

# marching ahead... Jawaharlal Nehru National Solar Mission

On 11 January 2010 India launched the Jawaharlal Nehru National Solar Mission (JNNSM), for development and deployment of solar energy technologies in the country. The immediate aim of the Solar Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralised and decentralised level.

By Staff Reporter

India is a party to the United Nations Framework Convention on Climate Change (UNFCCC), which sets an overall framework for intergovernmental efforts to tackle challenges posed by climate change. India has reasons to be concerned about the impact of climate change since a large part of its population

depends on climate sensitive sectors like agriculture and forestry for their livelihood. Any adverse impact on water availability would threaten food security and also affect the achievement of vital national developmental goals.

Planning in India seeks to increase wealth and human welfare, while simultaneously conserving the environment.

Emphasising on this aspect, the Prime Minister, Dr Manmohan Singh said, “I believe that ecologically sustainable development need not be in contradiction to achieving our growth objectives.”

A range of policies and programmes have been initiated to address the problem of climate change in the context of sustainable development - promoting renewable energy is one of them. India is witnessing rapid economic growth and consequently resource demand has increased manifold, particularly for energy.

### The Solar Mission and Climate Change

In the build up to the 2009 Copenhagen conference, the Bali Action Plan (BAP) was adopted in the UNFCCC in December 2007. One of the main pillars of the BAP was the Nationally Appropriate Migration Actions (NAMAs) - which are voluntary actions to be taken up by developing countries for reduction in green house gases (GHGs) and towards mitigation of climate change, according to their individual national circumstances, capabilities and resources. In India the NAMAs laid the foundation for the formulation of the National Action Plan for Climate Change (NAPCC), which was released by the Prime Minister, Dr Manmohan Singh on 30 June 2008. The NAPCC outlines a national strategy that aims to enable the country to adapt to climate change and enhance the ecological sustainability of India's development path.

Eight national missions form the core of the NAPCC, representing multi-pronged, long term and integrated strategies for achieving key goals in the context of climate change. These missions are: National Solar Mission; National Mission on Enhanced Energy Efficiency; National Mission on Sustainable Habitat; National Water Mission; National Mission for Sustaining the Himalayan Ecosystem; National Mission for a Green India; National Mission for Sustainable Agriculture and National Mission on Strategic Knowledge for Climate Change.

Consequent to the announcement of the NAPCC, the Ministry of New and Renewable Energy (MNRE), Government of India, on 11 January 2010 launched the Jawaharlal Nehru National Solar Mission (JNNSM), for development and deployment of solar energy technologies in the country to achieve parity with grid power tariff by 2022.

### The Solar Mission and Energy Security

The Integrated Energy Policy 2006 emphasises on ensuring energy security. It broadly aims at establishing the continuous availability of commercial energy at competitive

**“I believe that ecologically sustainable development need not be in contradiction to achieving our growth objectives.”**

**-Dr Manmohan Singh.**

prices to support economic growth and meet the energy needs of households with safe, clean and convenient forms of energy. The policy recognises the importance of renewable energy from a long term perspective keeping in mind the need to maximally develop domestic supply options as well as the need to diversify energy sources. NAPCC reinstates the importance of renewable energy, especially solar energy as it points out: “India is a tropical country, where sunshine is available for longer hours per day and in great intensity. Solar energy, therefore, has great potential as a future energy source. It also has the advantage of permitting decentralised distribution of energy, thereby empowering people at the grass root level”. Based on this vision the JNNSM was launched.



Beneficiary of solar a lantern

10 mw solar thermal power plant setup  
by ACME near Bikaner, Rajasthan



## Timeline

The JNNSM adopts a three phase approach. Spanning the remaining period of the 11th Plan and the first year of the 12th Plan (up to 2012-13) as Phase 1, the remaining 4 years of the 12th Plan (2013-17) as Phase 2 and the 13th Plan (2017-22) as Phase 3.

## Objectives and Proposed Roadmap

The objective of the JNNSM is to establish India as a global leader in solar energy by creating the policy conditions for its diffusion across the country as quickly as possible.

