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ENERGY AND NATURAL RESOURCES

The Rising Sun

A Point of View on the Solar Energy Sector in India

May 2011

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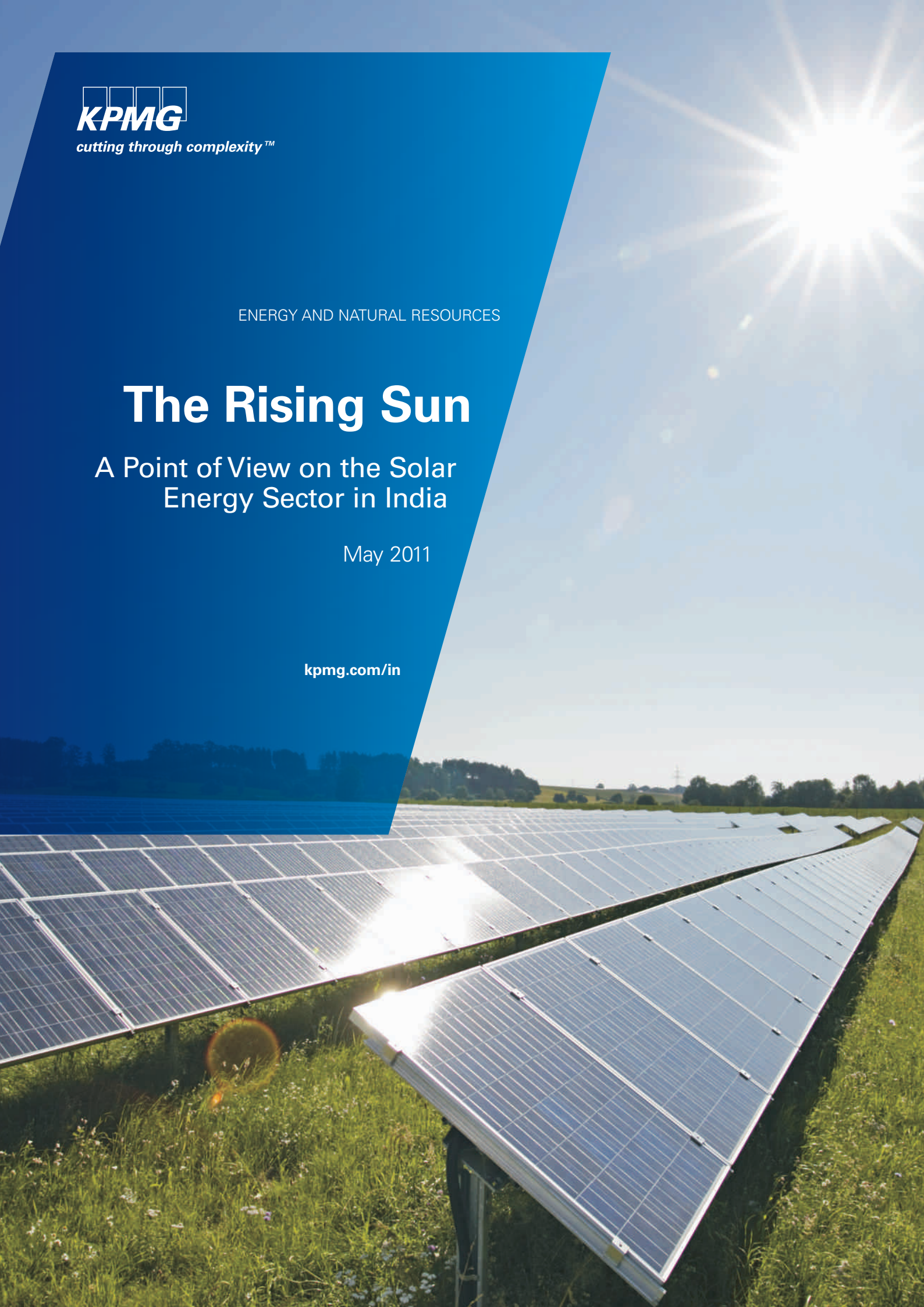


