



# India's Solar Ambitions - Challenges and Options

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## EXECUTIVE SUMMARY

India's recent announcement of adding 100 GW solar capacity by 2022 has created strong ripples in the global solar industry. While it seems a difficult target, it is not an impossible one. This paper lays out the key challenges and issues that face India in achieving this target.

The paper has identified financing the solar power addition, improving the finances of State Discoms, creating policies that provide a stable operating environment and expanding the manufacturing capacity for solar modules, as the key challenges that India faces in its solar ambition.

The paper also assesses the various options available to the policymakers to overcome these challenges.

For financing solar power additions, traditional forms of domestic Indian finance have limitations, owing to the existing infrastructure and power related NPAs in the Banking sector. Therefore, alternative sources of finance may have an important role to play. We believe that the proposed hard currency indexed PPAs might be a game changer, but will need to be used judiciously, as highlighted in the case of some emerging Asian and African countries that used this model in the '90s. 'Green bonds' is another option, individually or in conjunction with hard currency hedging. The effectiveness of Green bonds in isolation will depend on the maturing of the domestic bond markets. The other options available are the Yieldco structure, leveraging the balance sheets of PSUs, crowdfunding and community funding. In the Indian context, third party ownership model has been implemented with some success in Gujarat. With appropriate tax incentives, this model too could be useful in helping India expand its solar power capacity.

One key constraint for India is the weak financial health of its state Distribution companies (Discoms). The risk involved with the inability of Discoms to compensate the seller in a timely and fair manner may dissuade potential investors from participating in solar power opportunities in India, reducing the sector's bankability. Policymakers can assuage investors by providing either an escrow account mechanism or partial credit enhancement or guarantees to secure the cash flows to an investor.

The obvious, yet critical component of the success of the effort is a stable and consistent policy. This paper has tried to find lessons for India from the policy level experience of the leading countries with installed solar capacities, besides analysing the efficacy of India's own initiatives like Renewable Purchase Obligations till now. This paper finds that the German and Japanese policy of Feed-in-Tariffs (FiT) with a planned semi-annual degression in tariff offered to encourage installation pull forward and lock in system benefits of solar deflation. We view this as more effective at promoting distributed solar power compared to tax breaks and RPO/REC mechanism provided by the USA, which promotes centralised solar power and large



players. In India's own case, RPO/REC mechanism has failed to take off, partly owing to the Discoms' inability to fulfil their obligations.

The fourth challenge for India is to enhance its domestic solar manufacturing and research capacity, especially if the solar target is to have a positive rub-off on the Government's Make-in-India programme. Currently, India's manufacturing and research capabilities are far below requirement, although the recent initiatives by Indian corporates to tie up with foreign firms looks promising.

Finally, the paper looks at how distributed solar power capacity is especially important in the Indian context and how RBI's inclusion of renewable energy in Priority Sector Lending norms, Banks lending thrust and initiatives like solar leases are important tools to promote it. The paper also argues that technological developments, that increase efficiency and drive costs down, besides policies like FIT and net metering are critical to expanding the capacity of distributed solar in India.

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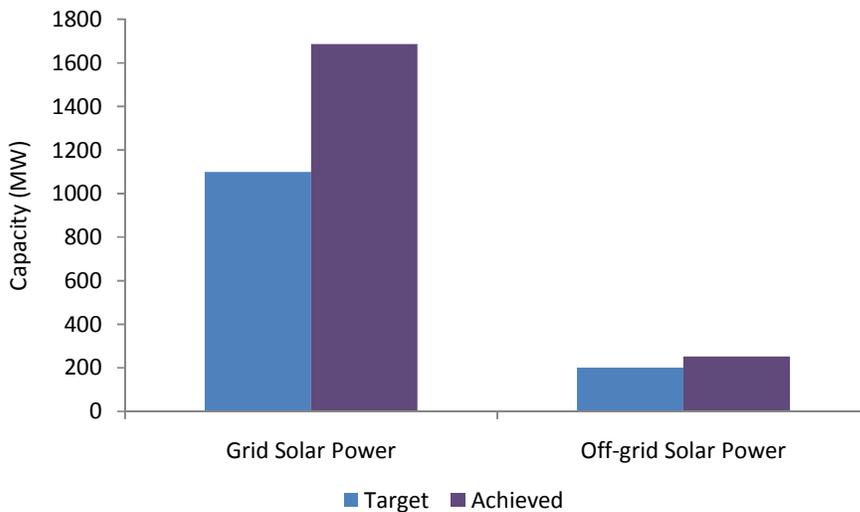
## INDIA'S SOLAR AMBITIONS