The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration

in the country both at a centralised and a decentralised level. Phase 1 will focus on capturing the low hanging options in solar thermal and promoting off grid systems to serve populations without access to commercial energy and a modest capacity addition in grid based systems. The greatest potential area of off grid relates to solar technologies. These include solar water heating systems, home lighting systems comprising of solar lanterns, solar cooking systems, solar pumps and small power generating systems. Under the Solar Mission, it has been proposed to cover 2000 MW equivalent by 2022 which includes all of the above, except solar water heating systems for which there is a separate target of 20 million sq m. Within the off grid component, there is a

separate target of covering 20 million rural households with solar lights. This includes coverage under the Remote Village Electrification Programme (RVEP) wherein solar lighting is provided largely to off grid villages and is almost entirely funded by central grants. In addition, in other areas, where grid is available but power supply is erratic, solar lighting is financed through loans given by rural banks.

In Phase 2, after taking into account the experience of the initial years, capacity will be aggressively ramped up to create conditions for upscaled and competitive solar energy penetration in the country. The proposed road map for attainment entails large scale deployment of grid connected as well as distributed solar generated power, and also decentralised off grid provision for commercial energy services. The deployment across the application segments as envisaged is given in Table 1.

### Phase 1 target (up to March 2013)

- Government has approved the implementation of Phase 1 of the Mission and the target is to set up 1000 MW grid connected (33 KV and above) solar power plants through NTPC Vidyut Vyapar Nigam (NVVN), a trading subsidiary of National Thermal Power Corporation (NTPC) Limited. NVVN will directly purchase the solar power from the project developers as per the norms and guidelines fixed in this regard.
- The Mission will encourage 100 MW rooftop solar photovoltaic (PV) and other small solar power plants, connected to LT/11 KV grid, to replace conventional power and diesel based generators. It is envisaged that the distribution utility will pay the tariff determined by the State Electricity Regulatory Commission (SERC) for the metered electricity generated from such applications (whether consumed by grid connected owner of the rooftop/ground mounted installation or fed into the grid).
- Deployment of 200 MW capacity equivalent off grid solar applications of solar thermal technologies (e.g. solar water heaters, solar cooking systems, air drying, steam cooking and power generation, sterling engine etc.) and PV technologies (e.g. solar PV home lighting, police station communication and lighting, tribal habitats, small powered looms, solar inverters, solar PV pumps,

**Phase 1 will focus on capturing the low hanging options in solar thermal; on promoting off grid systems to serve populations without access to commercial energy and modest capacity addition in grid based systems.**

powering computers in schools, small milk chilling plants, refrigeration for medicines in primary health centres; systems for powering telecom towers, etc.). In addition hybrid systems would also be supported and will be implemented through a combination of low interest loans and/or central financial assistance as per norms and guidelines fixed in this regard.

- Acquiring 7 million sq m of solar thermal collector area.
- Supporting various activities as necessary in research and development, human resource development, technical assistance, training, publicity and awareness etc., for successful implementation of the Mission.

The Solar Mission's strategy in Phase 1 and 2 includes



Solar home lighting systems

**Table 1: Deployment across application segments**

Application Segment	Target for Phase 1 (2010-13)	Target for Phase 2 (2013-17)	Target for Phase 3 (2017-22)
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	1100 MW	4000-10000 MW	20000 MW



A telecom tower running on solar power

the announcement of the broad policy framework to achieve its objectives by 2022. The Mission document states that the policy will create the necessary environment to attract industry and project developers to invest in research, domestic manufacturing and development of solar power generation and thus try to create a critical mass for the domestic solar industry. The Mission will work closely with the state governments, regulators, power utilities and local self government bodies to ensure that the activities and policy framework being laid out can be implemented effectively.

## Progress so far

### (I) Grid connected solar power projects

During 2010-11 the Ministry has selected grid solar power projects of 800 MW capacity for implementation and power purchase agreements (PPAs) have been signed with investors. Grid connected solar power generation is a new application in the country and so far a limited capacity has been set up. Therefore, the annual targets and the requirement of funds have been set only to gradually achieve 1100 MW capacity by March 2013. In Phase 1, this comprises of the following main components:

#### 1000 MW capacity grid solar power plants

- 84 MW capacity, connected to 33 KV and above, grid connected solar power projects have been allocated by the NRVN under the migration scheme. NRVN has signed power sale agreements (PSAs) and PPAs with the concerned states and project developers in October 2010.
- NRVN had issued request for selection (RfS) of projects of 620 MW capacity (470 MW of solar thermal and 150 MW of PV) in August 2010.
- NRVN received 423 applications for a total of 441 projects. 363 proposals were to set up PV plants of 1815 MW (at an average of 5 MW per applicant). 78 applications were for 3311 MW capacity of solar thermal projects. In October 2010 NRVN completed the scrutiny of applications for setting up the new grid connected solar power projects. NRVN then issued request for proposal (RfP) to the selected applicants, who were requested to submit their offer of discount on the Central Electricity Regulatory Commission (CERC) tariff by November 2010 for final selection of projects.