Executive summary

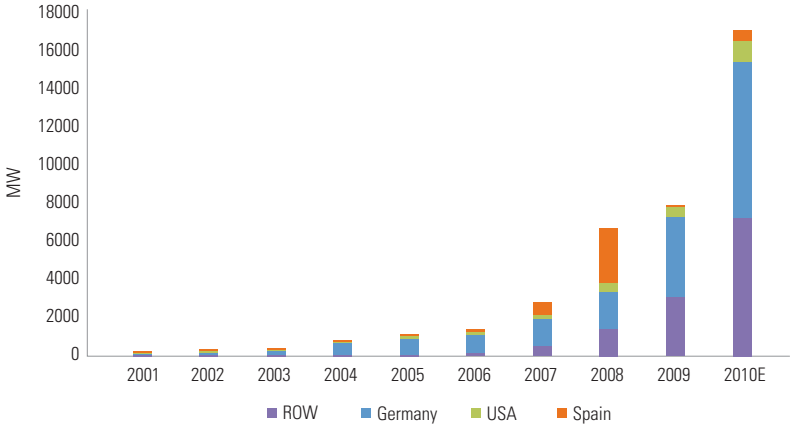
The Indian economy faces significant challenges in terms of meeting its energy needs in the coming decade. The increasing energy requirements coupled with a slower than expected increase in domestic fuel production has meant that the extent of imports in energy mix is growing rapidly. Oil imports already constitute nearly 75 percent of our total oil consumption. Coal imports which were negligible a few years back are likely to rise to around 30 percent of the total coal requirement by 2017. 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[1], India has a responsibility to achieve the growth trajectory in an environmentally sensitive and responsible manner. India has set a voluntary target to cut the emissions intensity of GDP by 20-25 percent by 2020 compared to the 2005 level.

In this backdrop, the thrust on renewable sources of energy is a step in the right direction. The Prime Minister's National Action Plan on Climate Change (NAPCC) released in June, 2008 envisages meeting 15 percent of our power requirements from renewable energy sources by 2020. One of the eight missions under the NAPCC is the Jawaharlal Nehru National Solar Mission (JNNSM) which was launched in late 2009. The mission targets 22,000 MW of solar power by 2022. The first phase of the program has been initiated and projects amounting to 704 MW have already been allocated. The policy goals and the steps taken to achieve it have been in the right direction. We must compliment the Government of India for taking this far sighted and strategic initiative with full earnest. In addition, some states, notably Gujarat, have taken visionary steps to support the program at the State level. Furthermore, the Renewable Energy Certificate (REC) mechanism which is already operational can play a catalytic role in the development of the solar power market in India. We believe the seeds have been sown for a rapidly scalable and a very large solar energy sector in the near future. As we will explain later, we believe that the potential of this sector and its impact on our strategic considerations of energy security and GHG mitigation can be far greater than is generally believed.

1. United Nations Greenhouse Gas emissions

Globally, the solar power industry has been growing rapidly in recent years. In 2010, an estimated total capacity of 17,000 MW was installed globally. Germany leads the race with more than 40 percent[2] of the total global market.

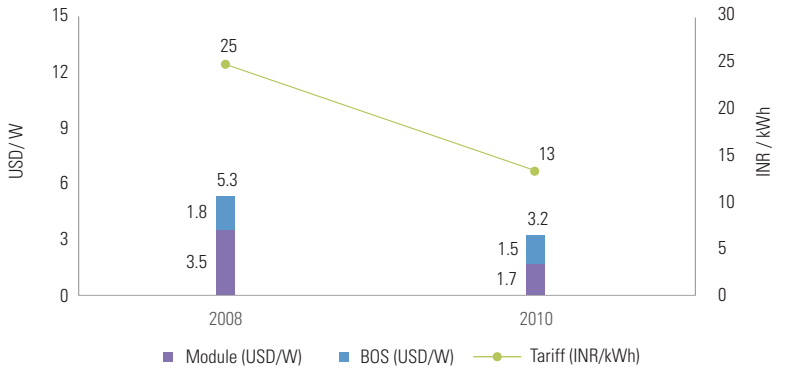
Global Annual Installations - Germany is the Market Leader



Source: EPIA, KPMG Analysis

The exponential growth is expected to continue and projected to be in excess of 40 percent annually in the coming years. This growth rate has been accompanied by rapidly declining cost curves as shown in the exhibit:

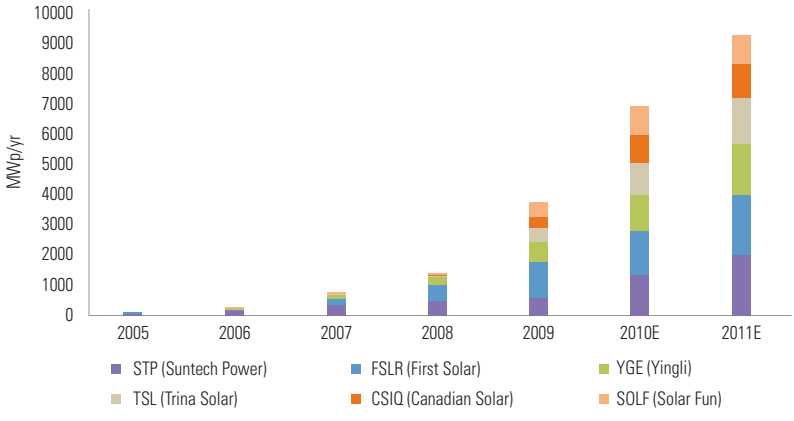
Globally, solar PV system prices have dropped significantly...



