Courtesy: MNRE, Government of India

Courtesy: MNRE, Government of India

process of the solar power plants. Larger aim is to have in place a well devised monitoring cum benchmarking system in order to maximize the gain from these power plants. The Centre for Wind Energy Technology (C-WET) is working in tandem with selective few organizations to design and implement a system for collecting ground based solar radiation along with the meteorological data. Along these considerations, a total of 51 solar radiation and meteorological stations have already been set up throughout the country. Out of these, 10 stations were planned to have an assembly of special high precision instruments. The effective idea is to get information on phenomena such as spectral distribution and aerosol concentration too. Data thus gathered is to be compared and combined with satellite data in time sequence. It is expected to result in making of accurate predictions of the solar radiation availability at a given location (solar map).

Understandably, support programmes can then be developed by the government agencies. It is then going to make the projects safer for the developers and investors alike. That is not all as C-WET is currently gathering data on the actual performance of existing range of solar power plants. These plants are thus being monitored paving the way for making country-wide comparisons of the efficiency of the installed PV systems. The outcome is being shared with project operators and developers in tandem with the observations and recommendations regarding efficiency improvements in power plant efficiencies, etc. One of the unique advantages is coming together of relevant institutions both at the national and regional levels for collecting and processing of field driven information. GIZ is enabling the transfer of German experiences along with relevant knowhow in this area to professionals in India via periodic exchange cum cooperation programmes. A special Solar Resource Assessment group has been established, and trained in the installation, operation, and calibration of the stations.

Knowing a measuring station

The Ministry of New and Renewable Energy (MNRE) has recently carried out a major project on Solar Radiation Resource Assessment (SRRA) across the country. The basic idea is to assess and quantify the solar radiation availability along with weather parameters with an ultimate view to develop Solar Atlas. The Automatic Solar Radiation Monitoring Stations (ASRMS) have been put up in the first phase in different states using high quality, high resolution equipment/ instruments. Each ASRMS is made up of two towers of 1.5 m and 6 m tall each. The 1.5 m tall tower houses a Solar Tracker and is fully equipped with the following types of instruments:

- Pyranometer
- Pyranometer (with a Shaded Ring)
- Pyrheliometer

The simple yet an effective idea is to measure the solar parameters such as global and diffuse types of radiation along with the direct radiation. Each ASRMS is fully powered by 160 Watt SPV array. There are around 13 equipments/instruments at work, which record nearly 37 parameters (like some of the following few) inclusive of both measured and derived type.

- ambient temperature
- rainfall
- atmospheric pressure
- relative humidity
- wind speed and direction.

The data from each ASRMS averaged to 10 minutes, gets programmed for transmission. A central receiving station (CRS) has been set up at C-WET, Chennai, via GRPS mode. This project was formally implemented from February 2011 with a resultant outcome of all stations having been installed and completed in all

respects by now. The monthly average (daily) data received from each ASRMS is currently available on C-WET website as test run. Further, the quality checking process of the data is on.

Geographical distribution of the measuring stations

In all, 51 stations have been put up so far under the above mentioned initiative. Table 1 gives a state-wise breakup of these stations.

Table 1 State-wise breakup of measuring stations

State	Number of Stations installed
Rajasthan	12
Gujarat	11
Andhra Pradesh	6
Tamil Nadu	7
Karnataka	5
Maharashtra	3
Madhya Pradesh	3
Chattisgarh	1
Haryana	1
Pondicherry	1
Jammu and Kashmir	1

As expected, two states, i.e., Rajasthan and Gujarat have between themselves a distribution of nearly 50% of the monitoring stations. Rajasthan continues to maintain a well accepted solar edge over the rest of states even now.

Case specifics-AP

The Solar radiation monitoring stations or SRMS in short have been put up at Gurazala (Guntur), Vizianagaram, Rajahmundry, Chittoor and Adilabad. As per the available indications, the state of Andhra Pradesh is targeting the installation of at least 2000 MW of solar power within the next 4-5 years. The routine operation of the SRMS will be taken care of by the engineers of the state nodal agency, i.e., Non-conventional Energy Development Corporation of Andhra Pradesh (NEDCAP).

Test solar radiation measured data

As a case specific example, Table 2 presents a representative test solar radiation data available from the recently installed stations. The region chosen for the purpose is the state of Tamil Nadu.

These seven stations in Tamil Nadu show the variability in the values of measured solar radiation apart from the normally measured meteorological parameters. It sounds interesting to trace the most important parameteric relationships for a better understanding of this fast evolving concept base.

The solar pathway

The National Solar Mission has prompted a renewed plan of action on the solar energy front. It is no longer a regular attribute that India receives plentiful sunshine. Instead, the importance of solar energy being a definite determinant of number of units produced per year is fast gaining momentum. That for sure implies our national PV programme being on an extra engine of growth. ■

Table 2 Representative test solar radiation data

Station	Date of Commissioning	Global Horizontal Solar Radiation (kWh/m)	Diffuse Horizontal Solar Radiation (kWh/m^2)	Direct Normal Solar Radiation (kWh/m^2)	Wind Speed (kWh/m^2)	Rain accumulation (mm)	Air Temperature (°C)	Relative Humidity (%)
Karakudi	23-5-2011	4.752	2.592	2.880	2.568	215-5	27.192	85.04
CWET	28-5-2011	4.464	2.448	2.592	3.587	168.1	28.121	85.05
Ramanathpuram	3-6-2011	4.320	2.448	2.592	4.713	281.5	27.765	80.09
Kayathar	10-6-2011	4..896	2.160	3.168	4.285	374.1	27.835	73.52
Vellore	23-7-2011	—	—	—	—	—	—	—
Trichy	29-7-11	4.752	2..592	2.736	5.025	135.9	17.781	67.81
Erode	3-8-2011	5.040	2.592	2.880	3.125	176.8	26.962	74.97

SYNERGETIC GENERATION: Conceptualizing Solar PV Projects in the Existing Wind Farms in India

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Background

India has been doing exceedingly well in terms of promoting Renewable Energy (RE) sources. It has recently surpassed the 21,000 MW mark with wind power standing at an all-time high at over 15,000MW. The government is now expanding the contours of renewable energy programme in terms of the recently launched Jawaharlal Nehru National Solar Mission (JNNSM).

The first phase of the Mission banking essentially on incentives like remunerative feed-in-tariff and other unique features like reverse tariff bidding, bundling with coal power and a partial risk guarantee support, saw an unprecedented response from the investor community. It is making steady inroads to establish large scale (MW) solar power facilities across the country. The second phase of the JNNSM is currently under process and efforts are underway to put across some innovative mechanisms so as to reap further dividends. This article delves into the possibility of maximising the land use of wind farms by setting up some solar Photovoltaic projects.

Combining solar in a wind habitat

Solar energy drives the wind flow for sure. Now think of a scenario when the silent solar power panels work in tandem with the roaring wind turbines to generate clean energy! There are several advantages of doing so. These include:

- lower project cost (both development and maintenance)
- enhanced power generation
- better quality power (lower infirmity)
- optimum utilization of assets (i.e., land, transformer, wires, and personnel)

The proposed mechanism, if implemented, shall lead to setting up of 1500 MWp of Solar PV capacity within a short period of time with possible realisation of 8000 MWp of solar PV power (estimated potential) by the end of the 13th Plan period ending in 2022. Let us now take a closer look at some of the core issues involved.

Issues galore

Solar PV power projects require up to five acres of land for each MWp[1]. Due to current issues engulfing land acquisition[2], it has become all the more difficult to acquire land for setting up infrastructure projects. The requirement of large size un-obstructive shadow-free land for setting up of a solar power generation project limits the choice of developers to just a few remote locations.

Most of these remotely located projects are far from the existing grid lines. It thus requires the grid to be extended right up to the project site, thereby increasing the project cost.

The grid managers are also not very enthusiastic towards Renewable Energy (RE) technologies as they perceive RE with lower capacity factor and infirm generation.