#### 100 MW capacity solar power plants

- Projects to set up 100 MW capacity (connected to grid below 33 KV and of 100 kW to 2 MW size) have been short listed by Indian Renewable Energy Development Agency Ltd. (IREDA). All the project developers have already signed PPAs with the concerned state level utility. Eight grid connected solar PV power projects of about 15 MW capacity have been installed in the country during the last one year. This is a satisfactory beginning considering that small capacity projects of only about 2.1 MW were installed before this.

### (II) Off grid solar power projects

Approximately 33 MW capacity off grid solar power projects have been sanctioned as on 10 January 2011, against a target of 32 MW for 2010-11 (Table 2). The sanctioned systems include solar power plants, street lighting systems, home lighting systems and solar lanterns for installation at



Community power plant at Rampura

police stations, hospitals, bank branches, telecom towers, bus stations, educational institutions, para military forces and border villages with scheduled caste population etc. A budget of Rs 224 crore was earmarked for the programme in the year 2010-11. The entire allocated amount was spent by December 2010.

#### **Home lighting systems**

During March to December 2010 the Ministry has electrified 300 villages and sanctioned 341 projects for electrification. Households in about 7,000 remote villages and hamlets have so far been provided home lighting systems under this programme. The sanctioned systems include solar power plants, street lighting systems, home lighting systems and lanterns. One of the major initiatives among these is to provide solar PV systems of 10.28 MW capacity to all 9,168 Panchayat buildings in Rajasthan and 1.7 MW capacity solar PV power plants for tribal hostels, police stations and forest check posts in Madhya Pradesh.

#### **Solar thermal water heaters**

The Ministry under the Solar Mission has sanctioned support for solar thermal water heating systems to Haryana Renewable Energy Development Agency (HAREDA) and Non Conventional Energy Development Corporation of Andhra Pradesh (NEDCAP). Recently, the Ministry has sanctioned capital subsidy for installations of solar thermal systems to some state government agencies including the AP Rajiv Swagrhuha Corporation in Andhra Pradesh and Shri Mata Vaishno Devi Shrine Board in Jammu

and Kashmir. Subsidies are made available to the state agencies, which can be transferred to end users at the time of installation of the solar powered systems. At present a capacity of 60,000 sq m has already been sanctioned to the states and several state agencies are coming forward for installation of solar thermal systems.

#### **Stand alone rural solar plants**

Working towards its commitment to set up stand alone rural solar plants in the special category states and remote and difficult regions including border areas, the Ministry has sanctioned projects to set up power plants in Lakshadweep, Arunachal Pradesh, Jammu and Kashmir, Punjab (Gurdaspur), Sikkim, Uttarakhand etc., as on 7 January 2011.

#### **(III) Financial assistance and soft loans**

The Ministry is promoting lighting and hot water systems through the National Bank for Agriculture and Rural Development (NABARD) across the country. Under this

**The Mission will work closely with the state governments, regulators, power utilities and local self government bodies to ensure that the activities and policy framework being laid out can be implemented effectively.**