Source: Analyst Reports KPMG Analysis

The main drivers for this cost reduction are achievement of economies of scale, technological advancements and emergence of low cost manufacturing locations.

Significant scale up in manufacturing capacity - Select players



Source: Company Reports, KPMG Analysis

2. Solar Energy Industries Association & Germany's Federal Network Agency, IMS Research

These trends are definitely very encouraging and have positive implications for our energy security and future energy requirements. Solar energy potential is virtually infinite and if cost economics work out favourably, it can be tapped to meet a significant part of our needs. Here is an interesting statistic – a square piece of land in the Rajasthan desert with each side of 55 km can be tapped to generate enough solar power to equal the existing power generation quantum in India. A path-breaking initiative called the Desertec initiative actually targets to meet 17 percent[3] of Europe's power requirements by large scale solar plants in the North African region with power transported across the Mediterranean. Such is the potential of this vast energy source.

The key driver of the growth of this sector is a concept called grid parity. This refers to the point when the cost of solar power equals the cost of conventional power. In the recent round of reverse auctioning process for the solar projects under the National Solar Mission, the price discovery for levelized tariff was in the range of INR 10.49 /kWh to INR 12.24 /kWh for solar-thermal and between INR 10.95 /kWh and INR 12.76 /kWh for solar PV projects. As against these discovered solar prices, the conventional power at grid level, including the interregional transmission charges and losses, is available at INR 4.00 /kWh[4] on a levelized tariff basis. Moreover, the average landed cost of power at consumer end in 2010-11 is estimated to be as high as INR 5.42 /kWh[5], which factors the costs of the transmission and distribution network and includes the transmission and distribution losses. The pace at which the gap between solar power tariffs and the landed cost of power will be bridged will determine the pace at which solar power will take off. The point at which grid parity occurs is a function of two variables – the rate of increase in conventional power prices and the rate of decrease in solar power prices. Based on data from external sources and KPMG's own analysis, we believe the following could be the key trends:

- We expect landed cost of conventional electricity to consumers to increase over the next decade at the rate of 4 percent per annum in the base case and 5.5 percent per annum in an aggressive case. This factors in an increasing proportion of raw material imports, cost of greenfield generation and network assets and improvements in operational efficiencies of utilities.
- We expect solar power prices to decline at the rate of 5 to 7 percent per annum over the next decade. This is after factoring in ever increasing economies of scale in equipment manufacturing and advancements in product technology thereby improving solar-to-electricity conversion efficiencies. Emergence of low cost manufacturing locations are expected to aid this trend.

With these assumptions, we expect grid parity to occur in the years as mentioned in the table below:

	Aggressive Case	Base-Case
Grid Parity – All India	2017-18	2019-20

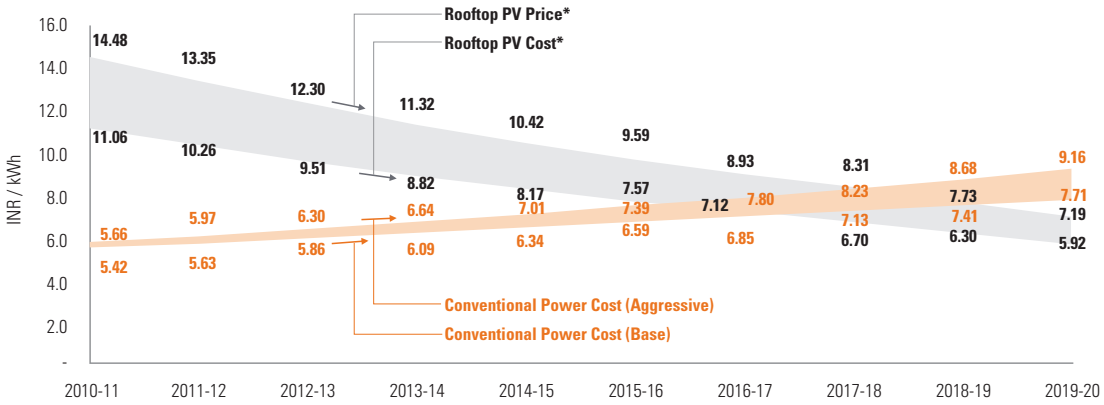
Source: KPMG in India's The Rising Sun, May 2011

