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ENERGY AND NATURAL RESOURCES

The Rising Sun

Grid parity gets closer

A point of view on the Solar Energy sector in India

September 2012

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01

Foreword

The Solar PV industry has seen dynamic changes in the last twelve months. Module prices have seen precipitous fall thereby encouraging forecasts of early grid parity; while at the same time, this has raised concerns about the health of the manufacturing sector and sustainability of the cost reductions. In our last report released in May 2011, we anticipated utility-scale grid parity in the timeframe of 2017-2019 for India. We now believe it is likely to occur at the earlier end of that range and therefore solar power presents a potential disruptive change in our energy scenario. This could help India leapfrog the energy technology space, and enable solar power to make a meaningful and substantive contribution to our energy scene by the end of this decade. Policy makers need to take a serious note of this potential.

The National Solar Mission has triggered the development of solar ecosystem capacity in India in the last two years. India's solar capacity has grown from less than 20 MW to more than 1,000 MW in the last two years[1]. The seeds have been sown and the investments in capability building have been made. What is now needed is that the 'green shoots' have to be nurtured; else, we could see them die away, putting significant national resources to waste. We believe that the Government should keep the momentum going by providing sufficient clarity on the market, announcing the next phase of the NSM quickly and addressing some regulatory issues which can open up the private contracts market.

This year, our report focuses on the solar cost trends and looks at segments of the market which are most suitable for adoption of solar power within the coming few years. Given the financial position of the power utilities, we believe that rooftop market for customer segments that already see parity with utility power tariffs has the potential to be a game changer in the coming five years. Within rooftop, the solar lease model is becoming attractive in the Indian market. Given the fuel, land and environment challenges that the country is facing in setting up new power capacity, we feel that the state governments, utilities and regulators should encourage this market to realize its potential by providing critical enablers such as net metering infrastructure, banking facility and developing an ecosystem for rooftop market installations.

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1 Ministry of New and Renewable Energy (MNRE)

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01

Executive summary

The challenges in the power sector continue. India is facing a power deficit of 9 percent[1] and this is likely to continue over the next few years. In many states, industries are facing upto 50[2] percent power cuts. The gap between the power purchase costs and the power tariffs has severely constrained the finances of state power utilities with net losses estimated at around INR 88,170 crores[3] in 2012-13. India faced massive power black-outs in July, 2012 due to overdrawing and grid indiscipline.

On the other hand, solar power costs have reduced rapidly in the last few years. Globally, the solar photovoltaics (PV) market has grown from around 9.5 GW in 2007 to 69 GW of cumulative installations by 2011[4]. Accordingly, the solar PV industry has grown from USD 17 Bn in 2007 to USD 93 Bn in revenue by 2011.[5]

The Indian solar market has seen significant growth with the installed solar PV capacity rising from under 20 MW to more than 1000 MW within the last two years. In fact, the tariffs discovered in the highly competitive bidding in the recent rounds of auction under Jawaharlal Nehru National Solar Mission (JNNSM) and State level programs are already comparable to the marginal power tariffs applicable for industrial and commercial power consumers in some states in India.

Table 1: National Solar Mission - Tariffs Discovered[6]

	Round – I (Dec - 2010)	Round – II (Dec – 2011)
Solar PV Tariffs		
Highest Tariff	12.75 (USD0.23)	9.44 (USD0.17)
Lowest Tariff	10.95 (USD0.20)	**7.49 (USD0.14)**
Median Tariff	12.12 (USD0.22)	**8.91 (USD0.16)**
Marginal Retail Power Tariffs	**5.50 – 7.50[7] (USD0.10 - USD0.14)**	

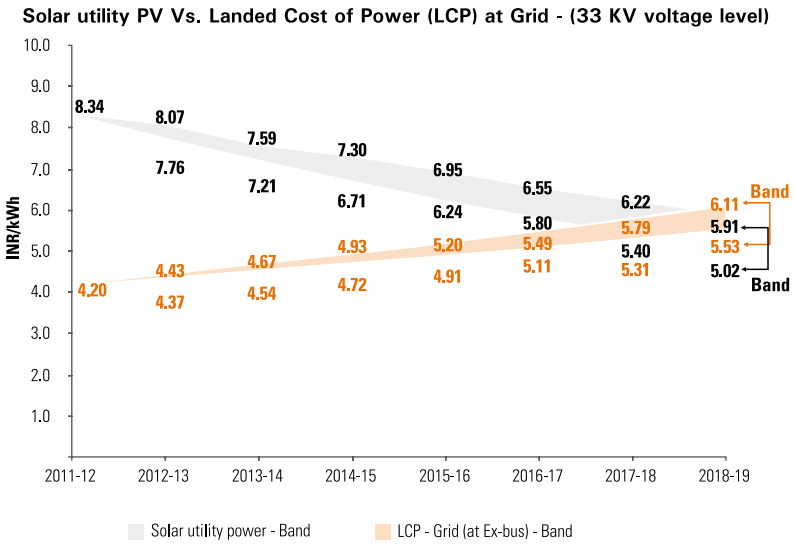
1 CEA – Monthly Highlights of Power Sector – July,2012
2 CEA – Monthly Highlights of Power Sector – July,2012
3 Thirteenth Finance Commission Report
4 BP Statistical Review - 2012
5 Solarbuzz
6 Exchange Rate – INR 55 per USD
7 Power tariff range for the highest slabs for certain consumer categories across States as per the State Tariff Orders

We had estimated in our analysis last year that grid parity could happen in the period 2017-19. The recent trends in the solar power prices indicate that utility scale grid parity could happen at the earlier end of this range[8].

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. We believe the following could be the key trends:

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

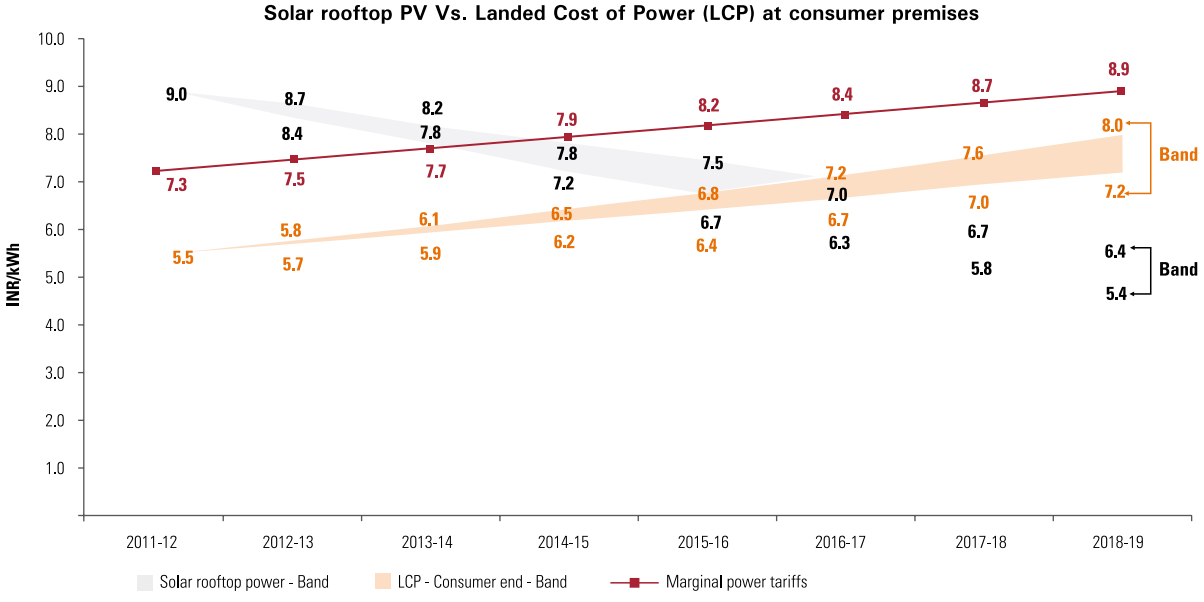
Fig.1: Grid Parity for Solar Power – Utility Level



Source: KPMG's Solar Grid Parity Model

It is also worthwhile to look at parity in respect of cost of power delivered to the consumer i.e. consumer level conventional landed cost of power vis-à-vis the cost of power from solar PV installation on the rooftop.[9]

Fig.2 Grid Parity for Solar Power - Consumer Level



Source: KPMG's Solar Grid Parity Model

8 Levelised power tariffs – INR 3.75 per unit; T&D Cost – INR 0.15 per unit (upto 33 KV level); Losses – 8.0 percent

9 Levelised Power Tariff – INR 3.75 per unit; T&D Cost – INR 0.80 per unit; Losses – 20 percent

The prevailing power tariffs for some cross-subsidizing consumer categories are higher than the landed cost of power. Helping the case for consumer end parity is the recent rise in power tariffs for consumers across multiple states. We believe that grid parity could happen earlier for certain market segments – especially the industrial and commercial category of power consumers. The retail tariffs of these segments are already upwards of INR 7-8 per unit at the margin and would be even higher if one were to take a levelised view (long-term cost).

An innovative lease model can further improve the market attractiveness for consumers by avoiding high upfront costs and reducing monthly power bills. For example, a high-end residential consumer[10] can install a 1 KW solar PV system[11] - to reduce marginal power consumption - with a monthly EMI payment of around INR 2000[12] for five (5) years and avoid an average discounted monthly payment of around INR 1200 over the lifetime (25 years) to the grid. With rising power tariffs, the lease model can make it attractive for power consumers at the bottom of the pyramid - the less affluent residential power consumers - to adopt solar PV systems within this decade.

Further, even at the wholesale procurement level for utilities, the marginal cost of power procurement is in the range of INR 4.00-5.50 per unit[13] in many states, which after adding the costs of transmission and distribution and associated losses comes to INR 5.50 -7.50 per unit[14] as delivered to the consumer. As a result, when utilities supply power during the power deficit situation and in peak periods, the state power utilities are often not in a position to recover their power purchase costs through consumer tariffs. Hence, there is a case for the utilities to encourage rooftop solar power for captive consumption that can displace the need for power procurement on the utilities part. Looking at the economic analysis, we believe that over the next five years around 4000-5000 MW of rooftop solar power market potential can be economically viable. To realize this however, utilities and regulators should create an enabling environment recognizing the specific characteristics of solar power.

Solar power can already economically reduce diesel power consumption. The cost of diesel based power production is upwards of INR14/kWh, much higher than that of solar power; however, diesel power is available on demand. In states which have power deficits, if utilities agree to regulate load shedding to consumers according to sunshine hours, then solar power can effectively mitigate diesel consumption, thus saving the economy precious resources and foreign exchange. By extending the 'banking facility', which allows the consumer to get an offset for solar power generation against his monthly energy consumption, and by providing the required metering infrastructure, utilities can play an important role in developing solar power market for captive consumption. The 'banking facility' would enable a captive solar power producer to inject power into the grid and draw it back as and when required - subject to the terms and conditions of the agreement with distribution utilities.

While the Renewable Energy Certificate (REC) market for solar power is still in a nascent stage, the enforcement of renewable purchase obligations on utilities and captive consumers along with the energy efficiency scheme Perform Achieve Trade (PAT) of Bureau of Energy Efficiency (BEE) can give a push to the solar market. PAT scheme, under the National Mission on Enhanced Energy Efficiency (NMEEE) is aimed at improving energy efficiency in the industry thereby reducing energy consumption. In the first phase, 478 designated consumers have been given around 5-6 percent energy reduction targets to be met over a period of three years. Use of renewable energy in place of conventional power allows these consumers to get an offset against their energy consumption.

10 Monthly average power consumption ~ 400 units

11 Solar PV system can replace the day time power consumption ~ 30 percent of the total power consumption of a consumer from the grid

12 Zero Downpayment

13 Tariff Petitions from Distribution Utilities

14 Transmission & Distribution (T&D) Cost – INR 0.80 per unit, T&D loss – 20 percent

Being intermittent in nature, it is argued that solar power could pose grid integration issues. Several studies[15] on distributed generation suggest that penetration levels of upto 15 percent are permissible without requiring any additional investments. While grid integration issues may not be an area of concern in the next five years even if the rooftop market penetration accelerates, yet a detailed interconnection study needs to be conducted taking into account the immense potential that rooftop market provides. Such studies have been conducted in countries where a high proportion of energy comes from renewable sources and have resulted in transmission related investments as well as specification of standards for renewable energy production equipment.

Another segment of solar energy that is witnessing increased level of interest recently is the solar thermal market for process heating. We believe that the economics for this market should drive usage of solar community cooking, industrial process heating and solar enabled cooling given the favorable payback with fuels such as furnace oil, diesel, and commercial LPG. We believe that the market potential of the solar thermal process heating industry comprising – community cooking segment, cooling segment and industrial process heat for priority industries - to be about 5.25 Mn sqm of solar collector area.

