seem the tariff may have been sustainable unless the two developers bidding in Karnataka misjudged the situation.

There has been a sharp learning curve for solar thermal project developers, going from an installed base of 2.5 MW to what will be around 500 MW when all the projects contracted are finished. In this period, developers have started realising that available solar data is flawed and that the areas that most projects chose – north-western Rajasthan – might not be the best option. Solar thermal relies on direct sunlight; in Rajasthan, the prevalence of dust blocks the sun. Some developers argue that northern Gujarat is a better location due to the lower amount of dust.

The best option, as far as direct solar irradiation is concerned, would be to set up plants in Ladakh. A high-altitude desert, Ladakh has high solar irradiation and very low amounts of dust and precipitation. However, it has its own share of problems: lack of good transportation facilities and low electricity demand.[4]

Table: Solar thermal projects in India

Project	Programme	Size and technology	Location	Status	Deadline
ACME Solar Power Tower	JNNSM migration phase	2.5 MW solar tower (supposed to come to total of 10MW)	Bikaner, Rajasthan	Functioning but with reduced capacity	Completed
Entegra	JNNSM migration phase	10 MW Parabolic Trough	Rajasthan	May be cancelled – company could not get financing[1]	February 2013
Dalmia Cement	JNNSM migration phase	10 MW Sterling Dish producer of technology	Rajasthan	May be cancelled – has moved headquarters[2]	February 2013
IIT-Bombay test plant	Unknown	1 MW Linear Fresnel	Solar Energy Centre, Gurgaon, Haryana	Linear Fresnel mirrors and tube up in November 2011	No deadline – completion expected in July 2012[3]
Abengoa demonstration plant	Unknown	1-3 MW Parabolic Trough	Solar Energy Centre, Gurgaon, Haryana	Trough constructed by November 2011	No deadline - completion expected in beginning of 2013[4]
Lanco Solar 'Diwakar'	JNNSM Phase 1	100 MW Parabolic Trough with	Askandra, Rajasthan 4 hour storage	Land-levelling done, orders put for most equipment	May 2013
KVK Energy Ventures	JNNSM Phase 1	100 MW Parabolic Trough	Askandra, Jaisalmer, Rajasthan	–	May 2013
Reliance Power (Rajasthan Sun Technique)	JNNSM Phase 1	100 MW Linear Fresnel	Dhursar, Jaisalmer, Rajasthan	–	May 2013
Corporate Ispat Alloy/Abhijeet	JNNSM Phase 1	50 MW Parabolic Trough	Nokh, Jaisalmer, Rajasthan	Basic engineering completed and orders put for most equipment	May 2013
Godawari Green	JNNSM Phase 1	50 MW Parabolic Trough	Nokh, Jaisalmer, Rajasthan	Land-levelling done, orders put for most equipment	May 2013
Aurum	JNNSM Phase 1	20 MW Parabolic Trough	Mitrala, Porbandar, Gujarat	Land-levelling done, orders put for most equipment	May 2013
Cargo Solar	Gujarat Solar Policy	25 MW Parabolic Trough with 9 hours storage	Kutch, Gujarat	'Under construction'	Expected commissioning in March 2013
MEIL Green Power	JNNSM Phase 1	50 MW Parabolic Trough[5]	Pamidi, Ananthapur, Andhra Pradesh	Unknown	May 2013
Sunborne Energy Services	Karnataka Solar Policy	10 MW	Karnataka	Won bidding in end of April 2012	30 months from signing contract
Atria Power Corporation	Karnataka Solar Policy	10 MW	Karnataka	Won bidding in end of April 2012	30 months from signing contract

Sources: Unless otherwise stated, the information has been compiled from site visits, interviews with site managers and from the document 'Details of Sanctioned Solar Thermal Power Project in Rajasthan under NSM Phase-1' obtained from Jodhpur Vidyut Vyapar Nigam Limited (JVVNL) on October 19, 2011

1. Interviews with Bharhava, B (director, MNRE), on November 10, 2011 and with Anil Patni, project manager, RREC, on October 20, 2011
2. Interviews with Bharhava, B (director, MNRE), on November 10, 2011 and with Anil Patni, project manager, RREC, on October 20, 2011
3. Email communication with J K Nayak, IIT Bombay, May 18, 2012
4. Personal communication with scientist at Solar Energy Centre, May 25, 2012
5. http://www.energynext.in/siemens-to-supply-solar-receivers-to-megha-for-its-csp-plant-in-india/

CHAPTER 3

Manufacturing

The solar manufacturing sector in the country has evolved and expanded along with the policy initiative to support solar energy. Although JNNSM supports the domestic industry through its indigenisation clause, it also leaves certain loopholes. These have proven to be detrimental for the sector which is currently in crisis. Fresh impetus is needed to revive the domestic solar manufacturing industry

The solar PV equipment manufacturing industry in India is a little over three decades old. State-owned enterprises such as Bharat Heavy Electrical Limited (BHEL) and Central Electronics Limited (CEL) have been making solar panels and other equipment since the 1970s, but their scale was limited to research and demonstration (R&D) and prototype-level manufacturing till the middle of the last decade.

In the 1990s, a few companies began small-scale manufacturing of modules, but these were limited to off-grid applications. The first commercial scale manufacturing plant was set up by Moser Baer in 2006-07, with a 40-MW manufacturing capacity. Indian solar power industry has not looked back since. Exponential growth in global demand and the ambitious National Solar Mission have led to a mushrooming of domestic manufacturers.

Today, India has an installed manufacturing capacity close to 900 MW for solar cells and almost 2 GW (2,000 MW) for solar modules (*see Table 3.1: Solar technology manufacturing in India by company*). It is another matter that more than 80 per cent of this facility is currently not operational.

There are 19 cell makers registered with the MNRE, and over 50 module makers in the country. Initially, when there was little domestic policy support, the industry mainly targeted exports. Aggressive policy support options like

THE STORY OF AJIT SOLAR

Ajit Solar is a small solar module manufacturer in Jaipur, Rajasthan. The company has a factory producing 25 MW worth of solar modules per year; it has 80 employees. The manufacturer, like many others, is feeling the pressure from international competition. The production facility is being under-utilised and it has had to put on hold its expansion plans.

The company is requesting support for the industry in the same manner that European, US and Chinese manufacturers receive. It has suggested that India follows the Italian example of giving 10 per cent extra on tariff to developers who choose domestic equipment. Another suggestion is to increase the custom duty for solar modules while lowering it for imported raw material and components.[1] This would, however, work against creating a complete ecosystem of 'sand to module' where one company produces poly-silicon ingots, slices them into wafers, produces the cells and assembles the modules, as it would be better to import the poly-silicon and wafers instead of producing them in the country.

Table 3.1: Solar technology manufacturing in India by company

	Cells (in MW)	Module (in MW)	Announced but on hold or abandoned
Access Solar		18	
Ajit Solar		20	
Alpex		35	
BHEL	8	8	
CEL		10	
EMVEE Solar		120	
Euro Multivision	40		
Evergreen		20	
Green Brilliance		45	
Goldstone			100
HHV		50	10
Indosolar	190		
Jupiter Solar	45		
KL Solar	7	6	
Kotak Urja		15	
KSK Energy			150
Lanco		70	
Maharishi Solar	2.5	17	
Microsol		14	
Moser Baer	250	280	565
Photon Energy Systems		50	
Photonix		15	
PLG Power		100	
Premier Solar Systems		30	
REIL	2	2	
Reliance Industries		30	
Shurjo		5	
Solar Semiconductor	30	195	
Surana Ventures		40	
TATA BP Solar	96	125	
Titan Energy		100	
TopSun Energy		5	
UPV Solar	12	7	
USL Photovoltaics	6	10	
Vikram Solar		100	
Waaree Energy		60	
Webel SL Energy Systems	100	120	
XL Energy	60	210	
Total	848.5	1932	825

Source: Centre for Science and Environment

significantly higher feed-in tariffs (FIT) announced by several European governments such as Germany, Spain and Italy drove the initial investment. By 2010-11, several other markets, including the domestic, opened up.

JNNSM and manufacturing

While the JNNSM led to a spurt in solar power production, it is lagging behind in achieving its other key objective: to strengthen domestic manufacturing of solar technology. The JNNSM did provide for domestic content requirement for projects under the scheme, but this domestic content demand was restricted to crystalline silicon technology and did not cover the more recently developed thin-film types of solar modules.[1] The guidelines allowed free imports of thin-film modules on the ground that India had only one thin-film module producer, Moser Baer[2,3].

The competition in JNNSM has, therefore, been between imported thin-film technology and domestically assembled (although often with raw material or even finished PV cells imported from other countries) crystalline silicon panels. It has, however, been far from a fair competition.

The technology choices for projects under JNNSM have been heavily skewed in favour of thin-film panels due to several reasons. First and probably the most attractive is that thin-film panels are cheaper compared to their mono or polycrystalline counterparts. The cost benefit, however, is somewhat neutralised by the fact that they are less efficient. Larger numbers of thin-film panels are required to generate the same amount of electricity, thus increasing the land demand for projects that use them. The technology also has a shorter track record.[4]

With cheap land provided by states the land costs have, however, become of secondary importance, while the risks of under-performing panels are generally covered by warranties given by the technology provider. To illustrate the shorter track record – Abound Solar, a manufacturer selling panels to India with a 25-year warranty, began as a Colorado University research study only in 1993 – 19 years ago; it started production of its modules in 2009, just three years ago.[5]

But lower up-front costs have definitely dictated the technology choice. Almost 60 per cent of the projects under phase I of the Mission have opted for imported thin-film panels. This is a huge

FAST-START FINANCING AND TRIPLE-ACCOUNTING OF US STATE DEPARTMENT

The United States is using the climate 'fast start financing' to its perverse advantage for ruining the Indian domestic solar PV manufacturing industry. Currently, 80 per cent of the Indian manufacturing capacity is in a state of forced closure and debt restructuring with no orders coming to them, while US manufacturers are getting orders from Indian solar power developers.

Fast start financing is a US $30 billion fund set up under the United Nations Framework Convention on Climate Change. The fund, adopted at the Copenhagen climate meeting in 2009, is supposed to help developing countries deal with climate change impacts and limit greenhouse gas emissions.

The US has been very ingeniously using this fund to promote its own solar manufacturing. The US Exim Bank and the Overseas Private Investment Corporation (OPIC) have been offering low-interest loans to Indian solar project developers on the mandatory condition that they buy the equipment, solar panels and cells from US companies. This has distorted the market completely in favour of US companies.

Though the JNNSM mandates a domestic content requirement – all projects must buy domestically manufactured solar equipment – it does it only for the crystalline PV technology and not for the thin-film. Taking advantage of this loophole, the US Exim Bank and OPIC have been offering very low rates of interest (about 3 per cent) and a long repayment schedule (up to 18 years) to Indian solar project developers on the condition that they buy thin-film panels manufactured by US companies.

Loans from Indian banks come with an interest rate of close to 14 per cent or more. This has skewed the market completely in favour of thin-film panels imported from US despite the fact that thin-film has lower efficiency when compared to crystalline panels. Close to 60 per cent of the panels installed in India are thin-film type, even though thin-film accounts for only 14 per cent of the global capacity.

According to the US Department of State reports for the years 2010 and 2011 on fast-start financing, an amount totalling US $248.3 million has been disbursed by the US Exim Bank and OPIC for grid-connected solar plants in India. The major beneficiaries in this case have been American producers such as First Solar and the now bankrupt Abound Solar.

As recently as on July 19, 2012, the US Exim Bank authorised two loans totalling US $57.3 million to Solar Field Energy Two Private Limited and Mahindra Surya Prakash Private Limited, respectively, "to finance the export of American solar panels and ancillary services to India". The solar panels, manufactured by First Solar, will be used in the construction of solar PV plants in Rajasthan. According to a US government release, these "transactions will support 200 US jobs at First Solar's manufacturing facility in Perrysburg, Ohio".

The US is also fudging its data on fast-start finance. When giving loans as aid, only the difference of the rate of interest between the 'soft' loan and a commercial loan is counted as aid. However, in this case, the US has counted the entire loan sum as aid under fast-start finance. If a fair counting was to be done, the fast-start financing amount shown by the US would be reduced to a fraction. While on one hand this misuse of fast-start financing is unethical, on the other it is doing more harm than good to the Indian solar sector.

Interestingly, the US government has put anti-dumping duties on solar equipment imported from China because of the alleged subsidies that China is giving to its solar manufacturers. However, the US is engaging in a similar practice in India!

over-representation, as globally only 14 per cent of the modules produced are thin-film.[6] Also, in state programmes like the Gujarat Solar Policy, there is no requirement for mandatory buying of domestically produced equipment – project developers are free to do what they wish.

Financing of projects and manufacturing have become inter-twined, as the US Exim Bank and the Overseas Private Investment Corporation (OPIC) have aggressively been giving low-interest loans to project developers in exchange for use of American-made solar PV modules (*see Box: Fast-start financing and triple-accounting of US State Department*).[7,8]

Indian banks, on one hand, are reluctant to give loans; on the other, they demand a comparatively higher interest on any loans given. This is because there is an uncertainty in recovering the costs incurred during the initial phase of the project – producers are unsure whether they will be paid by state utilities which are already under strain.

BALANCE OF SYSTEM

The capital cost of solar is generally divided into two parts: solar modules and balance of system (BoS). BoS is a catch-all term for everything besides the module. One of the positive sides of a solar farm is that it has few moving parts and is quite modular and simple to set up – "like a LEGO set", according to one developer. When modules were in the price range of US $3-4/Watt peak a few years ago, the cost of the modules would be 70-80 per cent of the project[1]. With falling prices, this has come down to about 50 per cent, with the remaining 50 per cent coming from BoS. The main parts of BoS are:

Structures: The modules need to be mounted on structures, usually made of steel, to be set at the correct angle towards the sun. The structures are heavy but not technically complicated and are produced in India by manufacturers such as Tata Steel.[2]

Tracker: A tracker is a system which lets the operator swivel the solar module so that it is directly aimed at the sun. The tracker can work on 1-axis and either track the sun across the sky during the day (east to west) or – depending on the season (more or less inclined) – can do both on 2-axis. A tracker can be motorised or hand-swiveled (eg. Suncatcher). This is optional and in India, few projects have used it (eg. Mahindra's 5-MW plant in Rajasthan and Solar Millennium's 10-MW plant in Gujarat)[3]. Trackers can increase generation by up to 30 per cent. But they have so far not been used by most projects, as using them creates a risk of breakdown, higher maintenance costs and higher capital expenditure.[4]

Inverters: Solar modules produce direct current, (DC) while the grid requires alternate current (AC). Inverters change power output from DC to AC. Almost no inverters are produced in India at the moment, but there have been discussions about including them in components that have to be made in India in phase II of JNNSM.[5] Some international manufacturers are contemplating setting up inverter manufacturing plants in India.[6]

Transformer: The voltage of modules is around 30-40 volts – this has to be stepped up to transfer through the transmission companies' sub-stations. JNNSM mandates 33kV or higher[7], Gujarat generally connects to 66kV[8] or higher while the solar park in Charanka has a sub-station of 250kV while another is being built for 440kV.[9]

This has led project developers to turn towards the cheaper US bank loans. Half of the projects in the first batch of the first phase that opted for thin-film technology, acquired panels from American companies such as First Solar and Abound Solar.[9,10]

The state of the Indian industry

In states like Gujarat where there is no indigenisation policy, Chinese and American technology has captured the market. Most of the Charanka Solar Park is supplied by manufacturers such as MEMC, Suntech or CSun. Moser Baer plants in Kamalpur and Zenabad are supplied by LDK, Trina and other Chinese companies.[11] Reliance Power's 40-MW PV project being set up for the REC market will use First Solar panels financed by the US Exim Bank.[12]

In fact, indigenous panels are being used only by Indian project developers who are also manufacturers. These include Tata Power's 25-MW plant in Gujarat which is using Tata BP panels[13] and Lanco Solar's 35-MW plant in Rajasthan that uses panels manufactured in-house.

But in some cases even the domestic manufacturers are opting for imported modules. Moser Baer, for instance, opted for American modules when setting up what was briefly the largest PV solar plant in Asia, a 30-MW project in Gujarat.[14] Though Moser Baer has a c-Si line in India, the company still uses Chinese poly-crystalline in at least three of its Gujarat projects – Ujjawala, Responsive Sutip and Chattel Constructions all use panels from Trina, LDK and other Chinese manufacturers.[15]

Most domestic manufacturers are in dire straits – at Tata BP, only one out of three production lines are working.[16] Indosolar, India's largest cell manufacturer, has had to let go of 170 staff, mostly engineers, and is currently managing with a skeletal work force. The company had made a combined investment of Rs 1,200-1,300 crore for an over 400-MW plant which is currently non-functional. As per its last year's balance sheet, the company has lost about Rs 200 crore due to the forced closure. "In 2010, what we produced in the morning was off to the airport in the afternoon, but we don't have clients today," says Rahul Gupta, managing director of Indosolar.[17] "We have lost clients in France, Lithuania, Italy, Hungary, Spain, Greece and India."

He adds: "We are already on the verge of collapse and without intervention, this sector will become a purely import business. If nothing is done soon most of this capacity will die down never to resurface again."

Gupta says that only 20 per cent of the country's manufacturing capacity is actually operational. The rest is dormant as there is not enough demand for Indian solar modules and cells. For instance, Maharishi Solar, an Indian producer, has said that its plant is not operational because of lack of demand. Eighty per cent of Indian manufacturing is in debt restructuring, meaning manufacturers and banks are renegotiating the payback plans for their loans as they cannot repay them at the moment. Debt restructuring is generally seen as the step before bankruptcy.