Moreover, many of the incentives including bundling (with cheaper coal power) and partial risk guarantee available in the current phase of the JNNSM might not be extended to the subsequent phases of JNNSM. These reasons apart from the high cost associated with solar technology in comparison with other sources even after considering reduced module prices on account of economies of scale may act as a deterrent for the investor community willing to participate in the next phase of the mission starting from the year 2013.

This may act as a show stopper in the tremendous growth hitherto witnessed in the first phase of the Solar Mission.

As such, some innovative and out-of-the-box ideas are required to take the Mission forward.

Proposed solution

One of the possible mechanisms can be using the spare land available within the periphery of existing wind farms for setting up grid connected Solar Photovoltaic (PV) power generation projects.

Consider this: If the spare land within a wind farm is utilized for setting up Solar PV projects, it shall provide solutions to many of the vexed issues confronting the Solar sector, simultaneously providing with an additional source of revenue generation for the wind farm owner.

This is a classic case of two renewable technologies complementing each other and powering the nation in an environmentally sustainable manner.

The distinguishing factor though is that solar and wind power system are not directly in a hybrid combination, but shall be working in tandem to generate clean power.

Notching up a few gains

The land required to set up a wind turbine project is around 5-10 acres per MW[3], depending upon the profile of the land – topography, altitude, and usage pattern. The area acquired for setting up a wind turbine includes the land for turbine footprint, transformer, evacuation lines, and approach road facilities. The actual area utilized within a wind farm is lesser than the total land area normally acquired for the project. Thus some

spare land is available within a wind farm which may be put to use for some other revenue generating activity as well.

It may be noted that the wind farms commissioned till some years back were put up on land area as high as 15 acres per MW of turbine.

The 20:20 factor

A 200 kWp Solar PV plant requiring up to 1 acre of land can be easily set up within an existing wind turbine of 1 MW capacity. This means a Solar PV plant with size up to 20% of the turbine capacity can be put up on the spare land available within a wind farm. This gives a proportion of 1kWp Solar PV for every 5 kW of wind turbine capacity. As the turbines prevalent in the years preceding 2008 were of lower ratings (250 kW, 500 kW, 600 kW), the optimum size of PV plant can be derived based on the aforementioned ratio, i.e., 50 kWp for 250 kW turbine, 100 kWp for 500 kW turbine and 120 kWp for 600 kW turbine respectively.

Quicker timelines

As the site for setting up solar PV power projects would be identified beforehand (within the earmarked wind farms), it shall normally lead to quicker implementation of the projects. Further, as the land would be already acquired/ leased by the existing turbine owner, the need for fresh land acquisition would be done away with, further obviating the need of sourcing any approval from the respective government agencies. It will effectively lead to reducing the overall time taken in setting up Solar projects.

Optimizing asset utilization

Many of the equipment/ systems being used in an existing wind farm can be used by the Solar modules. This includes land, transformer, and evacuation system. This shall help in setting up a Solar PV project at a substantially lower cost than what it is generally associated with. It is estimated that up to 20% reduction in project cost[4] can be achieved by use of the existing wind turbine infrastructure like land (1%), preliminary and pre-operative expenses (10%), and transformer and evacuation system (6%).

The evacuation of power generated from the Solar PV plant can be from the existing set up being used for evacuating power from the wind turbines.

The transformers used in the wind farms have a certain margin over and above the capacity of the wind turbine, and are designed to carry a higher load (roughly up to 10%–15% or even more). As such, this margin can be optimally utilized to step up the power generated from the Solar panels for onward feeding by the same transmission lines used in wind power evacuation.

This shall increase the overall asset utilization of the transmission system, as it shall now be carrying more power per circuit km and for more period of the year (even during period of low-wind speeds).

Common threads in implementation and maintenance

Many of the works required in setting up a Solar PV project would be similar to what is required in setting up wind turbines. The PV projects can be implemented by the same companies which are involved in setting up wind farms, mostly under a turnkey business model (concept to commissioning).

Though the current wind farm projects are located in far-flung areas of the country, these have well developed roads, facilitating ease of delivery of the solar equipment at the project sites.

The solar PV modules are inherently robust and normally require minimal maintenance post commissioning. The personnel maintaining the wind turbines can be provided training towards keeping the PV system in order. As such, expenses normally attributed towards O&M of a typical Solar plant shall get further reduced.

Economies of scale

Most of the turbines in a wind farm are of a similar make, and operated by the same EPC supplier/ equipment manufacturer. This provides the advantage of putting up a large number of solar PV plants adjacent to wind turbines in a typical wind farm, and would help in maintaining these projects at a reduced cost due to related economies of scale.

Benefiting from experience

The Tamil Nadu Energy Development Agency (TEDA) has put up Solar PV modules alongside its wind farm at Kayathar, in Thoothukudi district of Tamil Nadu. Although it is not known whether the Solar and Wind generators are feeding the grid through common facilities, yet it adequately proves that spare land within the vicinity of wind farms can very well be optimally utilized for putting up Solar PV plants.

Programme initiation

The proposed solar installations can be rolled out in the wind farms located in the windy states of Tamil Nadu, Maharashtra, Rajasthan, and Gujarat, which have witnessed large scale addition of wind turbines in the last few years. The total installed capacity of wind power in these states was around 7,500 MW[5] till the end of FY 2007-08 (up to which period wind farms were set up on large size land areas).

Further the turbines installed in the years preceding 2008-09

would have experienced some de-rating, providing more spare transformer and line capacity for carrying the solar power generated.

These states are also provident enough to have good solar insolation values[6].

It may be noted that work on re-powering of some of these older and de-rated small size turbines associated with lower generation efficiencies (kWh/ MW) and occupying larger land area (MW/ acre) shall commence in the next couple of years[7]. Within this rejig, the proposal for setting up solar plants may be experimented.

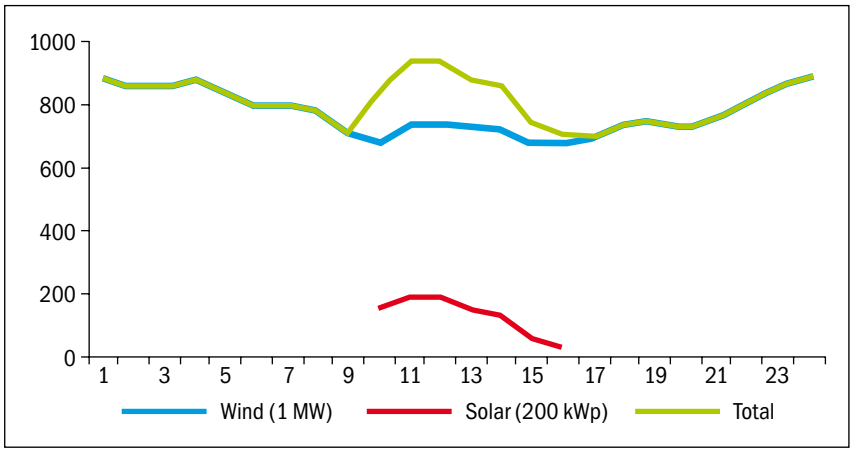

Figure 1 Effect on power generation via solar installation used in a wind farm

Solar providence in windy surroundings

The existing wind turbines are located in remote / rural areas, far off from the urban cities. The topography of these wind farms is hill tops/ mounds, with an appreciable height above mean sea level. Both these attributes shall provide PV modules with unhindered/ uninterrupted solar insolation, leading to better generation than as experienced otherwise. Further, due to cleaner air, the chances of dust getting accumulated on the panels would get substantially reduced. Though generation may get impacted by the shadow of the turbines, this factor can be taken into consideration while designing the solar PV project.

Improved diurnal power output

The generation from Solar PV plant would complement the generation from wind due to the unique characteristics of both these technologies. Wind follows the sun (gets generated from heated atmosphere). Wind velocity builds up during the course of the day and a turbine starts generating at around 11a.m., peaking up by later afternoon, after which the velocity starts declining[8]. On the other hand, a Solar PV plant starts performing from 7a.m. in the morning and peaks at noon, generating till 5 p.m[9]. Further, during the periods of low wind regime, the generation from Solar PV would complement the wind power generation, providing more stable output.

Thus, the combined power from wind and solar output shall be more firm and consistent, possibly increasing the acceptability of these renewable sources among the grid managers.