India, being endowed with a high solar insolation, is in a favourable position to reap the benefits of the falling costs of solar power. The Ministry for New and Renewable Energy estimates India's solar potential at 750 GW. To tap into the high solar potential, India launched the Jawaharlal Nehru National Solar Mission (JNNSM) in 2010. The mission was divided into 3 phases; currently the second phase is in progress. JNNSM has used various tools like Viability Gap Funding, Generation Based Incentives, accelerated tax depreciation and Bundling to promote solar power addition in India.

### Good beginning

If the early indicators are anything to go by, the Indian solar power mission has got off to a decent start. Phase I of JNNSM overshot its targets quite significantly. For instance, the target for commissioning grid connected solar power plants was set at 1,100 MW. Instead, capacity of over 1,800 MW was commissioned. This is even more remarkable, given that targets in Coal Power addition are missed regularly.

**Exhibit 1 – JNNSM Phase Capacity Addition – Targets vs Achieved**



Source: MNRE Annual Report FY2015, Equitorials Research

In addition to the capacity addition, the prices also have shown a considerable decline, with a forecast for further significant declines still to come (5-10% pa). Some reports say that the costs of solar power in India are much lesser than the global prices, as the balance of systems cost is cheaper than the rest of the world – in some cases even cheaper than China<sup>1</sup>.

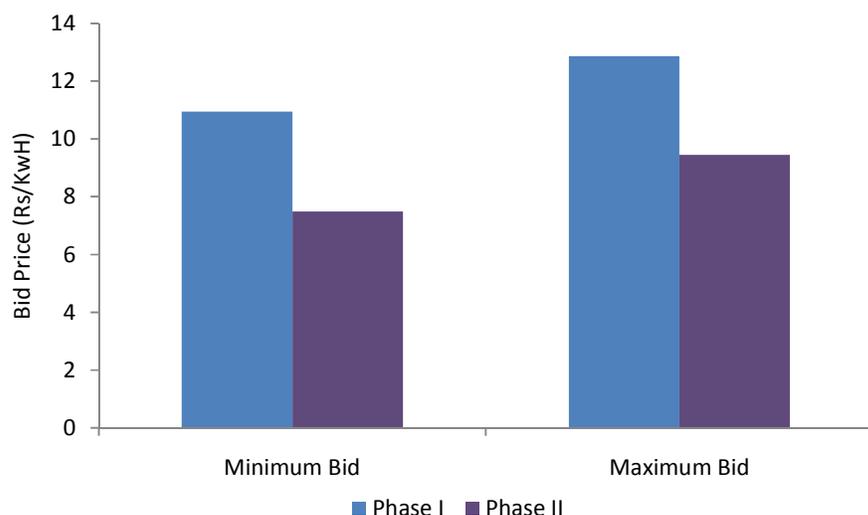
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<sup>1</sup> <http://www.thehindubusinessline.com/opinion/columns/vidya-ram/india-likely-to-exceed-target-of-100-gw-of-solar-power-by-2022-solairedirect-chief/article6757490.ece>

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## Exhibit 2 – JNNSM Solar PV based Power Bid Price

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Source: MNRE Annual Report FY2015, Equitorials Research

As of March 2015, India had already set up over 3.7 GW of Grid connected solar plants, in addition to 234 MW of Off grid SPV systems based power capacities<sup>2</sup>. Most of these capacity additions have been achieved under the JNNSM.

### Indian government's ambitious target

For India, solar power is a major strategic option, given that it not only provides much needed energy security and electricity system diversification, but also an opportunity to bolster India's domestic solar power equipment manufacturing base. Solar power through the distributed rooftop plant model, also fits in well with India's constraints of limited access to electricity, where 300 million people are still not fully covered by electricity access. With these strategic objectives in view, the government under Prime Minister Modi has declared ambitious solar power capacity addition targets. Late last year, India announced a target of adding 100 GW of solar power plants by the year 2022. If successful, India would become one of the largest three solar power players globally behind only China and Japan.

Indicating the concerted push for solar capacity additions in India, India's largest power producer, NTPC has committed to developing 10 GW solar power capacity over the next five years<sup>3</sup>. The company has already operationalised 110 MW of solar capacity<sup>4</sup>. Additionally, it has announced allocations for 1.42 GW solar PV capacity in May, 2015 alone<sup>5</sup>.