3. http://www.desertec.org
4. While recent Case 1 bids have shown a levelized tariff in the range of INR 3.50 / kWh to INR 4.0 / kWh, we have taken the higher end of the range because utility scale solar plants are likely to be located in the north-western states and parts of peninsular India where the transmission penalty for conventional plants from the pithead is high. Further, medium scale solar plants can be connected at sub-transmission voltage levels and therefore have benefit of lower network losses.
5. PFC report on performance of State Utilities, KPMG Analysis

A similar conclusion is reached for distributed solar PV generation at consumer premises. In the exhibit below, we have showcased a band representing solar rooftop costs. The band variation signifies the margins, i.e. the difference between cost and price (includes margins across the value chain). We expect the solar tariff to lie anywhere within this band depending on the bargaining power of the developers.

The exhibit below captures the comparison between landed cost of power (LCP[6]) to residential or agriculture consumer categories in a particular year against the levelized solar tariffs in that year*.

Rooftop PV Costs vs. Conventional Power Cost at Consumer-end



Grid Parity Year	Aggressive Case	Base-Case
Rooftop PV Price	2017-18	2019-20

Source: KPMG's Solar Grid Parity Model
***Note** that the CDM benefit of INR 0.60 / KWH has been factored in the Solar Costs

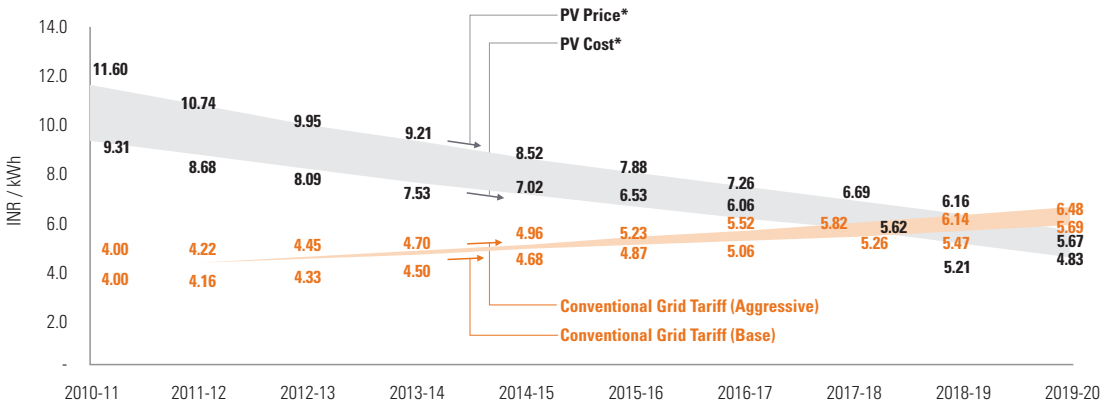
While we expect grid parity for these consumer categories – domestic and agriculture - in 2019-20, based on state-specific and end-use specific cost economics, the adoption for solar is likely to happen earlier.

We expect high-end residential consumers to be proactive in adopting solar rooftop given their higher power tariffs. A large number of these consumers are likely to start adopting solar power from 2017-18. However, government involvement will be required in encouraging non- high-end residential and agriculture consumers to use solar power from 2017-18. Roof-top PV will spur other intangible benefits. Being highly "visible" in the public eye, it will contribute to generating a great deal of awareness among the population about clean energy and benefits of distributed generation. This, we expect, will contribute to a culture of energy conservation and environmental responsibility which is very important from a national perspective.

6. LCP would include the power losses at transmission and distribution (T&D) levels and also the cost of servicing and maintaining the T&D assets.

The large scale utility power can be procured either from Solar PV or from CSP depending on the cost economics. In the exhibits below, we have captured various scenarios in which grid parity could occur for both CSP and PV technologies*.

