Sol(ar) searching

In a country blessed with 300 days of sunlight and which has vast solar energy potential of about 5,000 trillion kWh per year, the solar option is but a given. We take a look at the impact of the National Solar mission on Rajasthan and in technologies we take an in-depth look at thin film, especially in terms of funding issues, says **R Srinivasan**.

A sizeable portion of our population are forced to go without grid-connected power and use kerosene lanterns. Also, our country's over-dependence on coal, which cannot last forever, is impractical and also not viable in terms of its large carbon footprint. So what is the way ahead? Apart from other renewable sources of energy such as wind, hydro, biomass, geothermal, tidal etc, the solar option offers many advantages since India is blessed with around 300 days of sunlight and has vast solar energy potential of about 5,000 trillion kWh per year.

The 89,000 TW of sunlight reaching earth is about 6,000 times more than the 15 TW equivalent of average power consumed by mankind. Also there is a lot of potential for off-grid photovoltaic (PV) in remote areas for lighting and it will also lead to job creation. As per the Ministry on Non-Renewable Energy (MNRE), about 100,000 jobs will be created by the photovoltaic industry by 2020. But investments are required which can reduce the price of solar technology by 40 per cent by 2020, and increase its competitive edge.

So to make solar energy attractive, the government has offered fiscal incentives, reduced customs duty and loans at cheaper rates for project developers. Now let us see what are the developments in solar and then the challenges, especially in terms of funding.

SOLAR INITIATIVES

The Jawaharlal Nehru National Solar Mission (JNNSM) aims to achieve 20,000 MW (20 GW) by 2022. The response to it has been good and since it was launched, 300 bids for solar photovoltaic (PV) and 44 for solar thermal projects were received by the NTPC Vidyut Vyapar Nigam (NVVN), the nodal agency for sale and purchase of grid-connected solar power. Also, Indian Renewable Energy Development Agency (IREDA) has given the green signal to about 67 developers to implement 77.8 MW solar PV under the first phase of the solar mission.

These measures have been welcomed by developers and many states intend to join the solar bandwagon. As a case in point, Rajasthan, which receives radiation in the range of 5.5 to 6.8 kWh per square metre, is all set to attract an investment of Rs 6,000 crore in the first phase of JNNSM. The state is estimated to have a massive 1.5 lakh MW of untapped potential. The Centre has accordingly approved 5 solar thermal projects of 400 MW and allocated 21 solar PV projects of 5 MW each in the first round. Also, the power rate for companies that entered into an agreement with NVVN at that time was fixed at Rs 17.91 per unit for solar PV and Rs 15.32 per unit for solar thermal.

THIN FILM

Thin film was first seen in the form of the strips on solar calculators. A thin-film solar cell or thin-film photovoltaic cell is made by depositing one or more thin layers (thin film) of PV material on a substrate. The thickness range of such a layer varies from a few nanometers to tens of micrometers. Some categories of thin-film solar cells in terms of the photovoltaic material used are amorphous silicon (a-Si), cadmium telluride (CdTe), copper indium gallium selenide (CIGS), dye-sensitised solar cell (DSC) and other organic solar cells. **Design and fabrication:** Silicon is mainly deposited by chemical vapour deposition from silane gas and hydrogen gas. Other deposition techniques are sputtering and hot wire techniques.

ISSUES IN SOLAR ENERGY

The cost of developing solar energy is around four times the investment required in coal-based thermal power generation. Land acquisition too is a major challenge and it is also said that the industry, in which 30,000 persons are currently working, will face a shortage of skilled manpower in the years to come and especially in research and development (R&D) and manufacturing. A good move though has been made in the form of a 2 per cent annual allocation of Rs 1,000 crore for education. On the issue of solar funding, this is what some persons from the industry had to say...