India and the world

The global solar manufacturing outlook is not great for someone trying to break into the market. Crystalline-silicon production has been cornered by Chinese producers. Indian manufacturers, together producing 1.2 GW of modules in 2011 (50 per cent more than in 2010), cannot match even one large Chinese manufacturer and are not even close to the total Chinese production of 20 GW a year. An industry insider asks: "How can Indian companies, making 40-60 MW of modules each year, compete with the Chinese market leaders making 2 GW and controlling the whole process of manufacturing?"[18] Chinese manufacturers such as Trina and Yingli control the process from poly-silicon production to module assembly thus cutting costs.[19]

After a prolonged low, prices of solar modules had begun stabilising in 2012. But in March in the same year,[20,21] Germany – which has the largest market for solar PV – announced cuts in subsidies, triggering low demand[22] (after strong opposition from unions, the cuts are being temporarily halted[23]). Disregarding the lack of demand, China announced that it would increase the manufacturing of solar modules. This possibly led to a glut in the market and lower prices.[24] The Chinese move is being interpreted as a final blow to push rivals outside China into bankruptcy.

Currently, the entire global solar manufacturing sector is in a rut. Analysts say that the industry has followed the most optimistic projections for future orders and created a huge over-capacity. According to estimates, while the global demand was to the tune of 30,000 MW, manufacturing capacity was double that at 60,000 MW. Complete or partial collapse of supporting policies in European nations, Spain being the worst hit with a complete moratorium on immediate support for solar, made matters worse. "When Spain had announced a higher FIT for solar, it had budgeted for 600 MW and before they knew it 2,600 MW was set up in the country. They simply did not have the cash to support such a mega scheme," says an industry insider. And no one could have predicted such a sharp fall in prices in solar equipment which only made the governments wary to pay the much higher tariffs they had announced when the price of solar was far higher.

According to a report 'Global trends in renewable energy investment 2011', prepared by Bloomberg New Energy Finance and the United Nations Environment Programme (UNEP), "moves by Spain and the Czech Republic to make retroactive cuts in FIT levels for already operating PV projects damaged investor confidence. Other governments, such as those of Germany and Italy, announced reductions in tariffs for new projects – logical steps to reflect sharp falls in technology costs. What caused concern was the idea that governments facing economic hardship might go back on previously promised deals for existing projects, damaging returns for equity investors and banks."

According to Bloomberg New Energy Finance estimates, the price of PV modules per MW fell by 60 per cent between 2008 and 2011. Other estimates point to an even greater decline. If the falling price of polycrystalline, the basic building block for a type of solar cells and modules, is taken as an indication the drop has been massive. Polycrystalline spot price fell from US $500 per kg in 2008 to the current US $25 per kg.

India does not fare well in the first step of solar module production – the making of poly-silicon, ingots and wafers[25] – which is also the step with the highest margins. A representative of Maharishi Solar complained at the second batch bid meeting in December: "I have sunk some US $500 million into this venture but cannot get the money back.

THE RISE OF CHINA

China's emergence as the leader in solar manufacturing industry has completely changed the geopolitical equations in the global renewable energy industry. In the last decade, the country has captured more than half the global solar production capacity, all at the expense of Japanese, American and European companies. Today, the largest cell and module producers in the world are Chinese (see Tables).

According to Bloomberg New Energy Finance, China now produces over half of the photovoltaic modules used globally and is home to several of the biggest brands in the sector. In 2010, some 55 per cent of modules worldwide were produced by companies with headquarters in China (up from 39 per cent in 2009), with 13 per cent from companies based in Europe, 18 per cent from those based in the Americas and 13 per cent from Japanese companies. Currently, four of the world's top five cell manufacturers and three of the world's five largest module manufacturers are Chinese. China has grown from accounting for just 1 per cent of global market in 2001 to over 50 per cent today. The US share fell from 27 per cent to just 5 per cent in the same period.

Chinese manufacturers have an average capacity of more than 1 GW, the combined cell manufacturing capacity of all Indian producers. Even the US has an average manufacturing capacity of about half a GW. China's total annual production is 20 GW.

With the implementation of the Renewable Energy Law in 2005 in China, both solar and wind manufacturing exploded. According to a US Department of Commerce investigation,[1] 30 out of China's 47 poly-silicon manufacturers are regarded as 'authorities' under the government and seven more have ownership and management interest from the government. In the US investigation, the following support programmes were found to support Chinese solar power manufacturers:

- Golden Sun Demonstration Programme: A programme for financial assistance and technological support
- Preferential Policy Lending: Subsidised loans and financial assistance for production of crystalline silicon solar cells
- Provision of poly-silicon for LTAR: LTAR stands for 'less than adequate remuneration' – poly-silicon was provided to producers of solar cells at a lower cost than an adequate market-price.
- Provision of land for LTAR: Chinese solar manufacturers were given subsidised land
- "Two Free, Three Half" Program for Foreign-Invested Enterprises (FIE): This programme confers full income tax exemption for two years and half the tax exemption for three years.
- Preferential Tax Programs for High or New Technology Enterprises: Income tax reduction from 25 to 15 per cent
- Import Tariff and Value Added Tax (VAT) Exemptions for Use of Imported Equipment
- VAT Rebates on FIE Purchases of Chinese-made Equipment
- Value Added Tax exempted for Chinese Equipment bought by Foregin-Invested Enterprises.

Table: Largest cell producers of 2011

Rank	Company	Technology	MW
1	JA Solar, China	c-Si	2500
2	Suntech, China	c-Si	1900
3	Trina Solar, China	c-Si	1550
4	Yingli Green, China	c-Si	1500
5	Q-Cells, Germany	c-Si, CIGS	1100
6	Canadian Solar, China	c-Si,	1050
7	Hanwha,China	c-Si	925
8	Gintech, Taiwan	c-Si, Thin Film Si	905
9	Motech, Taiwan	c-Si	900
10	Kyocera, Japan	c-Si	775

Source: GTM Research

There is no way we can keep up with the R&D. In this business, you have to reinvent constantly, and we don't have the means."[26]

Incentives to the domestic sector

The Indian government has mandated domestic content requirement for crystalline modules. This, however, was not done for thin-film modules, a loophole that project developers have exploited, skewing the entire market in favour of thin-film. The ministry of new and renewable energy (MNRE) needs to rectify this anomaly and mandate that thin-film and crystalline modules, as well as cells, are sourced from Indian manufacturers. State policies and other schemes such as renewable energy certificates should follow the same domestic manufacturing requirement.

Photovoltaic manufacturers have benefitted from a special incentives package announced by the

Table: Largest module producers of 2011

Rank	Company	Technology	MW
1	First Solar, US	CdTe	2001
2	Suntech, China	c-Si	1866
3	Yingli Green, China	c-Si	1.554
4	Trina Solar, China	c-Si	1395
5	Canadian Solar, China	c-Si,	1363
6	Sharp, Japan	c-Si, Thin Film Si	1155
7	Hanwha, China	c-Si	825
8	Jinko Solar, China	c-Si	782
9	LDK Solar	c-Si	774
10	SolarWorld	a-Si	767

Source: LUX Research

- Sub-Central Government Subsidies for Development of "Famous Brands" and "China World Top Brands": Lump sum awards to companies that become 'famous' internationally.

Along with these, there were a number of smaller 'Discovered Grants':

1. Wuxi Airport 800KW program
2. PV Technology Research Institute of Jiangsu (Suntech)
3. Fund for Solar Optoelectronic Application Demonstration by Management Committee of the New District
4. Self-Research on Core Equipment of Solar PV and Semiconductor Lighting Industry—Self Research on New On-Line Direct Method PEVCD
5. Demonstration Project of 300KW Roof Solar PV Grid Power Generation System
6. Industrialization and Research of New Solar Cells
7. Research and Industrialization of Thin Film Cells
8. Research on Highly Efficient and Low-Cost Thin Film Cells
9. Technology and Application Research on Glass-Base Suede Gazno Transparent and Electrically Conductive Film Manufacture
10. Demonstration Program of 300KV Roof Solar PV Grid Power Generation System
11. Renewable Energy of Finance of Bureau, Wuxi City
12. Research on New-Style High-Transmission Solar Cell Reducing the Refection Film with Nano Structure
13. Fund for Construction of Suntech's Energy Institution by the Management Committee of New District
14. Public Welfare Project Funding From Supervision and Examination Station of Product Quality, Wuxi City
15. Provincial Export Credit Insurance Supporting Development Fund Allocation by Management Committee of New District from December 2008 to June 2009
16. Patent Fund from Management Committee of New District, Wuxi Government
17. Special Reward for "333" Program by Municipal Organization Department
18. Science and Research Budget Allocation for Renewable-Energy Construction Application Technology Project of Wuxi Suntech's R&D Building by Construction Bureau of Wuxi
19. Photovoltaic Technology Research Expenses by Personnel Bureau
20. Social Insurance Fund for Employers from Sichuan Earthquake Stricken Area
21. Import Discount by Jiangsu Provincial Government
22. Employment Expansion Planning Reward by Management Committee of New District
23. Fund for Demonstration Company of 2009 Provincial Intelligence Introduction Program
24. The First Group of Patent Fund in 2010 Provided by the Wuxi Government
25. Research, Development and Industrialization of Technology and Key Equipment for P-Type Solar Power Cells with High Efficiency and Low Cost
26. Award for Luoyang City Outstanding Private Enterprise for 2009
27. Plan for Thousand Talents

Department of Information Technology in 2006. In the beginning, much of Indian solar manufacturing was supported by this package which was announced under the Semiconductor Policy of 2006. In an effort to set up 'fabs' (manufacturing units producing semiconductor chips for electronics), a 25 per cent (20 per cent in SEZs) capital subsidy was given to projects.[27]

Although not directly aimed at solar PV manufacturing, this policy covers PV production as an off-shoot of the semiconductor industry. As per the policy, an 'ecosystem' unit that reached a threshold investment level of Rs 1,000 crore would receive 25 per cent of the cap-ex cost back from the government as a subsidy.

But the policy failed to create 'fabs' in India. Import of semiconductor chips remains very high, though it might have helped the PV industry. According to one report, 15 proposals[28] for PV manufacturing were received and 12 of these received acceptance in principal.[29]

The total investment in these 12 projects was estimated at Rs 92,915 crore. Out of these, five projects have reached the Rs 1,000 crore threshold needed for the 25 per cent capital expenditure return. The policy extended from 2008 to 2010; one manufacturer says that the first payouts may come this year to one or two of the projects.[30] There might be a second special incentive package coming from the Department of Electronics and Information Technology (earlier Department of Information Technology), but there is no firm assurance about it.

The package may have incentivised manufacturers, but as Rahul Gupta of Indosolar says: "It is great, but it will be useless unless we can also sell what we produce." There was an application from Reliance to set up wafer production as well, but so far nothing has been announced by the company on this.[31]

The geopolitics of manufacturing

Bilateral free-trade agreements as well as agreements within the World Trade Organization (WTO) make it difficult to subsidise domestic industry without other countries countering the subsidy with higher custom duties or other counter-measures. The US has criticised India for its domestic content requirement under the JNNSM, reasoning that it is an illegal support granted to Indian manufacturers[32,33]. India contends that JNNSM comes under government procurement agreement in WTO, to which India is not a party[34,35]. The US wants India to join the government procurement agreement.[36] But India is not alone in having a domestic content requirement policy for its national mission (*see Table 3.2: India not alone: Domestic content requirement for solar PV projects*).

Ontario, a province of Canada, has stipulated that 60 per cent of content for projects under its solar policy must be sourced from the province. This policy has been opposed in the WTO by Japanese and European manufacturers and the case came into court in April 2012. The outcome of the decision may be important for India as the Ontario government also states that it is a government procurement and the province and its implementing agency, the Ontario Power Authority, are not required to observe the government procurement agreement. The resolution of the case is not expected before October 2012.[37]

India has in turn threatened to join the US suit

Table 3.2: **India not alone: Domestic content requirements for solar PV projects**

Country or province	Domestic content requirement
Ontario (Canada)[1]	60% of goods and labour has to come from Ontario to qualify for solar tariff
Italy[2]	60% of components sourced from European facilities gives 10% extra on solar tariff
Greece (proposed)	80% of components sourced from European facilities gives 10% extra on solar tariff
France (proposed)	60% of components sourced from European facilities gives 10% extra on solar tariff
Ukraine[3]	15% (commissioned before 2013), 30% (between 2013 and 2014) or 50% (commissioned after 2014) of 'total construction volume' from Ukraine.
Malaysia[4]	Bonus to tariff if local modules (0.01 USD/kWh) and inverters (0.003 USD/kWh) are used.
Turkey[5]	Up to 50% bonus on tariff if solar components are made in Turkey.
China	See box

Sources: 1. Ontario Power Authority 'Domestic Content' accessed on 14th May 2012 at http://microfit.powerauthority.on.ca/domestic-content 2. Gipe, Paul 'New Italian PV Tariffs Complex and Robust --Effectively No Cap on Rooftop Systems' Renewable Energy World 14th July 2011 http://www.renewableenergyworld.com/rea/news/article/2011/07/new-italian-tariffs-complex-and-robust-2000-mw-may-be-installed-in-2011 3. NOERR 'Amendments to the Law of Ukraine "On Electrical Energy" with regard to local content requirements for renewable energy projects' accessed on 14th May 2012 at http://noerr.com.ua/press-centr/press releases/amendments_to_the_law_of_ukraine_on_electrical_energy_with_regard_to_local_content_requirements_for_renewable_energy_projects/; 4. Gipe, Paul 'Comment: Malaysia adopts feed-in tariff' 11th May 2011 Renewable Energy Focus http://www.renewableenergyfocus.com/view/17895/comment-malaysia-adopts-feed-in-tariffs/; 5. Gipe, Paul 'Turkey Adopts Limited Feed Law' Renewable Energy World 17th January 2011 http://www.renewableenergyworld.com/rea/news/article/2011/01/turkey-adopts-limited-feed-law against China, arguing that China is giving heavy support to its solar manufacturing through cheap loans, export credit and inexpensive land.[38] On October 19, 2011, a group of seven US solar manufacturers under a grouping called Coalition for American Solar Manufacturing (CASM), filed petitions with the US International Trade Commission and the Department of Commerce's International Trade Administration seeking relief for domestic US manufacturers against their Chinese competitors. CASM is led by SolarWorld Industries America, the US division of German manufacturer SolarWorld AG. SolarWorld AG along with another German company Coenergy had filed a similar complaint in August 2009 with the German government and European Union, but the EU did not initiate an investigation.

Petitioners have sought relief in two different forms. An anti-dumping petition seeks duties to offset Chinese dumping where dumping means a foreign company selling goods in the US at less than the production costs. "Countervailing duty petition alleges that China illegally subsidises its solar industry by providing cash grants; discounted polysilicon and aluminium necessary for production of solar panels; heavily discounted land, power and water; multi-billion dollar preferential loans and direct credit; tax exemptions, incentives and rebates; export grants and insurance and by holding its currency under value," says the May 2012 report *China's solar industry and the US anti-dumping/anti-subsidy trade case*, by a non-profit, The Kearny Alliance. "China's solar manufacturers benefitted from a series of huge government debt financing deals. Loan guarantees worth US $32.5 billion were extended to 10 manufacturers including LDK Solar, Yingli Green Energy and Suntech Power Holding, creating an intimidating backdrop for foreign competitors," says the UNEP-Bloomberg report.

On March 20, 2012, the US Department of Commerce announced preliminary countervailing duties on two Chinese companies: 2.9 per cent on Suntech Power and 4.73 per cent on Trina Solar. All the other Chinese producers were levied a duty of 3.61 per cent. Later, on May 17, 2012 the Department of Commerce announced preliminary anti-dumping duties of 31.22 and 31.14 per cent on Suntech Power and Trina Solar, respectively. A tariff of 31.18 per cent was levied on 50 other Chinese manufacturers including JA Solar, Yingli, Hanwha SolarOne, Canadian Solar, LDK Solar and Jiawei Solar China. All other Chinese producers were levied a duty of 249.96 per cent. Final orders have yet to be passed in both investigations but sources following the case say that the duties would be confirmed.

Levying of duties seems to have had the desired impact. Industry sources say that US imports from China dropped by 64 per cent two months in a row after the duties were imposed. China's loss tuned into gains for manufacturers in the Philippines, Malaysia and Taiwan who replaced the Chinese in the US markets. "Chinese cannot afford to lose the US market. They might off-shore their manufacturing base to Korea, US or even India to circumvent the duties," says an industry source.

The Solar Manufacturers Association of India has filed a case with the Director General Anti-dumping (DGAD) in the Union ministry of commerce alleging that China, Taiwan, Malaysia and the US dump solar equipment in the country. It has sought imposition of anti-dumping duties on imports. The DGAD is expected to admit the petition after an initial internal investigation.

The prices at which most foreign (Chinese and US) equipment are currently selling in India range between US $65 to 80 cents per Watt, while the current production costs, anywhere in the world, stand at about US 95 cents to US $1 per Watt. What this means is that most of these companies are taking huge losses. "The Chinese and American companies are bleeding money. LDK [one of the larger Chinese manufacturers which sell to India] lost US $600 million in the last year and First Solar, a US company, wiped out a billion dollars in losses in the last two quarters. They are making severe losses but because of their size they could do it for a lot longer than small Indian manufacturers," says Indosolar's Rahul Gupta.

A steep fall in prices, global oversupply riding on huge growth in the industry and a highly aggressive Chinese policy to support its manufacturers have made life difficult for this sector. At least six US companies filed for bankruptcy in 2011; in 2012, Abound Solar became the latest casualty. Abound Solar has been a supplier for many projects under JNNSM: its dissolution has made the status of the 25-year guarantee that producers give for solar panels unclear. Globally, more than 20 companies have either shut down, filed for bankruptcy or have gone into temporary closure. Even the companies currently operating, including the biggest Chinese ones, have seen a sharp drop in share prices, in

INDIGENISING CONCENTRATED SOLAR THERMAL POWER (CSP)

With a much smaller and less mature world market for solar thermal, some argue that India has a better chance to carve out a niche in the CSP market.[1] CSP plants have different designs, but all require some common components such as specially made mirrors with low iron content, special vacuum tubing that keeps heat well, steel-structures, valves, pumps, turbines, generators, cooling towers, control rooms, heat-transfer liquids, valves and heat exchangers. Some CSP plants also use storage tanks which usually utilise molten salts.

