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Cover story: Looking skyward

8 January 2013

India is heading for a "solar boom". Branded Solar India, the National Solar Mission, a major initiative of the Central and state governments, aims to promote ecologically sustainable growth while addressing the country's energy security challenge, writes k v venkatasubramanian

India is intently gazing skyward at the sun to solve its perennial energy needs ~ to harvest solar power. Catapulting demand for energy with increasing industrialisation, galloping oil prices, depleting

fossil fuel reserves and the real impact of climate change have forced the country to review its energy-mix policies. Projects launched, exactly three years ago on 11 January, by various states under the

Jawaharlal Nehru National Solar Mission (JNNSM) appear to be progressing "satisfactorily and according to schedule". Branded Solar India, the mission, a major initiative of the Central and state governments, aims to promote ecologically sustainable growth while addressing the country's energy security challenge. It has set a target to deploy 20,000 MW of grid-connected and 2,000 MW of off-grid

solar power by 2022 in three phases. From tentative beginnings, production is picking up steam. From just 19.8 MW three years ago, the generation is around 1,050 MW (including 290 MW under the National programme) and will cross its targeted 1,100 MW very soon.

Sunny days

Having virtually achieved its Phase-I target, the country is heading for a solar boom. "Some of the solar-rich states have been the foci of solar development, but slowly and gradually deployment of solar power is spreading to each and every corner of the country," says a new draft policy document for the mission's Phase II, released by the ministry of new and renewable energy (MNRE). Being tropical, the country is blessed with abundant solar energy ~ around 300 sunny days (or 3,000 hours) in a year, and solar insolation or irradiation (energy from the sun) of 4-7 kWh per sq m per day. If harnessed efficiently, the country can produce 5,000 trillion kW of clean energy and reduce the energy deficit, and also the carbon emission. It also has the advantage of permitting decentralised distribution of energy, thereby empowering people at the grassroot level.

Solar energy can be generated using two technologies ~ solar thermal and solar photovoltaic (PV). The solar thermal technology directly harnesses sun's heat to produce power. This can be achieved by using solar converters and receivers (known as solar thermal devices). This power can be used for heating or cooling air or water,

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cooking, drying agricultural products and distilling and purifying water. The solar photovoltaic technology uses sun's energy to create electricity. A PV system requires only daylight~ not direct sunlight~ to generate electricity. Some of its applications are lighting for home and commercial buildings, running motors, pumps, electric appliances and outdoor (street) as well as rural and village lighting. Solar electric power systems offer independence from the grid and protection during extended power failures. SPV systems are found to be economical, especially in hilly and far flung areas, where conventional grid power supply is expensive to reach.

State participation

Sun power is being harnessed by various state governments. Gujarat and Rajasthan, which are endowed with the highest irradiation, have led the Phase-I installations. The two states together account for more than 80 per cent of installed capacity. Others include Andhra Pradesh, Karnataka, Maharashtra, Odisha, Tamil Nadu and Uttar Pradesh. India aims to emerge as a global leader in solar power by creating the policy conditions for its swift large-scale diffusion across the country. Implementation of Phase-I would end in 2013, Phase-II in 2017 and Phase-III in 2022. A wider participation by states is required to develop the entire value chain across the country. During Phase-I, their roles are very limited due to the smaller target capacity of 1100 MW. The focus has been largely on grid-connected projects ~ to achieve 500 MW of PV and 500 MW of solar thermal. "In Phase-II, they need to contribute in a big way to attain the cumulative capacity of solar to 10,000 MW," says the policy document.

Phased options

The first phase is capturing the low hanging options in solar; on promoting off-grid (not relying on central power supply) systems to serve populations without access to commercial energy and modest capacity addition in grid-based systems. In the second phase, the capacity will be aggressively ramped up to create conditions for up-scaled and competitive solar energy penetration. Some states are still focusing on the Central scheme for development of solar industry, while others are moving ahead with their own programmes. Gujarat leads the way. "With 824 MW, Gujarat accounts for around 70 per cent of India's installed solar PV capacity. It was the first state to come out with a dedicated solar policy. This was even before the announcement of the NSM," said Dr Tobias Engelmeier, Managing Director, Bridge to India, a leading adviser and project developer focusing on the Indian solar market. This sector has received great impetus since Gujarat announced its Solar Policy in January 2009, which was a milestone in the country's solar energy development programme. The policy, while allowing investors to set up projects, assured the purchase of generated power. Following an overwhelming response, the state allotted around 1,000 MW capacities to over 85 national and international developers. "High irradiation levels, fixed preferential feed-in-tariff (FiT), relatively efficient bureaucracy and ease of project allocation attracted a lot of investors," he adds.