Levelized Cost Comparison of Utility-scale PV and Conventional Power at Grid

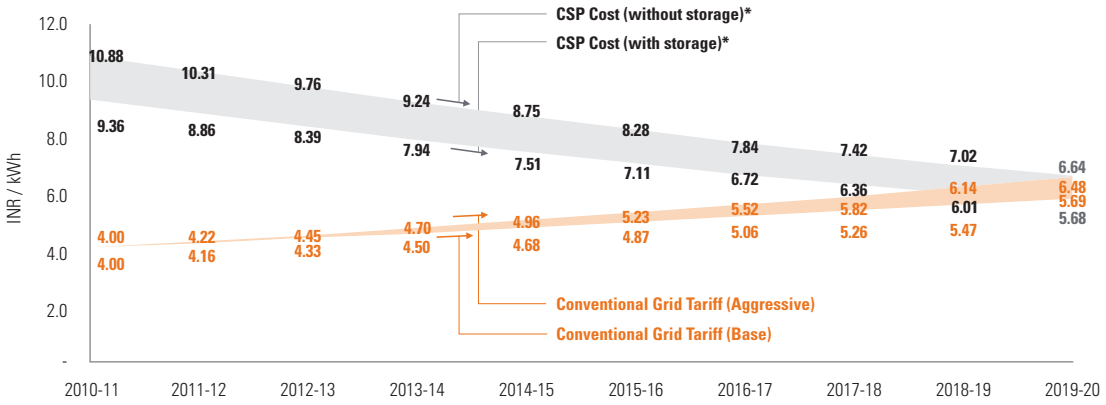


Grid Parity Year	Aggressive Case	Base-Case
Utility PV Price	2017-18	2019-20

Source: KPMG's Solar Grid Parity Model
***Note** that the CDM benefit of INR 0.60 / KWH has been factored in the Solar Costs

However, solar CSP, due to the storage factor, can be instrumental in meeting the evening peak requirements and therefore be potentially more attractive from a utility scale perspective.

Levelized Cost Comparision of Solar CSP and Conventional Power at Grid



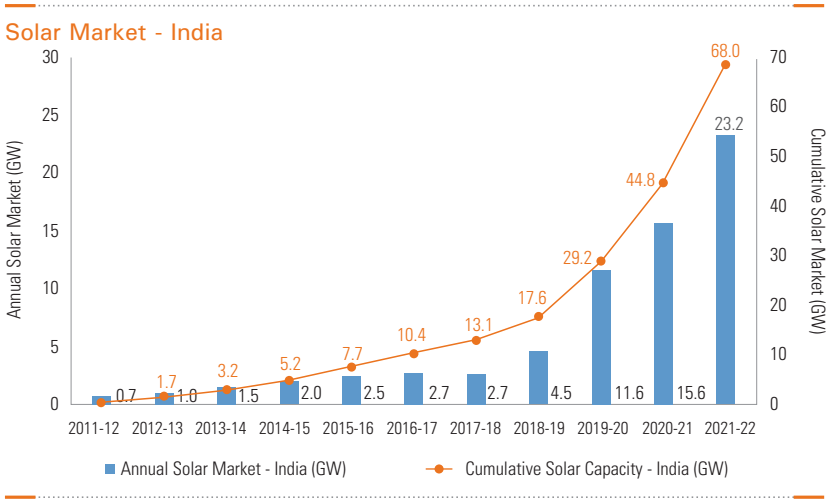
Grid Parity Year	Aggressive Case	Base-Case
CSP with Storage	2017-18	2019-20

Source: KPMG's Solar Grid Parity Model ***Note** that the CDM benefit of INR 0.60 / KWH has been factored in the Solar Costs

We expect the grid parity to happen in 2019-20 when the levelized tariffs from solar power are comparable with the levelized tariffs of grid power in this year.

It is important to state here that these conclusions are for broad-based grid parity across the country. Certain states will reach this point earlier. For example, the states of Rajasthan, Gujarat and Tamil Nadu are expected to reach this point earlier not only because they have higher solar insolation, thereby reducing the cost of solar power, but also because the cost of conventional power in these states is higher as they are located far away from coal resources and have little local reserves.

This conclusion has significant implications for market offtake of solar power. We expect significant offtake to start occuring in the years immediately preceding grid parity. The exhibit below captures our estimate of the solar market in India:



Source: KPMG's Solar Market Potential Model

In the table below, we have summarized the offtake trajectory from 2017-18 (the year from which we expect the cost economics to work in favor of solar power in India) from various segments – grid-connected and off-grid applications:

Annual Solar Market Off-take (MW)	2017-18	2018-19	2019-20	2020-21	2021-22
Grid-connected Solar Potential					
Residential Rooftop	1,024	1,356	3,600	5,341	7,677
Utility Scale Solar Power (CSP and PV)	1,043	2,229	3,570	5,084	8,146
Off-grid Solar Application Potential					
Solar-powered Agriculture Pumpsets	268	563	3,969	4,639	6,730
Solar-powered Telecom Towers	318	380	414	562	612
Total Annual Solar Market	**2,653**	**4,528**	**11,553**	**15,626**	**23,165**

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

This is significantly in excess of the targets under the National Solar Mission – cumulative capacity of 22,000 MW by 2022. The cumulative installations in the period 2017-2022 itself could be approximately 57,500 MW. In the period upto 2017, the market will continue to be policy driven. This phase of the market is extremely important if we are to achieve the rapid scale up post 2017.