Under JNNSM's phase I, plants are required to source 30 per cent of the plant technology from India (how this is estimated or calculated has not been clarified in the guidelines). Of these components, India already produces steel structures and cooling towers. CSP plants require special variable-speed turbines and generators of a size that Indian manufacturers do not produce,[2] the contracts, therefore, have been given to European and US companies such as Siemens, Areva and GE.[3,4]

Cargo Solar, a subsidiary of Cargo Power and Infrastructure, is setting up a manufacturing facility for curved mirrors needed in CSP parabolic trough plants, the first in India. Some of the production would be used for its own 25-MW plant to be set up in Gujarat.[5] India also lacks vacuum tube receivers and molten salts manufacturing.

The CSP manufacturing market is still developing: perhaps the most valuable part is the knowledge and experience of the few long-term international players. This makes it possible for some companies to sell their complete systems along with the database.

The only operational CSP plant in India, ACME's 2.5-MW solar tower in Bikaner, relies on remote controlled computer system of its US-based developer, E-Solar. ACME does not have the capacity to control the plant, leading to efficiency losses and constant dependency on the supplier.[6]

India is, however, not without technical know-how in solar thermal. IIT Bombay has produced a Solar Concentrating Dish for heating water, which is being used in multiple locations in India for heating, cooling, hotel laundry and milk processing, among other functions.[7] IIT Bombay has also set up a Concentrated Linear Fresnel Receiver (Reliance Industries is using the same technology for its plant) at the Solar Energy Research Centre located outside Delhi;[8] this will become operational in the later half of 2012.[9] if India wants to indigenise CSP along with PV, she will have to leverage this know-how.

excess of 90 per cent for most of them and in some cases as much as 97 per cent.

What the future holds

Globally, the demand for solar is set to increase in the coming years. China has plans for installing 12 GW by 2015 and 50 GW by 2020. Huge demand is expected from Japan as well, given the requirement for replacement of nuclear energy in the aftermath of the Fukushima disaster. Germany and other European markets, the US, the ever-growing markets in developing countries, and India's domestic market will fuel the demand for solar power. Manufacturers need to survive this phase to be able to compete with foreign companies in the coming years. India must decide today what it wants – a purely import-driven solar power industry that compromises energy security, or a robust domestic manufacturing base.

India may chose to go the Italian route. Italy's solar policy for 2011-12 stipulates that developers get an extra 10 per cent on their subsidy if they use European-produced modules. This would give Indian manufacturing a leg up on competition; so far, Italy has not been criticised by the WTO for the measure[39]. There would of course be an added cost to the government because of this extra tariff. It would also mean adjustments to the bidding process where developers would have to confirm whether they would use Indian technology or not, before the winning bids were revealed.

The government needs to make it clear that US Exim bank funding is a disruptive trade tool that hinders Indian manufacturers to compete in the Indian market. Early indications have started coming in that the government's overall mood is positive in supporting a healthy domestic manufacturing industry for solar sector in the second phase of JNNSM.

The MNRE is also contemplating a fund to give cheap loans or subsidies to developers who choose to buy Indian modules. Such a fund could compete with the US Exim Bank funding. However, resources for the fund have not been secured and it is unclear where it will come from.[40]

CHAPTER 4

Financing the Solar Mission

Feed-in tariff and bundling with cheap coal power has allowed India to invest in 2.5 GW worth of solar power. But now there is a major concern regarding funding more solar energy projects. State electricity boards, in general, are in poor financial health and want the Centre to pay for solar energy. The Central government, on the other hand, can support solar power through funds like the National Clean Energy Fund, but only to a limited extent. In such a scenario, India will need to look at all sources of funds -- international and domestic -- to reach its 22 GW goal

Solar power, currently, is more expensive than power from coal, hydro, wind and other sources. Although the price of electricity generated from solar PV has reduced in the last few years, at Rs 8-9/kWh it is still Rs 5-6/kWh more than what state electricity boards usually pay (*see Table 4.1: Rate of purchase of power*).

The first phase of JNNSM has been funded by bundling one unit of solar power with four units of coal thermal power. The state electricity boards (discoms) buy this bundled power at a price of Rs 5.50/kWh to fulfill their Renewable Purchase Obligations (RPO), which is already about 83 per cent over their normal buying price.[1] There are now indications that there is not enough coal thermal power to bundle.[2]

There are also indications that power utilities in states with high solar insulation are becoming reluctant to pay the higher price for solar electricity. Gujarat has not announced a third phase of its solar policy – at the Indian Solar Summit in Gandhinagar in April 2012, state officials attributed the reason for it to lack of funds in the state electricity board, Gujarat Urja Vikas Nigam Limited (GUVNL).[3]

The Rajasthan solar policy has been put on indefinite hold. While the Rajasthan Renewable Energy Corporation (RREC) says it was done because of "some confusion regarding the bidding procedure"[4], sources in the industry speculate that it was because of the discom's lack of funds.[5]

The Odisha government has stated that it needs funds from the Centre to pay for the solar power needed to fulfill its RPO. Rajasthan, Karnataka and Madhya Pradesh – states with ambitious solar plans – have utilities that are deep in debt (*see Graph 4.1: State-wise net internal revenues*).

All this means is that to continue the JNNSM, new sources need to be tapped for funds. But how much money do we need?

Funding the second phase

To calculate the approximate cost of the second phase of JNNSM (the targets for the third phase have not yet been set), which coincides with the 12th Five Year Plan, some assumptions have to be made. This is because of the uncertainties that dog the future costs of generating solar power and the model that will be used by the Centre and the states in awarding contracts.

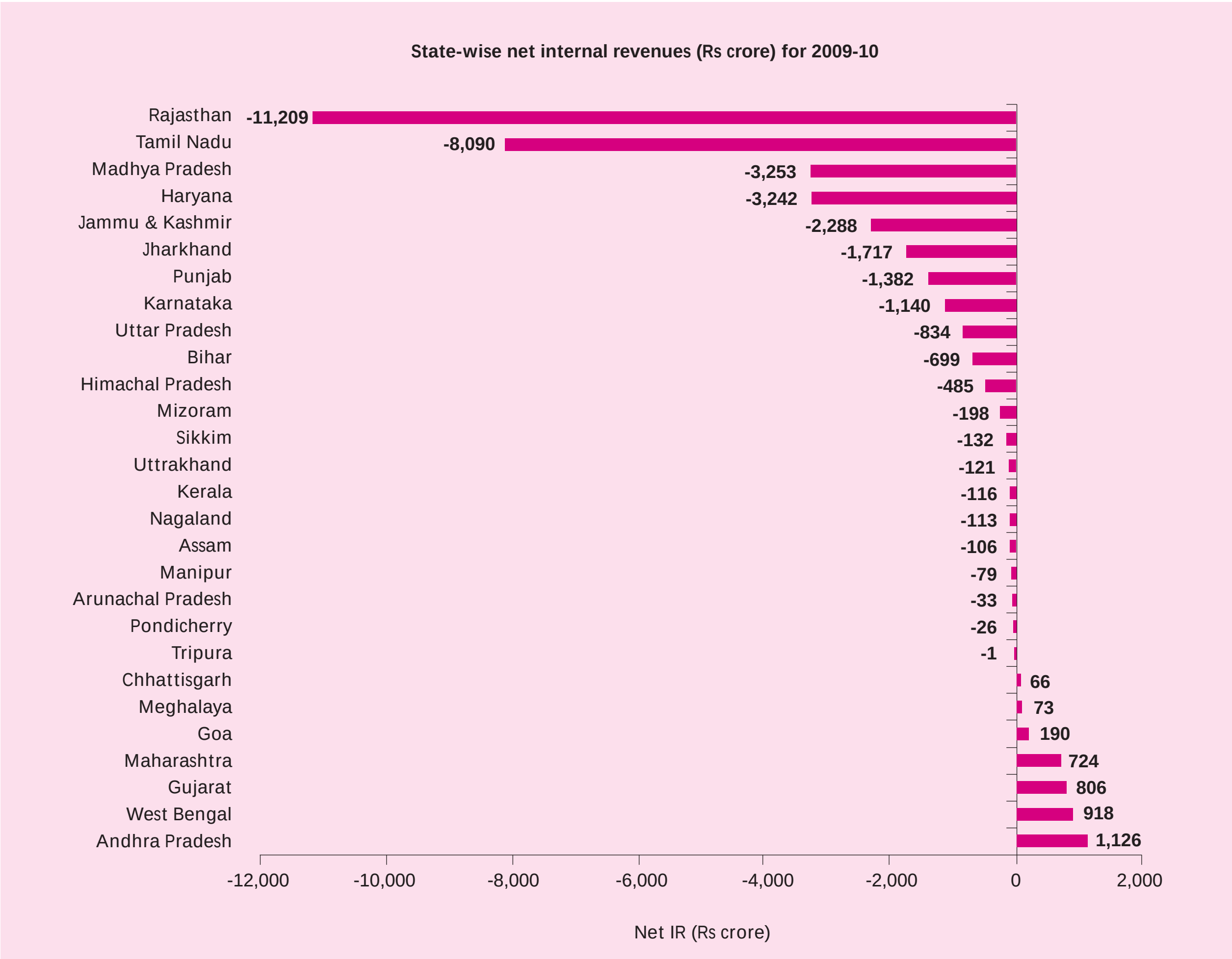
The MNRE has stated that it will aim for 9,000 MW in the second phase period (2013-17) – the original plan had envisioned 4,000 MW, but falling prices have made a more ambitious target possible. Out of this 9,000 MW, 3,000 MW will be supported directly by the Central government, while the rest would come from state programmes, RPOs or other mechanisms. In the assumptions,

Table 4.1: Rate of purchase of power (in paise/kWh)

	2007-08 (Actual)	2008-09 (Actual)	2009-10 (Actual)	2010-11 (Actual)	2011-12 (Actual)
State power utilities					
1. Andhra Pradesh	214.04	285.69	276.33	277.22	277.93
2. Assam	269.31	229.84	255.51	281.70	253.40
3. Bihar	207.31	226.23	263.21	267.58	288.74
4. Chhattisgarh	244.52	249.34	164.00	198.25	213.59
5. Delhi	272.90	277.76	346.96		
6. Gujarat	262.41	323.81	266.77	253.65	248.11
7. Haryana	209.22	218.56	225.19	229.80	248.39
8. Himachal Pradesh	281.50	323.07	328.22	304.33	314.09
9. Jammu & Kashmir	222.72	271.61	239.19	295.55	294.94
10. Jharkhand	242.15	273.38	312.76	265.23	273.23
11. Karnataka	224.86	268.52	258.35	298.29	296.59
12. Kerala	260.21	354.89	331.82	348.98	355.95
13. Madhya Pradesh	215.62	248.70	227.57	251.48	257.24
14. Maharashtra	216.38	260.44	278.94	291.66	312.08
15. Meghalaya	237.78	208.11	235.02	291.94	275.50
16. Orissa	142.51	145.54	143.21		
17. Punjab	355.79	355.86	317.96	432.67	431.06
18. Rajasthan	265.55	333.23	365.46	326.25	327.46
19. Tamil Nadu	324.57	381.29	370.05	364.29	365.75
20. Uttar Pradesh	214.97	242.73	271.76	279.12	280.85
21. Uttrakhand	165.11	215.48	248.24	267.21	307.82
22. West Bengal	207.48	226.81	258.53	272.49	283.73
Average	236.19	276.27	279.18	289.86	296.77
Electricity departments					
1. Arunachal Pradesh	158.80	98.06	95.83	103.64	119.49
2. Goa	176.61	195.80	191.07	198.16	228.62
3. Manipur	173.95	220.93	201.43	261.23	282.82
4. Mizoram	217.50	228.13	227.02	285.54	279.08
5. Nagaland	219.98	241.56	264.85	290.25	290.25
6. Pondicherry	193.93	231.66	199.86	257.76	248.57
7. Sikkim	192.39	164.00	173.94	109.36	121.72
8. Tripura	225.94	233.76	245.39	256.69	265.56
Average	**187.58**	**199.41**	**190.15**	**212.19**	**223.91**
All India Average	**235.37**	**274.95**	**277.76**	**288.56**	**295.57**

Note: 100 paise = Re 1
Source: Planning Commission, 'Annual Report 2011-12 on the working of State Power Utilities and Electricity Departments', October 2011, http://planningcommission.nic.in/reports/genrep/arep_seb11_12.pdf

Graph 4.1: State-wise net internal revenues



Source: Planning Commission, 'Annual Report 2011-12 on the working of State Power Utilities and Electricity Departments', October 2011, http://planningcommission.nic.in/reports/genrep/arep_seb11_12.pdf

we have considered the total amount of funds needed to pay for 9,000 MW of solar power.

Assuming the average tariff for the winning bids of solar PV projects in phase II is Rs 8.76/kWh, and state utilities buy power (generated from conventional sources) at Rs 3/kWh,[6,7,8] the average extra cost for buying solar would be Rs 5.76/kWh. The extra cost per year for buying solar electricity after the entire 9,000 MW is installed would come to Rs 8,600 crore per year. This is, however, not a fair comparison as electricity prices from other sources are going up each year while solar has been following a downward cost curve.

Coal[9] and gas[10] reserves are dwindling or becoming harder to access; Indian power producers are increasingly relying on imported

MEETA AHLAWAT / CSE

SURYA SEN / CSE

Coal and gas reserves are becoming harder to access, leading to growing dependence on imports coal and gas. The rise in fuel cost combined with high inflation means energy prices will continue to go up.[11]

The price of electricity from solar, both in JNNSM and the Gujarat Solar Policy, is fixed with 25-year contracts; tariffs, thus, are fixed and not adjustable to inflation. A project that is contracted for and built in 2013, would continue its tariff period till 2038. As the majority of expenses of solar power are in building the plant and only a negligible amount is required for operation and maintenance, the risk of cost fluctuation in future is minimal – unlike conventional power where the price calculation hangs on the cost of fuel.

Product prices, in general, follow inflation; India's inflation rate in April 2012 was 7.23 per cent.[12] Assuming electricity prices follow inflation, and assuming this rate continues, the price of electricity (from conventional sources) would be Rs 17.18/kWh in 2038. Assuming that in 2013 India will install 2,000 MW of solar PV projects at Rs 8/kWh, in 2038 the difference between the unit cost of solar and conventional power would be Rs 9.18/kWh. This means that 2,000 MW of solar in 2038 would save India Rs 3,047 crore just in that year!

A more suitable predicator of future electricity costs would be past electricity supply price hike. According to the Planning Commission, the unit cost of power supply between 1998-99 and 2009-10 – the full cost of the state electricity boards and utilities to buy/produce, transmit, maintain and administer electricity to the end-consumer – grew from Rs 2.63/kWh to Rs 4.78/kWh, an average of 7.4 per cent per year.[13, 14]

On the other hand, the price the state power utility (or other buyer) pays to purchase power (from conventional sources) from the producer has risen from Rs 2.35/kWh in 2007-08 to Rs 2.96/kWh in 2011-12 (*see Table 4.1*), an average increase of 5.86 per cent per annum.

Assumptions

We have calculated the cost of the second phase of the Mission, assuming the entire 9,000 MW will be installed. We assume that 1,000 MW of the second phase of the Solar Mission would be installed by 2013-14 and that a further 2,000 MW would be installed in each of the four following years.

The average tariff in 2013-14 for solar PV is assumed as Rs 8/kWh, slightly lower than the average bidding price for the second batch of the first phase that took place in December 2011 – but still, Rs 1/kWh above the lowest tariff bid so far.

For solar thermal, we assume Rs 11.35/kWh as average tariff by 2013-14. This is the benchmark tariff set by the Karnataka Electricity Regulatory Commission for the bids awarded in May 2012 in Karnataka; it is slightly lower than the average bid of Rs 11.48/kWh for solar thermal in the first batch bidding of the first phase of the Mission in 2010.

The cost of power (mostly conventional) purchased by discoms has been assumed to increase by 5.86 per cent per annum. We have assumed 25 years as the life of a solar plant and the contract length of both PV and solar thermal plants as per earlier power purchase agreements. The Capacity Utilization Factor (CUF) is assumed to be 19 per cent for PV and 23 per cent for solar thermal as per Central Electricity Regulatory Commission recommendations; 0.5 per cent degradation of PV output per year is assumed, while no degradation has been assumed for solar thermal output.

The cost for solar power in all the scenarios is the extra cost as compared to the price that the State Power Utilities (SPUs) and Electricity Departments (EDs) would pay for electricity from other sources.