**Table 2. List of projects sanctioned under off grid solar applications of JNNSM as on 10 January 2011**

State	Sanctioned systems	Location	Capacity (kW)
Andhra Pradesh	Power plants and street lights	Educational institutes, MPDO offices, commercial organisations, telecom towers, theatres, NGOs, homes, art galleries, engineering colleges and tribal villages	1681
Arunachal Pradesh	Power plants	SSB Battalian HQ and border outposts	320
Assam	Power plants	Guwahati University, SSB Assam Engineering College	500
Bihar	Power plants	Telecom towers and bank branches	1022
Chhattisgarh	Power plants	Rural bank branches, hospitals, temples, Government Institutes, PWD guest houses, SBI branches, Industry/charitable organisations	2282
Gujarat	Power plants	Saurashtra University	25
Haryana	Power plants, solar PV street lighting systems	330 villages in Sirsa, TERI retreat Gwalpahari, BPDO offices in Sirsa and Hospital at Rewari, rural branches of Banks in 13 districts	832
Himachal Pradesh	Power plants, SPV street lights, home lights, solar lanterns	SSB training centres, 34 villages in 5 districts	529
Jammu and Kashmir	Power plants, home lights, solar lanterns	Leh District, Kargil District, 69 health centres, Vaishno Devi Shrine	2829
Jharkhand	Power plants	Temples in Deogarh, BIT Deogarh, Palamu Tiger Project, Jari village	416
Karnataka	Power plants	Bus stations, KDA, 50 branches of Vikas Gramin Bank, 10 other locations	195
Kerala	Power plants	Balklava Sweets, Thodupuzha	10
Lakshadweep	Solar power plants	Islands	1100
Madhya Pradesh	Power plants, SPV street lights	Tribal hostels, police stations, forest check posts, CHCs, 438 villages	1927
Maharashtra	Solar power plants	Thane Municipal Corporation and SEEPZ SEZ	150
Manipur	SPV solar plants	Hospitals, jail and State Training Academy	100
Meghalaya	Power plants, home lights	Schools and aganwadi centres	639
Mizoram	SPV power Plants	Charitable institutions, hospitals	121
Orissa	Power plant	Secretariat	50
Punjab	SPV power plants, power plants	Educational institutions, 17 villages in Gurdaspur	505
Rajasthan	Power plants, PV pumps, home lighting system	Gram Panchayats, horticulture department, villages in 20 districts	10907
Sikkim	Power plants	Border outposts of SSB	115
Tamil Nadu	Power plants	Schools, Vaishnavi College, commercial organisations	107
Uttarakhand	SPV street lighting systems, power plants, solar lanterns	316 villages, Battalion HQ and Border Posts of SSB, 9 international border blocks, 381 villages, BEL Kotdwaar	2109
Uttar Pradesh	Power plants, street lighting systems	2,964 villages, 57 Ashram schools, 294 bank branches, 70 Baroda UP Gramin bank branches, telecom towers	3568
Others	Power plants, street lights, home lights	Bank branches, educational institutions, villages	853
<b>Total</b>			<b>32892 kW</b>

Source: MNRE

programme all regional rural banks will finance solar lighting for the users by providing capital subsidy of 30 per cent and soft loans at 5 per cent interest per annum, for which the Ministry is providing the funds. Details of promotional activities and incentives provided by the Ministry for the Solar Mission are:

- Capital subsidy for select devices and systems,
- Generation based incentives for power generation from wind and solar energy,
- Interest subsidy on select renewable energy devices and power projects,
- 80 per cent accelerated depreciation during first year,
- 10 year tax holiday for power projects,
- Nil or concessional customs duty,
- Excise duty exemption on specific devices and systems,
- 5 per cent duty on solar power projects,
- Loans through IREDA,
- Preferential tariff by some of the states on renewable power,
- Publicity and awareness campaigns through print and electronic media,
- Attainment of grid parity, discounting process for identifying investors has led to 30 per cent discounts on CERC tariff.

#### (IV) MNRE's promotional schemes

##### Promotion schemes for off grid applications:

- For Solar PV power packs a 30 per cent capital subsidy and loan at 5 per cent on 50 per cent of the capital cost



Weaving at night with a solar lantern

**One of the main objectives of the Solar Mission is to globally take a leading role in manufacturing of cutting edge solar technologies.**

has been put in place. MNRE considered Rs 300 per watt (with battery) as the benchmark for extending a 30 per cent capital subsidy, which amounts to Rs 90 per watt. It is Rs 70 per watt without battery. Also, PV crystalline silicon solar cells should be used.

- For solar thermal heaters subsidy is provided at Rs 3,000 per sq m for evacuated tube collectors (ETCs) and Rs 3,300 per sq m for flat plate collectors (FPCs).
- In respect of home lighting systems of up to 200 W lighting with 2x100AH battery set, an estimated cost of Rs 60,000 was prescribed by MNRE. The subsidy on the same is Rs 18,000 and loan amount is Rs 30,000. Inverter based systems are also eligible for financing schemes.
- To meet electricity requirements of unelectrified rural areas, a capital subsidy of up to Rs 150 per watt will be extended for mini local grids.
- Individuals are eligible up to 1 kW (5 kW for water pumping schemes) capacity and commercial/non commercial entities are eligible up to 100 kW. Micro grids of up to 250 kW capacity can be set up.
- Capital subsidy would be released to the banks upfront, on receipt of sanction of loan by the bank to the borrower. The loan amount is repayable in monthly instalments within 5 years. The banks will get refinancing of loan amount from NABARD (through IREDA) at 2 per cent.