Gujarat model

Gujarat has the biggest solar park in the world. Spread over 3,000 acres of wasteland bordering the Rann of Kutch, it produces 276 MW. With a capacity to produce 600 MW, the park at Charanka village in Patan district was inaugurated last April. It is estimated to save eight million tonnes of carbon dioxide emissions every year and also nine lakh tonnes of coal and natural gas annually. This park will manufacture solar power plant panels and other related equipment. Moreover, local people will be trained to work there. Such parks, which are essentially a concentrated zone of solar development, are being set up in other states under the NSM. The parks may consist of a minimum of 250 MW generation capacities spread over 600 hectare. The parks encompass all the required facilities for power generation, such as evacuation and transmission infrastructure, solar radiation monitoring station, telecommunication facility, fire station and green belt. Other elements could be manufacturing facilities, testing and characterization facilities and R&D. Gujarat has also demonstrated the way to eliminate acquisition of huge tracts of land by setting up a solar plant over a canal. India's first One MW canal-top solar power plant at Chandrasan village in Mehsana district, 75 km from Ahmedabad, was commissioned early last year. The pilot project, covering 750 metre of

Sardar Sarovar Narmada Nigam Limited (SSNL) branch canal, passes through Chandrasan, with a network of solar panels atop. It is a fusion of water and solar power. Water flows below keeping the plant cool as solar panels above harvest sun energy. Besides, panels above the canal prevent evaporation of millions of gallons of water.

"The originality shown by the Gujarat government in covering canals by PV modules is commendable. It is an early and timely recognition of the fact that availability of land will eventually be a constraint to the growth of PV power on a large scale," said S P Sukhatme, a former professor at IIT, Mumbai.

A step ahead

Why has Gujarat been successful and is ahead in solar power generation? Engelmeier explains, "Unlike the NSM and other state policies that opted for reverse bidding to determine the FIT, Gujarat

offered a fixed FIT. This provided more clarity to the investors. The Power Purchase Agreement (PPA) was backed by one of the few profit-making state electricity boards in India. This made the financiers comfortable and proved critical to the growth of the nascent sector." Gujarat's success is followed by Rajasthan, which offers cheap land and has one of the highest irradiation levels in the country. Most projects under the NSM have been set up in the state. "Around 220 MW has already been installed. It is also coming up with allocations under its own solar policy," Engelmeier said. In Maharashtra, the installed capacity is limited to 19 MW under the national schemes. The state is setting up a 125 MW project to meet its renewable purchase obligation. "The project is however, delayed by almost a year," he points out.

Solar Cities

To provide further thrust to "clean and green energy" and reduce greenhouse gas emissions, urban local bodies in various states are developing "Solar Cities" or "Renewable Energy Cities". The Solar

City aims at a minimum ten per cent reduction in the projected demand of conventional energy and increasing energy production through renewable energy sources and technologies. Approvals have been given to 48 cities and Master Plans for 20 cities prepared. About 1,000 MW of rooftop projects, both at off-grid and grid-connected levels, would be set up during Phase-II across the country.

The programme, which addresses the energy problem in urban areas in a holistic manner, includes promoting solar water heating systems in homes, hotels, hostels, hospitals and industry; deploying PV systems and devices and designing solar buildings. Gujarat's capital city Gandhinagar has taken the lead by setting up 5 MW solar roof top systems. Multiple installations of these with assorted ratings from 1 kW to 150 kW, aggregating about 1.50 MW, are functioning. The systems cover two hectare of roofs, being close to two per cent of the total roof space in the city. The electricity so generated is optimally used by households/government buildings and contributes nearly one per cent

of the city's total energy, says a Gujarat government official. Under this novel concept, a roof owner gets a green incentive of Rs 3 /kWh from the developer who sets up the system at his cost and gets paid a feed-in-tariff of Rs 11.50 per KWh inclusive of the green incentive. Similar schemes of 5 MW each are being set up this year in Surat, Vadodara, Rajkot, Bhavnagar and Mehsana.