The graph below depicts generation value from a wind farm complemented by a Solar PV plant in a configuration of 5:1 by wattage. It can be observed that the generation improves when solar is used in conjunction with wind in comparison to only wind based generation.

Laying bare the business models

Model 1 The solar power generated can be purchased by the host utility as per the applicable tariff notified by the concerned State Electricity Regulatory Commissions (SERC), which is over ₹14/ unit. It may be noted that most of the SERC's have come out with their solar tariff orders[10] as well as the Solar Purchase Obligations (Solar RPO)[11]. This purchase shall help the host utility to meet its Solar RPO targets.

Model 2 Another option can be by selling the power to the host utility at Average Power Purchase Cost as determined by the respective SERCs (in the band of ₹1.99 – 3.38/ unit), enabling the project developer to avail Solar based Renewable Energy Certificates (REC), in the price band of ₹9.30 – 13.40/ unit[12], making the effective returns in the range of ₹11.29 – 16.78 / unit. With the current and expected Solar project capacity looking well short to meet the Solar RPO targets as stipulated by the respective SERCs, the demand for Solar based REC would be considerable and shall provide the project developers with a ready market, fetching them handsome returns.

Financing innovatively

Assuming a cost of ₹12 cr / MWp[13], a 200 kWp Solar PV project would cost ₹1.9 crore, after taking into account 20% reduction in overall project cost on account of symbiosis with the existing wind farms. The banks, normally, insist on Debt Equity Ratio (DER) of 70:30. However, in this case, higher DER up to 80:20 may be considered as receivables from the existing wind turbine can be pledged as additional security. With this DER, the equity required from the project developer/ promoter shall be ₹40 lakh and the debt requirement would stand at ₹150 lakh. The repayment can be made using the receivables of both Solar and Wind power generated units.

Paying back ahead of time

A 200 kWp project would generate over 3.3 lakh units (kWh) of power assuming 19% CUF[14], though it may generate more for the reasons like higher insolation values and cleaner environment.

At the existing tariff being offered to Solar PV projects/ APPC + Solar REC Price (averaging ₹13/ unit), a 200 kWp SPV project shall generate a revenue of ₹43 lakh per year, giving a very attractive payback period of 3.5 years.

This shall be acceptable to both the project developers as well as the lending community. A separate meter can be put up at the output side of inverter to record the power generated from the Solar PV plant.

Advantage: The proposed mechanism, which may be undertaken in conjunction with the Solar Mission, shall be associated with the following advantages:

- Optimum Asset utilization
- Quicker implementation of Solar projects
- Improved and firm power output
- Reduced cost per MW
- Lower O&M costs
- Enhanced generation values
- Attractive payback period
- Comfort to lending community
- Complying with Solar RPO targets

The combined way forward Taking an average size of 200 kWp Solar PV project being set up alongside a MW of wind turbine, a total of 1,500 MWp capacity of Solar PV power generating plants can be set up in a two-year timeframe. For this purpose, wind farms set up in states of Tamil Nadu, Maharashtra, Rajasthan, and Gujarat prior to 2008 aggregating to over 7,500 MW capacity can be the initial target areas.

With cumulative capacity of wind power expected to reach 38,500 MW by the end of 13th Five-year Plan in the year 2012, which also happens to be the terminal year of the National Solar Mission, a cumulative Solar PV capacity of over 8,000 MWp can be installed on both the existing and upcoming wind farms. The larger purpose is to meet the ambitious capacity addition targets set up under the Mission.

Endnotes

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The author is a certified energy manager and has a decade long experience in energy efficiency–renewable energy areas.
Disclaimer: 'The views expressed above are solely attributed to the author and not to the organization where he works'

MOVING FROM DISPUTES TO COOPERATION

THE ONLY CHOICE UNDER THE MIGHTY SUN

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Introduction

Today renewable energy sources, more so Solar and Wind energy are fast gaining ground for a variety of reasons. In direct terms, their production cost is coming down paving way for an enhanced market penetration. However, increasing climate change concern coupled with a heightened need for energy security have propelled several governments worldwide to set up ambitious targets for renewable energy. The plain enough reason is to bring down the Greenhouse Gas (GHG) emissions. According to industry estimates, the global solar PV emissions are very low at around 25-65 g CO_2/kWh when compared to the emissions from coal in India for example at around 850 g CO_2/kWh. The governments of the day are also putting across such policies as these are bound to increase investment in the RE sector. Some of the key measures include direct subsidies, tax breaks, and feed-in tariffs, etc.

The sunny march

Selective few countries like USA and Japan across the world took some early initiatives to promote research and development in Solar PV area especially. However, the US programme for example slowed down in the mid eighties mainly due to expiration of federal solar tax credits and crash of energy prices. In fact, many solar systems were sold in USA between 1970-1980. Germany initiated its thousand-roof programme in the fall of 1990.

Since then Germany, with its aggressive policies promoted solar not only within Germany but set bench marks for other EU nations to follow. Germany also engaged very early with the Asian market.

The encouraging policies of the German government followed by other European countries like Spain and Italy catapulted Solar PV to what it is today. That out of the total global installed capacity of 40 GW by end 2010, EU accounts for 30 GW tells the story.

The magic of FIT

The feed-in-tariff or simply FIT has been responsible for a quick installation of both solar and wind power in more than 40 countries, including most of Europe today. By its very definition, FIT is a special fixed rate paid by the utilities in respect of power generated from renewable energy sources and fed into the locally available grid. Quite often, the contract period for doing so is anywhere between 15-25 years. Normally, FIT's are set at 2-4 times the regular grid power price. Take for example the German FIT initiated in April 2000. It is widely regarded as having been the first major program of its kind world over. Courtesy FIT, the solar PV power capacity is now nearly double of US capacity in Germany.

The resulting impact on manufacturing

The growth of German and other EU markets provided a great opportunity to set up manufacturing in low tech and labour intensive processes like module manufacturing in India. Several module manufacturing facilities sprung up in India between 2005 and 2010. Many of these facilities used the imported cell, from which finished modules were exported mostly to Germany and other EU countries. India thus enjoyed rapid growth in manufacturing with the module manufacturing capacity exceeding a GW. Likewise, cell manufacturing capacity reached close to half a GW in early 2010. As much as 70% of the modules manufactured locally were exported.

China fast tracking the PV growth

China began to focus its attention in the PV sector quite late. China was an insignificant global player till as recently as 2005. In fact in 2003 Chinese manufacturing capacity accounted for only 2% of the cumulative global capacity. However, favourable policies introduced by the government beginning from its Sixth Five Year Plan (2006-2010) led to large investments and China achieved spectacular growth in a very short span of time. Today, China has a manufacturing capacity of more than 13 GW and some of the world's leading solar companies like Suntech, LDK, Yingli Solar, and Trina Solar are all Chinese. The Chinese manufacturing capacity now accounts for a significant 45% of the global capacity. The Chinese market is still small at 1 GW, as compared to the EU market of 13 GW (2010), and most of the Chinese modules have found their way to meet the growing European market. Of late, the module supplies have been made to the US where the PV programmes are gaining momentum in line with the President Obama's declaration *"The nation that leads the clean energy economy will be the nation that leads the global economy. And America must be that nation."*

The last three years have seen the quadrupling of the total global installed capacity from 10 GW in 2007 to 40 GW in 2010.

The declining profitability

With the market galloping, everyone found opportunities to profitably operate their businesses. Under these favourable market conditions, some restrictive trade practices like domestic content requirement that were already prevalent did not take centre stage.

However, with the escalating financial crisis in the Euro zone, the solar market is seen to be shrinking due to spending cuts. A very recent report by Ernst and Young (E&Y) predicts a gap in investment to the tune of $45 billion covering Renewable Energy, tax credits and more. The deepening financial crisis and the consequent shrunk market could not have come at a more inappropriate time. The rapid build up of manufacturing capacities in the last couple of years has resulted in global inventory pileups, estimated at a record level of 10 GW. As a consequence, the prices have crashed – from about $2 / watt in 2010 to as low as $1.2 in 2011. This has substantially eroded the profit margins of several companies and they anxiously look forward to better market conditions.