In the off-grid space, solar power is already cost competitive with alternatives in certain applications. For example, telecom towers are an attractive market for solar PV installations. A large number of telecom towers are located in areas with limited or no grid connectivity and have to depend on diesel gensets for meeting their power requirement. Depending on the tower configuration and connected load, the price of diesel power can vary from around INR 15/ kWh to as high as INR 30/ kWh for low load towers in remote areas. Today, India has about 3.6 lakh[7] telecom towers that are likely to grow to 7 lakh towers by 2020 – a large proportion of the new towers would be coming up in rural / semi-urban areas reflecting the much higher pace of new consumer addition in rural / semi-urban areas compared with urban areas going forward. This would result in diesel consumption increasing from about 2 Billion liters / annum (comprising about 3.5 percent of India's annual diesel consumption) today to about 3.5 Billion liters / annum by 2020.

Solar PV installations are well suited to replace diesel consumption for the following reasons – solar power price is already competitive with the effective price of diesel based power for a large proportion of telecom towers and land availability for solar panel installations is generally not a constraint in rural / semi-urban areas.

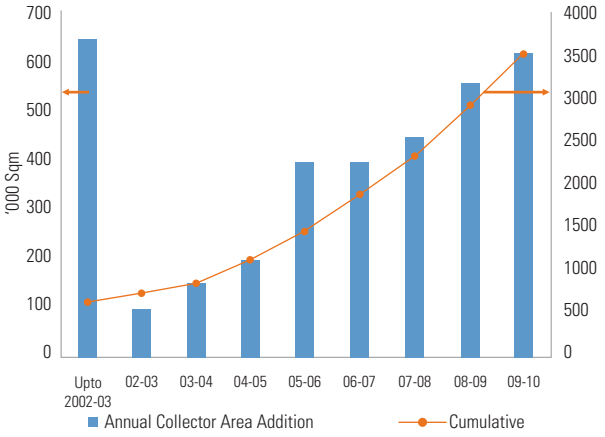
While solar power would not be able to completely replace diesel consumption, we believe that it has the potential to replace about 30 percent of diesel consumption. This implies a diesel saving of 5.4 Billion liters between now and 2022. This would also mean about 3,500 MW of solar panel installations that would create an industry (comprising of solar panels, inverters, battery banks and associated components) of USD 12.5 Billion in the same period.

Another off-grid application where solar power is well suited is the agricultural pumping segment. Presently, the power supply to agriculture segment is staggered and partially supplied during inconvenient night times when grid power is available. Solar power, with its ability to provide day time power, can meet the agricultural power demand from the farmers without the need to be connected to the grid. Moreover, unlike industrial and residential loads, the water pumping loads can tolerate a certain level of intermittency in power output, which is a characteristic of solar PV power.

The other segment of the energy market which can use solar energy is the solar water heating (SWH) segment. Solar water heating applications could be used in residential, commercial as well as industrial sectors.

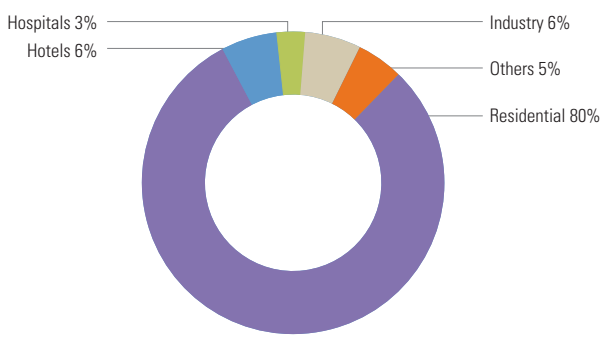
Internationally, SWH is a well developed technology and promises significant fuel savings and emissions reduction. China, European Union, Turkey, Japan and Israel are the leaders and cover about 90 percent of the global installed SWH capacity. While India is well endowed with solar insolation, the cumulative installed capacity in India in 2009-10 was only 3.53 million square meter. As a comparison, China with relatively lower insolation has 125 million square meters of SWH collector capacity.