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<sup>2</sup> <http://mnre.gov.in/mission-and-vision-2/achievements/>

<sup>3</sup> [http://articles.economicstimes.indiatimes.com/2015-02-17/news/59232503\\_1\\_largest-power-producer-ntpc-mw-solar-mw-capacity](http://articles.economicstimes.indiatimes.com/2015-02-17/news/59232503_1_largest-power-producer-ntpc-mw-solar-mw-capacity)

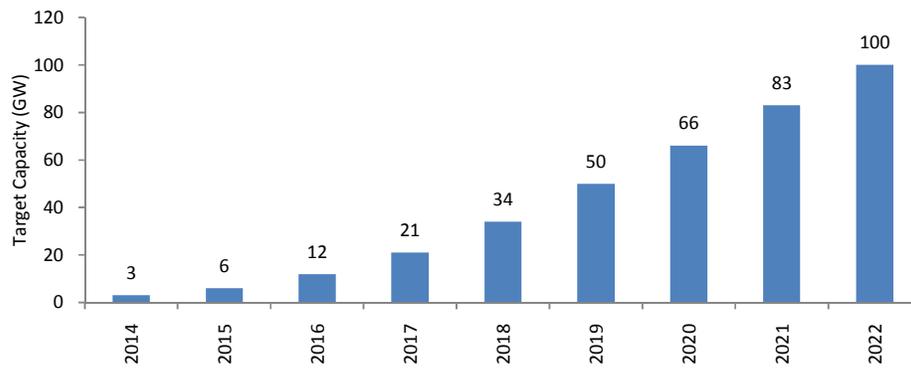
<sup>4</sup> <http://www.ntpc.co.in/en/power-generation/renewable-energy-and-distributed-generation>

<sup>5</sup> Bridge to India newsletter

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### Exhibit 3 – India’s Solar Power Addition Targets (Cumulative Installed Capacity)

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Source: MNRE, Equitorials Research

#### Old Implementation Issues Persist

However, some reports have suggested that the implementation of solar projects in India thus far have been marked by same old issues, like land acquisition disputes, particularly if solar is allowed to be installed on arable farmlands closer to grid transmission<sup>6</sup>. Besides land and finance, other issues may also be expected to crop up in India’s pursuit of the 100GW solar dream.

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<sup>6</sup> <http://forbesindia.com/article/real-issue/indias-solar-power-punt/40047/0>

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## KEY CHALLENGES AND OPTIONS FOR INDIA TO ACHIEVE THE SOLAR TARGET

The key challenges that India faces, in order to achieve its goal of 100 GW solar power installation by 2022 are related to financing the solar power addition, improving the finances of State Discoms, creating policies that provide a stable operating environment and expanding the domestic manufacturing capacity for quality solar modules.

There are a number of uncertainties for any potential investor in the Indian Solar Power market, that discourage potential investors, ranging from the nature of solar power itself to the fact that the predominant buyer in India, viz. the State Discoms are marked by weak finances. Moreover, the transmission network in India is untested for the potential load variations caused by Solar power, besides having a host of legacy issues.

Exhibit 4 – Uncertain environment for India’s Solar Power Sector Investors

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<b>Variable Output</b>	<ul style="list-style-type: none"><li>• Output varies as per the sun radiation/insolation</li><li>• Effected by weather vagaries</li></ul>
<b>Financially Weak Discoms</b>	<ul style="list-style-type: none"><li>• State Discoms' low credit rating</li><li>• Sitting on huge losses</li></ul>
<b>Grid Parity - Distant Reality</b>	<ul style="list-style-type: none"><li>• Solar power (Utility) yet to achieve Grid parity</li><li>• High disparity from the grid tariff in Distributed solar</li></ul>
<b>Weak Transmission Infra</b>	<ul style="list-style-type: none"><li>• Transmission infrastructure not prepared for Grid connected solar utilities</li></ul>

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Source: Equitorials Research

All or most of these issues must be addressed to attract investors and global players to India.

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## FINANCING THE SOLAR POWER ADDITION

The biggest challenge for India is to attract sufficient capital to finance the solar power addition. Solar power is still an emerging sector and in all the major cases around the world, it has taken government interventions to channel investments into the sector. In India, this is even more important given the various concerns that face a potential investor in this sector.