The adverse events of the recent past have led to an intense and unprecedented wrangling in the solar industry. With governments looking at the RE / Solar sector to develop local manufacturing capacities and to generate jobs, there is a growing tendency to bring in protectionist laws. Some of the laws are very explicit while some are not.

The legal firewall

The Canadian province of Ontario expects to generate 50,000 RE jobs by 2012 through the law they enacted in 2009. The Ontario Power Authority administering the FIT programme has an explicit law that mandates utilization of 50% domestic content for the period 2010 and 2011 and 60% beyond 2011 for PV systems of size > 10 KW. Such a requirement has resulted in some companies like Canadian Solar, Siliken, Samsung Renewable Energy, MEMC, and Silfab to set up module factories. That is not all as a few top line inverter manufacturers like Enphase, Scheneider and SMA are also setting up manufacturing facilities in Ontario.

Much before Ontario put forth its law, China introduced the condition that any company wanting to enter the Chinese market would have to form a Joint Venture (JV) with a local company. This paved the way for an unprecedented growth in solar and wind manufacturing capacities within a short time. We can certainly expect more and more nations across the world bringing in such policies in one form or the other as encourage local manufacturing and sourcing.

We also have our own explicit domestic content requirement. For the Batch 2 of Phase I of the JNNSM programme *"it will be mandatory for all the projects to use cells and modules manufactured in India"*. Thin film modules and concentrator PV cells however are allowed to be sourced from outside with out any mandated restrictions. The plain enough reason is their abysmally low scale of manufacturing here.

Free market economies, too, are not averse to imposing barriers. Italy for example as per the latest FIT law announced in May for the five year period 2011 to 2016 makes for an additional payment of *"10 % to PV plants whose cost of construction, excluding labour costs, is composed at 60% or more by components manufactured within the European Union"*. Likewise, the US state of Ohio has another interesting law which requires that 50% of the mandated Renewable Energy capacity has to be sourced from generation with in the state.

The immediate fallouts

Laws favouring local companies and laws incentivizing exports have caused certain trade disputes. Ontario's local content requirement introduced in 2009 led Japan to seek redressal from the World Trade Organization (WTO). Both the US Under Secretary of Commerce Mr Francisco Sanchez and the Secretary of State Ms Hillary Clinton spoke against protectionist measures in India. In fact US


Courtesy: TRINACRIA PHOTO

and EU have already lodged complaints with the WTO on the local sourcing provision in JNNSM. However, they have not filed a formal case so far.

As recently as October 2011, we saw a very major trade dispute emerging between US and China with Solar World and six other American Solar companies petitioning to the US Department of Commerce calling for anti dumping and countervailing duties on Chinese solar imports. The claim being made was that Chinese Government was extending several incentives like favourable tax regime, preferential loans and many other policy measures to boost exports. The US International Trade Commission (ITC) has already begun full investigation on the petition while the Chinese Government termed the petition as seeking of protectionist measures.

Unfortunately trade disputes take years to get resolved even if, a formal case is lodged with WTO. The protracted delay seems to provide enough leverage to nations to enact laws that tend to support domestic companies. With the global economy going through one of its worst phases, trade disputes are bound to mount. This is surely detrimental for an overall healthy growth of the fledgling solar industry which has seen spectacular growth recently.

The wake up call for better environment

The recent rates quoted for projects under the JNNSM have dramatically brought down the gap between the pricing regime of grid power and solar power. However, this remarkable momentum gained over the last few years could slow down if, governments and the various industries spend their time in some acrimonious disputes.

More ominously the *Global Carbon Project* in its report released on December 4, 2011 has said that the CO_2 emission rose to 5.9% in 2010. The scientists involved claim being that this is "*the largest absolute jump in any year since the Industrial Revolution began.*"

The time we have at our hands to lower greenhouse gas in the borderless atmosphere, is fast shrinking. It simply means that we have to replace combative and narrow national interests with the spirit of accommodation and greater responsibility. After all, the sun shines all over the globe and so would be the opportunity to tap it for the benefit of all. Instead of focusing our attention and spending years settling disputes at the WTO, all nations need turn towards developing global alliances to tap the clean and sustainable energies like solar. The underlying rationale is to secure our future and importantly, of the coming generation too.

Certainly, this sounds utopian considering human nature and the history of nations. But the impact of the climate change, as predicted by climate scientists even if viewed under optimistic scenario, would still incapacitate a large global population in a not too distant future. Handling a crisis of this magnitude, unknown to human experience, calls for a response that is nothing short of what would seem to be utopian. ■

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Disclaimer: 'The views expressed above are solely attributed to the author and not to the organization where he works'.

solar firms storm football stadiums

By Jörgen Heup

Football clubs are currently experiencing a surprising onslaught by solar sponsors. This shows two things: football is polishing up its image as a friend of the environment, and solar firms are in a mad panic. They know that to survive, they will have to become more visible. And they need to do it now.

Has the solar industry suddenly discovered a love of football? Or has it realised that the stands are full of potential photovoltaic (PV) customers? Or is it just weighed down with millions of excess euros that would be so easy to get rid of by buying perimeter advertising or space on the players' chests? All cynical speculation aside, one thing is for sure: photovoltaic companies have really ratcheted up their advertising in Bundesliga football. Football expert Philipp Kupfer of Sport + Markt, a Cologne-based research and consulting firm for the international sports market, says that "no industry has ever targeted the Bundesliga on this scale before." This year 15 solar companies are appearing as sponsors in the first division alone. Two of them are even shirt sponsors, or main sponsors: Sunpower for Bayer 04 Leverkusen and Suntech for TSG 1899 Hoffenheim. Industry observers estimate that it cost Suntech EUR 4.5 million to become the first Chinese shirt sponsor in German football. But that is still much less than what they would pay to sponsor a world-class team. US insurance broker Aon is paying Manchester United EUR 90 million to have its logo appear on the Red Devils' shirts for four years. And German logistics firm DHL has to shell out EUR 11 million a year just to have its name on the team's training bibs. The Bundesliga is a lot more affordable. Even so, Sport + Markt estimates that Bundesliga clubs will get EUR 20 million in solar sponsorship this year. The consulting firm says that last year it was only EUR 2.5 million. In total, the Bundesliga received EUR 511 million in advertising revenue last year.

"Sponsoring is a part of the marketing mix that requires comparatively high investment costs," says Kupfer. And that, in turn, makes the Bundesliga an expensive bit of advertising turf. But it is also one that has a big reach. Viewer numbers are rising, both in stadiums and in front of the TV. Official Bundesliga statistics say that last year set a new record, with an average of over 42,000 spectators attending each match and a total of 12.88 million watching the 306 games held in the top division. Watching football on TV is also becoming more popular: surveys say 80 per cent of German men and 60 per cent of German women are now interested in the sport. Foreign broadcasters are also televising more games from the German league.

Solar companies' new love affair with football began with Solarworld, when its CEO Frank Asbeck hired Lukas Podolski of the Cologne club 1. FC Köln to appear in adverts in 2009. The striker brought a lot of attention to Solarworld, and the company started sponsoring his club. Another manufacturer has been involved in the Bundesliga even longer, although most people do not associate it with the solar industry. Kyocera first appeared on the shirts of Borussia Mönchengladbach in 2005. Although the Japanese electronics firm is best known for its printers, it is also one of Japan's largest photovoltaic companies. Solarworld seems to be benefiting from its football involvement, which has helped the company increase brand awareness. A survey conducted by market research firm T.I.P. Biehl & Partner in February 2011 revealed that Solarworld was Germany's best-known solar manufacturer, followed by Schott Solar and Sharp. But it also revealed that about half of the people surveyed did not know any solar companies at all – they could not think of any themselves and did not recognise any names either. Even first-place company Solarworld was only recognized by, 21 per cent of respondents. T.I.P. Biehl & Partner summed up by saying that the results show that solar firms need to engage in more marketing activities.

All about money?