Imminent Challenges

Solar energy production faces three fundamental challenges that affect implementation ~ cost, its manufacturing procedure (R&D) and land acquisition for erecting power plants. "It is relatively expensive, although increasingly competitive on the consumer side; it is an intermittent power source (adding batteries would make it much more expensive) and requires space which is, in cities, often not available," said Engelmeier. Renewable energy being land-intensive, vast tracts of non-agricultural

land, which receive adequate radiation, are required for erecting solar plants. Estimates show that a 1,000 MW plant may require nearly 10,000 acres of contiguous land. Once land is made available,

the gestation period is short. Prof. J Srinivasan, Chairman, Divecha Centre for Climate Change, Indian Institute of Science, Bangalore, said "Large solar power generation systems are being installed for the first time and hence some teething troubles are bound to be there. However, the time required to install a solar power plant is much less than that for nuclear or coal or hydro-based power plant." He said land

acquisition could be a problem in some parts of the country, "but it should not be an issue in Gujarat and Rajasthan where there are large fractions of on-arable land". In only two years, competitive bidding had driven prices for grid-connected solar energy to nearly the price of electricity from fossil fuels, at Rs 7.49/kWh, according to a report of the US-based non-profit Natural Resources Defence Council (NRDC) and the Council on Energy, Environment and Water (CEEW), an independent think-tank based in New Delhi. Srinivasan said, "It is unrealistic to expect power generation at Rs 3-5 per kWh. In both the coal and nuclear industry, the cost of power generation does not take into account the environmental impact of mining (for coal) and the cost of disposal of waste (for nuclear)."

Solar Market

India has already sparked a powerful solar market in just two years and made important strides to attract new domestic and international players. This has driven solar energy prices low and demonstrated how government policy can stimulate clean energy markets. Strategically, Phase-I has made the grid-connected solar energy market grow tremendously resulting in lower prices and an increased participation by developers and financial institutions. During Phase-II, around 20,000 villages/hamlets are to be covered through an "energy access" scheme by deploying off-grid electricity generation projects. It is proposed to deploy solar water heaters, replacing electric geysers, in 15 cities, 50,000 solar cookers and around ten lakh off-grid lighting systems and 25,000 solar pumps by

end FY 2017. The solar energy industry is expected to employ about one lakh people by 2022 across domains, profiles and levels to fulfill the target under the solar Mission.

BOX ITEM

Expensive power

Even as state governments march ahead ambitiously, installing solar plants across the country under the National Solar Mission and on their own, consumers are apprehensive about the cost. Officials say

the high cost of solar power is a major cause of concern as India is a price-conscious market. However, the cost is coming down gradually, they add. The ministry of new and renewable energy says by 2017, when grid parity is expected to be achieved, power from solar plants will be sold at the same price as that from conventional sources like coal. Once the volumes increase, the prices will come down. Indigenisation of components and tax cuts on import of raw material and machinery

will also have a considerable effect. Officials say from an initial tariff, when the solar mission was launched, of Rs17 per kW hour fixed by the regulator, the tariff has come down to Rs 7.49 per kWh. Solar PV power is already cheaper than diesel generated power and increasingly it is becoming cheaper than commercial grid power tariffs. Diesel generated power is available at Rs 14 or 15 per unit,

whereas, solar power, even without government subsidy is available at Rs 9 per unit.

A KPMG report says solar power prices are expected to decline at the rate of 5-7 percent per annum. "This is after factoring the increasing economies of scale in equipment manufacturing and advancements in product technology which improves solar-to-electricity conversion efficiency. Emergence of low cost manufacturing locations is expected to aid this trend." Tobias Engelmeier, Managing Director, Bridge to India, says the levelised cost of energy (LCOE) of solar has been higher than that for conventional power sources. "Therefore, technology has traditionally required government support. These costs have now fallen significantly. A key benefit of solar power is its ability for distributed generation. This means that it doesn't necessarily need to compete with the cost of production of conventional power. It can be installed at the site for consumption and can actually compete with the cost of consumption (rather than generation)."

On the other side, households are also apprehensive about going solar. Installing stand-alone solar photovoltaic panels at home are expensive too, despite subsidies available. The main factors that impact price are location-specific ~ the number and sizes of solar panels may vary. Prof J Srinivasan, Chairman, Divecha Centre for Climate Change, Indian Institute of Science, Bangalore, says, government should provide a large subsidy to light every rural home with PV and thereby eliminate the need for subsidising kerosene.

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