Based on our analysis of various market segments, we believe that the cumulative solar PV power market potential is likely to be around 12.5 GW by 2016-17. The table below summarizes our estimates of potential for solar PV across key market segments:

Forecast of the solar power market in India

<table>
<tr><th>Distributed Generation</th><th>Utility Scale Projects</th></tr>
<tr><td>Rooftop Market ~ 4,000 MW
(Fast approaching grid parity)</td><td rowspan="2">Government Support Utility Scale Market ~ 4,000 MW
(Phase – II program of Central Govt and State solar programs)</td></tr>
<tr><td>Diesel Replacement ~ 2,000 MW
(Driven by economics)</td></tr>
<tr><td colspan="2">Captive and REC Market ~ 2,500 MW
(Driven by solar renewable purchase obligations and Accelerated depreciation market - shifting demand from wind power)</td></tr>
<tr><td colspan="2">Total Solar Market Potential (by 2016-17) ~ 12,500 MW</td></tr>
</table>

Source: The Rising Sun - 2012, KPMG in India analysis

15 US DOE – Sunshot Vision Study; EWEA – Large scale integration of wind energy in European power supply

Central and State governments have an important role to play in harnessing solar power. Supporting solar industry over the next five years is crucial to realize the immense potential solar power offers for an energy starved country like India. Some of the enabling measures include:

- Provide market certainty and stability in the near term – The worst thing to happen to the sector is a sudden withdrawal or reduction of the market support that has been provided in the last two years. Ecosystem capacities have been built on the back of this support program, and a stable gradual program needs to be sustained. This means that the next round of the central program needs to be announced quickly.
- Share National Clean Energy Fund (NCEF) with State Governments – The NCEF has been created through levy of a cess on coal which is ultimately borne by states/consumers. A direct subsidy from this fund can be provided to states that meet certain targets in encouraging solar power. This financial assistance can help States support solar power and mitigate payment security concerns.
- Promote retail participation in Renewable Energy Certificates (REC) trade – The REC market provides an alternate market option today for renewable energy producers. By enabling access for retail and off-grid consumers - the adoption of solar power can be increased substantially. Moreover, increase in participation in the REC trade will lead to higher liquidity and promote transparency in the market.
- Promote 'private contracts' solar power market – Solar power is likely to reach parity for retail power consumers earlier than at the grid-level. Rooftop and small scale solar power projects at consumer-end have several advantages over grid connected solar power plants. State governments and regulators can encourage deployment by providing the necessary infrastructural support, appropriate regulations such as 'banking facility' or 'net metering' facility that allow commercial viability for power.
- Consider providing a partial risk guarantee mechanism – We have seen use of foreign currency financing in many solar projects which have enabled the cost of power to be reduced substantially. Financing related costs can contribute as much as 45 percent of the total cost of solar power. It is encouraging to see dollar denominated funding flowing into the sector. However, the recent volatility in the currency movements will raise the cost of such financing. A partial risk guarantee fund can be created by the Central Government to mitigate this risk. The economic rationale can be developed based on the long term mitigation of forex exposures due to enhanced energy security and lower dependence on energy imports that solar power will enable.
- Support lending community – Increasing the availability of credit to solar market is critical for the success of solar program in India. A separate solar/renewable energy sector specific exposure/cap can go a long way in increasing the pool of financial resources for solar sector. Given the importance of energy security and carbon mitigation potential, lending to solar/renewable sectors should be classified as 'priority sector'. Furthermore, debt mobilization through say - long tenure tax free solar bonds - can go a long way in providing access of low cost long term debt for developers. This can address the inherent asset liability mismatch of the banking system and lend stability to the interest rates charges on developers.
- Creation of Solar Sector Focused Manufacturing & Investment Zones – Government of India has proposed the creation of a number of National Manufacturing & Investment Zones (NMIZ) to boost growth of manufacturing sector in India. The concept of NMIZ proposes a framework for more business friendly policy, procedures and approval ecosystem, combined with superior physical infrastructure[16]. Government should consider developing solar industry focused manufacturing and investment zones to encourage investments in this clean source of energy. This will enable development of scale economies and equip India with the required supply chain manufacturing infrastructure to harness its immense solar potential. In addition, the State Governments could identify potential sites for developing solar parks with all the basic infrastructure in-place.

In sum, supporting solar power in the next five years is important to nurture the 'green shoots' that have emerged in the ecosystem and set the platform for solar power to play an important role in meeting the energy security and clean energy considerations of India. As mentioned in our earlier report of May 2011, we believe that solar power can make a substantive contribution by the end of the thirteenth plan, potentially meeting as much as 7 percent of our power requirement and mitigating 30 percent of our imports of coal and 2.6 percent of our carbon emissions in that year. The forex savings due to coal and diesel mitigation can be as high as USD 8 billion per annum[17] by then.

The promise of this great source of energy has grown stronger over the last one year. In this respect, the sun has truly risen.

16 "Ministry of Commerce & Industry, Press Information Bureau, January 2011"
17 Total Coal Savings ~ 70 Mn tones; Coal Price – USD 100/tonne, Diesel Savings – 1 Bn litres

02

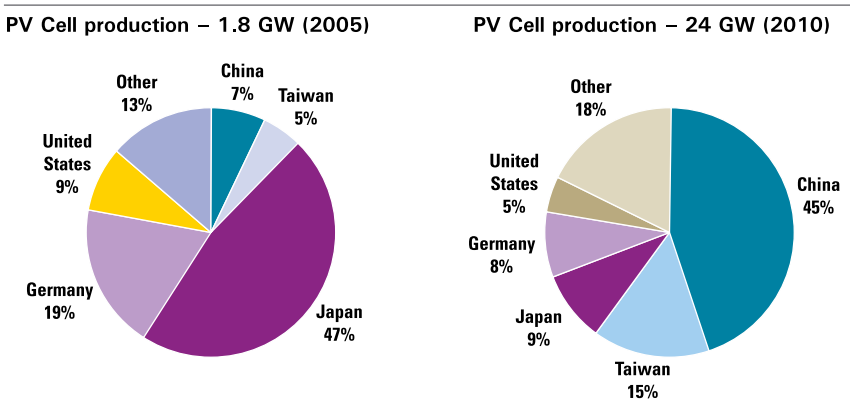
Our projections on grid parity

A big driver of increasing solar installations has been a sharp reduction in solar PV module prices. Post the crash in poly-silicon prices in 2008, large scale manufacturing of PV modules has picked-up in China taking advantage of the presence of local raw materials, experience in electronic manufacturing, low labour costs and Government incentive support. The profile of the leading companies in the solar industry has undergone a significant churn.

The Bloomberg Bisolar Index comprising of the list of large companies in the solar market shows an increase in the number of players in the solar market and points towards a gradual shift from West to East with Chinese companies dominating the index. Market share of companies like Q-Cells, a PV manufacturer based in Germany, which dominated the industry five years ago (having about 10 percent market share of global production) has now been replaced by new entrants like Suntech, Trina and Yingli.

While the global solar industry has grown consistently over the past decade, the market has experienced exponential growth in the last 2-3 years with the number of installations growing at over 50 percent YOY.

Table 2: Geographic distribution - Solar cells production



Source: Earth Policy Institute

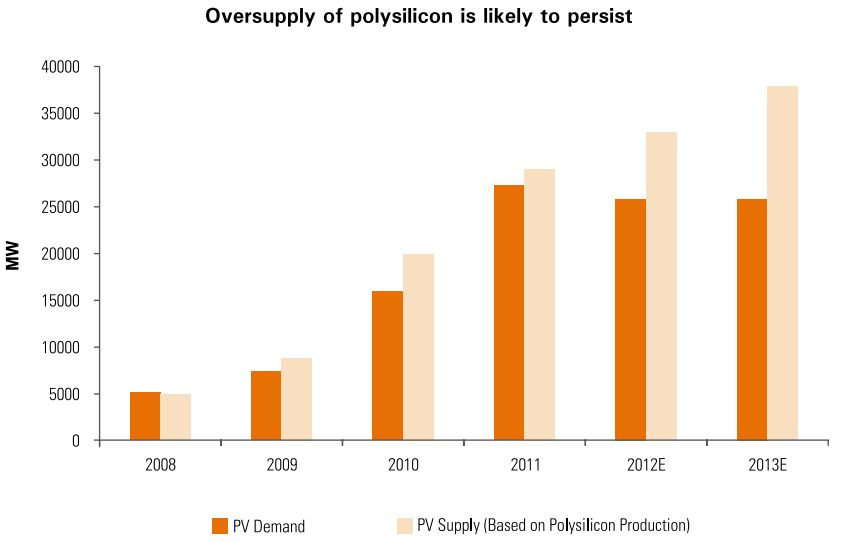
From 2004 to 2008, the global solar market was driven by favorable economic conditions and proactive support by the Governments in Europe, primarily in Germany and Spain. For a short period, the increase in demand for solar PV installations drove up the prices of poly-silicon and resulted in creation of profit pools across the solar PV value chain. However, the emergence of large low cost manufacturing capacity, reduction in poly-silicon prices, along with a fall in the feed-in-tariff in major European nations has contributed to prices dropping rapidly leading to increase in solar power installations. The global market has also received a boost through market support programs for solar energy in countries like China, US and India over the last 2-3 years. This high demand growth has been followed by significant capacity additions by most solar manufacturing companies, contributing to a further decrease in prices due to scale benefits and efficiency improvement.

Global demand supply

Globally, the pace of manufacturing capacity additions/supply has outstripped demand growth. For example, the capital intensive polysilicon manufacturing capacity segment saw significant ramp-up in the last few years leading to a crash in the poly silicon prices.

Moreover, since module production capacities can be ramped up/shut down quickly, the gap between the polysilicon demand and supply will be crucial in determining the overall market equilibrium in this industry.

Fig.3: Global demand supply of polysilicon



Source: Analyst report – Deutsche Bank

While different estimates are available on the extent of mismatch between supply and demand and on the timelines for reaching equilibrium, the general consensus is that the oversupply conditions will persist over the next 12 to 24 months.

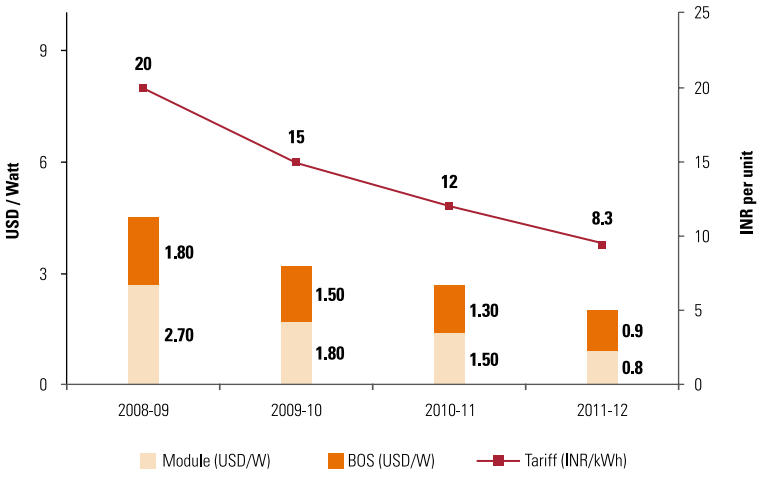
Top European markets like Germany and Italy, which together have accounted for around half of the global solar PV market installations in 2011, have announced tariff reductions and cap on incentives. For instance, Germany, the market leader in the solar installation space with over 28 GW[1] of cumulative solar PV capacity, has approved feed-in-tariff cuts of 20-30 percent and capped the applicability for incentives at a cumulative installation of 52 GW. This could lead to a drop in the global annual installations market.

Given this backdrop, we believe that, going forward, the global solar PV market would increasingly be dominated by countries like China, US, Japan and India.

2.1 Solar market – Cost reduction trends

The solar industry has seen a drastic reduction in the selling price of solar modules during the last year. Most leading solar PV manufacturing companies have been adversely affected. In fact, the drop in prices has resulted in large-scale consolidation in the global solar PV manufacturing industry.

Fig.4: Solar PV system price trends



Source: Analyst report – Deutsche Bank

1 http://www.renewableenergyworld.com/rea/news/article/2012/06/deal-reached-on-german-feed-in-tariff

Several solar manufacturing companies globally have filed for bankruptcy or cut operations over the past year, including former world No 1 PV cell maker. The list of companies includes industry pioneers such as Q-Cells, Solyndra, Abound Solar, Solar Millennium, Solon, Centrotherm, and Schott Solar etc.

Moreover, an analysis of the financials of leading solar PV manufacturing companies indicates that most of the companies are not in a position to recover the margins required to realize their full costs. Given the global demand supply scenario, it is expected that the companies would be finding it increasingly difficult to make money unless they lower the production costs further. On the other hand, the decline in solar system prices is driving the solar end-use market.

Forecast of solar power costs

Economies of scale, technological innovation and the learning curve effects continue to drive the costs further down. The contribution of Balance of System (BOS) costs in the total solar system costs as a percentage is on the rise and is already more than 50 percent[2].

Solar module

Solar module costs have seen significant reduction owing to innovation contributing to lower manufacturing and processing costs. Some of the key drivers that are likely to contribute to the cost reductions going forward have been summarized in the adjacent table:

In the current scenario, most producers are at best recovering operational costs with the current sale prices not being adequate to cover the cost of capital.