Growth of SWH in India



Source: MNRE Estimates

Category wise break-up of SWH installation in India



Source: Greentech Report on Solar Water Heaters in India

7. IDBI report on Telecom Infrastructure

Residential SWH comprises ~80 percent of the total installed capacity. One of the biggest drivers of SWH offtake for residential applications is the favourable cost economics which works out to a payback period of 2.71 years. However, the barriers to this are the following:

- High upfront cost of the SWH systems. This can be potentially addressed through a consumer financing solution.
- Presently, the cost to consumer of alternates such as electric geysers do not fully reflect the true cost of these alternatives since electricity prices for the residential segment are mostly subsidised.

Hot water / steam are also vital inputs for a variety of industries including dairy, pulp and paper, textiles and leather among others. If solar installations were to replace fuel to an extent of 30 percent in industrial processes running below 250 deg C (where the solar solutions are relatively simpler) today, we believe that about 70 Mn Sqm solar collector area would be required. This would result in a saving of 4.8 Mn tons of oil per annum that is equivalent to USD 3.5 billion[9].For solar power to find a place in industry, we believe that emergence of solution providers who provide performance assurances is necessary. These solution providers would customize the product to meet each industry's specific need and provide assurances around hot water / steam requirements – duration of availability, temperature and pressure conditions, etc. We believe that solar equipment vendors would need to invest in technology as well as adapt to a more services driven model (similar to an Energy Services Company model) to be able to penetrate the industrial segment. However, we are confident that if and when such models evolve, the solution providers will find significant demand from the industrial segment.

We have discussed SWH implemetation issues in more detail in the main report. The table below summarises the potential for residential and commercial segments:

SWH Market Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Collector Area - Mn Sqm[8]	4.4	5.8	7.9	11.3	16.1	22.3	30.5	40.8	51.1	61.4	71.7
Incremental Market Size – USD Mn	219	230	363	635	915	1,212	1,664	2,143	2,207	2,273	2,342

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

To summarise, solar energy has immense potential to meet our energy requirements. If the potential as described earlier is achieved, solar energy has the following significantly positive implications for our energy security and climate goals:

- Solar energy can contribute to about 7 percent of our total power needs and displace ~16,900 MW[10] of marginal conventional power by 2022 implying a saving of 61 MTPA of coal / annum. Additionally, 72 Mn sqm of solar collector area can save about 11 MTPA of coal / annum. Since this reduction would spare the marginal requirement which is likely to be imported coal, this would mean a saving of 71 MTPA of imported coal which is a reduction of more than 30 percent of our coal imports.
- Furthermore, solar power can save 95 Million Tonnes of CO2 per annum by 2022. This is ~2.6 percent of India's total emissions in that year and will be a very useful contribution to our voluntary target of 25 percent reduction in the carbon intensity of GDP.

8. Usage of solar power for telecom towers and capturing solar heat through collector area installation are already economically viable options. Hence, from an economic viability perspective, these applications do not have to wait till 2017-18 for a self-sufficient market to get created.
9. BP Statistical Review - Conversion factor from MTOE to MBOE is 7.33. Assumed oil price is USD 100 per barrel
10. This calculation factors the PLF of conventional plants and solar plants.

However, for all this to be achieved, the Government has an important role to play in the coming five years. These include the following:

- Keep the market stimulus going
  The first phase under the JNNSM is the right beginning. The Government has to keep the market going so that the supply chain and ecosystem continue to evolve for the rapid scale up. A graduated scale-up is desirable rather than a fits-and-starts approach. The scale-up should be calibrated based on trade-off analysis between current affordability and long term benefits.

- Get the funding in place and channelise it to the utilities
  The Indian power utilities are highly cash strapped and reeling under the burden of rising fuel costs and greenfield investments. They need to be given the full support to absorb the cost of this program. A more direct support from the Centre to the state power utilities is the need of the hour. In the absence of this, the program has a serious risk of derailing. We understand that steps are being taken to utilise the fund created by the cess on coal (National Clean Energy Fund) to assist states in building the evacuation infrastructure. While this is welcome, we suggest a more broad based utilisation of this fund that will support states in meeting their RPO (Renewable Purchase Obligation) targets for solar power.