But what is motivating the football clubs? Is it just the money? Suntech is not Hoffenheim's only photovoltaic partner; Wirsol is also on board. Wirsol is a local systems provider and Suntech's biggest customer in Germany. This summer, the Hoffenheim club even renamed its stadium after Wirsol. The club's CEO Jochen Rotthaus says, "Football clubs live from this kind of partnership. It wasn't like that 20 years ago but today there's no way around it. Having a sponsor is like making a commitment." A commitment to environmental responsibility? The club's billionaire patron Dietmar Hopp says, "Here at the club we are happy to benefit from the respect that solar power enjoys from the public. We want to be as green as we can." Hoffenheim will also benefit from the products and expertise of its current partner. It is planning to build the world's largest PV carport around the stadium, and wants to use solar power at the club's 13-hectare training centre. The solar panels will come from China, but the retailers and installers will be local, so the region will still benefit economically.

Borussia Dortmund was clearly also thinking about the practical benefits when it chose a sponsor. Not only is its new premium partner Q-Cells paying the club EUR 1.5 million a season, it will also be providing a photovoltaic plant for the stadium. Environmental responsibility is important to the clubs; after all, their giant stadiums use lots of electricity. The club that first got the green ball rolling into stadiums was SC Freiburg, which put a PV plant on its stadium roof back in the 1990s. In 2009, FSV Mainz caused a stir when it joined forces with green energy provider Entega and became the first climate-neutral club in the Bundesliga. That was good for its reputation and made the club more likeable. At the other end of the spectrum is FC Nürnberg. The management's decision to agree a sponsorship deal with French atomic energy company Areva genetated a lot of resentment from the fans.

The marketing onslaught from solar firms comes as no surprise. Sales were down dramatically for makers of solar modules in the first half of the year. Many companies could not get rid of their stock and slid into the red. The industry consolidation that analysts have been predicting for so long seems to have begun. Companies that do not sell this year will have a tough time, analysts say. The pro-active measures that manufacturers are now taking support that statement. Germany is still their most important market. Jerry Stokes, president of Suntech Europe, says, "The photovoltaic market is clearly moving towards residential roof-top systems, especially in Germany." No-name companies have it particularly hard here. Right now the solar industry is all about brand building. Chinese companies are vying particularly hard for attention, and football seems to be the perfect place to find it.

But how do clubs and companies actually get together in the first place? "It's normally the club that takes the initiative. It more or less depends on whether the club markets itself or whether it uses an agency," says Kupfer. That fits in with Rotthaus's experience. He says Suntech was being courted by a number of different clubs, so he sees it as something of an honour that they chose Hoffenheim.

Nevertheless, it appears that the sudden surge of solar in the Bundesliga is mostly down to the companies. Borussia Dortmund says it had 20 solar firms beating a path to its door. And an example from club Bayer Leverkusen shows just how tough the competition is among the firms. In early August, the team proudly announced Chinese firm Jinko Solar as its new premium partner. The deal primarily involved perimeter advertising. The club's CEO Wolfgang Holzhauser was overjoyed when he told the press, "We want to really fill this partnership with life over the next three years. Both companies are acting on the same wavelength." Two weeks later the Chinese company was out of luck. US company Sunpower proved it was even more on the club's wavelength – by digging deeper into its pockets. Sunpower became the new shirt sponsor and refused to allow any other solar company to advertise in the stadium. ■

This article is reproduced from the New Energy magazine.

The SOLAR QUARTERLY

The Complete Solar Magazine

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List of Holidays

- **January 26** Indian Republic Day
- **February 05** Milad-Un-Nabi
- **February 20** Maha Shivaratri
- **March 08** Holi
- **April 01** Ram Navami
- **April 05** Mahavir Jayanti
- **April 06** Good Friday
- **May 06** Buddha Purnima
- **August 10** Janamashtami
- **August 15** Independence Day
- **August 20** Idu'l Fitr
- **October 02** Mahatma Gandhi's Birthday
- **October 24** Dussehra
- **October 27** Idu'l Zuha
- **November 13** Diwali
- **November 25** Muharram
- **November 28** Guru Nanak's Birthday
- **December 25** Christmas Day





INDIAN SOLAR PROGRAMME RISING ALONG WITH THE SUN

A KPMG Report

Part I

Background

The Indian Solar programme was essentially being dubbed as a subsidy driven programme mostly till very recently. This seems to have changed now with the recent initiation of Jawaharlal Nehru National Solar Mission (JNNSM). It is apt to mention here that the first batch of JNNSM has set up a clearly visible benchmark moreso in a government driven processes and procedures. It is evidenced by the glaring fact that bid were sought for around 650 MW of solar projects within a very short span of time between October 2010 and July 2011. The remarkable outcome can be seen in terms of financial closure having been achieved for 34 projects with an equivalent capacity of 615 MW. The second batch of the solar mission has just taken off with the opening of RFP's on December 2, 2011. Good news is that the cost of solar PV based power is likely to fall below ₹8/ kWh by 2013. There seem to be few good reasons for solar PV now inching fast towards the grid parity. Increase in the size per project from 5 MW to 20 MW, higher allocation possibilities per company (up to 50 MW) together with an appreciable drop in solar module prices (to < $ 1/ Wp) enabled the participation of some very large companies. This ultimately paved the way for offering of aggressive discounts. However, the core issue is also of according due attention towards the off-grid sector too. After all, a huge chunk of rural population is still keenly awaiting solar glow in their homes.

This article is solely based on the excerpted portions of the KPMG report entitled," The Rising Sun" released in May 2011.

Importance of solar power

India is a rapidly growing economy which needs energy to meet its growth objectives in a sustainable manner. The increasing energy requirements have meant that the extent of imports in the energy mix is growing rapidly. Oil imports already constitute nearly 75 per cent of our total oil consumption. Coal imports which were negligible a few years back are likely to rise to around 30 per cent of the total coal India is a rapidly growing economy which needs energy to meet its growth objectives in a sustainable manner. Globally, there is intense competition for access to energy resources. This is a serious cause for concern as the Indian economy gets exposed to the global fuel supply market which is volatile and rising. Moreover, being amongst the top five greenhouse gas (GHG) emitters globally, India has a responsibility to achieve the growth trajectory in an environmentally sensitive and responsible manner. Given this backdrop, alternate fuels like nuclear fuel and renewable energy technologies have been gaining in prominence lately. However, there are several sensitivities related to costs and environment when it comes to nuclear technology. In fact, the recent Japanese experiences at the Fukushima nuclear reactor following a devastating earthquake and tsunami has reignited the debate around safety of nuclear energy and triggered the usual "NIMBY" (Not in My Backyard) syndrome. These developments further strengthen the case for Renewable Energy and particularly that for Solar Energy.

India is a tropical country with abundant sunshine. From time immemorial, Indians have idolized the Sun as the Visible God that provides vital energy for sustenance of life. It is time we utilize this immense potential of solar power which addresses the twin objectives of Energy Security and Carbon Mitigation for India. Moreover, being modular in nature, solar power

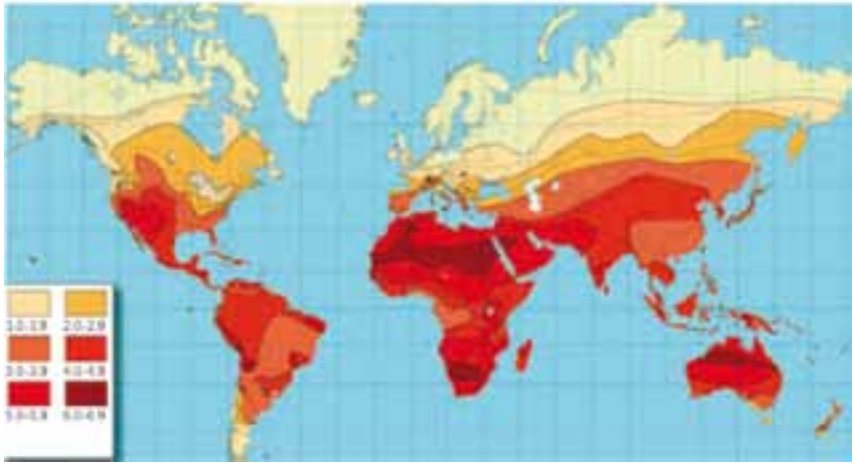


Figure 1 Global solar radiation map (figures in kWh/sq.m/day)

Source http://www.oksolar.com/abctech/images/worldsolarradiation/large.gif

can meet demand for wide ranging market applications where the size of installations can vary from as low as KWp to MWp scale projects. Further,solar power can meet requirements in areas where conventional power was unable to reach economically due to infrastructure bottlenecks. The global solar radiation map as shown in the exhibit overleaf clearly shows that India has a radiation advantage compared to several European nations which have . However, high costs have come in the way of solar energy reaching its true market potential. While solar power costs remain costlier when compared to other conventional sources of energy, the cost curves for solar power are declining rapidly. All in all, besides reducing carbon emissions, solar power can play an important role in sustaining the energy needs of the country.