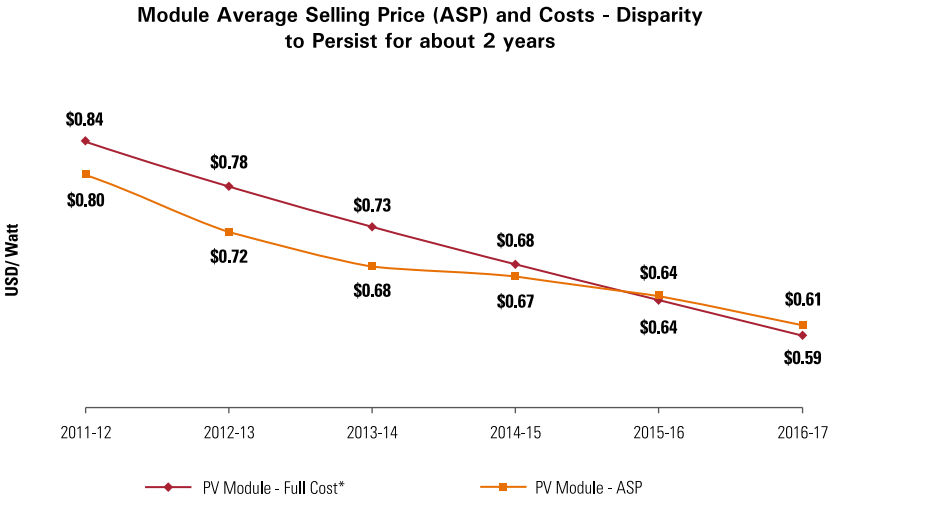
The increase of Average Selling Price over cost from 2014-15 onwards is due to an estimated improvement and consolidation in the global demand/supply scenario for solar PV modules. Subsequently, it could be expected that the pricing power of the module manufacturers would improve.

Table 3: Solar PV cost reduction - Drivers

Module-Level	2010	2012	2016
Wafer thickness (Micro meters)	200	180	125
Silver Per Cell (grams/cell)	0.3	0.23	0.1
Cell efficiency	14%	16.50%	20%
Glass absorption	4%	3%	1.75%
Glass reflection	0.98%	0.80%	0.55%
Glass thickness (mm)	3.2	3.2	2.85
Module to cell power ratio	97%	98.50%	100%

Source: International Technology Roadmap for Photovoltaic (ITRPV) and Other Estimates

Fig.5: Forecasts of solar PV module costs



Source: KPMG in India analysis, NREL, Analyst Reports;* Driven by global demand supply conditions besides other factors

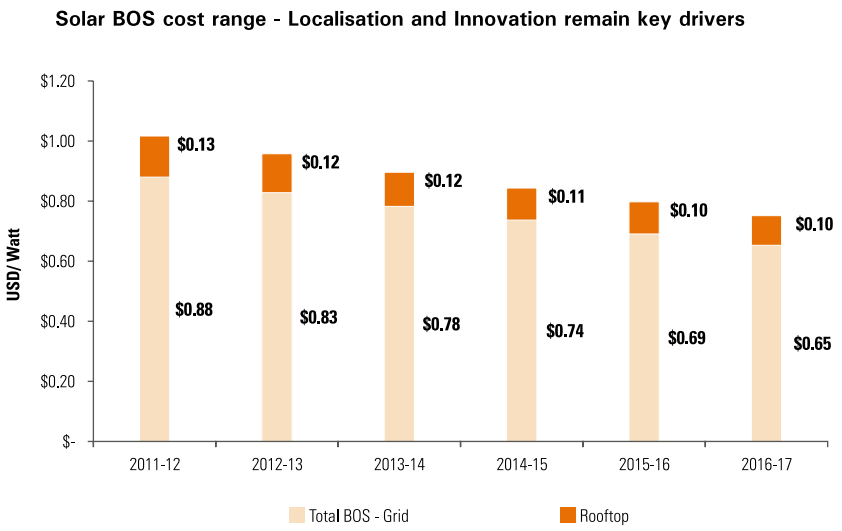
2 KPMG in India Analysis

Solar BOS

The cost reduction possibilities in the Solar BOS segment are driven through reduction in installation costs and lower material usage. Some of the key drivers contributing to the cost reductions have been summarized below:

1. Design efficiency:
   - Integrated structural design/lay-out in collaboration with manufacturers, installers and certifiers
   - Efficient wind design – It is estimated to reduce the wind forces on modules by 30 percent leading to higher structural efficiency.[3]
2. Power electronics/ technologies:
   - Usage of DC power directly for powering applications
   - Reduction in investment cost and losses in solar system.
3. Minimize installation labor:
   - Higher automation and site development could reduce installation costs and labor.
4. Innovation in mounting and installation:
   - New mounting solutions that can be used on any type of roofing material
   - Innovative solutions that reduce onsite installation time and component usage.

Fig.6: Forecasts of solar PV BOS costs



Source: KPMG in India analysis, NREL, Analyst reports

Localisation, innovation and scale benefits can lead to cost reductions in the BOS segment. Further, inverters costs play a major role in driving solar BOS costs down. Interestingly, inverter companies are making profits during the period from 2008 to 2011 suggesting thereby that unlike in the module segment, reasonable economic returns are being made.

3 "Achieving Low-Cost Solar PV: Industry Workshop Recommendations for Near-Term Balance of System Cost Reductions, Rocky Mountain Institute, September 2010"

Levelised solar power tariffs

The overall solar PV system costs will also be driven by factors like exchange rate fluctuations and interest rates. With an increase in cost of imported elements in the solar PV system, the impact of any exchange rate depreciation will have an adverse impact on the overall system costs and the resultant power tariffs. Similarly, reduction in interest rate can improve the overall system costs and returns for the developers.

Table 4: Levelised solar power tariffs (INR/ kWh)

Exchange Rate	Interest Rate	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Grid Connected							
55	11%	8.34	8.07	7.59	7.30	6.95	6.55
50	10%	8.14	7.53	7.08	6.80	6.47	6.10
Rooftop Connected							
55	11%	9.00	8.69	8.17	7.85	7.46	7.04
50	10%	8.79	8.14	7.65	7.34	6.98	6.58

Source: The Rising Sun - 2012, KPMG in India analysis

2.2 Grid parity – Utility scale projects

The power supply requirements in India have been met predominantly from coal sources. With domestic production of coal not keeping pace with the requirement, coal shortage is on the rise. Demand for coal from power plants is being met through blended coal – a mix of domestic and imported coal. The levelised tariff of electricity discovered at grid level has been in the range of INR 3.60- INR 4.00 per unit based on the recent bid results. The landed cost of electricity at the distribution periphery for power utilities will be higher due to the transmission charges and losses.

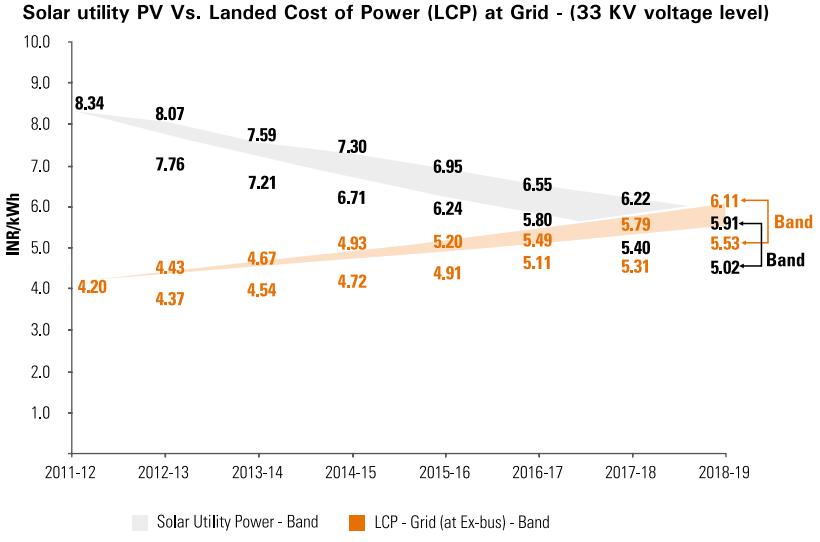
The pace at which the gap between solar power tariffs and the landed cost of power will be bridged will determine the pace at which solar power will take off. The point at which grid parity occurs is a function of two variables – the rate of increase in conventional power prices and the rate of decrease in solar power prices. We believe the following could be the key trends:

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

It may be mentioned here that utility scale solar projects can be connected at sub-transmission voltage levels[4]. Accordingly, the forecasts of the landed costs of power and the costs of solar power at the grid level (33 KV voltage) are shown in the figure below.

However, the period of grid parity could vary across states based on the landed price of power from coal and solar. We believe that grid parity from a utility scale project perspective could happen during 2017-18.

Fig.7: Grid parity projections – Utility scale solar power



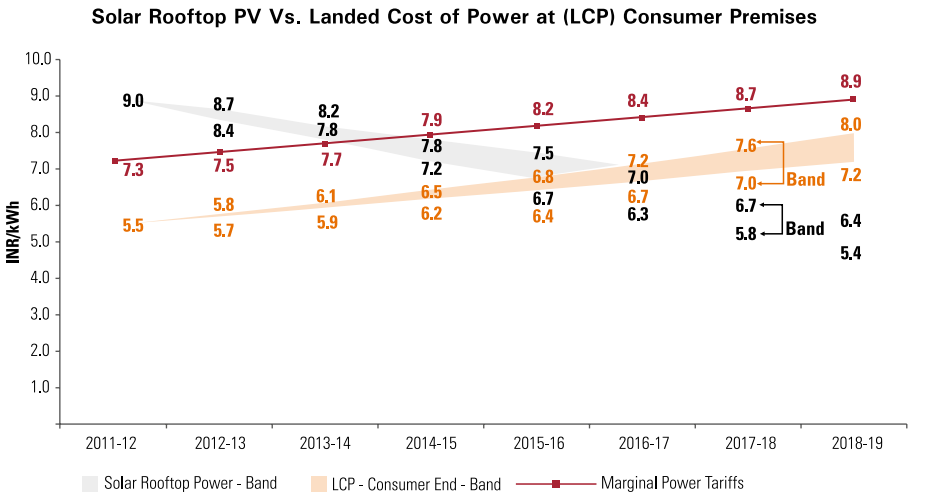
Source: KPMG's Solar Grid Parity Model

4 Levelised Power Tariff – INR 3.75 per unit; T&D cost – INR 0.15 per unit (upto 33 KV level); Losses – 8.0 percent

2.3 Grid parity – Retail level projects

The landed cost of power at the LT level is higher when compared to utility scale power[5]. This is due to the fact that the utility incurs additional network costs of providing the necessary infrastructure for meeting the last mile power requirements besides high losses. Hence, this segment is likely to reach grid parity first. Accordingly, an assessment of the forecasts of the landed costs of power at consumer premises and the costs of solar power at the rooftop level are shown in the adjacent figure:

Fig.8: Grid parity projections - Retail level



Source: KPMG's Solar Grid Parity Model

As shown in the figure above, the marginal power tariffs for some consumer segments are higher than the landed cost of power. Moreover, the landed cost of power is different for different end user consumer categories. The actual power tariffs for the consumers are determined by the State Electricity Regulatory Commission (SERC) – across consumption slabs and voltage levels. The prevailing marginal power tariffs for retail supply for some consumer categories in different states are shown below:

Table 5: Marginal power tariffs for consumers (INR/kWh)

Category	Andhra Pradesh	Karnataka	Maharashtra	Gujarat	Madhya Pradesh	Tamil Nadu
LT - Domestic	7.25	5.50	7.50	4.80	4.80	5.75
LT – Industrial	5.02	5.55	5.17	4.77	6.01	4.92
HT – Industrial	4.24	5.77	5.62	4.88	5.91	7.32
HT - Commercial	5.84	7.69	8.14	7.00	6.45	7.00
LT - Commercial	7.00	7.20	6.45	4.91	6.00	7.00

Source: Tariff Orders for States, KPMG in India analysis

Moreover, the tariffs can be higher by INR 0.30-0.50 per unit due to the fuel surcharge that is passed on to the consumers on a periodic basis in a year. As seen from the above table, certain consumer categories in some states are already very close to grid parity. Going forward, as regulators pass on higher cost of power procurement to consumers, these categories would find it economical to shift to solar power to replace their marginal consumption.

We believe that the adoption of solar power by certain categories of consumers is likely to increase even before grid parity actually happens. The table below lists out the likely parity period for different consumer categories. However, this estimate is likely to vary across states and is mainly driven by the power tariffs.

However, adoption is likely to happen earlier depending on availability of fiscal benefits like capital subsidy, accelerated depreciation etc.