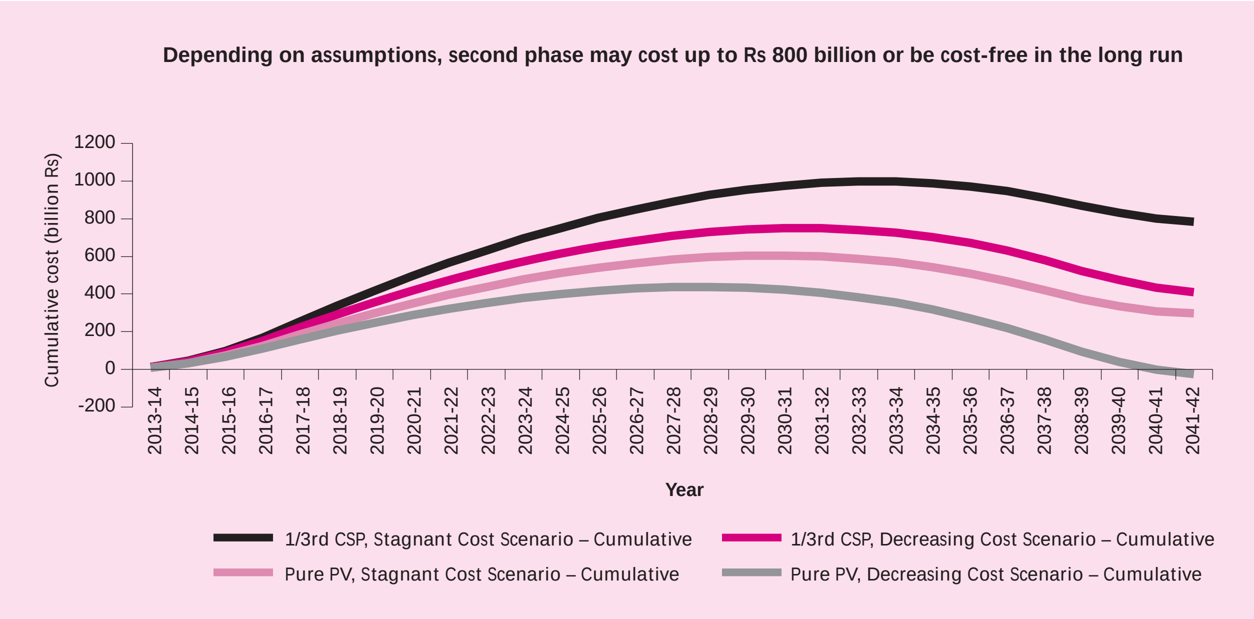
The MNRE had stated earlier that it is planning a separate allocation for solar thermal under the second phase. There is, however, little installed capacity so far and solar thermal is not cost-competitive with PV yet. We have, therefore, done two scenarios with one-third (3,000 MW) as solar thermal and the rest (6,000 MW) as PV. We have also done two scenarios without any solar thermal as comparison.

There is an uncertainty whether solar prices will continue to drop from their already depressed levels. PV prices are down as panels are reported to have been sold under the production cost; it is uncertain what cost savings can be done for solar thermal. We have, therefore, made two scenarios where the cost, and thereby the tariff of solar (both CSP and PV) decrease by 5 per cent per year (tariffs are fixed for 25 years) and two scenarios where the cost, and thereby the tariff, are stagnant.

In total, we consider four different scenarios:

1. 1/3rd solar thermal, 2/3rd solar PV with stagnant cost
2. 1/3rd solar thermal, 2/3rd solar PV with decreasing cost

Graph 4.3: Cumulative cost of 9,000 MW of solar capacity under phase II of the Solar Mission



Source: Centre for Science and Environment (CSE)

3. 100 per cent solar PV with stagnant cost of solar
4. 100 per cent solar PV with decreasing cost of solar

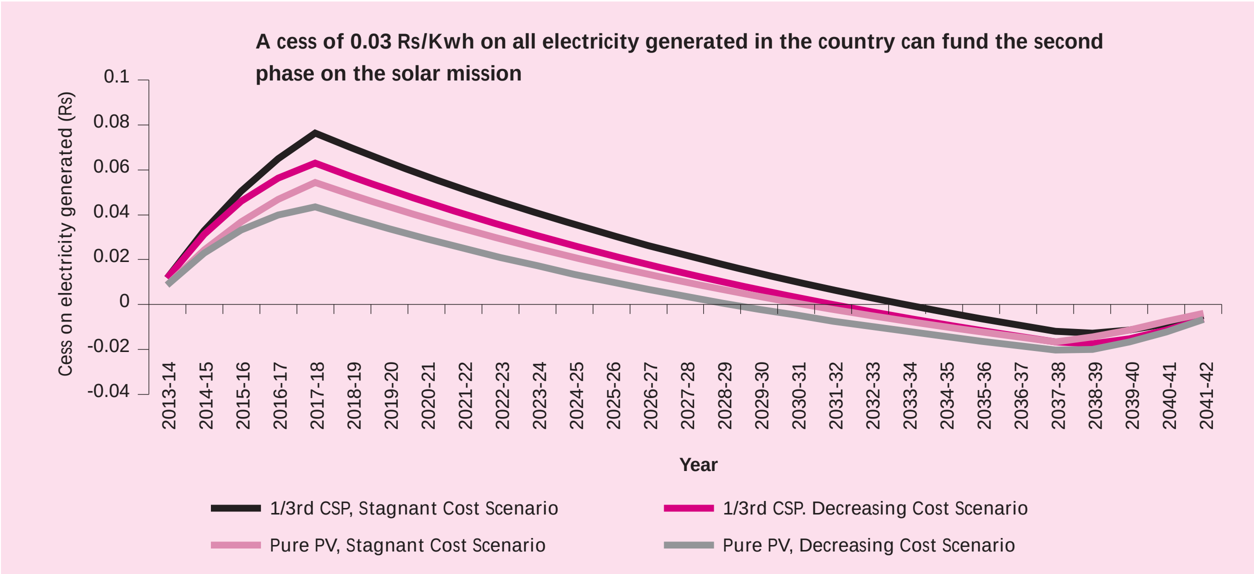
Result

- In all the scenarios, solar power reaches grid parity between 2030-2033.
- One hundred per cent PV with decreasing cost of solar is the cheapest option, with the cumulative extra cost compared to other conventional power actually becoming negative. In this scenario, solar is – in the longer term – saving money: Rs 2,800 crore by the end of the contract period for the last plants (2041-42). The difference in the beginning between solar power cost and average power purchasing cost is Rs 5 and will reach purchase cost parity in 2031. By 2041-42, each kWh of solar electricity would be Rs 8.26 cheaper than the average cost of purchasing 1 kWh from conventional sources (*see Graph 4.3: Cumulative cost of 9,000 MW of solar capacity under second phase of the Solar Mission*).
- The scenario of one-third solar thermal with stagnant cost is the most expensive, with the total cumulative cost coming to Rs 78,200 crore and the average yearly cost at Rs 2,700 crore. Grid parity in this scenario would be reached by 2033.
- If we disregard the years when the solar power has become cheaper than conventional power costs, the total amount of funds required in all the four scenarios are (*see Graph 4.4: Funding the second phase through cess*):

1. 1/3rd solar thermal, 2/3rd solar PV with stagnant cost: For 19 years, funding will be required at an average of Rs 5,200 crore a year. The total required would be Rs 99,600 crore.
2. 1/3rd solar thermal, 2/3rd solar PV with decreasing cost: For 17 years, funding would be required at an average of Rs 4,400 crore a year. The total would be Rs 74,700 crore.
3. 100 per cent PV with stagnant cost of solar: Funding required for 17 years would be an average of Rs 3,500 crore a year; Rs 60,300 crore would be the total.
4. 100 per cent PV with decreasing cost of solar: 15 years of funding would be required at an average of Rs 2,900 crore a year, with the total coming to Rs 43,600 crore.

- The extra cost of solar energy in all four scenarios comes to Rs 2,900 to 5,200 crore for 15 to 19 years. This money can be raised by putting a cess of Rs 0.023-0.028 on electricity generated from all sources till solar power reaches grid parity (*see Graph 4.4*).

Graph 4.4: Funding the second phase through cess



Note: When Solar Power becomes cheaper than average power purchase cost the cess becomes negative. At this point the cess may be cancelled or used to fund other programmes. Calculation assumes a power consumption of 811 TWh in 2010-11 and a yearly increase of power consumption of 5 %.
Source: CSE calculations.

Sources of funds

Electricity supply in India is handled by individual states, where each state has either state electricity boards or discoms to provide power to end-users. Indian utilities, however, are able to recover only 69 per cent of the total cost, on an average.[15]

Much of Indian electricity supply is subsidised in different ways – either by the state government funding the utilities, utilities taking loans and suffering losses, state governments subsidising certain segments of electricity users (such as the Rajasthan government subsidising agriculture and first 50 kWhs of domestic use)[16] or through cross-subsidy where some segments of electricity buyers pay higher tariffs to subsidise others. Electricity for farmers and low-income segments are often subsidised, but these consumers also often receive poor or intermittent supply.[17,18]

For special programmes, the Central government allocates funds or provides subsidies, like the bundling scheme for JNNSM's first phase, or the Generation-based Incentive (GBI) scheme for wind power.[19]

For funding the second phase of the Mission, the following possible domestic sources can be used.

Instead of increasing electricity prices for all, heaviest polluters such as steel and cement producers can be asked to pay more

NCEF: WHAT IT IS FOR

The Union ministry of finance has given guidelines on how to utilise the National Clean Energy Fund (NCEF). This covers funding of the on-grid part of JNNSM as well as manufacturing.[1]

1. Projects supporting the development and demonstration of integrated community energy solutions, smart grid technology, renewable applications with solar, wind, tidal and geothermal energy;
2. Projects in critical renewable energy infrastructure areas such as silicon manufacturing;
3. Projects which result in replacing existing technology in energy generation with a more environmentally sustainable approach;
4. Projects related to environment management, particularly in the geographical areas surrounding the energy sector projects;
5. Renewable/alternate energy: This would include advanced solar technologies, geothermal energy, bio-fuels from cellulosic biomass/algae/any waste, offshore marine technologies (wind, wave and tidal) and onshore wind energy technologies, hydrogen and fuel cells.
6. Clean fossil energy: This would include power, oil, gas and coal technologies including coal gasification, shale oil/ gas, lignite/CBM, advanced turbine and technology for IGCC power plants, methane hydrates, enhanced recovery from unconventional resources and fossil energy advanced research, carbon capture and sequestration as also carbon capture and reformation.
7. Basic energy sciences: This would include energy storage for hybrid and plug-in electric vehicles, solid state lighting, catalysis, biological and environmental research, advanced computing, high energy and nuclear physics etc. The Fund may also support pilot & demonstration projects for commercialisation in the relevant field.
8. Mission projects identified in the National Action Plan on Climate Change (NAPCC) and projects relating to R&D to replace existing technologies with more environment friendly ones under National Mission on Strategic Knowledge for Climate Change (NMSKCC).
9. The projects relating to creation of power evacuation infrastructure for renewables.

In 2011, the MNRE received around Rs 200 crore for funding NABARD's low-interest loans for acquiring solar technology under the off-grid portion of JNNSM.[2] Rs 400 crore was set aside from the fund for the Green India Mission for afforestation and environmental remediation programmes.[3]

So far, in 2012, there has been no further information on the kind of projects NCEF is funding.

The MNRE has shown an interest in utilising the NCEF to fund better transmission and distribution networks for solar and wind projects.[4] There are concerns about renewable energy not being evacuated to the grid in many parts of the country. Many wind energy producers in Tamil Nadu complain of lost income as the transmission lines are not in place.[5] Solar power producers in Rajasthan have begun complaining that the sub-stations are not sufficient: in Bap, Jodhpur district, solar power plant owners agreed to shut off their plants to avoid overloading the sub-station.[6] The Gujarat transmission company GETCO is also facing problems with completing evacuation, although this may have more to do with time than funds.[7]

The National Clean Energy Fund

The National Clean Energy Fund (NCEF) was set up under the finance ministry in the 2010-11 budget and is administrated by an inter-ministerial group headed by the finance ministry; the Union ministries of power, coal, chemicals and fertilizers, petroleum and natural gas, new and renewable energy and environment and forests are also represented in the group.[20] The funds are collected from a Rs 50 cess on each tonne of coal, lignite and peat produced in or imported into India.[21] In 2011-12, the total fund has been estimated at Rs 3,249 crore; by 2012-13, this can go up to Rs 3,684 crore.[22]

Domestic output of coal is estimated to have been 554 million tonne (MT) in the fiscal year 2011-12; imports amounted to 45.549 MT[23, 24]. According to the Planning Commission, coal demand may rise to 1,000 MT per year by 2017[25] – this would mean that the cess would bring in Rs 5,000 crore per year.

If we assume an increase in coal and lignite consumption at 5 per cent per year from 590 MT in

2011-12, and that all of NCEF was used fully for 18 years from 2013-14 to 2031-32 (around the time solar costs achieved grid parity in different scenarios), the funds under NCEF would come to Rs 94,600 crore or Rs 5,260 crore per year; more than what is needed to fund the second phase in even the most pessimistic scenario (*see Graph 4.5: Funding the phase II of JNNSM through cess and NCEF*). Financing the Solar Mission through the NCEF would be appropriate as it fits the mandate of the Fund (*see Box: What the NCEF is for*).

National solar cess

Like the Gujarat solar cess (see Box in Chapter 2, Going solar in Gujarat), a national solar cess can be put on the entire electricity generated in the country to fund JNNSM. The total generation of electricity in India in 2010-11 was 811.1 terra-Watt hour (TWh), according to the CEA's National Electricity Plan 2012.[26] In the last four years, generation has increased by 4.8 per cent per annum. During the 10th Five Year Plan, it increased by 5.16 per cent per annum. It can be assumed that power generation in India will increase at 5 per cent per annum in the future.

In the four scenarios, a national cess of between 0.023/kWh-0.038/kWh for the years the solar cost is higher than the average purchasing cost of power for the grid, can fund the second phase of the Solar Mission. In 100 per cent PV with decreasing cost scenario, the national cess would be Rs 0.023 for about 15 years. In 1/3rd solar, 2/3rd PV and stagnant cost scenarios, the cess would be Rs 0.038/kWh for about 19 years (*see Graph 4.5*).

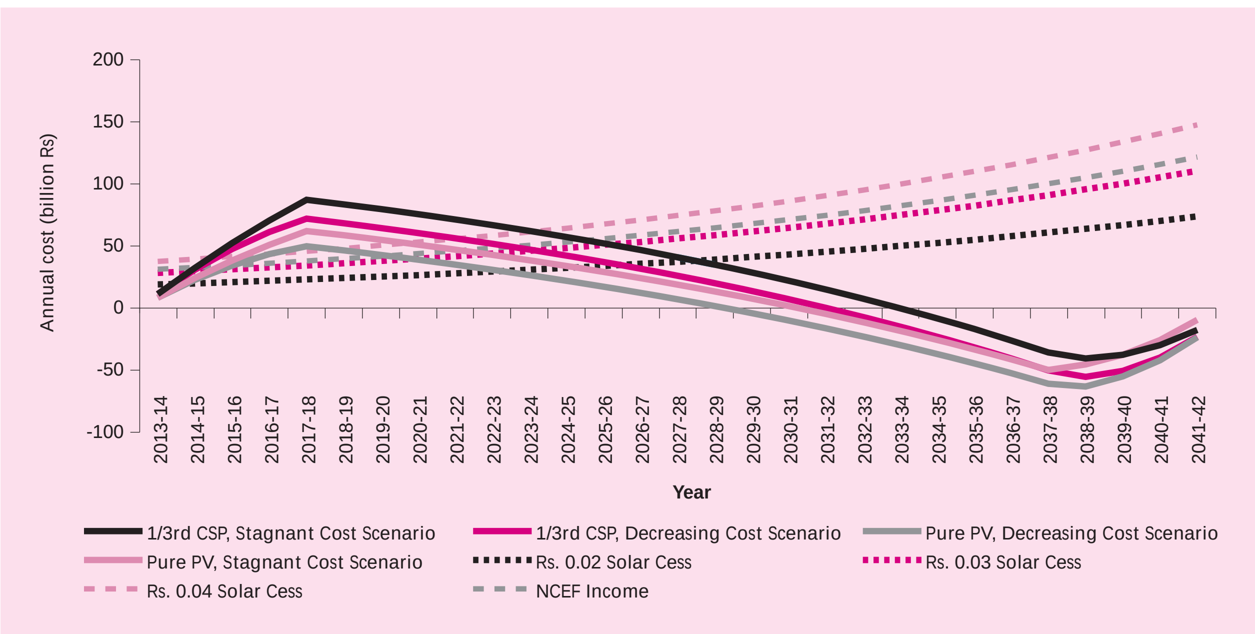
A Rs 0.03/kWh solar cess would bring in Rs 86,000 crore for 18 years at Rs 4,800 crore per year.

As the cost of JNNSM is projected to be between Rs 2,900 and 5,200 crore per year, a Rs 0.03/kWh cess would be most likely to cover the funding for the second phase easily.

A further cess may have to be added for the third phase of the Solar Mission depending on price changes of solar power purchasing cost and of average power purchase cost for the grid.

In the above calculations, the solar cess of Rs 0.03 per kWh is set on every unit produced, including the approximate 3-4 per cent that is renewable energy generation. If a national solar cess is instituted, power from renewable generation should be excluded from the cess as is the case in Gujarat.

Graph 4.5: Funding the phase II of JNNSM through cess and NCEF



Note: The per year cost of the different scenarios is in total numbers. As installations are staggered over multiple years, the highest cost is not until all capacity is installed. By 2038-39, plants begin to be decommissioned, so the total difference becomes smaller towards the end, not because of rising costs of solar but because of smaller capacity.
Source: CSE

Cross-subsidising solar

Instead of increasing electricity prices for all end-users to fund solar power, the cost may be laid on the heaviest consumers of electricity such as industry, corporate electricity users (for example offices and malls) or high-income households. It could alternatively be put on the heaviest polluters such as steel and cement producers.

Take Odisha as an example of cross-subsidisation (see Table 4.2: *Tariff brackets in Odisha*). Odisha heavily subsidises low domestic use and irrigation by increasing prices for heavy domestic users as well as industry. Electricity pricing in Odisha is stratified into 44 different brackets. The state also subsidises the cost by keeping tariffs below the average supply cost.[27]

The 25 MW of solar contracted in Odisha will produce approximately 41.5 GWh per year. The extra cost for the state will then be Rs 19.25 crore per year which has an average power purchase cost of Rs 2.36/kWh and a solar tariff of Rs 7/kWh. The cost of solar can be targeted at certain sectors – for example, industry and domestic use above 400 kWh per month. This way, it is the largest and most polluting consumer who pays for the solar energy.