Globally, Europe has taken the lead and has already installed significant solar based capacity. Germany is the largest solar market globally with total installations of around 17,000 MW. In fact, Solar PV provided 12 TWh(billion kilowatt-hours) of electricity in Germany in 2010, which is about 2% of the total electricity in the country. A point to note is the fact that the solar insolation in Germany at about 3.15 units per sq. meter per day is very low when compared to India's average of 5.50 units per sq.meter per day. The industry has seen significant capacity additions to meet the growing demand. Hitherto unknown names few years back are billion companies today with GW scale manufacturing capacities. Globally, the solar PV market had installations of more than 17,000 MW in 2010 recording a growth of more than 130% over 2009. While India's share at around 1% is very low at present, it is likely to increase substantially in future.

Concentrating Solar Power (CSP) market

The CSP market picked up globally after more than a decade of dormancy with active government support that incentivized solar installations. For example, Spanish legislation put in place incentives for CSP fostering the development of this technology.

Table 1 Concentrating solar power technologies

Key parameters	Parabolic trough (most commercially proven technology)	Central Receiver Systems - includes power tower (prototype, semi commercial)	Parabolic dish (prototype testing)
Solar concentration ratios	50–100 kW/sqm	600–1000 kW/sqm	1500–4000 kW/sqm
Key advantages	• High system reliability • Low materials demand • Proven hybrid concept • Storage capability • Best land use factory	• High temperature (around 800 °C) • HIgh efficiency possible • Hybrid operations Possible	• Potential for low capex • High efficiency • Modularity
Application	Grid-connected plants, mid-to-high process heat	Grid-connected plants, high temperature process heat	Stand alone, small off-grid power systems or clustered to larger grid-connected dish-parks

Source KPMG in India's The Rising Sun, May 2011

Creation of incentives through feed-in-tariff mechanism and investment tax credit route in several countries also contributed to increase in deployment of this technology. Currently, over 1,400 MW of CSP plants are operational worldwide and over 6,400 MW of plants are under construction. The total capacity of plants in pipeline is much larger. In fact, CSP projects in and arid and desert regions are expected to play an increasingly important role in meeting the electricity needs for the future. The DESERTEC initiative is a path breaking USD 560 billiob project underway in North Africa to meet 17% of total electricity needs of Europe using only 2,500 square km of land (less than 0.02% of total MENA area).

The solar market today is dominated by Europe and in the medium term is likely to be dominated by Germany and USA. The emerging markets like India and China will join the race as solar costs continue to drop.

Crystalline silicon technology costs

The solar crystalline silicon PV technology dominates the market for solar PV installations globally. Dynamic cost reductions have accelerated deployment of solar C-Si technology in the recent past. The module prices have dropped from around USD 3-4 per W about two years back to under USD 1.5-1.8 per W

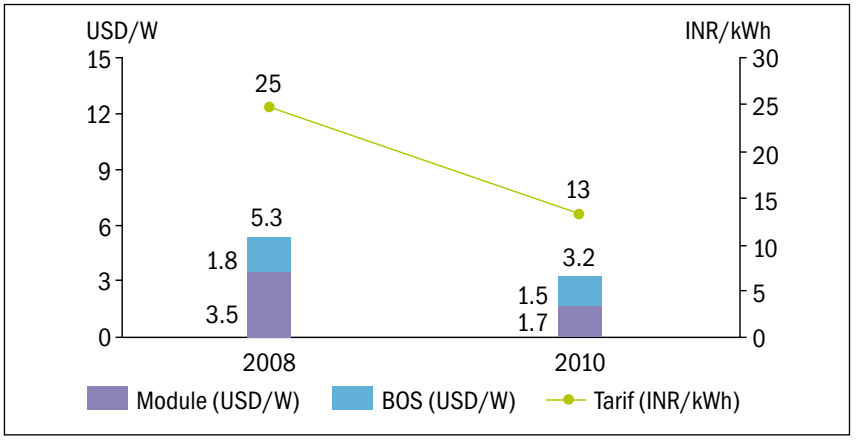


Figure 2 Declining prices of solar PV systems

Source Analyst Reports KPMG Analysis

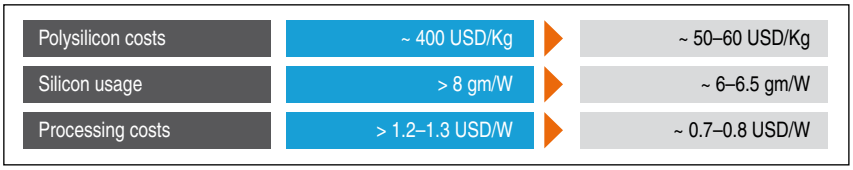


Figure 3 Major PV cost reduction drivers

Source DOE, NREL, KPMG Analysis

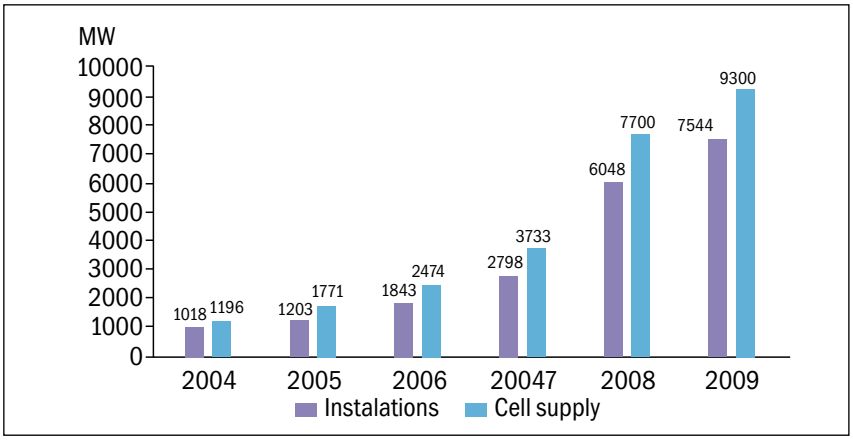


Figure 4 Market scenario – oversupply position

Source EPIA, Industry Estimates, JP Morgan Report, KPMG Analysis

today. Consequently, the proportion of module prices in the total system price has come down significantly. The corresponding price of electricity which was upwards of INR 25 has dropped down significantly now. The entry of China into solar manufacturing space has contributed significantly to lower costs. Economies of scale and global recession in 2008 coupled with oversupply of modules resulted in the squeeze on margins across the board, triggering a sharp fall in the prices. Going forward, while poly silicon prices continue to be an important determinant factor, other key elements like processing costs and silicon usage will gain prominence.

It may be mentioned here that within the overall system cost, the proportion of non-module system cost is increasing. In fact, the cost reduction possibilities in the non-module segment of the system costs could well determine the timing of grid parity. The cost reduction trends for non-module system costs are listed here as follows.

Solar grid connected power market in India

The last few years have seen significant developments in the solar sector. There is a growing recognition for the adverse impacts of global climate change. The importance of encouraging renewable energy technologies is well established. Globally, governments of various countries have announced market support initiatives targeted at increasing the share of renewable energy technologies in the overall energy mix. This increase in support is reflected in increase in size of solar market with annual installations increasing from less than 1,000 MW in 2003 to more than 17,000 MW in 2010. The global market size will increase significantly in the future with decreasing solar power costs.