Table 6: Grid parity period – Category-wise

Consumer Category	Likely Parity Period (Year)
LT – Commercial	2014-2015
LT – Domestic	2015-2017
HT – Commercial	2015-2017
HT – Industrial	2015-2017
LT – Industrial	2016-2018

Source: Tariff Orders for States, KPMG in India analysis

5 Levelised Power Tariff – INR 3.75 per unit; T&D cost – INR 0.80 per unit ; Losses – 20 percent

03

Solar market potential

Given the cost economics shown above, additional benefits such as accelerated depreciation, government subsidy for certain applications and the rising fuel prices - coal & natural gas, solar power can play an increasingly important role in meeting the market opportunity across both utility scale and distributed generation segments

Based on our analysis of the different market segments we have estimated the market potential for Solar PV power (by 2016-17) and is shown in the table here:

Forecast of the solar power market in India

<table>
<tr><th>Distributed Generation</th><th>Utility Scale Projects</th></tr>
<tr><td>Rooftop Market ~ 4,000 MW
(Fast approaching grid parity)</td><td rowspan="2">Government Support Utility Scale Market ~ 4,000 MW
(Phase – II program of Central Govt and State solar programs)</td></tr>
<tr><td>Diesel Replacement ~ 2,000 MW
(Driven by economics)</td></tr>
<tr><td colspan="2">Captive and REC Market ~ 2,500 MW
(Driven by solar renewable purchase obligations and Accelerated depreciation market - shifting demand from wind power)</td></tr>
<tr><td colspan="2">Total Solar Market Potential (by 2016-17) ~ 12,500 MW</td></tr>
</table>

Source: The Rising Sun - 2012, KPMG in India Analysis

04

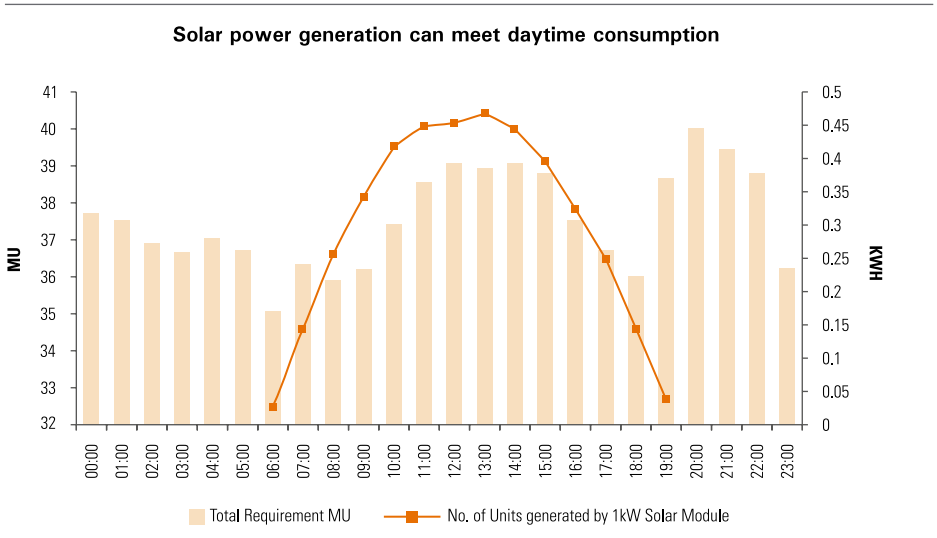
Distributed generation potential

Distributed generation at consumer end could drive solar power capacity additions going forward. In the following sections, we discuss the possible market potential from each of these market segments – Rooftop market, Captive market and Diesel replacement market.

4.1 Rooftop market – An attractive segment for the future

Solar power can be effectively used to meet the consumption requirements during day-time. A typical load curve of the peak requirement from the Northern Grid and the actual energy generation profile from a solar power source is shown in the table below:

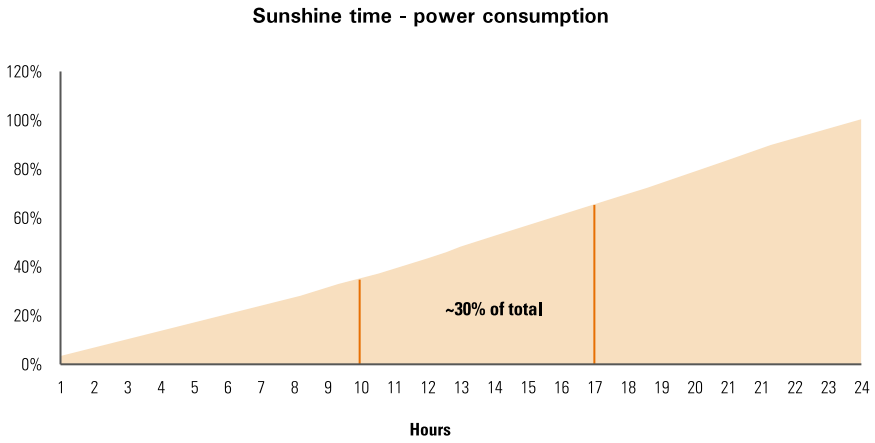
Fig.9: Intra-day solar energy generation profile



Source: NRLDC, NASA

As seen above, solar power can be effectively used for power consumption during the sunshine hours. Our analysis of the energy requirement for various consumer categories across 24 hours time block to assess the likely potential for solar energy – especially during sunshine hours in India - suggests that around 30 percent of the total consumption is met during sunshine hours.

Fig.10: Intra-day load curve of power consumption



Source: A typical discom, KPMG in India analysis

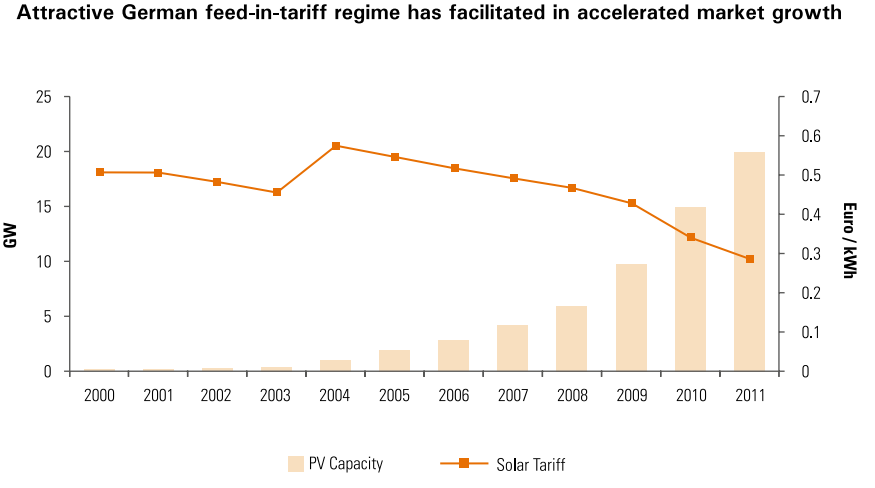
Economics will be the main driver for solar adoption in various consumer segments. Grid-interactive rooftop installations have been driving the solar market in matured markets like Germany, Spain and Japan. Germany, the market leader has more than 80 percent[1] of its total solar market from the rooftop segment – enabled by an attractive policy regime.

4.1.1
Rooftop solar market growth in Germany

Germany has been one of the leading renewable energy markets with over 20 percent[2] of its annual electricity demand as of 2011 coming from renewable energy sources. Furthermore, solar photovoltaic contributes about 4.5 percent of the annual electricity supply, with an installed capacity of 28[3] GW from solar PV.

The Renewable Energy Act passed in Germany in the year 2000, mandated targets for producing renewable energy and introduced incentives in the form of preferential Feed in Tariffs (FiT). In addition, captive solar power consumption was also incentivized by providing a small incremental incentive based on the difference between solar cost and electricity prices. The targets were revised annually and linked to the total number of installations, with the tariffs reducing - if installations exceed a certain threshold.

Fig.11: German solar market growth



Source: German Solar Industry Association

A stable market program with the necessary infrastructure support – in terms of net metering - has enabled Germany to become a global leader in the solar PV space.

It is an opportune time for India to take steps to encourage the rooftop market segment.

1 German solar industry association
2 Estimates of the Association of Energy and Water Industries (BDEW)
3 http://cleantechnica.com/2012/07/04/germany-sets-a-new-solar-power-record-14-7-twh-in-6-months/

4.1.2 Analysis of rooftop market potential in India

The rooftop solution can be deployed by different categories of customers. We have estimated the market potential for various consumer categories. Utilities develop tariff categorization based on connected load and voltage levels. For example, the LT – domestic category, would be the household consumer connected to low tension (LT) line. Similarly HT – Industrial category, would be an industrial consumer connected to the high tension (HT) line at 11 KV and above voltage.

In our analysis of the potential rooftop segments, we have considered the following consumer categories:

- LT – Domestic (High-end)
- LT – Industrial
- HT – Industrial
- HT – Commercial
- LT – Commercial.

In case of LT – Domestic category, only the high-end residential segments that can afford higher tariffs have been considered. The high-end segment comprises of only 1-2 percent of the consumer base but consumes upto 9.5 percent of the energy. Hence, around 10 percent of the total energy consumed in the domestic category can be considered to be attributed to high-end residential segment.

Methodology for computation of market potential

For all the target categories of consumers, the consumption pattern has been analyzed to ascertain the energy consumed during the day time between 10:00 hrs and 16:00 hrs. Since the storage of solar energy is quite expensive and, therefore not economical, we have assumed that only part of the energy being consumed during the day will be replaced by solar energy. The load curves for various categories have been analyzed and factors for day-time consumption have been computed. We have followed two methods to determine the market potential based on economics.

First, is based on the payback analysis - taking three years as a cut-off period for economic shift for consumers. Second, is based on the comparison of the leveled cost of solar power and leveled power tariffs. The adoption rates of solar power have been considered in an incremental manner. Our analysis has been summarized in the table below:

Table 7: Rooftop market potential estimates

Rooftop market potential by 2016-17							
	Units	LT - Domestic	LT - Commercial	LT - Industrial	HT - Industrial	HT - Commercial	Total
Payback Method							
% adoption	-	5.0%	10.0%	2.5%	5.0%	5.0%	
Solar power	MW	178	1657	318	1459	85	**3697**
Levelised Tariff Method							
% adoption	-	7.5%	10.0%	5.0%	7.5%	7.5%	
Solar power	MW	267	1657	636	2188	128	**4876**

Source: The Rising Sun - 2012, KPMG in India analysis

The solar power adoption trajectory might be higher in the industrial and commercial segments due to the prevailing tariff levels and persistent deficit. The adoption rates will increase substantially post the grid parity.

An innovative lease model can further improve the market attractiveness for consumers by avoiding high upfront costs and reducing monthly power bills. For example, a high-end residential consumer can install a 1 KW solar PV system[4] - to reduce marginal power consumption - with a monthly EMI payment of around INR 2000 for five (5) years and avoid an average discounted monthly payment of around INR 1200 over the lifetime (25 years) to the grid. With rising power tariffs, the lease model can make it attractive for power consumers at the bottom of the pyramid - the less affluent residential power consumers - to adopt solar PV systems within this decade.

4 Solar PV system can replace the day time power consumption ~ 30 percent of the total power consumption of a consumer from the grid

4.2 Captive consumption market

Captive solar power market is likely to be driven by two factors. First, to comply with the regulatory directives for meeting the solar RPO requirements and second, purely based on economics – helped also by the accelerated depreciation benefit.

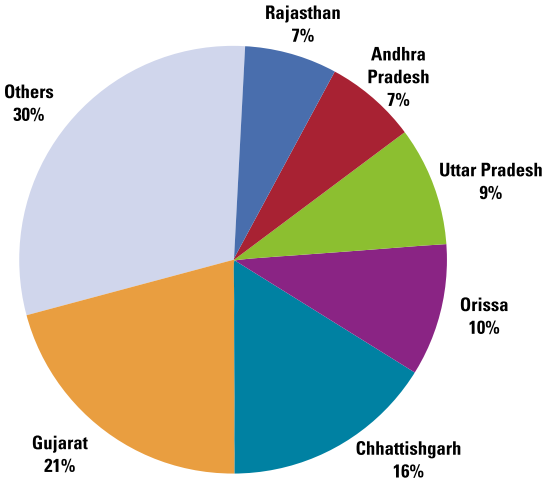
4.2.1 RPO market

Captive power plants have been in operation across industries – especially power intensive industries that require continuous supply. It has been estimated that more than 30,000[5] MW of captive power plant capacity has been installed in India. Further, it has been estimated that around 13,000 MW[6] of additional captive power capacity is likely to get added during the XII Five Year Plan. A large quantum of this installed capacity is based on diesel and natural gas.

There has been a rise in usage of diesel generators for back-up power even during the day time by commercial and other sectors.

Fig.12: Captive power consumption

Captive power consumption varies annually based on power deficit conditions



Source: CEA, Industry Research

The State Electricity Regulatory Commissions (SERC's) across many States in India have mandated renewable purchase obligations on captive consumers. The RPO obligations vary across states and enforcement of these obligations by the regulatory commission could result in a market potential of around 1000 MW in the next few years.