### Alternative Financing

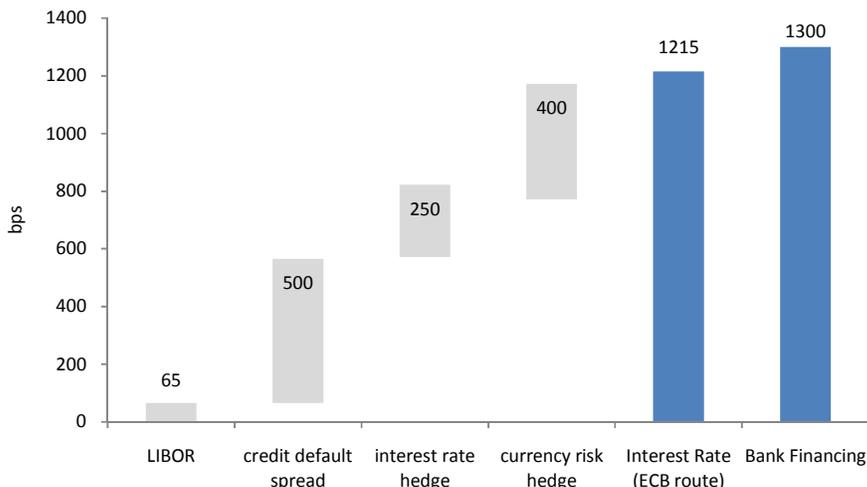
From the current 3.3 GW capacity to the tough target of 100 GW in 2022, India's Solar sector would need ~Rs 6 Lacs Crore. Out of this, ~Rs 4.5 Lacs Crore would be needed in the form of debt. However, Indian banking sector, the chief source of debt in India, is already inflicted with high NPAs, primarily due to the Infrastructure and Power (Conventional Sources) sector funding. That limits their appetite to fund relatively risky solar sector projects, whereas low interest rates and longer tenure loans are the key to achieve such humongous leap in seven years. Accordingly, the need for innovative financing options seems imperative.

### Options Available to Attract Capital

#### 1. Hard currency indexed PPA/ Hard currency denominated PPA

One of the problems that face investments in a developing country like India is the risks associated with default, interest rate movements and exchange rate fluctuations. Investors require a higher return to compensate for all these risks. This raises the cost of borrowing for such projects. For instance, funds raised through the External Commercial Borrowings route cost over 12.2% pa, with currency and interest rate hedge risks constituting more than half of these costs.

**Exhibit 5 – Uncertain environment for India's Solar Power Investors**



Source: Equitorials Research

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In this context, any move that can materially reduce hedging costs can be a disruptive development for the complete value chain of Indian Solar Sector. It could bring down the cost of financing by up to 450 bps while also opening up a significant new source of global funding. We believe that the Indian government's move of US dollar denominated policy can be that very game changing move!

It is expected that PTC would soon announce one such PPA<sup>7</sup> that would bring down the cost of green power to the Grid parity, around Rs 4.50/ unit. The fine print of the model will soon be out but it is expected to have foreign exchange risk sharing mechanism.

This model was used in early 1990s in several emerging Asian and African countries where the PPAs were indexed to the hard currency and the debt financing was also in the hard currency. But the Asian currency crisis which impacted many other emerging markets exposed the unsustainable nature of the financing strategy in its then existing form if a long term currency hedge is absent.

In the short term, it is a double edged sword and should be used with utmost care. On one hand, it generates an attractive proposition for the Solar Power Developers (SPD) but on the other, it shifts the foreign exchange risks to the power purchasers, which puts players like NTPC or PTC under huge pressure if things go astray in a short to medium term. RBI has already stated in its March 2015 bulletin that the 36-country Real Effective Exchange Rate was at the highest level since 2003 and that the Indian currency is overvalued by at least 10%<sup>8</sup>. Moreover, increase in US base rates, which is long due, will put further pressure on the Indian Rupee. There should be a well thought out mechanism (also covering the tail risks like the Asian Currency crisis of 1990s) to share the hedging costs/ currency risks in the shorter term. Otherwise it would be the consumer who suffers if the currency depreciation breaches a threshold. In the medium to longer term period, the hedging corpus can be expected to reach a sustainable level and provide enough cushion to stave off the vagaries of currency risks. Equitorials believe that this move can turn out to be a game changer for Indian renewable market if full hedging is used judiciously.