##### Schemes for promotion of grid interactive renewable energy power projects:

The Ministry has been providing subsidies to various organisations for grid interactive power generation projects based on renewable energy sources. For grid connected projects of at least 100 kW and up to 2 MW, connected to HT level (below 33 kV) of distribution network, a grid based incentive is payable to the project developer. Its value is the difference between the tariff determined by the CERC (Rs 17.9 for solar PV and Rs 15.4 for solar thermal) and the base rate, which is equal to INR 5.5 per kWh for the financial year of 2010 to 2011, and escalates 3 per cent every year. In addition to various schemes, the debt portion of investment can be financed by a soft loan at 5 per cent interest rate, which can be availed from IREDA.





Solar lantern making the nights bright

## (V) Accessibility

To ensure access, MNRE is promoting the home lighting and hot water systems through NABARD. All regional rural banks will provide capital subsidy and soft loans to the users for which the funds will be provided by MNRE.

## (VI) Research and development

The focussed efforts of the government on research and development include:

### Solar PV technology

Government efforts to support research and development in PV technology are through (i) supporting research groups and industry in reducing the cost of solar cells, modules and systems by improving the conversion efficiency, reducing the consumption of raw materials and developing new materials and processes; (ii) developing more efficient and

low energy consuming loads for use with PV systems; (iii) supporting industry to indigenously produce critical materials such as silicon etc.; (iv) improving the reliability and life of PV products and systems; and (v) encouraging volume production in the country by facilitating market development including exports etc. The Ministry has identified the thrust areas of research and nine projects on different aspects of solar PV technology are under implementation.

### Solar thermal

Research and development activities in the area of solar thermal energy have led to significant achievements in the improvement and commercialisation of solar water heating systems and solar cookers. The technology of solar flat plate collectors used in solar water heating systems has changed from black painted absorbers to selectively coated absorbers;

the workmanship, finishing, piping and system design have also markedly improved. A number of models of solar cookers are now available commercially. These include box type model for domestic use, dish concentrating cookers for individuals and small establishments, community (Scheffler) solar cookers for indoor cooking, and steam cooking systems for large kitchens catering to the cooking requirements of thousands of people. Research activities have also been undertaken to establish the efficacy of various concepts of solar architecture.

#### **Cutting edge research and development**

Six major research and development projects, three each in solar thermal and PV technologies have been sanctioned. Projects with strong industry interface have been encouraged.

#### **Centres of excellence**

National Centre for Photovoltaic Research and Education (NCPRE) has been set up at the Indian Institute of Technology (IIT), Mumbai. While the Amrita Centre for Nanosciences and Molecular Medicine (ACNSMM) at Cochin and the Centre for Solar Passive and Green Building at Center for Environmental Planning and Technology University (CEPT), Ahmedabad are being set up.

#### **Supporting start ups and innovations**

The Centre for Innovation Incubation and Entrepreneurship (CIIE) has been set up in collaboration with the Indian Institute of Management (IIM), Ahmedabad to promote innovation in renewable energy and to provide incubation, mentoring and financial support for aspiring entrepreneurs and innovators.

#### **Solar Energy Centre**

The Ministry has set up a Solar Energy Centre at Gwalpahari, Gurgaon. The Centre has world class facilities for testing solar thermal and solar PV devices and systems. In addition the Centre is also providing training and consultancy support to various user organisations. As a result of the efforts made by the Centre the Indian solar energy industry is able to meet various national and international standards for solar energy systems. In addition the Centre is also undertaking joint research on (i) testing and field performance evaluation of solar cells, modules and systems, (ii) development of secondary reference solar cells, (iii) development of long life batteries for solar PV systems, and (iv) development of new applications.

### **(VII) Developing human resources**

#### **Training**

Model course content to teach solar energy at B.Tech, M.Tech and ITI levels has been prepared. Some of the National Institutes of Technology (NITs) have started following this course. In collaboration with Director General of Employment and Training, Ministry of Labour,



Power station at Kurawa Village, Jharkhand

**To achieve the local demand, right levels of incentives for solar generation have to be continued, with a combination of financing.**

course material for craftsmen training and modular skill development has been finalised.