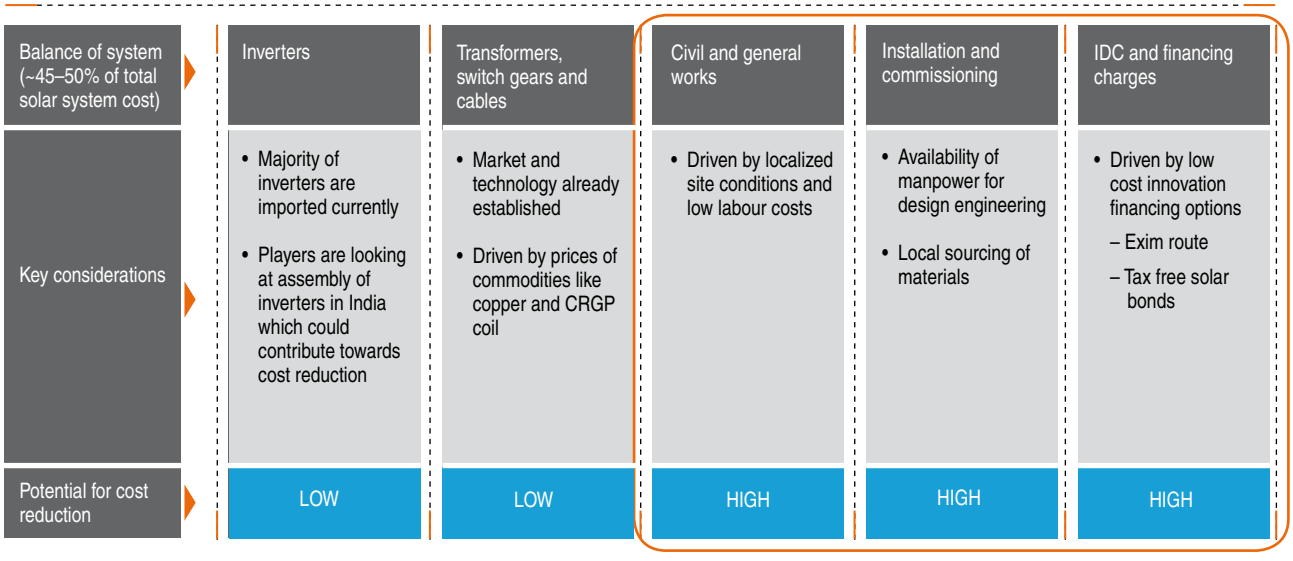


Figure 5 Comparative features of thin-film technology options

Source IEA-PVPS, Industry Estimates, NREL, KPMG Analysis

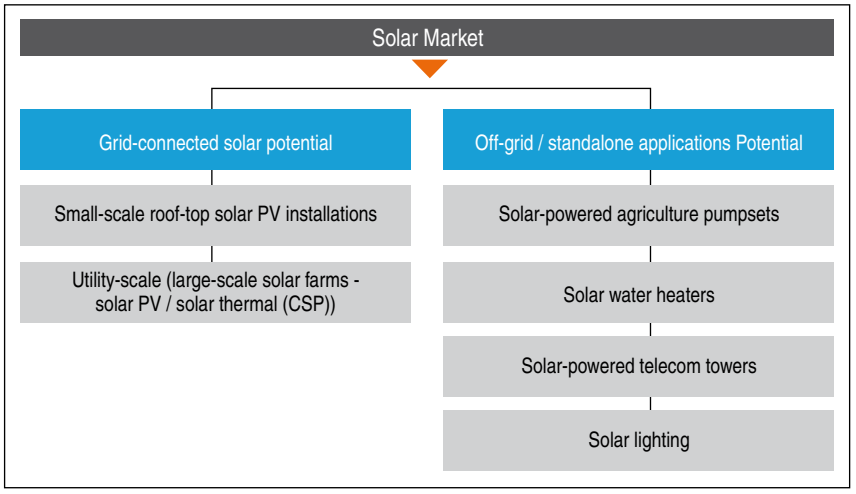


Figure 6 Key application segments of PV market

Source KPMG in India's The Rising Sun, May 2011

As we approach grid parity, consumers are likely to evaluate the option of adopting solar power due to its cost economics. There are multiple applications that would make solar power potentially attractive.

Demand for solar power-grid connected consumer segments

The likely potential from different consumer segments depends on the tariff and pattern of usage. Solar power could become attractive for the high end consuming segments in the residential category where the tariffs are reflective of the cost to serve. The agriculture sector has been testing the finances of the utilities due to its low paying capability. Moreover, the supply hours are staggered and service quality is poor. Solar power has a good fit with agriculture as the power will be available when the sector needs it the most. During the monsoon, the agriculture sector would use lesser power since their water requirements would be rain-fed. Therefore, once grid parity is achieved, solar power can be an economic and convenient alternative to grid power for the agriculture sector even without storage solutions. For the industrial segment that requires continuous demand, the shift is not likely to happen without cost effective storage solutions. However, utilities can plan for solar installations at suitable sites. The below given exhibit summarises the solar attractiveness for various customer segments and the mode of solar power that could be supplied to each of them.

Table 2 Solar attractiveness for various customer segments

Consumer segment	Solar attractiveness	Reason	Solar Application
Residential	●	• High-end residential consumers are likely to adopt solar rooftop to offset likely high residential tariffs (cost-to-serve reflective) • Government involvement would be required to encourage other residential consumers to adopt solar rooftop as they would likely to be subsidized segment	• Solar rooftops • Utility-scale solar power • Off-grid / standalone applications – Solar water heaters – Solar lanterns
Commercial establishments	◔	• Accessibility (installation constraints) • Tariffs would likely reflect Landed Cost of Power • Some potential exists for schools / educational institutions and other stand-alone commercial establishments	• Utility-scale solar power • Solar-powered telecom towers
Agriculture	●	• Governments likely to encourage hybrid models to reduce increasing subsidy payout • Agriculture consumers may not resist as they will get reliable supply during day time	• Solar-powered agriculture pumpsets
Low-tension industries	◔	• Accessibility (installation constraints) • Tariffs would likely reflect landed cost of power • Some potential exists in stand-alone LT industries	• Utility-scale solar power • Solar water heating devices
High-tension industries	◔	• Will require reliable and continuous supply • Tariffs would likely reflect landed cost of power • May not prefer solar unless storage solutions are viable	• Utility-scale solar power • Solar water heating devices

◔ Low ◐ Medium ● High

Source KPMG in India's The Rising Sun, May 2011

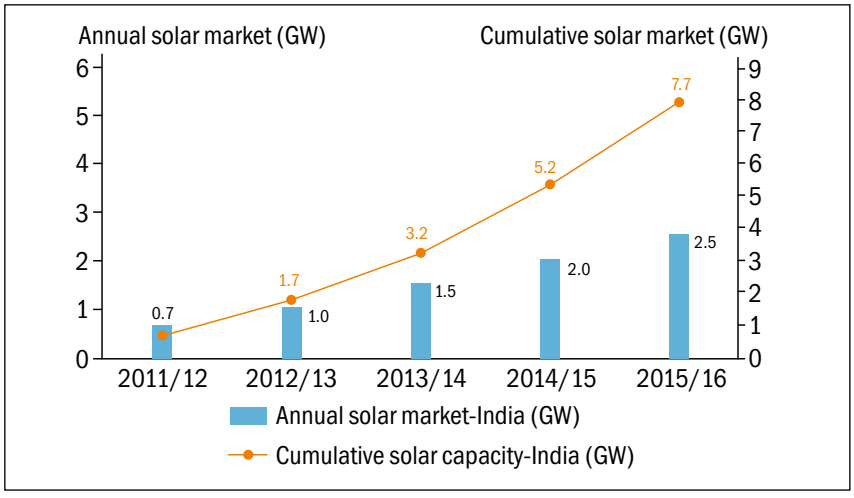


Figure 7 Medium term grid connected PV market opportunity

Source KPMG's Solar Market Potential Model

Grid connected market opportunity-medium term

The market will be driven in the medium term by the government support at the centre and at the state level. Our estimate of the likely market potential is shown in the exhibit. Furthermore amended tariff policy stipulates the solar power purchase obligation to go up to 3 percent by 2022. Accordingly, the solar power requirements and the corresponding estimates of the additional financial cost on the sector have been computed and are as shown in the exhibit. Unless the burden is shared through a credible funding plan, it would be difficult to sustain the solar power quantum. This stage is quite important if we are to achieve the longer term potential once grid parity is achieved.