5 Planning Commission – The Working Group on Power for 12th Plan
6 Overview of Power Sector – Planning Commission – Working group for 12th Plan

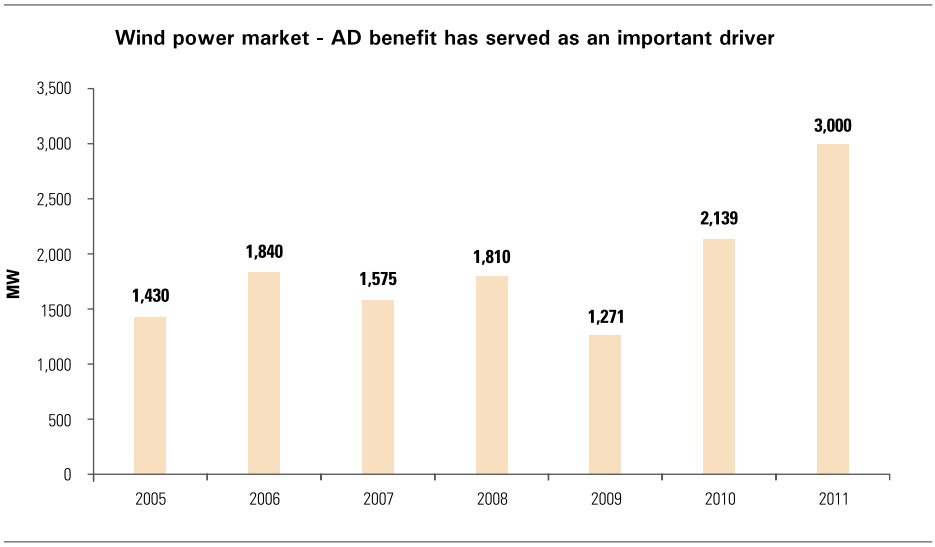
4.2.2
Accelerated Depreciation (AD) market

The spurt in growth of the wind power sector was largely on account of accelerated tax depreciation benefit market. Wind power market has seen installations of around 1800 MW on an average basis - annually over the last few years.

Solar power projects are eligible to avail the accelerated depreciation benefit. With capital investments for solar power projects on the decline and comparable to large size wind turbines, this market can be potentially accessed.

By providing banking facility to captive power producers from solar energy - along with necessary metering infrastructure – the power utilities can play an important role in encouraging this market. Solar power banking facility would mean that the captive power producers (CPPs) can inject solar power into the grid during the sunshine hours and can withdraw banked power from the grid as and when required (subject to terms and conditions of the PPA with discom). Based on our assessment of the captive market, we believe that a total market potential of around 2,500 MW of solar PV power can be tapped in the next five years.

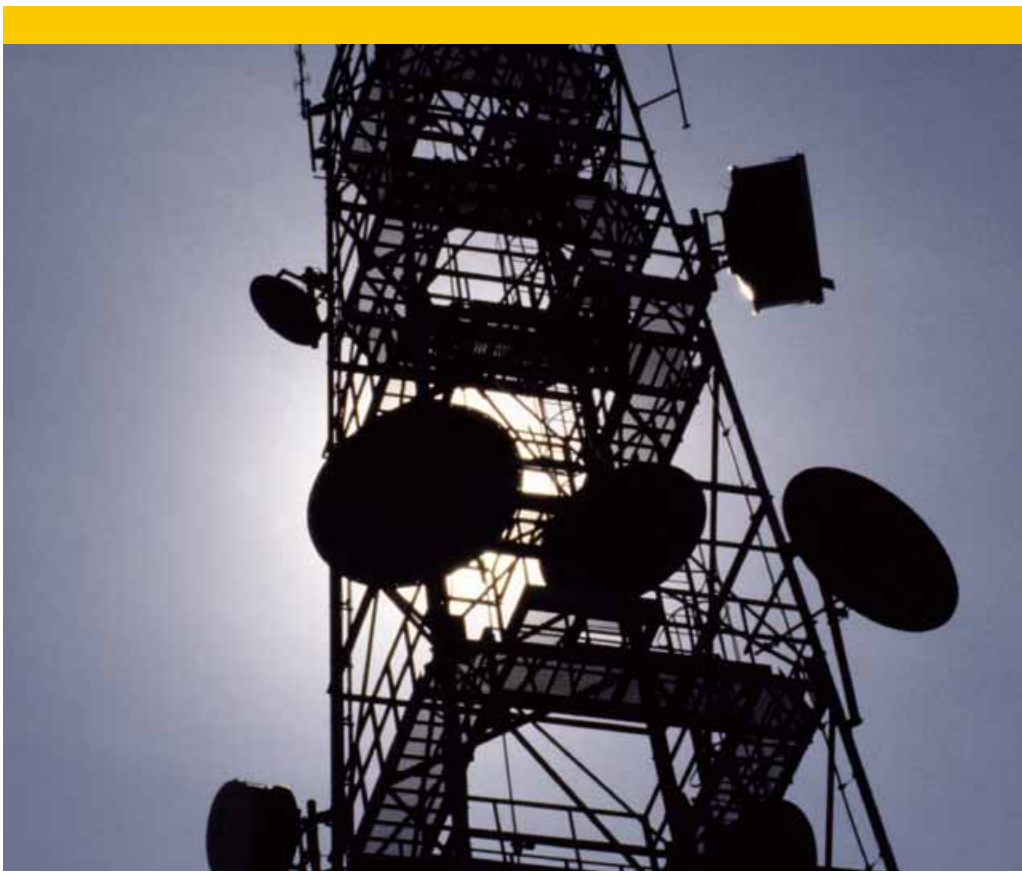
Fig.13: Annual wind power installation market in India



Source: GWEC

4.3 Solar diesel replacement market

Solar power can economically replace diesel fuel consumption. Diesel power is used in industrial and retail sector - both as a back up and as a full-time source of power generation – the latter is usually observed in far-flung areas where grid connectivity is nearly absent. Our analysis suggests that DG-sets operating for more than 4 hours daily can economically use solar power - especially during day time. While diesel based power consumption can be reduced by usage of solar power, it may not be economically feasible to replace diesel generation completely through stand-alone solar systems with battery-bank. Solar powered telecom towers and solar powered agriculture pumpsets - are attractive market segments from a scale and potential perspective.

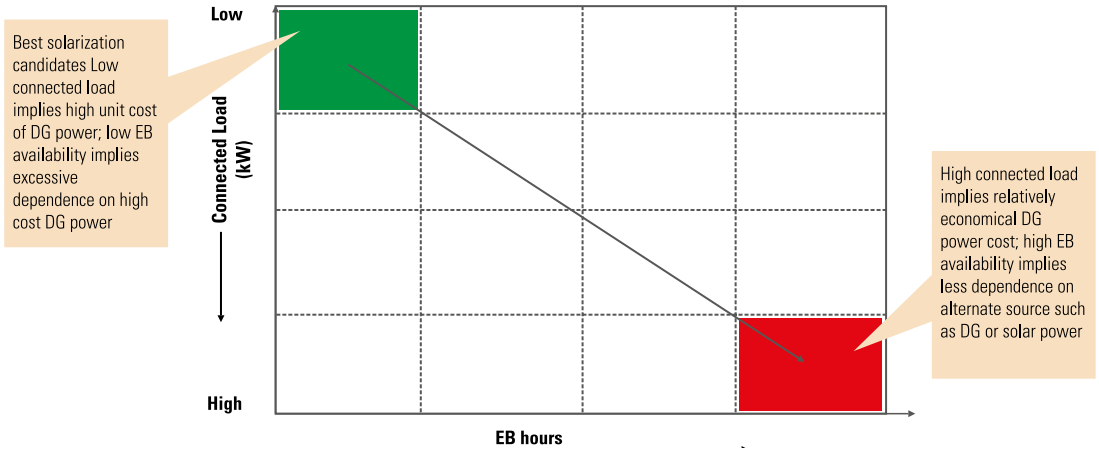


4.3.1
Diesel consumption in telecom towers

In India, a large number of telecom towers are located in rural/semi-urban areas with limited or no grid connectivity and have to depend on diesel gensets for meeting their power requirement. Going forward, such category of towers are only going to increase with rise in the subscriber penetration in rural areas. In fact, a preliminary analysis shows that diesel consumption in telecom tower industry will increase 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[7].

Despite the high dependence on diesel, industries acknowledge that power from DG-set is quite expensive. Depending on the hours of grid power supply (EB hours) and connected load, the price of diesel power can vary from around INR 14 / kWh to as high as INR 30 / kWh[8] for low load towers in remote areas. The following matrix shows how these two parameters (EB hours and connected load) are linked to DG power cost and subsequently viability of solarization.

Table 8: Categorisation of telecom towers



Source: Industry Research, KPMG in India analysis

Towers with low connected load and almost non-existent grid power supply are the most viable candidates for solarization. On this basis, we believe that around 50,000 towers in the country today have a strong business case for solarization and require minimal subsidy support from the government[9]. Accordingly, an opportunity for installation of around 250 MW of solar PV capacity is viable. Further, the potential will increase with more towers becoming viable in the coming years.

There are some challenges faced in solarizing telecom towers. First is the need for optimal design of solar systems for telecom towers. Each tower site is unique from an energy viewpoint – tenancy levels, and therefore, connected loads, availability of grid supply, diesel cost including pilferage and transportation costs - all vary with the site. To add to the complexity, energy provision for an off-grid tower has to be designed keeping in mind the likeliness of grid availability in future to save the solar assets from redundancy.

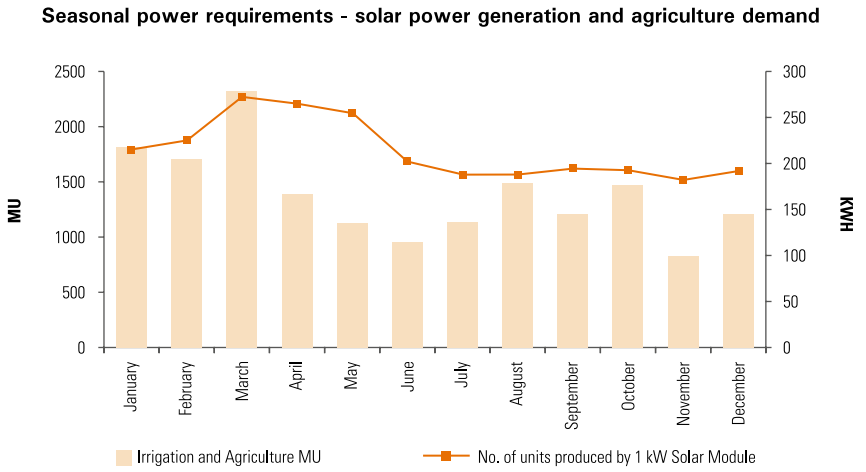
Second is the financing arrangement for solarizing telecom towers. An arrangement that can reduce the high upfront investment and increase the tenor of the debt/funds can help reduce the entry barriers for solution providers. Herein, development of a solar lease model for telecom towers can enable higher solar power adoption.

7 Assuming no. of towers double by 2020
8 KPMG in India analysis, Discussion with Industry experts
9 The estimation does not take into consideration constraints such as – site level constraints, availability of right solution providers, limitations of components (charge controllers etc.), grid development etc.

4.3.2
Suitability of agriculture segment

Agriculture demand contributes more than 20 percent[10] of total power sales in the country. According to CEA, in India, there are more than 18 million pumpsets energized[11]. However, due to power shortfall and tariff subsidy, the power supply to this category of consumers is erratic. This segment is most suitable from a solar power generation perspective. In fact, the correlation of solar power generation with the irrigation and agriculture category is the highest amongst all the other categories analyzed i.e. Domestic, Commercial, HT Category at 11kV and HT Category at 33kV. For example, the correlation of the monthly agricultural sales consumption in the State of Andhra Pradesh and the probable solar power production has been given in the adjacent figure:

Fig.14: Solar power generation profile and agriculture demand



Source: Data for a southern state, KPMG in India analysis

A targeted solar powered agricultural pumpset solution taking into account the solar radiation levels, water table and cropping pattern can potentially replace conventional powered agricultural pumpset - post grid parity.

India has an installed base of 25 million pumpsets, with 18 million electric pumpsets and around 7 million diesel pumpsets[12]. Based on economics, the diesel based pumpsets can be largely replaced with a solar based solution. This could lead to a potential of around 12,000 – 15,000 MW[13] for solar power. However, the actual market potential that can be tapped would depend on local factors – like water table, cropping pattern, weather conditions etc. We believe that the total agriculture based solar powered pumpsets market to be around 1,500 -1,600 MW over the next five years – through targeted replacement of diesel based pumpsets.

Governments should encourage pilot programs to support development of solar – powered agricultural pumpsets market in India by providing incentives/ direct subsidy support for solar powered agricultural pumpset purchase.