- Government should play an active role in giving the requisite support to the lending community
  In the first phase of the program, the lending community is likely to have concerns related to technology risk and power off-take and payment security. The Central Government has indeed evolved innovative steps under the National Solar Mission such as the bundling program wherein the solar power is pooled with conventional power and the bundle is sold to state utilities at an average rate. This softens the impact of the higher price of solar power and gives comfort to lenders that payment default is less likely to occur. However, we believe the following steps can be taken to further strengthen the environment for financing: 1) Classify renewable energy and cleantech areas as a separate sector for measuring sectoral exposure limits for banks; currently they are considered part of power sector for measuring exposure limits leading to sectoral limits emerging as a constraint 2) Grant priority sector lending status to solar sector and 3) Allow banks to issue tax free solar bonds which will enable access to a long tenure stable interest rate source of finance. Further, for the first phase of the National Solar Mission projects, it would be prudent to provide a calibrated back-stop arrangement (atleast for a certain time frame) in the event of payment default by states utilities. We understand that such a mechanism is being worked out and that will indeed be a very supportive measure. It is important that the first phase of NSM receives the necessary financing to be successful. This has serious implications for the long term.

- Support domestic R&D through public-private collaboration
  While vendors may be able to indigenize certain low value components of both grid and off-grid applications by themselves, high value technology intensive components may require R&D support from Government agencies / institutions for indigenization. Some examples of such components are absorber tubes for parabolic trough plants and collector dishes for high temperature / pressure industrial processes. Institutes such as the Indian Institutes of Technology could collaborate with the industry under a Government driven R&D funding framework to engineer products in the country. There are successful examples from the US where the National Renewable Energy Laboratory (NREL) collaborates with the private sector for collaborative research.

- Look at innovative possibilities for large scale solar powering of agriculture pumpsets
  The total connected load of agriculture pumpsets is expected to be in excess of 100 GW by 2020. We believe that this could be a very large market for solar-powered pumpsets and could commence earlier than expected if the Government adopts an innovative execution model that provides scale to manufacturers to bring down costs and a viable service delivery chain to provide a reliabe solution to the farmers. To start with, diesel replacement can commence immediately due to favourable cost economics. Pilots in this direction should commence immediately.

- Push Solar Water Heating (SWH) in residential catergory
  Various State Governments and Municipal Corporations have implemented policy measures such as mandating SWH installations by amendment of building bye-laws, rebate in property tax, rebate in electricity bills etc. Additionally, MNRE has programmes for providing interest rate / capital subsidies for SWH installation. In our view, while these programs have met with success in a few regions, the potential is far from realised. Reasons for this could be lack of awareness of policy measures among users, lack of interest among banks to actively fund SWH installations and certain concerns in the mechanism of capital subsidy disbursement. We believe that the schemes / policy measures need to be strengthened through an effective dialogue between stakeholders (end users, Government , Municipal Corporations and Financial Institutions). Also, mandatory implementation policies need to be followed up with effective monitoring to ensure compliance.

From an industry standpoint, the solar sector presents an immense opportunity. The total investment requirement in only the "projects" or "applications" space (not including manufacturing) is an estimated USD 110 billion in the period 2012-22. This could provide tremendous potential for solar-specific product markets (inverters, parabolic mirrors etc.) to develop in India during the corresponding period, which could be around USD 30 billion.

For mainstream solar companies, we believe that the following are the key imperatives in the near term:

- Since there is intense competition among the players to get access to projects which are limited in number, it is necessary to work out a model which gives a cost advantage and thereby enables a higher chance of winning projects. Sources of cost advantage could be a certain level of vertical integration into the manufacturing or EPC value chain, access to land sites where solar insolation is superior and access to low cost financing.

- Solar companies should also keep a slightly broadbased focus and include segments like off-grid applications and other renewable technologies in their portfolio. This will enable them to optimise their resources in an environment where access to new projects may be uncertain.

- Indian companies should also look at overseas solar markets in the US and Europe for access to projects. In the immediate future, these markets will offer more opportunities and help Indian companies to move up the learning curve and be poised to capitalise on the Indian market when it scales up rapidly. Transaction opportunities to access these markets should be explored.

On the supply chain front, industry will have to gear up to meet this massive requirement and this presents an opportunity from manufacturing to system integration to installation services. The manpower requirements will also be very large and more than one million direct jobs are likely to be created by 2022.

We believe that the solar energy sector is going to have a discontinous impact on our energy sector and certainly a positive and welcome one. The impact will come sooner than most people expect and therefore a readiness to respond to this opportunity needs to be developed if we are to capitalise on it in a timely manner.

It is fair to say that as far as harnessing energy from the sun is concerned, "The Sun Is Rising" and we must equip ourselves to make the most of it.

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