ISSUES IN SOLAR FUNDING

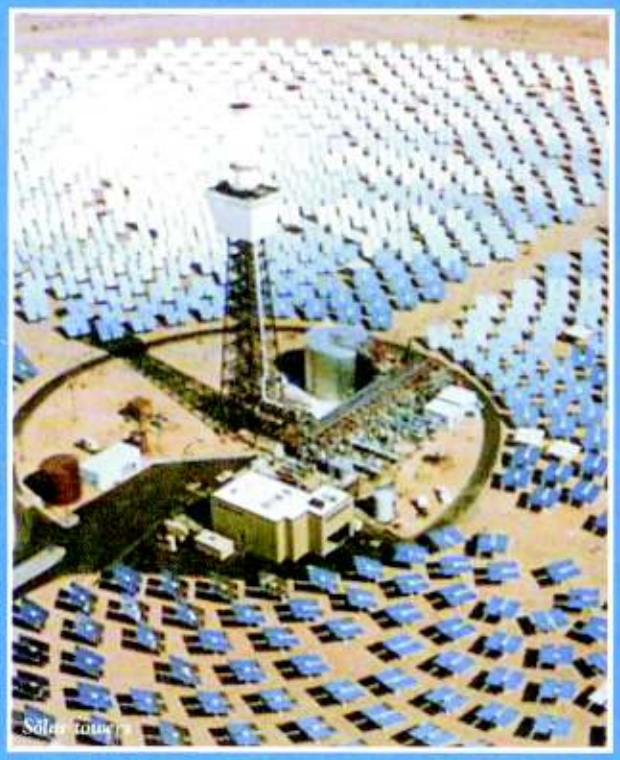
Regarding the funding challenges in India and especially for thin-film, **Srinivas Chakravarthy, Country Head, Industry Services, TUV Rheinland (India)** said, "The projects that have been bid in India as of today need funding of about Rs 10,000 crore. Obviously the banks are concerned. Unfortunately we do not have appropriate data specific to the locations where the PV industry should focus. We have a policy but there are still lots of issues as the PPA signing has revealed. In order to fund a solar PV power plant, investors and banks need adequate information on their ROI and how they will get it. Today, this is not possible due to lack of information. Also, there are issues related to the installation i.e., if it follows a certain procedure and certification to ensure the life of the plant. With regard to thin-film technology, this is a technology that is still evolving. There is no

SOLAR TECHNOLOGIES

The two basic technologies used to derive solar energy are solar photovoltaics (PV) and cconcentrated solar power (CSP) or thermal (CST) systems. In PV, sunlight that falls on large solar panels gets converted into electricity and in solar thermal, mirrors convert sunlight to heat which then runs a turbine and generates electricity.

The forms of concentrating technologies are parabolic troughs, dish stirlings, concentrating linear fresnel reflectors and solar power towers. Each concentration method can produce high temperatures and correspondingly high thermodynamic efficiencies but they vary in the way that they track the sun and focus light.

Dish stirling



Solar tower

Linear Fresnel reflectors

Parabolic troughs

concrete data to provide information on long-term efficiency of the modules. Also, the efficiency of thin-film modules is very low as of today's technology. Thin-films need more land for the same wattage as that of crystalline modules. These are some of the challenges of thin-film, which can be a hindrance for funding. It is issues such as these that affect investment in thin-films today. However, they have their advantages and these can be used to overcome the issues and hence support funding. They can be used in high temperature locations, on surfaces of roof-tops, building facades and in desert locations. Design-based thin-film can be advantageous in view of the location and application."

On being queried if challenges in financing could also be due to a selection of technologies, Srinivas Chakravarthy said, "Absolutely. Technology plays a huge role in the output of the modules and hence their financing. The module design in case of hot and humid conditions is different from that in colder but high intensity sunlight conditions. Then there is the maintenance which could become expensive if the location is not suitable for the type of glass selected or thickness of the module frame selected etc. If care is not taken at the design stage itself, the project may become expensive or even incur losses."

Vish Palekar, Business Head, Cleantech Ventures, Mahindra Solar, on challenges in funding of thin-film said, "Tandem junction and triple junction thin–film technologies are good technologies, but their long term durability has not yet been demonstrated. They tend to be slightly lower costs than crystalline silicon (c-Si) but the longest operating commercial tandem junction is only about 4-5 yrs old. So bankability and financing can be a challenge due to the choice of thin-film technology. To overcome this, a developer should get a stronger engineering, procurement and construction (EPC) guarantee with a well-known EPC company and also work with stronger thin-film technology suppliers around the world."

Satish Kashyap, co-founder and Director, General Carbon, on the funding issue said, "Funding of projects is at an early stage. Funding agencies are coming to grips with the various technologies. Each technology supplier and project developer is offering a different mix of technologies and this is adding to the learning curve of funding agencies. Data on historic generation from the technology (thin-film or CIGS) in other geographies is becoming key while on-ground data under Indian conditions is still a while away. The REC framework is in the early stage of adoption and the fund-raisers' standpoint is of cautiously moving ahead watching the happenings in the market. Given the above facts, the first few solar projects which have been funded with strong tariff commitments are being watched with bated breathe by industry and analysts. Newer technologies may benefit from a technology leapfrog in India, but one would have to wait for a while before the verdict is out."

Speaking of the funding scenario and challenges, **S Vasanthi, Director, Technical and Marketing,**

THE ADVANTAGES AND DISADVANTAGES OF SOLAR PV

Advantages of solar PV

- No fuel cost since sunlight is available everywhere even if it is in varying degrees, unlike wind, geothermal etc.
- Plant is modular in nature so it is easy to install and scale up easily.
- Does not contribute to global warming
- Since electricity can be generated at the point of use, it is best suited for rural and remote ele trification and it also reduces transmission and distribution losses.

Disadvantages

- High cost of electricity as compared to conventional grid power.
- Power generation varies over geographical regions due to climatic conditions and effects like shading etc.