10 Planning commission – Report on power sector
11 CEA monthly report – June 2012
12 CEA, EPRG
13 Avg HP per pumpset – 5HP; Avg specific consumption – 1200 KWh; Solar PLF – 18 percent

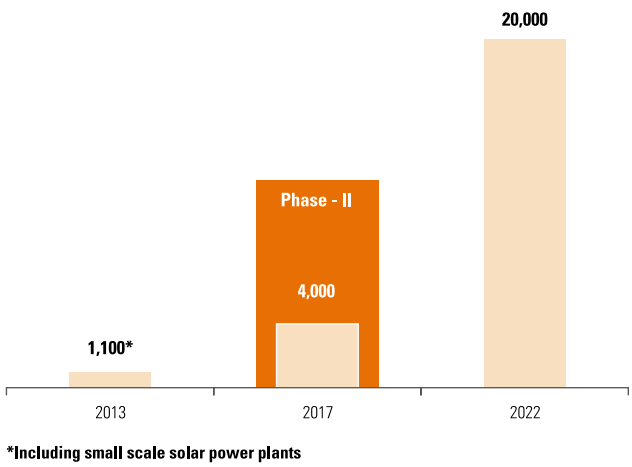
05

Utility scale potential

The utility scale market segment would be primarily driven by the power purchase agreements signed by the distribution utilities for solar power procurement and large scale captive market installations.

The government driven JNNSM and State level capacity addition programs could amount to a utility scale market potential of around 4000 MW over the next five years.

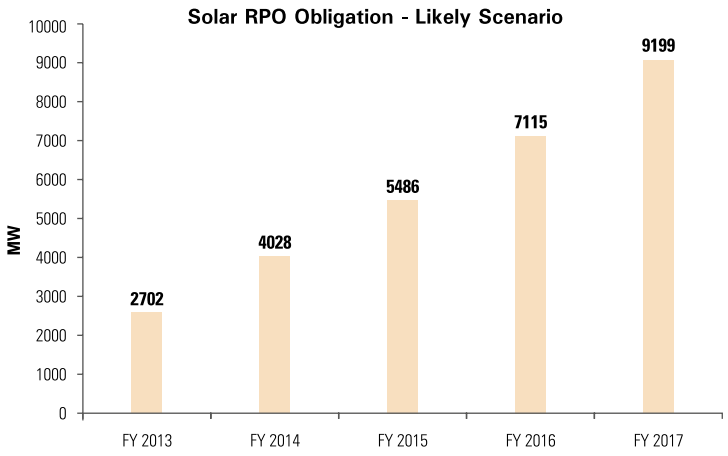
Table 9: National and State level solar programs

JNNSM	
State Level Programs	Around 1000 MW of capacities are likely to be on offer under State solar power programs within the next few years • Rajasthan – 900 MW by FY 2017 • Karnataka – 200 MW by FY 2016 • MP has allocated 200 MW of projects.

Source: NSM and State level solar program announcements

In fact, the solar RPO market itself would support capacities in excess of 9000 MW in next five years if the National Tariff Policy (NTP) guidelines are followed. Out of this, 7500 MW could come from state utilities under their RPO targets. According to the amended NTP, the solar RPO obligations are to incrementally increase by 0.25 percent every year to reach 3 percent by 2022. Accordingly, the likely solar RPO obligations in 2016-17 will be 1.5 percent.

Fig.15: Solar RPO demand for utilities (including captive market)



Source: The Rising Sun - 2012, KPMG in India analysis

However, many of the state power utilities are in financial stress.

Table 10: Net losses of state power utilities

Net Losses of State T&D Utilities at 2008 Tariffs in INR crores				
2010-11	2011-12	2012-13	2013-14	2014-15
68,643	80,319	88,170	98,664	116,089

Source: Estimates made in 13th Finance commission report

There would be issues concerning the ability of the utilities to afford solar power thus increasing the perception of payment security risk as far as some of the state level programs are concerned.

06

Thermal market applications

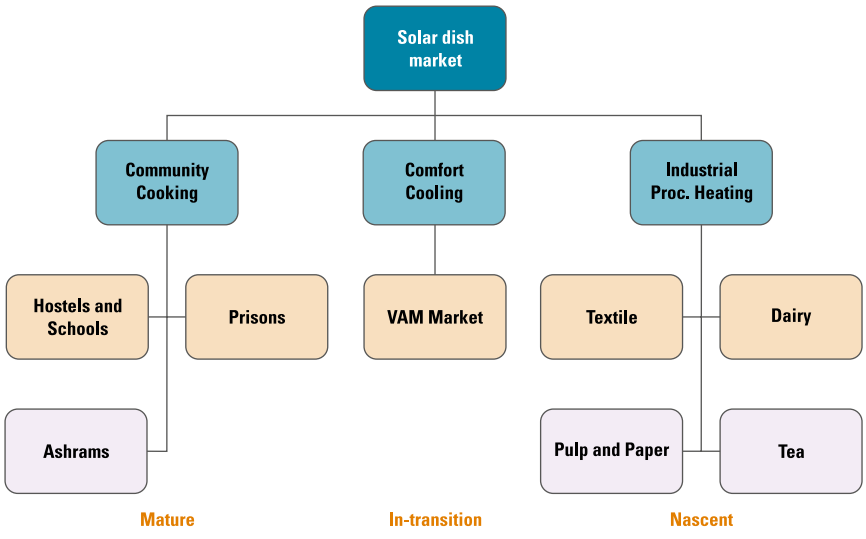
With the advent of solar concentrator technology, the market for solar thermal applications has broadened in the past few years to include a wider range of applications. Solar concentrators reflect solar radiation at a particular focus (receiver) and can generate thermal energy at temperatures beyond 80°C (up to a maximum of 300°C) – a feat previously not possible with flat plate collectors/evacuated tube collectors. This development has enabled the market to open up to different sets of consumers in domestic/commercial/industrial segments (requiring thermal energy at high temperatures) and thus makes it interesting to have a closer look at it and understand the potential opportunity size it could offer.

In this section, we will primarily focus at parabolic dishes and their potential market.

A parabolic dish is made up of mirrors arranged together on a parabolic frame. It is usually equipped with a tracking system that aligns it with the sun's position in order to capture maximum solar energy. In India, two types of dish technology are currently being deployed – fixed receiver technology (Scheffler dish) and fully tracked technology (Arun dish).

It was around 25 years ago that Wolfgang Scheffler developed the first solar dish technology which was primarily designed for cooking applications. Since then many players have started manufacturing solar dishes based on the Scheffler technology and have been positioning it as an offering for applications such as cooling, process heating, laundry etc. The following chart shows the key illustrative market segments for solar dishes:

Fig.16: Solar dish market segments

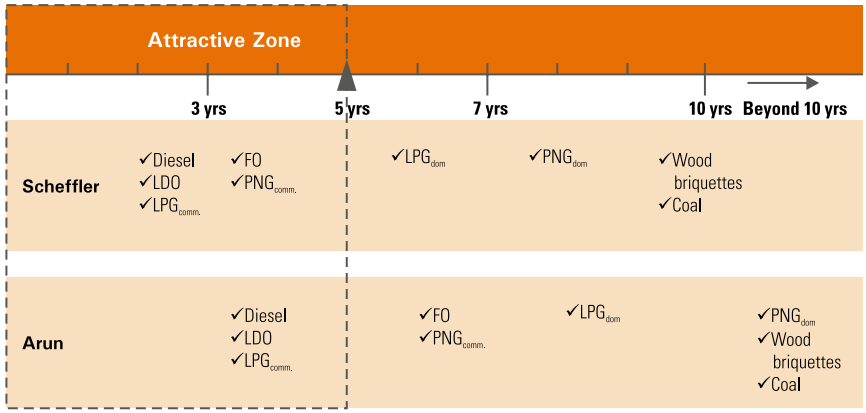


Source: The Rising Sun - 2012, KPMG in India analysis

The acceptability of any new technology/ product/solution is ultimately determined by the price tag it comes with. Based on our analysis, we understand that a payback period of less than 5 years (compared to current system/fuel) is considered attractive by the consumers. This means the market for solar dishes is currently limited to thermal applications where fuels such as diesel, LDO, FO and commercial LPG are used. The following figure shows the payback period of solar dishes with respect to different fuels used for steam generation.

Current market, though limited to replacement of certain fuels, still offers a substantial opportunity size. With rise of crude oil/coal prices, this size is going to expand - as more and more fuels would come under attractive payback zone.

Fig. 17: Payback period of solar dishes



Source: The Rising Sun - 2012, KPMG in India analysis

6.1.1 Solar cooking

Till date, most of the transactions observed in the solar dish market has come from the cooking application segment. In FY-2011, projects with an aggregate cost of INR 5.75 crore were sanctioned by MNRE. With Govt. contemplating increasing subsidies on solar cookers (as stated in 12th plan report), the market is expected to take a good shape within the next few years.

Solar based cooking can be carried out in two ways – direct heating and steam based cooking. Steam based cooking is generally carried out in segments where cooking is done on a community scale – schools, hostels, canteens, prisons, temples, and ashrams. We believe that the market potential for this segment is around 2.6 lakh square meters of collector area (~INR 400 crore[1]).

Challenges

- Biomass, firewood and other fuels used in rural areas prove to be more economical as compared to solar
- Upfront capital availability is a key issue especially for govt. and aided schools
- Space availability is a constraint in urban areas
- The cost of providing after sales services for small requirements (2-3 dishes) is high compared to the proceedings from the sales.

6.1.2 Solar cooling

As the solar dish technology evolved, solar dishes became more efficient and companies started looking for application segments beyond cooking. One such application that has now become a potential market opportunity is comfort cooling. Solar dishes can be integrated with Vapor Absorption Machines (VAMs) to provide cooling solution in areas which have a limited grid power supply and are dependent on costly power from diesel generators.

We believe that the market potential for this segment is around 1.3 lakh square meters of collector area (~INR 200 crore).

6.1.2.1 Some potential challenges include

- Space availability a constraint in urban areas
- Subsidy plays a major role in calculating payback periods - market scenario will change if subsidy amount changes
- Customized solutions require skilled manpower for conducting prefeasibility studies and providing after sales service.

1 Based on KPMG's analysis of the market share of different types of dishes - a cost benchmark of ~INR 15,817 per square meter of collector area has been taken for a solar cooking dish.

6.1.3 Industrial process heating

Another opportunity which is expected to form bulk of the solar dish market in the near future is process heat requirement in industries. In India, industries account for ~40 percent[2] of the primary energy consumption out of which around 70 percent is used in thermal form. While coal, being the cheapest available fuel, is used widely in industries for thermal energy requirements, some of the industries do use costly fuels such as diesel, LDO, FO for the same. These industries constitute the right target segments for solar dishes as they would achieve a faster payback and hence would make the entire proposition attractive for them.

We believe that the total market potential for the four priority industries (Textile, Dairy, Pulp & Paper and Tea) is around 48.6 lakh square meters of collector area (~INR 11,000 crore[3]). Some potential challenges include:

Challenges

- Industry would require stringent SLAs given process criticality
- Dearth of trained manpower for installation and maintenance of systems
- Non-availability of site specific DNI data: After talking to various customers of solar dishes, it has been observed that the DNI data given by NASA which has been used as a benchmark to study any site for dish installation is inaccurate due to non-consideration of aerosol content. As a result the actual output from the solar dishes has been less than compared to what has been promised by the vendors. Thus the non-availability of site specific DNI is also a key challenge which is essential to overcome to gain customer confidence.

6.1.4 Solar steam augmentation

Another promising application of solar concentrator technologies that is currently being looked at globally is steam augmentation in coal/gas based power plants using solar field.

A solar augmented conventional power plant involves producing certain amount of steam from solar thermal field and integrating this steam with the conventional power generation system to reduce the fossil fuel consumption. In fact, solar power can also be used to augment the electrical energy output from the plant. The solar thermal technologies that are being proposed for hybridization include parabolic trough, power tower and linear fresnel.

The benefit of such hybridization is clearly reflected in the cost economics. Since for the hybridized power plant, no additional investment is required on the power block side, the leveled tariff for the units generated from solar power reduces by more than 50 percent. Savings on fuel consumption and avoided carbon emissions add to the attractiveness of this solution.

Nevertheless, the efficiency gains from the system would have to be analysed on a case-to-case basis after evaluating several factors. Some of the factors that need careful consideration are as follows[4]:

- Age of the plant
- Capacity factor
- Annual avg. DNI (kWh/m2/day)
- Land availability
- Land topography
- Solar use efficiency.

Globally, pilot projects are underway to explore the technical and commercial viability of this concept. According to a study by NREL on Solar-Augment Potential of the US Fossil-Fired Power Plants, the total augment potential for parabolic troughs is around 11,000 MW and the total augment potential for power towers is around 21,000 MW in the US. The potential estimates have been arrived after carrying out a detailed study of each of the gas and coal fired power plants in the16 states of southwest, south-central and southeastern US.

This concept might be particularly relevant in a country like India where import dependency on fuels is increasing rapidly. It is an opportune time for the government to consider undertaking a similar detailed study to assess the technical feasibility and potential for solar based steam augmentation for coal and gas fired power plants in India.