International sources of funding

CDM, sustainable development and solar projects

Clean Development Mechanism (CDM) has been set up under the United Nations Framework Convention on Climate Change (UNFCCC) as a tool to combat climate change by lowering greenhouse gas (GHG) emissions. It works through developed countries buying carbon credits (CERs) worth 1 tonne of carbon dioxide (CO_2) each from environmentally sound projects set up in developing countries that lower or avoid GHG emissions.[28]

The possibility of benefits from CDM funding is accepted under all the major solar programmes in India, including JNNSM[29], RPSSGP[30], and the Gujarat[31] and Karnataka solar policies.[32] JNNSM, RPSSGP and Gujarat follow a policy in which the project developer applies for CDM funds, and the profits are then shared. The first year profits go completely to the developer; in the second year, 10 per cent is given to the government agency and each year after that a further 10 per cent is added to the share of the government until a 50-50 share is reached. The receiving agency is generally a utility or distributor[33], for example GUVNL in the case of Gujarat; in the case of RPSSGP projects in Odisha, it is the transmission company GRIDCO[34] while in Karnataka, it is the transmission company ESCOM.[35]

Four solar power projects have been registered or are about to be registered (*see Table 4.3: Projects in advanced stages of receiving CDM funding*). At least 77 large-scale solar power projects from India are under validation for CDM accreditation for a total of 1,783,432 CERs per annum (tonnes of CO_2 avoided).[36] If we assume that all 77 projects under validation are registered for 1,783,432 CERs per annum and that these CERs are sold at the current

Table 4.2: Tariff brackets in Odisha

Tariff bracket	Tariff in paise/unit
Agriculture, pumping and irrigation	100-120
Domestic use up to 50 units	220
Domestic use 50-200 units	390
Domestic use 200-400 units	490
Domestic use above 400 units	530
General purpose, large, heavy or power-intensive industry, mini steel plants, railroad (all at high tension or extra high tension voltage)	390-495
General purpose, small, medium and large industry, public purpose over 400 units at low tension voltage	530
General Purpose (non domestic) over 400 units (at less than 110 KiloVolt)	680

Source: http://www.orierc.org/orders/2011/FINAL_RST_Order_DISCOM_fY (23.03.2012).pdf

CER-EUA price of 6.92 Euro per CER, then CDM will provide an additional amount of Rs 85.87 crore per year to these projects. As stated above, this CDM benefit has to be shared between the developer and the government in a pre-defined proportion. Over a 25-year period, if we assume that the price of CER remains constant at 6.92 Euro, the government can hope to gain Rs 945 crore from these projects as CDM benefits.

Over 200 more projects are in the first stage of 'prior consideration'.[37] These include many of the phase I JNNSM projects, Gujarat state policy projects and projects under RPGGSP.

Taking Adani Enterprises' 40-MW PV project (*see Table 4.3*) as an indicator (it provides 62,217 CERs per year from 40 MW), the total amount that the government may receive from 9,000 MW under JNNSM phase II (assuming the price of CERs is the same and all 9,000 MW are installed and accredited for a full 25 years) is Rs 8,239 crore (at an average of Rs 330 crore per year).

Of the four projects registered under CDM, the Moser Baer project in Tamil Nadu has assumed a CER price of €22 per tonne of CO_2 while Reliance (Khimsar) has assumed a CER price of €16. With the price today at €6.92 for carbon credits under EUA-CERs and around €3 for CERs, the income from CDM funding would be much lower.

All solar projects in India receive a preferential tariff and would have to argue that they fulfill the 'additionality clause' in CDM. For any project to receive carbon credits, the project needs to show that the project is 'additional' and that it would not be financially viable without CDM funding. Every project has a period to receive comments from the public on the project design document. Almost every solar project in India has been criticised for over-stating their costs to fulfill the additionality clause and almost all critique comes from three or four sources only identified by an incomplete name.[38]

Although the criticism about creative accounting may have a ring of truth in it, the big issue here is the concept of 'additionality'. CDM

Table 4.3: Projects in advanced stages of receiving CDM funding

Project Name	Location	Size and technology	CDM status	GHG avoided (tonnes CO_2)	Amount of funding from CDM estimated	Percentage of total income CDM makes up
Reliance Industries[1]	Khimsar district, Rajasthan	5 MW PV	Registered	7184	51.9 lakh/year (excluding 25% to Rajasthan Discom)	4% (Income from electricity – 1230 lakh/year)
Sapphire Industrial Infrastructure – Moser Baer[2]	Sivaganga district, Tamil Nadu	5 MW PV	Registered	7825	115.9 lakh/year[3]	13.79 % (Income from electricity – 724.01 lakh/year)
KPCL Yalesandra[4]	Kolar district, Karnataka	3 MW PV	Requesting	4220 Registration	20.3 lakh/year*	–
Adani Enterprises[5]	Kutch district, Gujarat	40 MW PV	Requesting Registration	62217	299.6 lakh/year*	4.4 %(Income from electricity – 6524.5 lakh/year (levelised)

Note: *If CER price is not given in project design document then CER-EUA price for May 28th 2012 is taken (6.92 Euro/tonne of CO_2). 1 Euro on same day = Rs 69.584463. EU-Allowances (EUA) are carbon credits which can be traded in the European Union only.

Sources: 1. Anon. 'Project Design Document' in 'Project 5129 : Solar Power Generation Project', http://cdm.unfccc.int/Projects/DB/RWTUV1313924550.68/view accessed 28th May 2012

2. Anon. 'Project Design Document' in 'Project 4615 : 5 MW Solar PV Power Project in Sivagangai Village, Sivaganga District, Tamil Nadu' http://cdm.unfccc.int/Projects/DB/TUEV-RHEIN1301296733.47/view accessed 28th May 2012
3. Anon. 'Appendix 2 - IRR_5 MW Solar' in 'Project 4615 : 5 MW Solar PV Power Project in Sivagangai Village, Sivaganga District, Tamil Nadu' http://cdm.unfccc.int/Projects/DB/TUEV-RHEIN1301296733.47/view accessed 28th May 2012
4. Anon. 'Project Design Document' in 'Project 5560 : 3MWp Grid Connected Solar Power Project at Yalesandra Village, Kolar District, Karnataka, India' http://cdm.unfccc.int/Projects/DB/RWTUV1323884923.93/view accessed 28th May 2012
5. Anon. 'Project Design Document' in 'Project 5928 : Adani Enterprises Limited Solar PV Power Project in Gujarat, India' http://cdm.unfccc.int/Projects/DB/RWTUV1332412112.62/view accessed 28th May 2012

Table 4.4: What stakeholders say on Reliance's Khimsar project

To receive CDM accreditation, every project needs to have a stakeholder meeting in which the local population and any other affected groups have to be invited to state their questions or concerns about the project. The four projects registered or waiting for registration have all held stakeholder meetings according to their project design documents. However, only one of the projects – Reliance Industries – has chosen to put up the comments 'ad verbatim' on its website; the company has also given a list of the stakeholders and photographs.[60]

The three other projects only give a short summation of the general concerns and comments in a manner which makes it very hard to get a real understanding of the opinion of the stakeholders. The stakeholder meetings seem to be dominated by the project proponent. Many project design documents have been criticised for not submitting the list of stakeholders present at the stakeholder meeting, nor stating the amount of local employment generated or the water usage of the plants.

Stakeholder query	Answer
Hukmichand Khanchi: Will this project provide an opportunity for our villagers to work at site?	The project will definitely generate employment for local residents (for skilled as well as unskilled humanpower). It was also informed to be in touch with the contractor appointed for employment opportunity.
Nanharam: How will our farmer community be benefited by this project?	House, water, proper food and cloths and electricity are the basic requirements for quality living in villages. This project will provide electricity to nearby villages. Our future generation will get a better environment to study and progress; it will also improve living standards, business opportunities etc.
Mehendra Khovada: As a shopkeeper, how will we be benefited by this project? Will RIL purchase any materials from our shops for the project?	Inventories related to operation and maintenance of projects in future will be received from our central stores. However, the day to day requirements will be fulfilled from the local market. The project will anyhow give other benefits related to sustainability and overall growth of village.
Mahavir Sharma: The project is new and not replacing any fossil fuel at site. How would it result into reduction of GHG emission?	In the absence of the project activity, the equivalent power would have been generated in the grid. The local grid contains generation stations which mostly use fossil fuels and hence GHG emission per unit power generated is higher in the grid. Also, the emission factors for power generated in the grid are published by the Indian government. These are used to arrive at the emission reduction from the project activity.
Shanlal Guliya: What financial incentives does the project proponent get for this project activity?	The project proponent has not received any special incentives on capital or depreciation expenses. However, incentive based tariff is provided by the government for the power exported to the grid from this project. The project will receive revenue from carbon credits which will be shared with DISCOMS.
Bhavarram: What is global warming? How does CO_2 emission contribute to global warming?	There are many GHGs such as CO_2 which aggravate tapping of sun rays that enters earth's atmosphere. Due to this, there is rise in temperature in the atmosphere. As the quantum of emission rises, the trapping of heat increases which causes global warming. Also, explained the harmful effects of global warming. It was informed the project does not release any other harmful gas.
Hukmichand Khanchi: Will the project need additional infrastructure?	On completion of the project, while the plant is operational, no additional infrastructure like roads, water supply, transportation, etc would be required. Further, also informed that there are no impacts anticipated on water pollution, water availability, water allocation, natural drainage pattern, solid waste generation/disposal, land use/landscape, plant life, agriculture/horticulture, habitat fragmentation, etc as it is a renewable project. Hence, there are no negative impacts of the project in any way on any stakeholder.
Shanlal Guliya: Do you have any plan for welfare of our village?	RIL is a socially responsible company and carries out regular activities for community welfare and uplifting local villagers. We would plan the same in future.

Sources: Anon. 'Project Design Document' in 'Project 5129 : Solar Power Generation Project' http://cdm.unfccc.int/Projects/DB/RWTUV1313924550.68/view accessed 28th May 2012

Globally, over 20 coal plants have applied for CDM financing as they argue that their 'super-critical' technology is more efficient and lowers emissions per unit of electricity produced than conventional sub-critical technology

should be funding solar power projects, and not the coal power projects that are projected to flood the carbon market with cheap CERs.

More than 20 coal plants, mainly in China and India, have applied for CDM financing as they argue that their 'super-critical' technology is more efficient and lowers emissions per unit of electricity produced than conventional sub-critical technology.[39] Five of these projects have been approved – these include two Reliance projects totalling 8,000 MW, two by the Adani group totalling 2,640 MW, and a 2,000-MW project in China.[40] The five projects total 68.2 million CERs per year over 10 years and would be worth US $919 million (or Rs 5,086 crore); Reliance and Adani, incidentally, have solar projects vying for CDM money as well.

Additionality and the low price of CERs, mainly because of cheap CERs from coal power and other sources being dumped in the market, have given CDM a marginal role in solar installations in India. KPMG indicates in its report that CDM financing may give a Rs 0.6/kWh extra to solar projects[41] but this amount is dependant on the price of the CERs. Even if the projects now in the pipe-line are accepted, the income per project will make up only a small part of the income of the project. This must be rectified as solar is a perfect target for CDM funds.

For already installed plants and plants not receiving CDM funding for the full project, certain equipment could be installed with CDM funding. Many solar plants in India have forgone solar trackers which increase efficiency, but also raise the maintenance costs. If it can be shown that CDM funding would be needed to make tracker installation possible later, then this could be an income source. Another similar technology which increases plant output (but may not be cost-effective) is thermal storage for solar thermal.

Global Environment Facility

The Global Environment Facility (GEF) gives grants to environmentally positive projects across the world. It works as a financial mechanism for multiple international treaties, including UNFCCC, as well as for administering trust funds of which the GEF Trust Fund is the largest; this fund has US

$15.2 billion from 39 donor countries, including India.[42]

In India, at least one solar thermal project has been proposed as a GEF-funded project. It was supposed to be a solar thermal and fossil fuel integrated power plant in Mathania, Rajasthan supported by US $49.75 million from the GEF. The project was, however, cancelled due to financial risks and high cost.[43]

The GEF has also provided money through IREDA to renewable energy projects, including solar: US $26 million was provided from 1992 to 2000.[44]

Funding for renewable energy projects fall under the 'climate change' heading at GEF. A total of US $3.167 billion has been invested in this area since GEF's inception in 1991.[45] That is an average of US $150.8 million a year or about Rs 840 crore. Even if all the money from GEF was funnelled into funding solar power in India (which would be highly unlikely and unfair to other countries), it would only cover one-fourth of the annual cost of the second phase of JNNSM (Rs 3,320 crore, as estimated in the full PV convergence scenario).

As GEF has already financed and promoted solar thermal, it could be a good option as a regular source of funds to support the expansion of solar thermal in the country.[46] Funding for technology that is not fully established in India (such as hybrid solar thermal, solar thermal storage and manufacturing of solar thermal equipment) would fit the GEF profile well.

The way ahead

It is not clear how the government is going to fund phase II of the Mission. There are indications that bundling might not be the option. Sources within the government are talking about a 'viability gap' funding for Central projects. For the remaining 6,000 MW to be implemented by the state governments, nothing is clear. Most state electricity boards are facing bankruptcy; even a state like Gujarat is not keen on allocating money for the next phase of its own solar programme.

The current source of international funding is too little. CDM cannot support even 10 per cent of the FIT at the price which CERs are being sold. The GEF is too small a fund. The Green Climate Fund (GCF) -- worth US $100 billion -- could be a possibility. But for that, developing countries will have to work together to include Feed in Tariff (FIT) as a fundamental part of GCF.

Money is going to be the key requisite -- at least in the next 10 years -- for expansion of solar power in India.

CHAPTER 5

Impacts – land, water and people

Large-scale grid-connected plant do require a lot of land. Sometimes this leads to unrest in communities living near the solar parks. Involving these communities in project development is key to an amicable solution and a right atmosphere for development of mega-scale solar parks

Land is crucial for any solar technology. It provides the surface on which panels or mirrors are placed. Solar modules can be put on rooftops, but if the installations are large, then it is more common to place them directly on the ground.

Land in India is scarce and heavily contested. Hence, there are three important concerns to keep in mind with respect to land for solar: minimise land usage, ensure that the land being used is not forest or agricultural land, and allow local communities to benefit from large-scale solar installations.

It should, however, be noted that although solar does take up land, so does any other energy technology – while coal plants take up less area, the mines they use for providing the coal are often much larger.

Land for solar: The Indian experience

The Central Electricity Regulatory Commission (CERC) sets the benchmark for land use at 5 acres (2.02 hectares or ha) per MW while deciding the land cost for PV plants.[1] It sets no specific land use benchmark for solar thermal or CSP, either because of too high a variance between CSP technologies or because of lack of data. However, in at least one example used by the CERC, the land use per MW for CSP has been determined as 6.25 acres (2.52 ha).[2]

ENVIRONMENTAL IMPACT ASSESSMENT

Solar power has been exempted from the Environmental Impact Assessment (EIA) procedure in India. EIA is usually required for any energy project, but because of lack of air and water pollution solar energy has been exempted. However, because of the impact on land and communities there has been talk among local environmental organizations that EIAs should be made mandatory for solar power as well. So far only one project in India has made an EIA – this is the 40-MW Dhanu Reliance PV power plant. The Asian Development Bank (ADB) as well as the US Exim Bank which are financing the project, demanded an EIA[1].

This EIA may be seen as a precursor to solar EIAs. The need for an EIA needs to be weighted against the fact that it will create further paper-work and may delay projects. One of the selling-points of solar power is the short time between contract signing and commissioning. Some solar plants have been commissioned in as little as 90 days[2] compared to coal and nuclear plants which may take from four to 10 years. One of the more important aspects of EIA is mandatory consultations with communities – these consultations should be made mandatory even without a full EIA.

The government of Gujarat's Department of Energy and Petrochemicals has set the 'norm' in Gujarat at 6 acres (2.42 ha) per MW for poly-crystalline PV and solar thermal (with extra allowance if storage is used or for higher efficiency) and 8.6 acres (3.48 ha) per MW for thin-film PV technologies[3].

Researchers from CSE analysed 18 solar PV projects and five CSP projects for land use. In the 18 solar PV plants under JNNSM phase I, the average land size has been 7.58 acres (3.06 ha) per MW.[4] For the 9,000 MW which has been planned for phase II of the Mission, this would mean an area of 75,800 acres or 307 square kilometers – about the size of the Sariska Tiger Reserve.

Thin-film occupied the maximum amount of land - 4.12 ha/MW on an average compared to 3.11 ha/MW for crystalline PV (see Table 5.1 for full break-down of on-ground figures of land use by different solar technologies in India). If India sourced all its current electricity (811 TWh in 2010-11) from solar power, then a solar capacity of 488 GW would be needed. If we assume a land use of 3 ha/MW, then this would take up 14.65.000 ha of land, or about 1/20th of Rajasthan's total area *(see Table 5.1: Land use of different solar technologies* and *Table 5.2: Land use per plant)*.

Land policies – Rajasthan vs Gujarat

The Rajasthan land policy for renewable energy plants is outlined by the GoR Revenue Department Notification No F.6(2)/Rev.VI/2001/32 (dated June 18, 2007). It states that projects may be allotted government land under lease. The cost for this land is a combination of a rent and a 'premium'. The rent is set at Rs 2,500 per hectare per year (which can be revised up by a maximum of 25 per cent every 10 years). The premium is set at 10 per cent of the market price of the land. The lease is given for 30 years and can be extended. A developer has to pay a lease rent every year and a one-time premium in the first year. The lease can also be used as a collateral against any loan the developer may need to take. The developer is allowed to sub-lease a part of the land as long as the sub-leasee also plans to set up a renewable energy plant.