#### **Technicians programme**

An MoU has been signed with Indira Gandhi National Open University (IGNOU) to start a technicians programme in the areas of solar PV and solar thermal from the next academic year. Course content to provide such specialised training to ITI passed technicians on PV, solar thermal energy and solar thermal power systems has been developed.

#### **National Solar Fellow**

This scheme has been developed to encourage innovative ideas in research and development and to promote research and product development in the area of solar energy.

#### **Other human resource development (HRD) schemes**

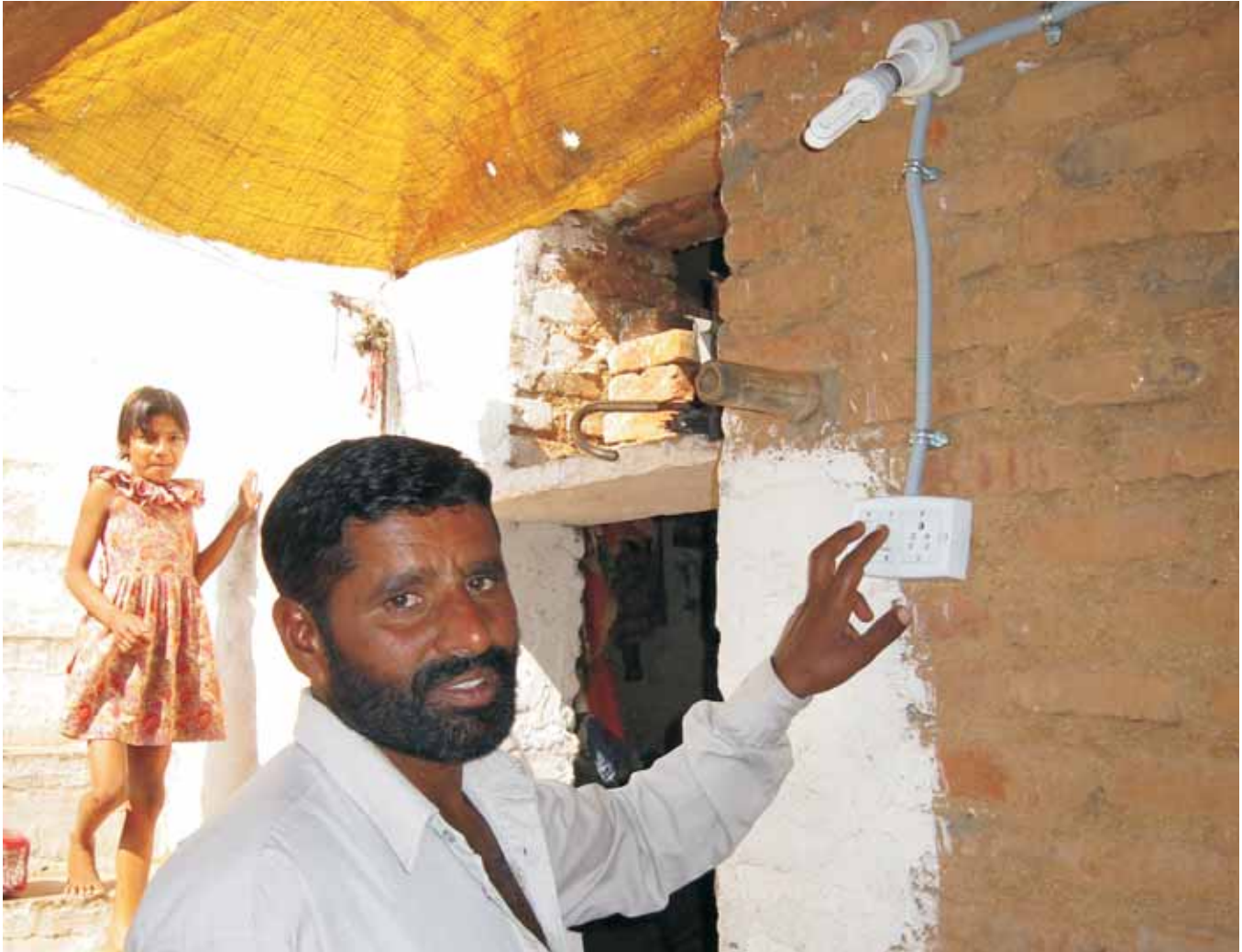
The Ministry has expanded the HRD scheme to (i) award substantially higher number of fellowships for pursuing postgraduate and doctoral programmes in the area of renewable energy (RE); (ii) provide grant for up gradation of laboratory facilities; (iii) provide support for RE chairs etc.