2 MOSPI, KPMG in India analysis

3 Based on KPMG's analysis of the market share of different types of dishes - a cost benchmark of ~INR 22,980 per square meter of collector area has been taken for an industrial dish.

4 NREL Report on Solar – Augmentation, CEA report

07

Why should India support solar power?

Solar power can help meet the twin objectives of long-term energy security and climate change considerations. We believe that decentralized solar power market has immense potential.

Small-scale/ rooftop solar power installations at consumer-end driven by economics would be a key market segment going forward. Some of the factors likely to drive this market include:

1. High power deficit

The power demand in India is increasing with the growing economy, whereas the supply has not been able to match the growth in demand. **The energy deficit in the country is around 9 percent**[1]**.** Furthermore, the quantum of power procurement by the distribution utilities has not been matching the demand growth due to the financial stress and lower purchasing capacity of the utilities. We believe that the power deficit scenario is likely to persist over the next five years. While aggressive capacity addition targets have been announced – issues pertaining to fuel availability, land acquisition, timely completion of evacuation infrastructure etc - need to be addressed effectively.

While the shortfall in power would ideally have to be shared among all the power customers, yet a disproportionately high quantum of this shortfall is borne by industrial and commercial sectors. To tide over this shortage, customers who can afford rely on alternate options.

Based on economics, we believe solar power solutions can displace certain amount of captive power consumption based on diesel & gas.

1 CEA

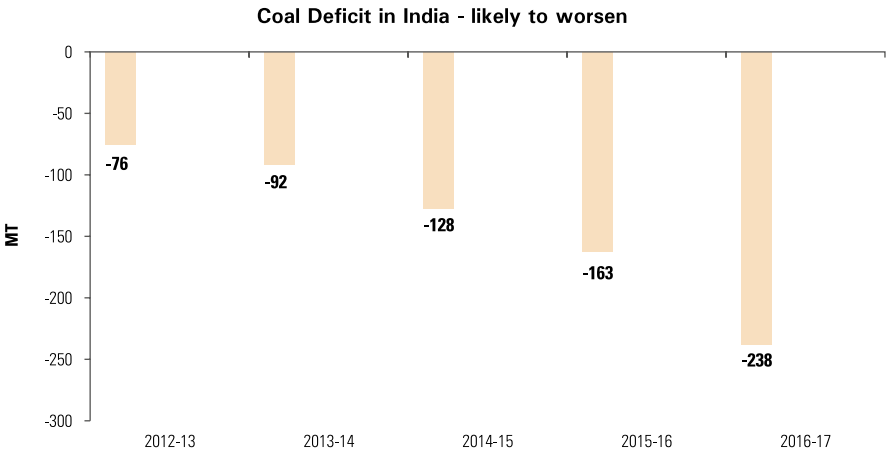
2. Rising import dependence

Import dependence is currently at almost 30 percent of our energy requirements and could rise to 59 percent in a worst case scenario by 2032[2].

- **Coal consumption** – Coal is the primary fuel used in power generation. However, due to the shortage in domestic coal production growth, there has been an increase in the quantum of imports over the year. In fact, coal imports are expected to increase four-fold during the next five years. Moreover, despite imports, coal deficit is likely to persist due to the constraints of blending in the power stations.
- **Diesel consumption** - India currently imports more than 75 percent of its oil and this share is expected to exceed by 90 percent by 2030[3].

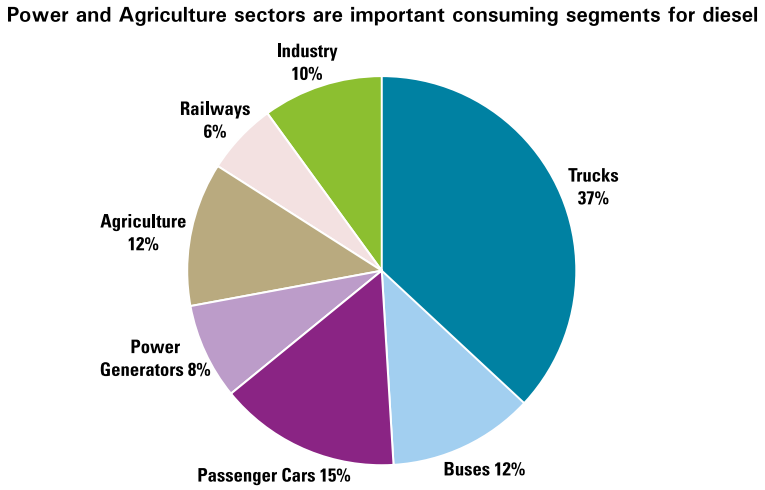
If the consumption of diesel from power segment reduces by 10 percent, it results in a saving of around USD 450 million annually[4].

Fig.18: Coal deficit in India



Source: CEA, Planning Commission Report

Fig.19: Diesel consumption breakup in India



Source: Kirit Parikh Committee - Sector-wise diesel consumption

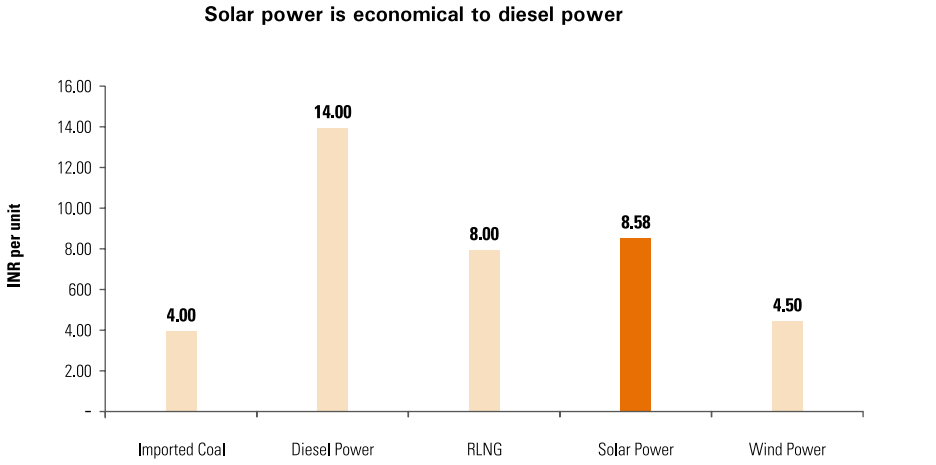
2 KPMG in India analysis
3 Planning Commission – Approach Paper to XII Five Year Plan
4 Diesel Consumption of 60 million tonnes; Tonnes to Barrel – 7.5; USD per Barrel -100

3. Favorable economics

At present, the variable cost of power from diesel based generation is upwards of INR 14 per unit. This is likely to go up with rise in diesel price. Economics with respect to variable cost of diesel is a key metric to assess substitutability - since solar installation can then co-exist with diesel genset which can provide power on demand when solar power is not present.

Solar power currently is less than INR 10 per unit and is likely to reduce further making it economical to replace a portion of the demand that is currently being met by diesel –

Fig.20: Comparison of power costs from different fuels



Source: CEA, KPMG in India analysis

Moreover, the power tariffs especially during the peak periods are very high. For example, the short term power purchase costs for utilities in the Southern Region (SR) during February to May are comparable to solar power costs.

Table 11: Power prices on the exchange

Year	Weighted avg price of power during Feb to May at power exchanges in SR – INR/unit
2010	5.78
2011	7.04
2012	9.06

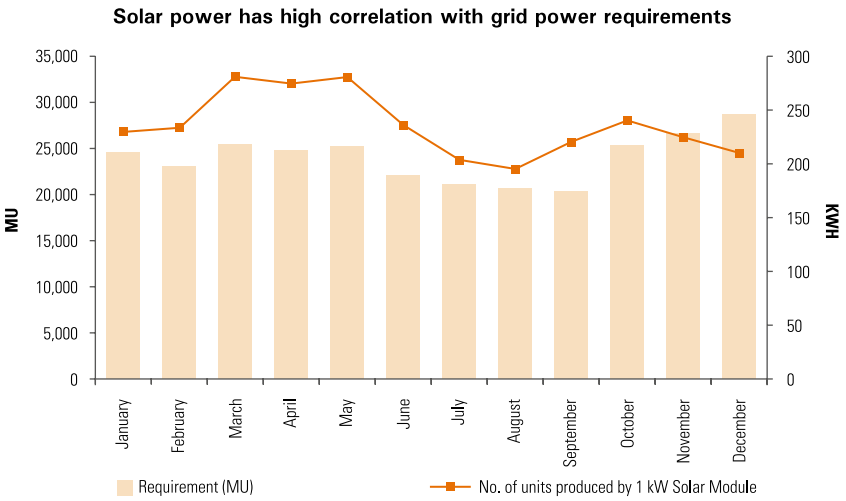
Source: CERC, IEX

Further, from a consumer point of view, the power tariffs for end-use consumer segments – especially for industrial and commercial segments are on the rise. In fact, the marginal tariff rate of the higher slabs for these customers is already comparable to the cost of solar power.

4. Grid demand synergy

Solar power generation is highest during the months of March, April and May. An analysis of the load curve indicates that the power requirements during this period in the country are also high. We have analysed the correlation between solar power generation and the load curves for different regions in the country. Our analysis suggests that the correlation for the whole country is on a higher side indicating the positive synergy between solar power and grid requirements.

Fig.21: Solar power generation profile and Western region grid demand



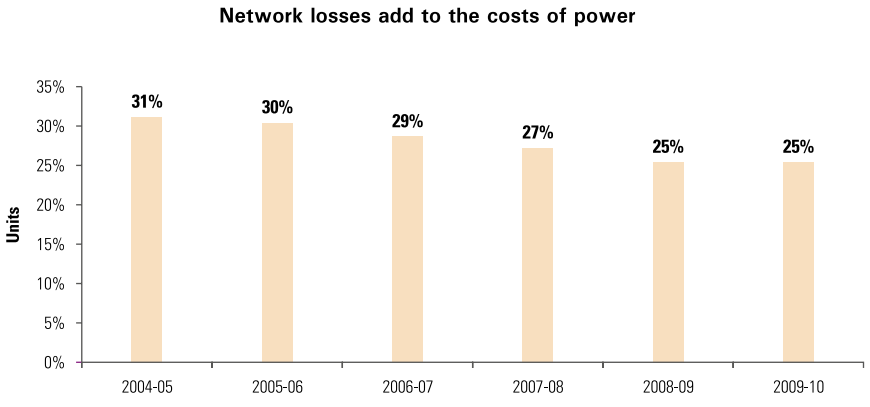
Source: The Rising Sun - 2012, KPMG in India analysis

Solar power can play an important role in meeting the day-time power demand.

5. Benefits of distributed generation

By encouraging solar power at consumer-end, the losses in the network can be saved by the power utilities.

Fig.22: T&D loss trends in India



Source: The Rising Sun - 2012, KPMG in India analysis

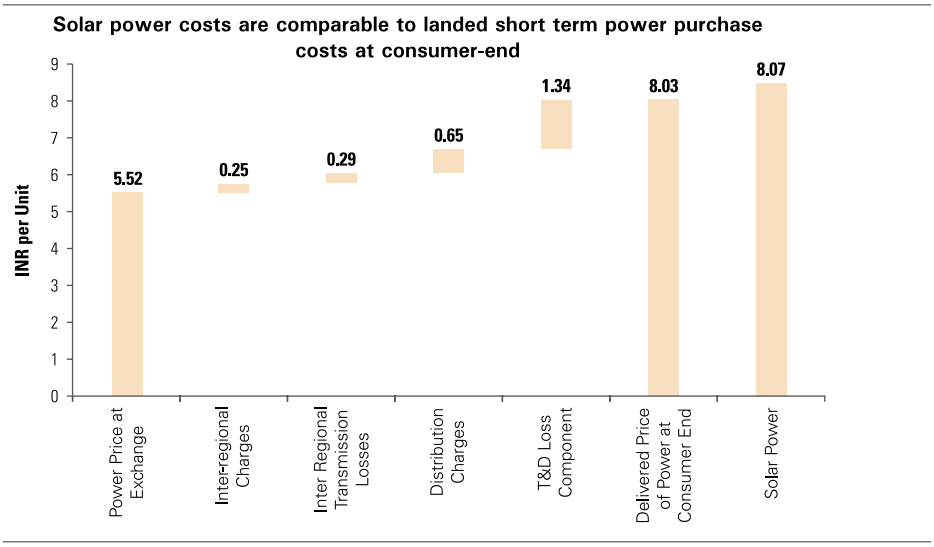
Our comparative analysis of the solar power tariffs and the delivered price of power from short term market at the consumer-end for a consumer in the Southern region[5]. It may be noted here that the weighted average price of short-term power in Southern region is high when compared with the price in other regions in both the power exchanges – due to high power demand in the Southern region and due to congestion between NEW Grid and SR Grid[6].

5 Inter-regional transmission charges – INR 0.25 /unit, Inter-regional loss adjustment factor – 1.0472; Intra-state T&D Charges – INR 0.65 per unit; T&D loss – 20 percent

6 CERC – Market Monitoring Report

The figure below illustrates the economics of solar power when compared to delivered price of power that is procured by utilities from the short term power market.