Latest developments

Microscopic algae: At Oregon and Portland University, researchers have discovered a way to use microscopic algae called diatoms to increase solar cell efficiency. It is said that that the dye-sensitised solar cells can produce three times the electrical output of ordinary solar cells.

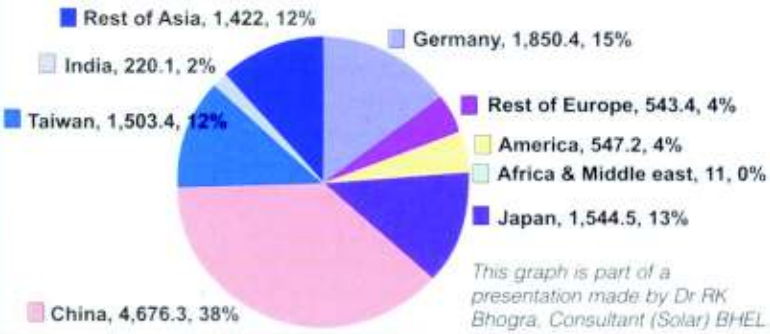
Power Plastic: The National Energy Renewable Laboratory (NREL) certified that US-based Konarka Technologies' organic-based photovoltaic (OPV) solar cells have demonstrated a record-breaking 8.3 per cent efficiency, which is the highest performance recorded by NREL for an organic photovoltaic solar cell. At the heart of the company's technology is a photo-reactive polymer material invented by Konarka co-founder and Nobel Prize winner, Dr Alan Heeger. This material can be printed or coated inexpensively onto flexible substrates using roll-to-roll manufacturing, just as newspapers are printed, on large rolls of paper. It can then be used in a wide variety of end-use products.

Websol Energy Systems, said, "For development for solar PV cells and modules manufacturing, the government has announced 20 per cent incentives on capital expenditure for SEZ and 25 per cent incentive for non-SEZs in 2007. The government is funding renewable projects in the private sector for research and development in solar PV manufacturing equipment, to promote product development and improvement in PV cell efficiency. A number of projects have achieved milestones and some products are under commercialised production. For solar PV plant developers from mini-grid to MW sized PV power plants, the government is funding projects as per the nature of projects. The government is giving 90 per cent capital subsidies for mini off-grid in rural electrification PV projects. For big power plants from 5 MW and above, as per the national solar mission or state government promoted PV projects, the number of nationalised and private banks are funding the debt part on a case-to-case basis as per the project's viability. In reverse bidding under the NVVN, a number of PV power plant developers have offered very high discounts to gain projects under the solar mission. Due to high discounts, some projects are not viable so funding for these projects will be difficult for financial institutions. Under the mission, there is no special policy or preference for thin-film. The government has mentioned that domestic crystalline cells and modules to be used in the solar mission and products manufactured other than crystalline silicon technology can be imported. For continuous growth, the government has developed a mechanism where PV power plants give performance for mentioned durations i.e., 25 years, projects are completed in the stipulated time and there is uniform development of PV projects."

Speaking about selection of technologies, she said, "Globally crystalline silicon has more than 80 per cent market share because it is a well-established technology and a number of power plants are working efficiently and giving the desired results. In the last three years, with an increase in demand and reduction in price of per watt peak, the number of competing technologies are available in the market. Each technology has its strength and weakness as per different geographical areas and legal requirements. The basic aim of developers is to generate more electricity with minimum investment in establish power plant."

GLOBAL PV PRODUCTION

Region-wise PV share in 2009 (in MW & Per cent)
Total PV production 12,318 MW



This graph is part of a presentation made by Dr RK Bhogra, Consultant (Solar) BHEL

She added, "With lower efficiency, modules need more space and high investment in balance of systems (BOS) while higher efficiency modules need less investment in the land under BOS. Crystalline PV modules have around 14 per cent plus efficiency while thin-film modules are 7 to 10 per cent plus efficiency under standard conditions, so developers need to select technology so that they can generate maximum electricity with minimum investment. PV power plants generating high electricity will have a low payback, attract investment for developers and equally get finance easily from banks."

Currently, solar energy forms a small portion of the generation from various sources of energy but this can improve with technological advances, improvement in efficiencies and as the cost of solar comes down. Of this, PV forms a smaller portion but estimates suggest that it could go to around 7 per cent by 2030.

Estimates also suggest that thin-film production will grow 24 per cent from 2009 levels and reach 22,214 MW in 2020 and that in the long-term thin-film PV technology will surpass conventional PV technology.

The cost of power produced by PV too has decreased by 60 per cent from $3.50 per watt to $2 per watt in recent years. High efficiency cells have efficiencies of over 40 per cent in the case of concentrating PV cells and efficiencies are increasing along with mass-production, even as production costs are falling.

While the debate is on regarding technologies, there is no denying that India, with the potential to generate 35 MW per sq km using solar PV and solar thermal, is now on the solar highway and needs all the help it can get in terms of different technologies which will serve to propel it to its rightful place among the nations of the world.