This makes the case for the governments at the central and state levels to continuously support the solar program in the medium term. While the RPO scenario suggest a higher market potential, we have taken a more modest scenario considering the financial challenges utilities are likely to face.

Grid connected solar potential long term

Grid connected solar power potential has been estimated by looking at utility scale potential as well as grid connected residential rooftop systems.

Solar PV rooftops

The residential consumer category contributes to about 29% of the total Indian power requirement. This is expected to increase to 34% by 2021-22. Cost economics could drive the high end residential consumers to adopt solar rooftops a few years before the actual grid parity. We have segregated the residential consumption as the high end(more than 200 units per month) and the non-high end (less than 200 units per month). To estimate the solar rooftop potential in the residential segment during the sunshine hours , we have considered a typical load curve of the residential category as shown in the exhibit below. As can be seen from the exhibit above, the sunshine consumption corresponds to around 30% of the total daily consumption of a typical household. Solar power can be used to meet this consumption for a typical household. ■

KPMG headquarters in Detroit, US

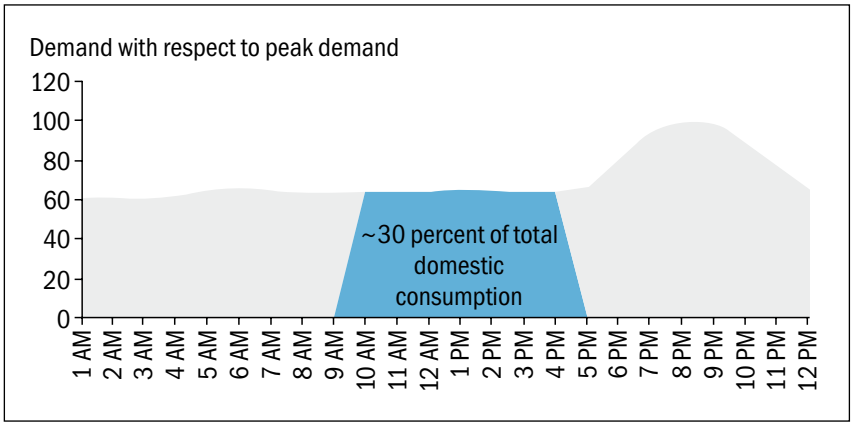


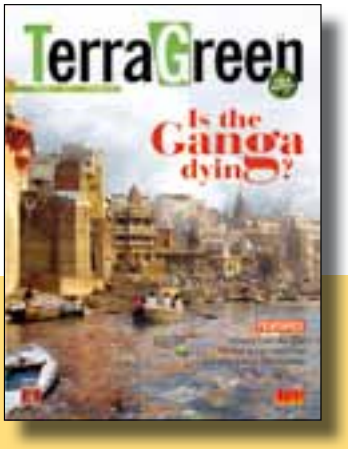
Figure 8 Typical load curve of residential category

Source KPMG's Load Curve Model for the state of Andhra Pradesh

Part II of the report will be carried in the next issue.

TerraGreen

EARTH MATTERS



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THE GROWTH OF THE SOLAR ENERGY PROGRAMME IN INDIA

Mr Tarun Kapoor is presently the Joint Secretary in the Ministry of New and Renewable Energy (MNRE), Government of India. With expertise in areas like hydro power generation, solar energy and macro issues in power sector, Mr Tarun Kapoor has worked for over four years as Director in a large Government company which owns and runs India's largest hydro-powering house of 15000 MW capacity. He also served for over three years as head of a Government-owned company developing 3000 MW hydropower and has also headed a power transmission company.

Presently posted in the Ministry dealing with renewable energy, Mr Tarun Kapoor oversees ministry work which includes the policy and programmes for promotion of solar, wind, small hydro, geothermal, and biomass in the country. Mr Tarun Kapoor talks to *The Solar Quarterly* about the emerging frontiers and challenges of Indian Solar Energy programme.

The solar energy programme has come of age in India. Could you kindly share your valued perception about its core strengths and opportunities at this juncture?

Solar Energy has certain advantages for India. Just to list a few - this is abundantly available all over the country; it can be made use of in remote areas and is absolutely clean and safe. The solar energy programme under the National Solar Mission covers both grid connected and off-grid solar power. It covers the entire country and has programmes to cover diverse and different energy needs of various parts of the country. It further aims at promoting solar energy through policy initiatives as well as monetary support. However, the biggest strength of this programme is its long term vision. Opportunities are tremendous considering the growing demand for energy in India, need for providing clean energy access and the recent developments all over the world which have brought down the price and thus improved the product penetration across several end-use applications further.

Do you view the formation of Solar Energy Corporation of India (SECI) as a big step forward to further bolster the image of solar power development both in off-grid and on-grid modes?

Formation of SECI is indeed a big step forward. There is a need for a strong professional organization to take this programme forward. While the schemes will continue to be largely implemented through the private sector and state nodal agencies, a strong organization is required to provide technical and financial help and also to directly step in certain areas or technologies.

Could you please familiarize us with the broad-based objectives of SECI and its expected roles and responsibilities in forging alliances with the key stakeholders in the solar community?

The SECI has a very broad mandate. It can directly execute projects, provide funds, channelize funds, provide

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technical guidance, do monitoring, disburse government subsidies, etc. It is expected to support the Government in implementing various programmes under the Solar Mission. The Solar Mission targets are big and so we need good institutional support for an effective implementation.

The solar programme of the ministry is often eyed as a window of opportunity to gain subsidy allocations. Is this trend going to continue keeping in view the current phase of enhanced technology commercialization?

Subsidies are being given to support certain products and make them popular so that with growing volumes, price will gradually come down. Ultimately free market has to prevail. This industry needs some support for the time being and then it will take off on its own.

There is a growing feeling within the solar energy community that on-grid solar programme is currently being accorded more attention at the cost of off-grid programme? Do you subscribe to this school of thought in any manner?

We are giving full importance to both on-grid and off-grid programmes. On-grid has got a lot of possibility as it is a new effort. Off-grid has been there for a long time now. On-grid is certainly giving big volumes (MW capacity) to the manufacturers and so the big manufacturers are probably giving it more importance. Gradually the market

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will adjust and take care of both these scenarios. Off-grid is very important for providing energy access particularly to the rural areas in the country. Gradually off- grid and grid connected configurations will start overlapping with introduction of large scale roof top connected to the grid and net metering.

The Solar Cities programme was put across with a purpose to showcase the immense potential of solar energy technologies for various end-use applications in an urban environment. Please tell us as to when we will be able to witness the selected cities for this novel demonstrated PV technology use donning the mantle of a full-fledged solar city?

Solar city programme is a very important programme. The first stage is preparation of plans for each of these cities. Thereafter these plans have to be accepted by the concerned urban local bodies and the state nodal agencies. Following which, a presentation is made before a committee in MNRE and the plan is accepted. Implementation starts after that. We have already accepted plans for five cities/ towns and implementation is starting now. Success, however, will depend on the interest shown by the various agencies involved.

The Ministry of New and Renewable Energy (MNRE) has been at the forefront of promoting PV building integrated energy use. Has there been any noticeable positive moment in convincing architects and real estate developers, etc., to deploy more of such systems?

Efforts to convince architects and real estate developers continues. Success is so far limited. But I am sure that we will see more use of PV in buildings in future.

Would you like to convey any special message to the young readers of our magazine in the backdrop of the solar industry offering major job opportunities in the near future?

Solar industry is in for a big growth. This will open great opportunities for employment at all levels right from entrepreneur to technicians. We are already facing a major shortage of trained manpower and are trying to get ITI's and other technical institutes to introduce solar technology into their curriculum. This is a very interesting area to work in where lot of innovation and independent thinking is possible. I therefore would like to encourage youngsters to learn about this subject and then if, they find it interesting, take it on as a profession. ■