Fig.23: Delivered power price - Comparative analysis



Source: The Rising Sun - 2012, KPMG in India analysis

To summarize, the utilities should encourage decentralized solar power market both from an economics as well as sustainability point of view. As shown in the graph above, when considered from the perspective of marginal cost of power and associated delivery cost to consumers, solar power is at break-even without considering subsidies. Thus, it can be shown that solar power is approaching pareto optimality in the decentralized segment.

08

Measures to support solar power

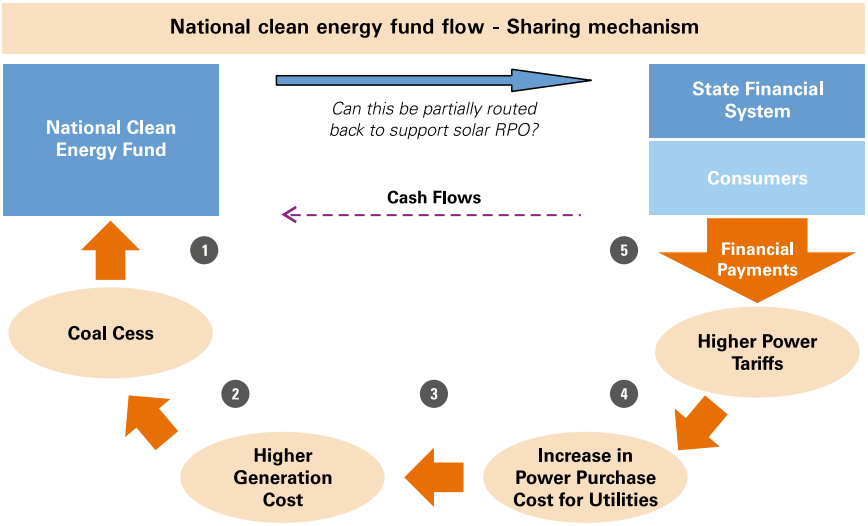
Sustained efforts from the Government and the Private sector can help realize the immense solar potential to benefit the country.

8.1 Government support

Government's support can play an important role in driving the solar industry. Several positive initiatives have been taken by the Indian Government to encourage solar energy in the country. Supporting solar industry over the next five years is crucial to realize the immense potential which solar power offers for an energy starved country like India. Some of the enabling measures include:

1. **Market certainty and stability:** The worst thing to happen to the sector is a sudden withdrawal or reduction of the market support that has been provided in the last two years. Ecosystem capacities have been built on the back of this support program, and a stable gradual program needs to be sustained. This means that the next round of the central program needs to be announced quickly. A consistent market support program would lend credence to investors looking at solar opportunity in India.
2. **Share NCEF funds with States:** JNNSM program has played an important role in building the solar eco-system in the country. A transparent process of award has been followed and many projects are already operational/under construction. However, the financial position of the state power sector poses a risk to the development of utility-scale solar projects in India. Though a payment security mechanism with a gross budgetary support of INR 486 crores has been put in-place, the Central Government could play an enabling role in supporting the solar power market creation efforts in the States. One such step could be to directly compensate States to encourage solar power market installations.

It may be mentioned here that the National Clean Energy Fund (NCEF) has been created through a coal cess and currently supported by levies which are ultimately paid by consumers/ state utilities. This fund can be used to compensate the States for supporting solar power. In fact, a sharing mechanism can be evolved based on certain parameters – solar capacity, RPO compliance etc to extend financial support to States that encourage solar power.

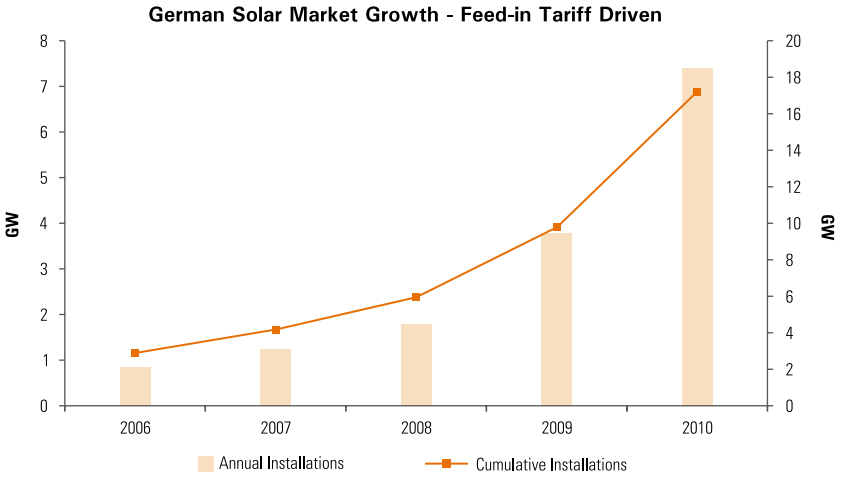


3. **Promote 'private contracts' solar power market:** The solar power market has a potential to change the way in which the power industry operates today. Solar power is likely to reach parity for retail power consumers earlier than at the grid-level. Further, rooftop and small scale solar power projects at consumer-end have several advantages over grid connected solar power plants.

Globally, rooftop market has been driving the solar power installations market.

Fig.24: Solar installations in Germany

Attractive feed-in tariffs in Germany have seen annual capacity installations increase from < 1 GW to over 7 GW in 5 years. Over 80 percent[1] of the total installations are from rooftop market.



Source: EPIA

This stable market support program has enabled the development of the solar eco-system in Germany. Business models that cater to the rooftop segment have emerged. For example, companies like SolarWorld AG, manufactures kits and retails them through distributors, with the latter providing EPC and O&M services to the client.

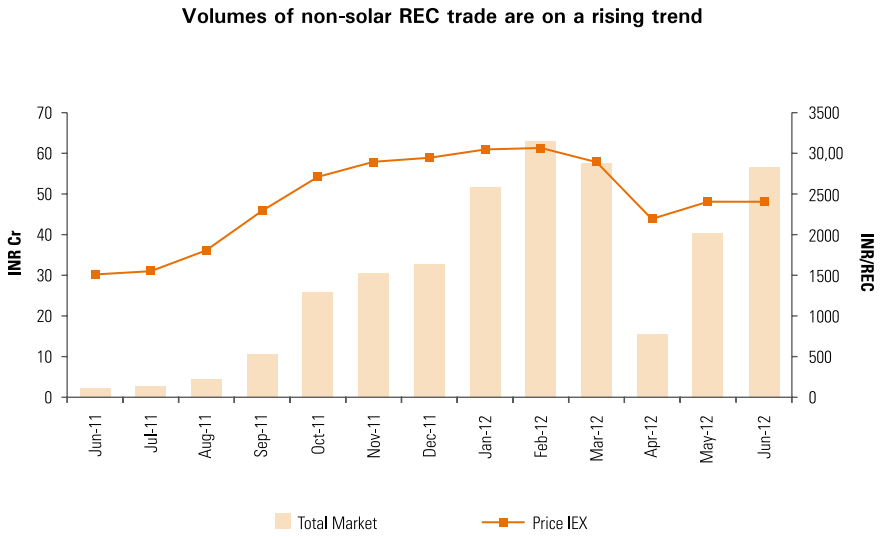
State Governments and regulators can encourage deployment by providing the necessary infrastructural support, appropriate regulations such as 'banking facility' or 'net metering' facility that allow commercial viability for power.

1 German Solar Industry Association

4. **Allow retail customers to participate in the REC market:** This can increase the liquidity in the market besides incentivizing solar power adoption amongst customers.

The REC market has picked up in the last year since its beginning. The first solar REC was traded recently. Given the increasing participation – volumes and trade – in the non-solar REC market, we expect that the REC market for solar will pick up as costs reduce.

Fig.25: Non-solar REC market trends in power exchange



Source: IEX

However, by encouraging retail REC's - market liquidity and participation will increase. Government and Regulators should take steps to expand the REC market to cover the retail power customers.

5. **Grid infrastructure planning:** According to a study titled 'Sun Shot Vision - 2020' by US Department of Energy currently, most utilities can allow up to 15 percent capacity penetration (rated output divided by peak load) per circuit of the Distributed Energy Resource (DER) to be connected to the grid using a simplified interconnection process and once that threshold has been reached, a detailed, interconnection requirements study is usually mandatory before interconnecting. It is therefore important to determine how much capacity of infirm power could be injected to the current grid infrastructure.

In the case of solar power, the uncertainty is inherent due to the variation in inter-annual solar insolation and intra-day cloud-induced variability. The extent of variation is dependent on several atmospheric factors that are beyond control. This variation in solar power insolation leads to variation in actual solar power generation. Hence, an integrated grid infrastructure investment planning that takes into account the capacity installed from solar/infirm sources of power, grid reinforcement requirements and backup capacity is the need of the hour.

6. **Government should provide partial risk guarantee mechanism:** Financing related costs can contribute as much as 45 percent of the total cost of solar power. Any reduction in funding costs will reduce solar power costs. We have seen use of foreign currency financing in many solar projects which have enabled the cost of power to be reduced substantially. It is encouraging to see dollar denominated funding flowing into the sector. However, the recent volatility in the currency movements will raise the cost of such financing. A partial risk guarantee fund can be created by the Central Government to mitigate this risk. The economic rationale can be developed based on the long term mitigation of forex exposures due to enhanced energy security and lower dependence on energy imports that solar power will enable.
7. **Support the lending community:** This can increase availability of credit to solar market which is critical for the success of solar program in India. Some of the enabling measures relating to solar sector from a lending perspective are as follows:
    - Sector specific exposure limits on lending - Banks have an internal sectoral cap / exposure limits for each sector. A separate solar/renewable energy sector specific exposure/cap can go a long way in increasing the pool of financial resources for solar sector. Further, given the importance of energy security and carbon mitigation potential, lending to solar/renewable sectors should be classified as 'priority sector'.
    - Long tenure solar bonds - Debt mobilization through say - long tenure tax free solar bonds - can go a long way in providing access of low cost debt for developers. This can address the inherent asset liability mismatch of the banking system and lend stability to the interest rates charges on developers. This issue is similar to what is being faced in other infrastructure sectors.
    - Solar data bank - Performance of existing plants and site data should be made available for the industry and banks. Banks on their part should spend enough resources to understand this sector well, since the strategic implications for the country are large and this represents an enormous funding opportunity in the coming decade.
8. **Enable solar eco system development in India:** The Government should create Solar Sector Focused Manufacturing & Investment Zones. Government of India has proposed the creation of a number of National Manufacturing & Investment Zones (NMIZ) to boost growth of manufacturing sector in India. The concept of NMIZ proposes a framework for more business friendly policy, procedures and approval ecosystem, combined with superior physical infrastructure[2]. Government should consider developing solar industry focused manufacturing and investment zones to encourage investments in this clean source of energy. This will enable development of scale economies and equip India with the required supply chain manufacturing infrastructure to harness its immense solar potential. In addition, the State Governments could identify potential sites for developing solar parks with all the basic infrastructure in-place.

8.2 Private sector investment

Private sector has played an important role in investing and developing solar power industry in India. Many grid connected solar power projects – under the JNNSM and State level solar programs – are under operation/construction. With solar power costs spiraling downwards, companies which are able to secure low cost financing and ensure performance standards in the most economical manner would benefit. Appropriate hedging mechanisms to mitigate exchange rate fluctuations also need to be in-place.

While the utility scale market would continue to be driven and defined by Government support, the distributed generation market is likely to provide an attractive business opportunity from an economics perspective. Solar companies should consider having a broad based focus and include segments like off-grid applications and other renewable technologies in their portfolio. This will also enable them to optimize their resources in an environment where access to new projects may be uncertain.

Unlike large scale projects, decentralized market would require solutions that have to be developed based on customer requirements and setting up logistical infrastructure to reach the customer. For example, a solar rooftop solution that provides quality performance at lowest possible cost at the consumer-end is the need of the hour. Given the immense rooftop market potential, an integrated approach that involves seamless collaboration amongst partners across the value chain is important. Some of the elements that need to be considered as part of the overall strategy for this market are as follows:

- Identification of target customer segments – based on cost economics, prevailing power tariffs and affordability to pay.
- Prioritization of focus geographies - locations that are most suitable for a rootop program – in terms of solar insolation, policy support, power supply scenario etc.
- Shortlist prospects for local tie-ups - based on market reach, technical and financial capabilities.
- Develop a value proposition - that can be taken to prospective customers /dealers/ prospects - based on branding, performance, economics and quality.

Another important element for enabling wider solar market adoption is access to finance. Innovative consumer financing models that can reduce the upfront capital investment can make it attractive for retail solar power market growth. It is important for investors/developers to tie-up and work closely with financial institutions for funding access and onward lending. Solar rooftop leasing models can drive wider adoption of solar PV by consumers. New business models to tap this market are already emerging.

To summarize, an appropriate risk mitigation strategy, scalable business models, innovative consumer financing and lease models can help solar companies do well.

2 PIB

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