An analysis by CSE of the solar projects given land by the Rajasthan government shows that companies are paying Rs 5,000 per acre per year as rent, and Rs 4,000 per acre per year as premium. For a project with a 25-year life span, the cost of land in Rajasthan (assuming a 25 per cent increase in it every 10 years) comes to Rs 33,600 per acre – a real throw-away price.

The only saving grace has been the practice of alloting 'revenue land' which is barren and non-forested. This has been followed in most cases, as found by the site visits conducted by CSE, although there are a few exceptions (*see Box: Askandra*).

The Gujarat Solar Policy of 2009 does not have

Table 5.1: Land use of different solar technologies

Solar technology	Hectares of land needed per MW according to CERC	Hectares of land needed per MW in Indian projects
Mono-crystalline PV	2.2	1.39 - 2.02
Poly-crystalline PV	2.2	2.14 (with tracker) - 3.5
Cadmium Telluride	2.5-3.2	2.5 - 3.4
Copper Indium Gallium Selenide/Copper Indium Selenide	2.5-3.2	3.64
Amorphous Silicon	2.5-3.2	5.34
Solar thermal - trough	2.6	2.86 to 6
Solar thermal - tower	2.6	2 to 2.4
Roof-top installation	0	0
Solar home-lighting system	0	0

Sources: 1. Anon, 'Explanatory Memorandum for Benchmark Capital Cost Norms for Solar PV and Solar Thermal 2011-12, 255-2010', September 2010. 2. Site visits and interviews by CSE researchers

Table 5.2: Land use per plant

Plant	Plant site	Technology	Hectares of land used per MW	Land use around plant or before plant erection
GSECL Gujarat Solar Canal	Sadan, Gujarat	Poly-crystalline silicon PV	0	Built over existing canal
Reliance Power - Khimsar	Khimsar, Rajasthan	Poly-crystalline silicon PV (mainly)	2.72[1]	Farmland and rocky grazing land
Moser Baer - Sapphire	Sivaganga, Tamil Nadu	Amorphous silicon thin-film PV	5.34	Unknown
CCL Infrastructure	Tuticorin, Tamil Nadu	Copper-iridium-selenide	3.64	Farmland
Punj Lloyd	Bap, Rajasthan	Cadmium-telluride thin-film PV	DPR states 2.42 needed.[2] Land bought is 3.4[3]	Marginal farming and wasteland[4]
Mahindra Solar One	Rawra, Rajasthan	Poly-crystalline PV (with tracker)	2.14	Flat desert-like wasteland
Newton Solar, Khaya, Finehope Allied, Vasavi, DDE Electromech, Saidham Overseas	Askandra, Rajasthan	Poly-crystalline PV	3.5[5] (respectively)	Mostly desert land, some khejri trees, 'oran' and gauchar land (sacred land/grazing land)[6]
Ujjawala and Responsive Sutip - Moser Baer	Kamalpur, Gujarat	Poly-crystalline PV	2.4	Surrounding area is mainly farmland
KPCL/Titan Energy	Kolar, Karnataka	Mono-crystalline PV	1.39 (land used) 2.02 (land bought) of this 0.782 for modules[7]	Unknown
ACME Telepower	Bikaner, Rajasthan	CSP - solar tower	2 to 2.4[8]	Farmland[9]
Godawari	Nokh, Rajasthan	CSP - parabolic trough	2.86	Desert-like bushy wasteland
Corporate Ispat Alloy	Nokh/Bikampur, Rajasthan	CSP - parabolic trough	6	Desert-like bushy wasteland
Lanco - Diwakar	Askandra, Rajasthan	CSP - parabolic trough	3.7 (changed from 3 in DPR)[10]	Mostly desert-like land, some Khejri trees, 'oran' and gauchar land (sacred land/grazing land)[11]
KVK Energy Ventures	Askandra, Rajasthan	CSP - parabolic trough	3.7 (changed from 2 in DPR)[12]	Mostly desert-like land, some Khejri trees, 'oran' and gauchar land (sacred land/grazing land)[13]

Sources and notes: Unless otherwise stated, all information is based on site visits and interviews with site managers and nearby communities. This calculation accounts for all the land, and not just the land occupied by modules. Plant areas may be occupied by sub-station, transformers, roads, inverters, ponds and control rooms.

1. Site visit and http://www.rrecl.com/PDF/Performance_analysis_5Mwp_solar_PV_plant.pdf, as seen on May 7, 2012
2. Detailed Project Reports
3. Not all the land occupied may have been used for the 5-MW plant.
4. Wikimapia images show signs of farming on land. Most land around the plant is, however, of low productive value.
5. According to copy of land purchase documents
6. According to nearby community
7. H Mitavachan, Anandhi Gokhale and J Srinivasan, 'A case study of 3-MW scale grid-connected solar photovoltaic power plant at Kolar, Karnataka', IISc-DCCC, August 1, 2011
8. Approximate figure of '5 to 6 hectares' given for the land occupied, according to site manager, October 12, 2012
9. Interview during site visit on October 12, 2012 with a local resident who said: "The people who lived there sold their land happily and went to live in Bikaner."
10. 370 hectare mentioned in land purchase document, but the figure was found to have been changed with a pen in the Detailed Project Report
11. According to a local community
12. 370 hectare mentioned in land purchase document, but the figure was found to have been changed with a pen in the Detailed Project Report
13. According to a local community

CASE STUDY

MUJO KI DHANI CHAK – LIFE NEXT TO SOLAR

Mujo Ki Dhani Chak, a small Muslim community traditionally employed as miners only about a hundred meters from the OPG 5-MW plant in Bap, Rajasthan is an illuminating example of the lack of impact (good or bad) large-scale solar seems to have on nearby communities.[1]

When the CSE team visited, the community was mourning a villager who had recently passed away, but the villagers were still happy to answer questions. According to them they have had no contact with the plant and see no positive – or negative – impact of it.

Although living within view of one of the most technologically advanced energy sources in the world, they use kerosene for lighting and firewood for cooking; houses are made of large stone slabs cut from nearby mines.

The village is not connected to the grid, so they cannot utilize the electricity from the plant. They cannot get jobs in the plant as contractors are hiring labour from cities like Jodhpur.[2] Neither can they get employed as security guards – a guard needs to bring his own gun for work, and these villagers do not own any guns (at another plant in Phaladi, CSE researchers saw guards with antique 19th century muskets, hardly useful for protecting against any panel-theft but enough to fulfil the criteria of owning a gun!).

On the flip-side, the villagers did not find anything negative with the plant either. They stated that the plant was on what had been unused waste land and except for an increase in traffic, there had been no nuisance or pollution while constructing the plant.

any specifications on land allotment. However, some benchmarks and norms have been given by the Department of Energy and Petrochemicals Notification 'Specifying the norms of requirement of land for the Solar Generating Plant - Prescribed Guidelines Thereof' (dated May 19, 2011).

The notification does state that as a policy, a maximum of 20 per cent of government land can be allotted to solar plants if it is surrounded by private land being bought by a developer. Gujarat has encouraged companies setting up plants outside the Charanka Solar Park (this is four-fifth of all projects awarded in Gujarat) to acquire private land by themselves at the market price.

At Dhama village in Surendernagar district, SunEdison paid approximately Rs 15 lakh per acre, according to a villager who sold the land. This is in the higher range; developers are willing to pay between Rs 10-15 lakh per acre.[5] The effect of Gujarat's land policy for solar has been a proliferation of cases where solar projects are being set up on what was farm land.

In Charanka Solar Park, half the land is owned by the government, while the remaining half is private land acquired by the government or brought by private parties. When CSE surveyed the land, most of it did seem quite barren – traces of marginal farming were visible (*see Box: Charanka*). Private land is still under the process of acquisition, but government land has already been given at Rs 194 per square meter; a development charge of Rs 100 per square meter is additional.[6] This amounts to a total cost of Rs 11.9 lakh per acre, with the possibility of more development charges being added.

The contrast in land cost is quite glaring. Assuming Gujarat developers pay, on an average, Rs 10 lakh per acre, it is 30 times more expensive than Rajasthan. This could be one of the reasons for setting up of a large number of plants under JNNSM's first phase in Rajasthan. A land cost of only Rs 33,600 per acre gives little economic incentive for the plants to minimise their land footprints.

Land acquisition

Many developers – including Askandra (*see Box: Askandra*) – claim that communities living near the proposed sites have raised concerns regarding land acquisition. K N Subramanian, CEO of Moser Baer, says that out of the 10 projects that his company is involved in, three-four are facing protests from villagers who say that these are sited on land which is theirs. Pashupathy Gopalan, managing director, Sun Edison South Asia, also admits that land acquisition issues are enormous. Inderpreet Wadhwa, head of Azure Solar, says: "We can build a plant in four-six months, but resolving

CASE STUDY
CHARANKA

Charanka village gives its name, and lies adjacent, to the huge Charanka Solar Park. The village is inhabited (and has been for 500 years according to the villagers) mainly by dairy farmers. How affected the village is by the solar park can be seen in the fact that the local barbershop is built out of cartons that PV modules were delivered in! But the local villagers are unhappy with this flagship project of the Gujarat Solar Policy.

Although not owning any substantial part of the 4,939-acre solar park[1] the villagers had traditionally used the area for grazing cattle and for gathering fire-wood. Now both those life-sustaining resources are gone. Apart from this, there was a check-dam on the land which was demolished by the project proponent. According to a GSPC engineer, there used to be a small natural pond on the land which has now been expanded. Since the area is being fenced, the access for villagers to this pond is uncertain. The GSPC has provided an above-ground tank for the village, but this tank remains non-operational.

The acquiring of a natural water body for the solar park is, according to Mahesh Pandya of the environmental organisation Paryavaran Mitra, against court orders in Gujarat: new projects are not allowed to take over natural ponds, which are seen as wetlands. The villagers have protested, but little heed has been taken of their protests; the presence of a bus-load of Gujarat police on site may have a dampening effect on any protests. The villagers report that wildlife have perished in this area which used to be a corridor for them between the village and the Rann of Kutch. However, at a solar conference in Gandhinagar, secretary of Gujarat's Department of Energy and Petrochemicals D J Pandian said he had visited the site multiple times with the forestry department and "the only wildlife (he found) there was Mr Pandiyan".[2]

As for employment, only one person in the village has a been given a job in the park. The park should have provided 240 jobs, many of them for module cleaning, guarding and general maintenance operations. The lone Charanka village worker plants trees along the roads of the park. Villagers say that when they applied for jobs, they were refused on grounds of not being qualified, even for cleaning panels. Labour for cleaning is bussed in from as far away as UP and Rajasthan.

LAND LOST

The MNRE has recently asked states to provide land cheap or for free[1]; in Rajasthan land is leased out at 10 per cent of the market price.[2] Under the first phase of JNNSM, solar developers got land at Rs 33,600 per acre – too low to give any incentive to developers to minimise their land footprints.

When a plant costs around Rs 10 crore per MW and each MW takes up 5.5 acres for poly-crystalline and 6.5 acres to 8.6 acres for thin-film (as per Gujarat benchmarks), the difference of 2.1 acres under Rajasthan policy would only be Rs 70,560 over the life-time of the plant.

The average price of silicon-based solar modules stands at US $0.838/Watt, while that of thin-film is US $0.733/Watt[1] – for 1 MW, this amounts to Rs 4.6 crore for silicon and Rs 4 crore for thin-film. The difference of Rs 60 lakh per MW between the technologies heavily outweighs the added average land-cost of Rs 70,560 under the Rajasthan policy.

An alternative to leasing land at 10 per cent of the land cost would be to lease it at market cost and take the funds generated from this to support the Rajasthan solar policy tariffs. The premium of Rs 4,000 per acre now calculated as 10 per cent of market value would instead be Rs 40,000 – a gain to the government of Rs 36,000 per acre.

Assuming the installation of 200 MW as planned under the Rajasthan solar policy, phase I would lease land at Rs 40,000 per acre, and would generate an extra Rs 4.68 crore (assuming 6.5 acres/MW) that could be distributed through tariffs. Assuming the vast majority (80 per cent) of JNNSM's phase II target (9,000 MW) is built in Rajasthan, 7,000 MW of plant capacity would give an extra land lease income of Rs 1,63,800 crore. A policy of adding this income to any JNNSM tariff would still attract developers to Rajasthan and avoid unintended consequences.

Solar developers would then get funds from generation rather than from land cost. There would be, thus, a substantial incentive to minimise land use.

CASE STUDY

ASKANDRA

On a remote stretch of road between Ramdevra and the Indira Gandhi Canal in northern Rajasthan lies a huge construction site that stretches off as far as the eye can see. It is where Lanco Infratech is building its solar empire – 826.5 hectares of land has been alloted by the government to Lanco for generating a total of 235 MW of solar energy from nine projects. This cluster, if counted as one plant, will be by far the biggest solar plant in the world.

On one side of the road an area is being cleared of bushes and trees, and the sand being leveled for one of the two 100-MW solar thermal projects taking up 370 hectare each. Directly on the other side are seven consecutive plots of land, each with space for a 5-MW solar PV project taking up about 122.5 hectares in all. All these projects are being set up by Lanco Infratech. The government of Rajasthan has argued that its north-western areas of the state are perfect for developing solar projects, as they are too dry, hot and rocky for any other use.

Askandra, the closest village to the Lanco plants, lies in the north-east of Jaisalmer district which, with 17 inhabitants per km^2 compared to the national average of 382 per km^2, is one of the most sparsly populated districts in India. It also lies close to Pokharan, the famous site of India's 1974 and 1998 nuclear tests. The village is a 15 minutes drive from the site-office of Lanco but because of the site's vastness it stretches almost to the doorstep of the village.

The villagers of Askandra have been protesting against the Lanco development: their grouse is that the project is coming up on sacred land, reserved for the local goddess Joyamati. "It's not like we couldn't have used the land if we wanted, parts of it could have been farmed but it is sacred [Devi and Oran] land and no one else can use it," say village elders. With the Indira Gandhi Canal running nearby, the water table is quite high and water quality is good according to both Lanco and the village. Farmers have been waiting for allotment of the same land for over 40 years – but Lanco has now managed to grab it within a few months.

Khejri trees grow on the construction site; this the state tree of Rajasthan and sacred to the villagers. "We cannot break a single branch of the trees and now they are cutting them down. We did not ask for this development to come here," says a villager.


JONAS HAMBERG

Leveling for 100 MW Lanco's solar thermal plant

According to Ashok Jain, site manager of a PV plant, Lanco the villagers have held dharnas on the road against the project. This had delayed the project so much so that he believed the plants would not be ready by the January deadline. Ashok Jain stated that Lanco had "got local MPs and MLAs to help us" to end the protest.

The villagers wanted to take the matter to court in Jaipur with the help of a local MLA but the government had persited that the land was government land as it had not been registered as sacred 'Oran' land, instead as revenue land. The villagers themselves believe they were tricked at the time of partition, being so remote none had been able to influence the government when land was being registred at the time. Jain believes the villagers of Askandra are in reality "worried about Lanco's intention in the long run and about encrochment of their 'comfort zone' rather than if actual land being taken away. Another Lanco site-manager admits that part of the land aquired should count as forest-land. Since it hasn't been registered as forest-land however the forest department in Jaipur has not been included in the process.[1]

As CSE surveyed the site indicated by the Lanco engineers to be where the KVK plant would be constructed parts of it was clearly being farmed. Just next to the Lanco thermal site local women were also picking fruit for goat-fodder from the ground – which will be impossible to do on the site now.

Lanco has promised refurbishment of schools and the local temple as well as solar panels for the villagers but the villagers of Askandra seem unconvinced – for them the clean energy revolution is looking much like any other land aquisition.

LAND FOOTPRINTS: COMPARISONS FROM THE US

Few, if any, comparisons of the land footprint of solar vs conventional power have been made in India, but in the US studies[1] have shown that even with lower solar insulation and higher calorific value of coal, solar technology occupies and disturbs less land per kWh over its life-cycle.

The US averages for land transformation are as follows: 6-18 m^2/GWh for the coal plant itself, 400 m^2/GWh for mining, 2-11 m^2/GWh for disposal of ash and sludge and 30-80 m^2/GWh for rail-road occupied by coal shipments.

For solar power, the indirect land occupation for mining the materials needed for the modules is 15-18.4 m^2/GWh; 7.5 m^2/GWh is required for the Balance of System materials. Direct land-usage varies from 164 m^2/GWh to 552 m^2/GWh for the solar installations. Solar (in the US), therefore, has a land transformation of 410.5-413.9 m^2/GWh, while the figure for coal is 438-509 m^2/GWh.

It should be noted here that land transformation for solar installations happens only once, at the end of their life-time (assumed to be 30 years for modules and 60 years for Balance of System); a new installation can be set up on the same land at no extra direct land transformation 'cost'. Another way to see it is that land utilization actually becomes lower the longer the same area is used for solar production This equation also assumes that all mining land in the US will be reclaimed, which is far from the truth – 95 per cent of mines in the US are not reclaimed[2] (*see Graph: Comparison of land use intensity*).