### **Way ahead**

One of the main objectives of the Solar Mission is to globally take a leading role in manufacturing (across the value chain) of cutting edge solar technologies and target a 4

**Table 3: List of selected projects by NTPC Vidyut Vyapar Nigam Limited (NVVN)**

State	Location	Project capacity (MW)	Solar project type
Andhra Pradesh	Kutagulla, Kadiri, Anantapur	5	PV
	T Veerapuram, Ravadurg, Anantapur	5	PV
	Thummala, Amadgur, Anantapur	5	PV
	Virannapalle, Pamidi, Anantapur	50	Thermal
Gujarat	Dwarka, Mojap, Jamnagar	20	Thermal
Karnataka	Murudi, Molakalmur, Chitradurga	5	PV
	Mandva, Malavalli, Belakavadi	5	PV
Maharashtra	Kalhe	5	PV
Orissa	Khurda	5	PV
Rajasthan	Mundwa, Naguar, Naguar	5	PV
	Bhojas, Khinvsar, Nagaur	5x6 = 30	PV
	Kathali, Javal, Nagaur	5	PV
	Kantia, Nagaur	5	PV
	Bap, Phalodi, Jodhpur	5x2 = 10	PV
	Amla, Phalodi, Jodhpur	5	PV
	Rawre, Phalodi, Jodhpur	5	PV
	Natisara, Phalodi, Jodhpur	5	PV
	Deh, Kolayat, Bikaner	5	PV
	Gajner, Kolayat, Bikaner	5	PV
	Ladkan, Kolayat, Bikaner	5	PV
	Marudi, Barmer	5	PV
	Pareware, Jaisalmer	5	PV
	Lanwa, Pokran, Jaisalmer	5	PV
	Nokh, Pokhran, Jaisalmer	5	PV
	Chinnu, Nachna 1, Jaisalmer	100	Thermal
	Chinnu, Nachna, Jaisalmer	100	Thermal
	Pokaran, Pokaran, Jaisalmer	100	Thermal
	Parewar, Jaisalmer	50	Thermal
Nokh, Pokhran, Jaisalmer	50	Thermal	
Tamil Nadu	Kombukaranatham, Tuticorin	5	PV
Uttar Pradesh	Naini, Allahabad	5	PV
<b>Total</b>		<b>620 MW</b>	



Solar home lighting in Jhansi District, Uttar Pradesh

to 5 GW equivalent of installed capacity by 2020, including setting up of manufacturing capacities for polysilicon material to make about 2 GW capacity of solar cells annually. It is necessary to augment the indigenous capacity to manufacture silicon material by setting up more plants in the public and private sector. New facilities are being created to manufacture concentrators, collectors, receivers and other components to meet the demand for solar thermal plants. To achieve the local demand, right levels of incentives for solar generation have to be continued with a combination of financing to set up solar farms. Transparent and fast track clearances and permissions are being created in consultation with the states. The creation of land banks for solar farms has also been explored. To attain grid parity initial attractive tariff and a reduction in capital cost is necessary. The efforts from the Ministry are in the right direction to reduce the generation cost of electricity in the next 8 to 10 years through concerted research and development. In the coming 2 to 3

years the on going research efforts are expected to improve the conversion efficiency of solar cells from the existing 15-16 per cent to about 18 per cent. Further, efforts are being made by the industry to reduce the consumption of the main raw material - silicon wafers. These measures are expected to reduce the cost of crystalline silicon solar cells and modules by about 15 per cent, from the present average price of Rs 120 to Rs 100 per watt. The Ministry is already working on the following future directions:

- 50 new solar radiation monitoring stations - These new monitoring stations are being set up to provide reliable ground data for setting up solar projects.
- Doubling of solar cells capacity - Capacity of solar cells production has doubled from about 600 to 1300 MW.
- 4 test laboratories set up - These laboratories have been set up for PV module qualification testing.
- 300 MW capacity PV projects - The remaining 300 MW PV will be selected in 2011-12 for implementation. ❁