Graph: Comparison of land use intensity

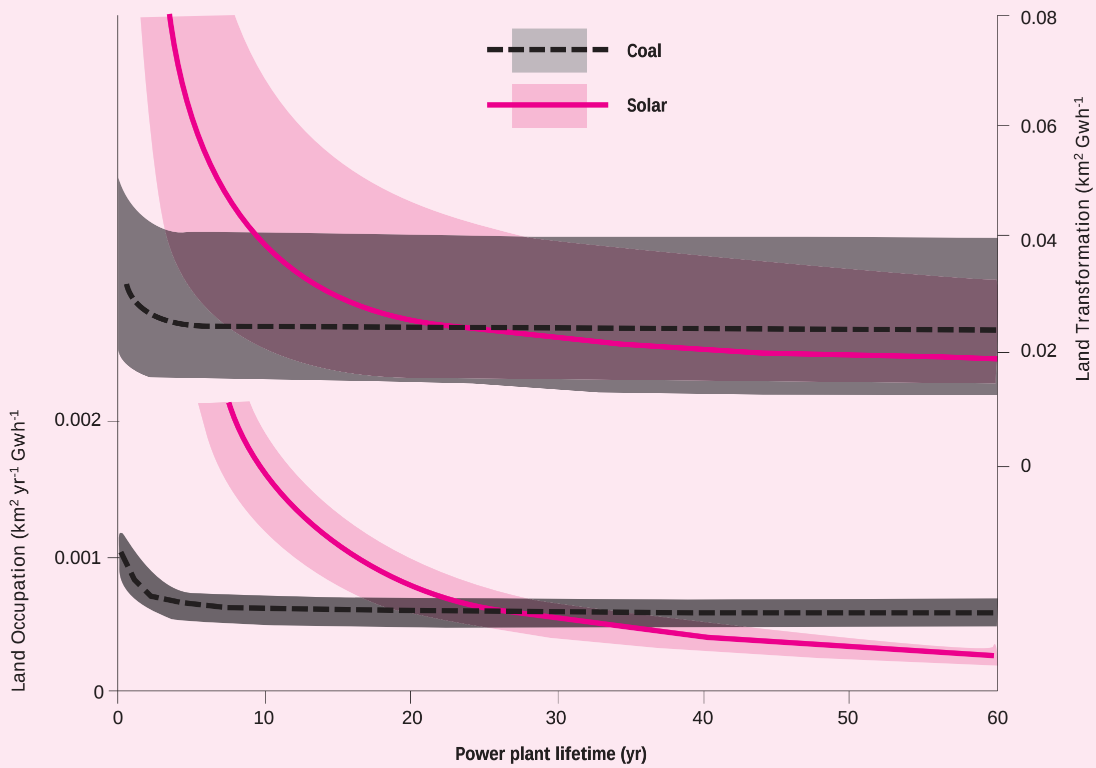


Fig. 1. Comparisons of land use intensity metrics for large-scale solar and coal power. The left ordinate shows land transformation, and right ordinate shows land occupation. For both ordinates the dashed line is the average result for coal powered electricity while te solid line is the average result for solar powered electricity. The gray shaded areas give the range of sensitivity of the calculations as the input parameters are varied over their possible values, as described in the supplemental information.

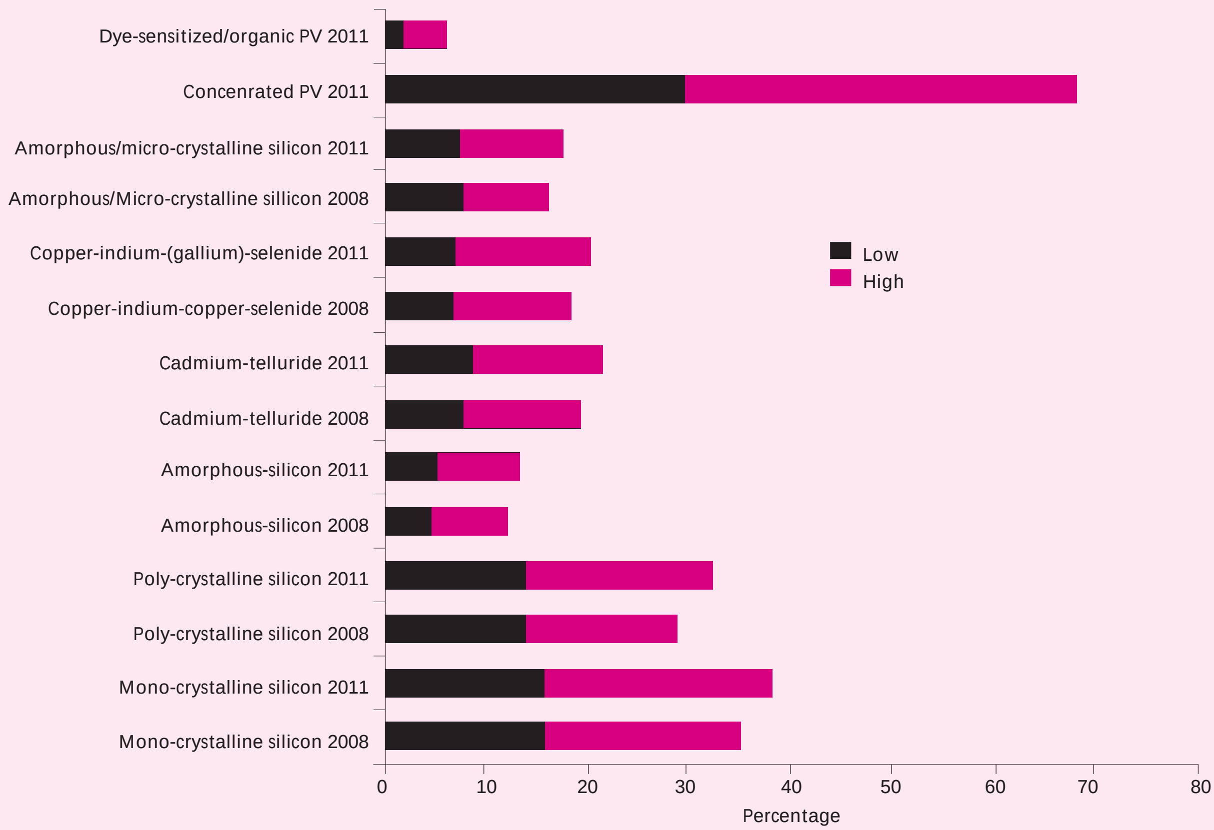
Source: Damon Turney, Vasilis Fthenakis 'Environmental impacts from the installation and operation of large-scale solar power plants' Renewable and Sustainable Energy Reviews 15 (2011) 3261–3270

CONVERSION EFFICIENCY VERSUS CAPACITY UTILIZATION FACTOR

Conversion efficiency is the amount of energy converted into electricity by a solar cell. Thin-film technologies have a lower conversion efficiency, but lower production cost makes up for the difference. At the plant level, efficiency is usually measured as Capacity Utilization Factor (CUF), which is the percentage of electricity produced as compared to the name-plate capacity (the peak capacity of all the cells combined). CUF and conversion efficiency have little to do with each other — a plant using cells that have low conversion efficiency can still have high a CUF (*see Graphic: Different technologies by conversion efficiency*).

During the first batch of the National Solar Mission's first phase, this has turned out to be on the lower side than what was allocated. Plants show an

Graph: Different technologies by conversion efficiency



Source: CERC, 'Draft Explanatory Memorandum Solar Power Projects' 30th June 2009; Eurpean Photovoltaic Industry Association 'PV Technologies: Cells and Modules' accessed on 19th May 2012 http://www.epia.org/solar-pv/pv-technologies-cells-and-modules.html

the land issues still takes two-three years."[7]

Revenue land in Rajasthan is owned by the state, but is often used by local communities as common grazing land or for foraging fruits and firewood. CSE has found that in 12 cases in Rajasthan, solar plants have been set up on land that was being used for grazing or other activities by traditional communities. These plants include Welspun, Astonfield, Northwest Energy (Videocon) and Diwakar Solar (Lanco), among others.

Gujarat faces a different problem: here, farmers sell their land and take home a lump sum; but often, they are unable to find another source of income, leading to poverty and destitution in the

Table: **Performance of solar technologies as kWh/day/hectare land used**

Technology	Plant	kWh/day/hectare land used
PV poly-crystaline silicon	Reliance Solar, Khimsar, Rajasthan	606[1]
PV mono-crystaline silicon	KPCL/Titan Energy, Kolar, Karnataka	2199 (land used) 1513 (land bought)[2]
PV thin-film – amorphous silicon	Moser Baer (Sapphire), Tamil Nadu	340[3]
Solar thermal – solar tower	ACME Solar, Bikaner, Rajasthan	1272[4]
Solar home lighting system	Sabhu Ram's house, Bharupawa Bikaner, Rajasthan	No land needed[5]

Sources and notes: 1. MNRE, '32/54/2011-12/PVSE Performance of Grid Solar PV Plants under demonstration programme', available on http://mnre.gov.in/file-manager/UserFiles/Grid_Solar_Demo_Performance.pdf; information also from site visit
2. H Mitavachan, Anandhi Gokhale and J Srinivasan, 'A case study of 3-MW scale grid-connected solar photovoltaic power plant at Kolar, Karnataka', IISc-DCCC, August 1, 2011
3. http://moserbaerprojects.com/solarpower-projects.asp?links=sp4, accessed on May 7, 2012; MNRE, '32/54/2011-12/PVSE Performance of Grid Solar PV Plants under demonstration programme', available on http://mnre.gov.in/file-manager/UserFiles/Grid_Solar_Demo_Performance.pdf (based on 190 days of data)
4. Site visit
5. Site visit

actual land use of between 5 and 9 acres per MW. The capacity is, however, less than the actual generation per acre (*see Table: Performance of different solar technologies as kWh/day/hectare*). It is still too early to get precise data on generation from the first batch of projects, but a few projects from pilot programmes can give an indication of the differences between the technologies.

long run.[8, 9]

There seems to be very little understanding of or respect for the fact that communities may have communal rights over the land, or that maps might be faulty. Perhaps giving developers a somewhat longer period for project development could provide them with enough time to sort out such issues in a fairer manner.

Compensation

A loss of revenue land used as commons should be compensated with part of the lease income.

Instead of selling private land, as in Gujarat, a more sustainable model would be for the owner to lease it out to the company at a price that would generate a sustainable income for the farmer. At the end of the solar plants' life-time, the land could be returned to the farmer if structures and cement foundations are dismantled.

Ashwin Ghambir, researcher at Prayas Energy Group, says: "Land cost is perhaps 1 per cent of a solar plant's cost – why not spend an extra 3 per cent on making sure the community around the plant is happy with it? Lease the land from locals so they can share the benefits. There should be adequate compensation for loss of useful land around the community."[10]

Other researchers are proposing instead that the best way is to compensate the sale of land by buying land somewhere else so that the income can be sustained.[11]

Access for the poor

Most small towns, villages and hamlets located close to solar power plants – finished or being built – have either no electricity connection or electricity for only two-four hours per day. Will solar power projects change things for them?

In Rajasthan, as per JNNSM, plants have to provide power to the national grid at 33kV. There is no incentive for distributing power locally, so the solar plant gives no extra benefits to the communities living near the plant. Even if the plants could distribute power locally, how well would the production curve of a solar plant match up with the demand curve of rural India?

Large-scale solar PV produces electricity during the period the sun shines; battery back-up is too expensive and inefficient to consider. For farmers in rural India, electricity is used in running pumps for irrigation and in domestic use. Large-scale solar generating electricity would be in sync with running irrigation pumps – however, domestic activities would find no electricity from the plants, as such activities are mostly conducted after sunset.[12]

Solar thermal plants with energy storage, such as the ones Lanco and Cargo Solar are building, are better suited to fit the demand curve for domestic usage as they can supply power for hours after sunset.

In the US, the solar industry touts that its production curve fits neatly with demand, especially in summers when the majority of Americans switch on their ACs. As urban India becomes more affluent and more households and offices install ACs, energy demand in cities will begin to match up with solar production during summer months. But rural India's demand curve will still take a long time before it matches solar production. Large-scale solar, thus, remains better suited for urban and affluent India than its rural counterpart.

Community

Solar power plants do not lead to air or water pollution while operational; while being constructed, the pollution they generate is negligible. The issues and concerns for the neighbouring communities around a plant, therefore, revolve around the amount of land used, the water used for cooling and cleaning, and employment.

While most plants visited by CSE researchers stated that they had contacted and surveyed nearby communities, most communities and farmers living near the plants claimed the contrary.[13] The general attitude towards the solar plants was of indifference; some complained that the plants avoided employing locals, and that the traffic and land prices had increased in the area because of the plants.[14]

There are, however, communities that are more strident in their opposition to solar plants (*see Box: Askandra*). Many communities living close to the plants have not been electrified and see little impact on their lives from the plants; project developers argue that they are not allowed to distribute electricity locally as per their contract. Guro, just north of the Indira Gandhi Canal, gives a different picture. No plants have been planned here, and local villagers say they will welcome solar plants as they have plenty of unused land; they also think these plants will provide employment opportunities locally.[15]

The chairperson of the Rajasthan discom, Girish Sant, says that Rajasthan has 208,000 sq km of unused desert land. The reality is, however, somewhat different. Although most projects coming up under phase I are on government land, there are many cases where land which was given away, was being used as grazing land for cattle, as temple land or for foraging. If the first projects are coming up on land that are in reality being utilized, then where is all this 'unutilized' land?

For the last 40 years, Rajasthan had been mulling over allotting government land to farmers. In a decision that took a mere few months, this land was given away to solar projects.

Table 5.3: Employment at solar sites

Name of project	MW	Place	Construction employment	Operations employment
Swiss Park	5	Osiyan, Rajasthan	300-400	30-40 guards and cleaners
Moser Baer	5	Osiyan, Rajasthan	150-200 builders and	– 20 engineers
Punj Lloyd	5	Bap, Rajasthan	200	–
Godawari	50	Nokh, Rahasthan	150 (during leveling of land)	–
Corporate Ispat Alloy	50	Nokh, Rajasthan	150 (during leveling of land)	–
GSPC Solar Park	198	Charanka, Patan, Gujarat	10000 (at height of construction work)	–
Ujjawala/Responsive Sutip	25+25	Kamalpur, Surendarnagar, Gujarat	300 construction labour 15-25 engineers	–

Source: Approximate numbers based on site-visits and interviews with contractors, labourers and site-managers

Employment

During its operation and maintenance, a solar plant needs engineers, electricians, security guards and cleaners (*see Table 5.3: Employment at solar sites*). Some of these workers – such as guards, cleaners, construction labourers and even electricians – can be hired locally. Establishing local training centres for electricians in areas where plants are coming up could help both local employment and the projects. But developers rely instead on contractors who bring in workers from distant cities.[16]

Instead of using a large number of workers once a week, a simpler measure would be to clean the panels regularly with the help of a smaller full-time workforce drawn from nearby communities. This would create goodwill among these communities.

Labour costs could be restricting some developers – one developer said that the cost of labour from villages and towns near the site is three times higher than that from cities further away, mainly because of the higher demand from competing plants. Labourers at the Punj Lloyd plant come from nearby villagers as well as further away and receive Rs 250 per day.[17]

Water

Both solar thermal and solar PV plants need water for cleaning mirrors and panels, respectively. Solar thermal projects also use water for cooling in the same way any thermal power plant does. The issue is that solar plants are usually situated in dry and hot areas where water is scarce.

Solar thermal projects can use air-cooling instead of water-cooling, but air-cooling is less efficient. It raises the cost of the electricity produced by 10 per cent and lowers output by 7 per cent.[18] Also, air-cooling does not work well in hot areas, where the air is also hot and the difference in temperature between the heated steam and cooling air is less.

A report by the Central Electricity Authority of India on a combined cycle power plant (combining gas and solar thermal) has predicted 6,000 m^3/MWh of water usage for the solar part.[19]

In India, most solar plants are coming up in Gujarat and Rajasthan; almost all future solar thermal will be built in the deserts of Jaisalmer district in Rajasthan. Five out of seven solar thermal plants under the first phase of the Solar Mission have been granted water from the Indira Gandhi Canal – the 100-MW projects have been alloted 2.2 cusec (cubic feet per second), while the two 50-MW projects have been alloted 1.2 and 2 cusec, respectively (*see Table 5.4: Allocated water per solar thermal project in Rajasthan under JNNSM phase I*). The total adds up to 9.8 cusec – this is about 0.05 per cent of

IMPACT OF MONSOONS

It is still unclear how the monsoon season in India will impact large-scale solar projects. There are, however, indications that it may lead to damage to the panels. Reliance Solar panels have been damaged when the rains hit very hot panels, leading to their discolouration.[1] The same has been observed in Karnataka at a KPCL plant.[2] The reason PV panels are dark-blue or black is that they can absorb most of the visible spectrum of sun-light. Changing their colour could lead to lower efficiency in plants.

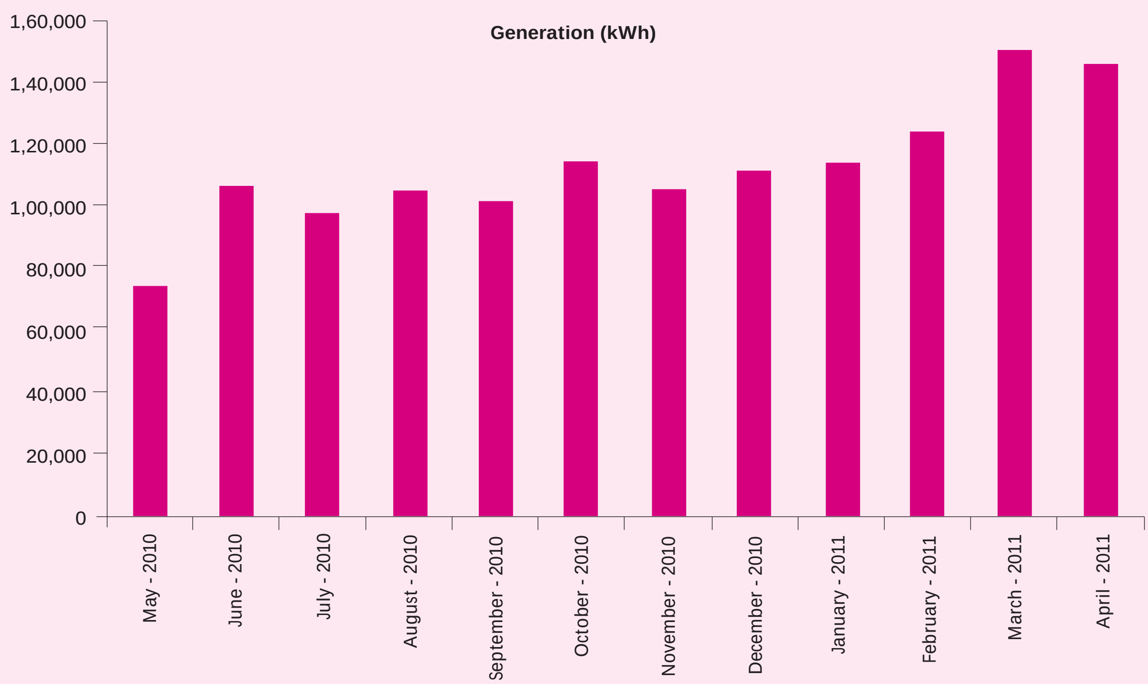
Monsoons could also lead to a dip in output — sometimes over 50 per cent as seen in some plants.[3,4] Not much thought has been given to this issue, but if solar becomes a substantial part of a grid's energy mix – which it might in Rajasthan and Gujarat in the coming years – a seasonal drop of solar would have to be made up from other sources such as coal, gas or hydro.

Monsoons create problems during the building stage as well. Many of the delays in solar in Gujarat have been attributed to inundation of land after heavy rainfall.[5] One plant in Tamil Nadu surveyed by CSE had a recurring problem: foundation work had to be stopped whenever the land became wet.[6] The project got delayed and had to relinquish part of its bid-bonds.[7]

It is, however, still too early to establish the impact of monsoons on generation – while monsoons do lessen the amount of sunlight hours, they have also been known to clean the panels very effectively. Immediately after its inauguration in April 2012, the Charanka Solar Park had its best day just after a short spell of rain, suddenly generating so much that it overloaded the park's transformer sub-station.

One of India's earlier plants – the Maharashtra State Power Generation Corporation's (Mahagenco) 1-MW A-Si thin-film plant in Chandrapur – showed little effects of monsoons on total generation in 2010 (*see Graph: Actual generation*).[8]

Graph: **Actual generation**



Source: Anon. 'Perfomance of Grid Solar PV Power Plants under Demonstration Programme' MNRE

ENVIRONMENTAL IMPACT OF CADMIUM

First Solar has become one of the real winners of the Indian push for solar. The American company has signed so many projects it is reported that all of the thin-film produced in First Solar's US factories are going to India. First Solar uses a technology called Cadmium Telluride (CdTe). Cadmium is the sixth most toxic material used by humans[1] and may cause lung-cancer and liver failure if ingested or inhaled.[2] This has caused some concern as to leakage of cadmium from panels; especially if the panel would be affected by fire. According to one of the few life-cycle analysis conducted of CdTe modules the amount of Cadmium in the module is limited: 1kW of panels uses only as much cadmium as 10 'C' Nickel-Cadmium batteries and the risk of leakage is minimal as panels are enclosed in glass and fuses and the cadmium and glass fuses at fire. Compartively to the release of cadmium into the air by coal burning power stations, the release from the whole life-cycle of CdTe modules is very low - 0.001984 mg per MWh. Even with the best technology present and good coal quality (which India does not have) cadmium release from coal power is at least 2 mg per MWh - 1000 times higher than CdTe.[3]

First Solar has promised that all its modules will be recycled and that funds are set aside for this at purchase. These funds are put into a separate third-party trust that is supposed to continue to function even if First Solar goes out of business.[4]

There are still sceptics arguing that since CdTe doesn't have a long enough history and 25-30 years in harsh desert conditions can cause situations not thought of in laboratory tests. They also argue that even if there are promises of recycling of the modules 25 years is a very long time for manufacturers and even a considerable time for established insurance companies.[5]

Jim Brown, President of Global Business Development at First Solar stated directly to CSE that each module has a toll-free hot-line number on the back to call for module pick-up anywhere in the world. The question is if Rajasthani or Gujarati farmers finding these modules in 25 years can read the English on the back of the modules and if they would even care to make the effort.[6] It is paramount that safe-guards are put into place so that project developers and owners cannot abandon modules at end of plant-life or end of lease.

Table 5.4: Allocated water per solar thermal project in Rajasthan under JNNSM phase 1

Project	Capacity (MW)	Water alloted (cusec)
Rajasthan Sun Technique (Reliance)	100	2.2
Diwakar Solar Projects (Lanco)	100	2.2
KVK Energy Ventures	100	2.2
Godawari Green Energy	50	1.2
Corporate Ispat Alloy (Abhijeet)	50	2

Source: JDVVNL 'Details of Sanctioned Solar Thermal Power Project in Rajasthan under NSM phase-1' obtained from JDVVNL offices in Jodhpur 19th October 2011

the total capacity of 18,497 cusec of the canal at its head.

The Rajasthan government's water resources department has given a lump sum of 58 cusec for 40 years to solar thermal projects[20] – enough for about 2,500 MW, according to the RREC. A total of 450 cusec from the Indira Gandhi Canal has been set aside for energy production.[21] According to an earlier report in the *Economic Times*, though, it was said that 12 cusecs have been set aside for the 400-MW of phase I projects and a total of 400 cusecs have been set aside for solar thermal.[22] Assuming 23 per cent CUF as per the CERC guidelines, this would mean a water requirement of 9.7 m^3/MWh.[23]

If we assume an efficiency of 40 per cent – quite possible for efficient solar thermal projects – the water use would be 5.6 m^3/MWh. This is, however, still far above the figure that the IEA states as the approximate usage: 3 m^3/MWh or the average water used by efficient coal-based thermal power projects in India.[24] How the allocation of water to the projects was done is unclear, but there seems to have been an over-allocation. It is also unclear whether the full allocation will be used by the plants. There has been some indication that some projects might make use of dry-cooling.[25]

Take the example of the Acme Telepower Solar Tower in Bikaner, the only functioning commercial solar thermal plant in India at the moment: 7 MWh per day is produced by the plant, which uses 20,000 litres of water for this.[26] It would mean a total usage of 2,857 litres of water per MWh. The International Energy Agency (IEA) states that solar towers may have lower water consumption than the parabolic trough and linear fresnel design being used by the five projects now under construction in Rajasthan.[27] This would make solar towers preferable from a water-usage perspective.

To correctly judge solar thermal's water impacts, we need to compare it to other power plants in Rajasthan. According to CEA, the 'typical' 1,000-MW coal plant uses 4,000 cubic meter of water per hour mainly for cooling and ash-disposal.[28] Assuming 80 per cent Plant Load Factor (PLF) a 'typical' Indian coal plant would use 5 m^3/MWh. For a real world example, the 125-MW Giral Lignite Plant in Barmer district takes in 660 cubic meter of water per hour from the Indira Gandhi Canal.[29] This would mean 6,600 litres per MWh (assuming 80 per cent PLF).

This, however, disregards any water usage for mining the lignite used as fuel. The Neyveli lignite mines in Tamil Nadu pump out an estimated 40 million litres of water per day to drain mine galleries. Neyveli Lignite's 250-MW plant in Bithnok has stated a need for 6,000 l/MWh (again, assuming 80 per cent PLF) from the Indira Gandhi Canal even though it is reported that the plant will use induced-draft cooling – a type of air-cooling.[30] Sathyam Power's 10-MW biomass plant in Kota will take 200 cubic meter per hour from the same canal as well as from tubewells: this comes to 25,000 l/MWh with air-cooled condensers.[31]

Another lignite plant – Jindal's RajWest near Giral in Barmer – will take 37 million cubic meters per year from the Indira Gandhi Canal, enough to sustain 2 million people for the same time.[32] The major difference between water used in solar thermal and coal thermal plants is that much of the water used in coal mining will be contaminated by fly-ash and other pollutants[33] while the water used in solar thermal evaporates or can be reused.

PV plants coming up in phase I of the Solar Mission will mainly rely on borewells and tankers. They are not disclosing how much water they will need, but some concerns among developers have begun surfacing about the availability of water for panel-cleaning.[34]

Water is sparse in the regions where solar insulation is good and it needs to be kept in mind. Above all project should need to publicise their water-usage. It does however need to be put in comparison to the alternatives – the even more water-intensive coal, lignite or biomass power projects.

CHAPTER 6

Recommendations

Guidelines and policy

- Karnataka's guidelines on fraud and corrupt practices, as outlined in the Karnataka Renewable Energy Development Limited (KREDL) Request for Selection documents, should be used in all future Request for Selection documents and any other applicable documents such as Request for Purchase and Power Purchase Agreements.
- The possibility of using accelerated depreciation should be completely removed. It should not even be kept with a lower tariff. It is an inefficient mechanism and has been shown in wind power to lead to lower efficiency levels in production of electricity.
- Controlling ownership of projects should be defined as 51 per cent of shareholding, under all policies and missions, making no distinction between preference shares and equity shares. Ownership should remain with the same controlling owner for at least three years after commissioning of the project.
- Time allocation for commissioning should depend on the size of the project, as laid down in the Madhya Pradesh solar policy. In general, the commissioning time should be extended. The first batch of JNNSM has shown that a majority of projects did not meet the deadline because of monsoons, lack of skilled humanpower or land acquisition issues.
- For the safety of investors and communities living close to projects, it would be advisable to give time to procure land in a fair manner. Time should be extended by two months for PV projects (from 13 in JNNSM batch II phase I). A high bid-bond and bank-guarantee should, however, remain as deterrents so that projects do not get delayed unnecessarily.
- Verification of commissioning of plants must be done by an independent party which does not have any connection with discoms or renewable energy agencies. Third-party verifiers should double-check plant commissioning at randomly selected sites.
- Definition of commissioning should be made absolutely clear. To be declared as commissioned, a plant should put in place all the equipment for the full allotted capacity. Also, it should meet a minimum generation level.
- There should be no cap on the amount of electricity that can be sold at the preferential tariff rate for projects. Removing the cap as it is set in JNNSM will give a boost to innovations in efficiency and give incentives to install trackers and other technology that may increase output.

Funding

- Funding for second phase will come from multiple sources. It is clear that no single fund is large enough to fund 10,000 MW of solar energy. The National Clean Energy Fund should be part of the funding while there should be a drive from the Indian side for a new international climate funding mechanism that could fund solar energy in India.
- Other funds may be provided through the Central government. With increasing energy prices in India, the gap in funds per year will fall, even if solar cost (with module prices already depressed below production cost)

does not fall below Rs 8/kWh. Depending on assumptions, the long-term 25-year contracts signed between utilities and producers may become profitable over fossil fuel electricity in the long run.

- It should be noted that grid-connected solar energy is energy for the rich – it is expensive and better suited to the demand curve of industry and urban population. Cross-subsidization should be the norm for solar energy. The extra cost of solar energy that state utilities incur should be levied on high domestic consumers and on industries.
- A nation-wide solar cess of Rs 0.03/kWh on conventional power production would provide about Rs 4,800 crore per year – more than enough to cover the National Solar Mission phase II and state policies.
- The funds gathered from encashing bank-guarantees and bid bonds need to be clearly accounted for. The funds should be utilised to support R&D and training or used as part of a financing mechanism for projects using Indian manufactured solar equipment.
- It should be made clear that the US Exim Bank funding is a disruptive trade tool that hinders Indian manufacturers from competing in the domestic market. The fact that the Exim Bank accounts these loans as climate financing under the Copenhagen Accord, should be clarified as double-accounting.
- Climate financing should come through grants, without any demand for buying equipment from donor country. This financing could support the Indian Solar Mission and state policies.

Manufacturing

- Thin-film technologies are over-represented in India compared to global usage because of easy Exim Bank financing from the US and exemptions to thin-film in JNNSM's indigenisation requirement. Both thin-film and crystalline modules and cells should be sourced from Indian factories. State policies and other schemes such as Renewable Energy Certificates should follow the same indigenisation requirements.
- The other option for indigenisation requirement could be to give a 10 per cent extra tariff to projects which use Indian manufactured cells and modules. Indian modules are reported to be 20-30 per cent more expensive than Chinese and as modules make up 50 per cent of the project cost, the extra tariff should take care of the difference.
- Clarification is needed on what the 30 per cent of technology (excluding land) of solar thermal project's indigenisation requirement means, and how it will be calculated. Indigenisation of advanced solar thermal equipment such as receiver tubes, mirrors, generators, valves and computer-controlled tracking technology should be encouraged.
- A second 'Special Incentive Package' to encourage large-scale poly-silicon, wafer and cell production in India is required. To be able to compete in the long run, Indian manufacturers of solar technology need to have the same scale as Chinese manufacturers.

Land, water and community

- 2.5 hectare (ha) of land per MW should be the mandatory cap on land use for any solar photo-voltaic plant receiving preferential tariffs or RECs, or set up to meet RPO requirements. The Yalesandra KPCL plant in Karnataka as well as the Mahindra Solar One plant in Rajasthan have shown that PV plants require 2.5 ha of land per MW or less.
- Using trackers for PV modules may increase land use per MW, but may at the same time decrease land used per kWh generated, as efficiency increases. Trackers should be encouraged: therefore, the 0.1 ha/MW increase in per MW per 1 per cent increase in CUF (extra output warrantied by tracker-provider) that the tracker provides, should be allowed.
- For solar thermal, 2.5 ha per MW should be considered as a cap on land use for a project up to a Plant Load Factor of 23 per cent as per Gujarat land norms. As per the same norms, a 0.1 ha increase in land use per MW per 1 per cent increase in Plant Load Factor should be allowed for solar thermal with storage.
- Any continuation of the Roof-top PV and Small Solar Generation Programme must demand roof-top placement. If necessary, the projects should be allowed to split the total capacity over multiple roofs. Roof-top projects must be scaled up to an appropriate size – the 1-2 MW

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size, which has been used for RPSSGP, is too large for single roof-top projects.

- Solar energy needs solar farmers: For solar projects, land should not be acquired; instead land, whether government-owned or private, should be given to companies on lease. Companies should be asked to pay the lease rent either on the basis of the amount of electricity produced or on the basis of per hectare of land leased. Fertile agricultural land and forest land should not be leased out for solar power generation.
- While land leasing should be promoted instead of land buying (as per the policy in Rajasthan), any revenue land that is sought for a project should be given as per the market price (DLC). Rajasthan could use the extra funds received from this towards financing more solar – the aim should be to support solar generation and not just solar capacity.
- Any land used as community land to source firewood, graze cattle, forage for fruits or for wildlife conservation must be reimbursed as a loss of income to the community.
- To minimise use of land, roof-top, canal-top and other similar projects should be encouraged. The feasibility of such projects has been proven with the pilot canal-top project. Developers should be provided canal tops, while communities' right to access the canals should be safeguarded. A maximum percentage of the canal-top area must be designed in a manner which will allow enough sunlight into the water. The higher erection costs in these cases due to the extra structures meant for bridging the canal may be offset by no land cost, but this idea may need further incentives to interest developers.
- Inventive land use should be encouraged – for example, solar can be used to re-habilitate mining areas or degraded lands.
- An indepth study on the impact of monsoonal rains on the longevity and output of solar panels is needed. Studies are needed on how Indian weather conditions will impact both longevity and output of Indian solar and how that will affect supply-curves and transmission networks.

- There is an urgent need for transparency in water usage by PV and CSP solar plants. The government should prepare a report on the amount of water used per kWh of electricity generated at PV plants. No clear information is available currently on this; neither is there a benchmark or best practice. The report needs to take into account the cumulative impact on areas with large concentrations of solar PV and solar thermal, such as the Phalodi area in Rajasthan or Kutch and Patan district in Gujarat – these are areas which are already water-scarce.
- A standard needs to be set for the maximum amount of water that can be used by CSP plants. These plants should be encouraged in the coastal areas with desalination and dry and hybrid cooling.
- Large solar parks need environment assessment and environment mitigation plans. Presently, an environment impact assessment (EIA) is not required for solar power plants. However, large solar parks of hundreds of hectares are being planned. Such large land conversion projects will have environmental impacts – especially on land, water, biodiversity and common community resources. Solar power plants will also have to plan for the disposal of panels, batteries and other electrical appliances all of which contain toxic and hazardous wastes. It is, therefore, important that some form of environmental assessment is done for large projects and for every project of over 50-MW size an environment management plan is developed. The MNRE should work with the MoEF and come out with a template for environment impact assessment and environment management plan. It should also fix a simplified process, with time limits, for assessment and clearance of large projects.
- With large amounts of cadmium telluride modules being erected in India, government regulations should be established to fix responsibility for these possibly hazardous modules, in cases where a project is decommissioned or abandoned.

Transparency

- The website of the Gujarat State Load Dispatch Centre shows real-time plant-wise data for solar power generation in the state. The CEA gives monthly generation figures for all generating stations. This should be done for JNNSM as well through the MNRE or NLDC. This will increase transparency, help the civil society monitor solar generation, and lead to the establishment of best practices.
- Any new contracts signed by JNNSM or a state body for power purchase agreement or bidding should exclude any type of clause that limits transparency and circumscribes the Right to Information Act (as in non-disclosure agreements). Bidding sums should, of course, still be kept secret until the bid opens.
- State and national nodal agencies should, in general, increase the quantum of information available from publicly subsidised projects (JNNSM, state policies and REC-certified projects). All projects that take public funding must show details such as location, project size, land use, technology used, technology-provider, water use and generation data. This will help establish best practices and benchmarking.

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Centre for Science and Environment
41 Tughlakabad Institutional Area, New Delhi – 110 062, India
Ph: 91-11-2995 6110, 2995 5124, 2995 6394, 2995 6499
Fax: 91-11-2995 5879, 2995 0870
Email: cse@cseindia.org **Website:** www.cseindia.org

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