## 2. Green Bonds

Bond markets in India are in an under-developed stage and have little foreign access. A strong domestic bond market will go a long way in achieving debt financing for India's solar ambitions. Green bonds<sup>9</sup> are issued for those projects that are directly contributing towards a greener tomorrow focusing on clean energy.

Globally, renewables are being considered increasingly as an attractive investment option and that has also reflected in the demand for Green bonds, which hit a

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<sup>7</sup><http://www.livemint.com/Industry/XSqt3KUpfjy9PHahM0ycO/PTC-may-call-for-solar-power-bids-in-dollar-denominated-tari.html>

<sup>8</sup><http://www.livemint.com/Money/zokIGqI9cfzAffwNxPMlck/Dollars-runaway-rally-and-the-rupees-overvaluation.html>

<sup>9</sup>Re-invest Daily Newsletter, Feb 17, 2015

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record issuance of \$37 billion<sup>10</sup> in 2014. China has also set up a task force to plan and finalize a corporate green bond market in 2015. Since 2008, World Bank and International Finance Corporation (IFC) have issued close to \$12 billion<sup>11</sup> in green bonds.

Recently, India has contemplated raising US dollar denominated green bonds through the Indian Financial institutions like India Infrastructure Finance Co. Ltd (IIFCL), Power Finance Corp. Ltd (PFC), REC, IDBI Bank Ltd, Indian Renewable Energy Development Agency Ltd (IREDA), ICICI Bank Ltd and Yes Bank Ltd. But raising funds through Green bonds poses certain challenges in the international markets e.g. high currency hedging costs, poor sovereign ratings and low tenure. Following are the Green bonds that have been issued in the Indian bond market<sup>12</sup>:

- Green Infrastructure Bond by Yes Bank: Rs 1,000 Cr (10 years, AA+ rating, 8.85% coupon)<sup>13</sup>
- Green Dollar bond by Exim Bank of India: \$500 million issue 2.75% notes<sup>14</sup>

Another problem that plagues the Indian renewable sector is its credit risk rating. That is one of the major reasons why the solar sector projects have not been able to tap the international bond market. It is about time when the domestic bond market is nurtured to grow into a matured one and some credit risk enhancement exercises are performed.

### 3. Yieldcos/Project Funds

‘Yieldco’ is an innovative financing source which is still in its nascent phase, but growing rapidly. ‘Yieldco’ is short for ‘yield companies’ i.e. companies which are publicly traded and formed to own a portfolio of operational renewable energy projects and pass most of the cash flows in the form of dividends to the investors. The idea is not new and can be seen as a refined version of Noida Toll Bridge, although the entity stands for a single project. But ‘Yieldcos’, due to their project portfolio provide a diversified experience. Many renewable firms in the US have sought to this financing strategy in the last year or so. Three US ‘yieldcos’ were floated in 2014 which raised \$1.6 billion and the six US ‘yieldcos’ have risen more than 50% since their Initial Public Offering<sup>15</sup>, with several additional floats pending near term.

In UK, a similar financing product, named ‘project fund’, has been adopted. These are listed entities but have a lower market capitalization. These project funds offer around 6% yield which is way better than the 2% yield offered by government funds. Similar financing model has also been adopted by a Spanish MNC recently.

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<sup>10</sup> Global Trends in Renewable Energy Investment 2015, FS-UNEP Collaborating Centre

<sup>11</sup> <http://www.worldbank.org/en/topic/climatechange/brief/green-bonds-climate-finance>

<sup>12</sup> <http://www.livemint.com/Politics/xTctEMl1ViQWlJurMTg75l/India-plans-push-for-green-bonds.html>

<sup>13</sup> <http://www.climatebonds.net/2015/03/weekly-update-eib-eur400m-450m-gb-negative-yield-india's-1st-gb-yesbank-closes-inr10bn-161m>

<sup>14</sup> <http://www.climatebonds.net/2015/04/weekly-blog-unibail-rodamco-€500m530m-green-bond-x6-oversubscribed-exim-bank-india's-green>

<sup>15</sup> Global Trends in Renewable Energy Investment 2015, FS-UNEP Collaborating Centre

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For a country like India where many infrastructure firms are heavily indebted and the financial institutions, due to their peaking NPAs are reluctant to fund the risk prone renewable energy sector, 'Yieldco' can prove a fantastic way to garner funds without stretching the balance sheets.

#### 4. Third Party Ownership Model

Gujarat has been one of the early adopters of this model where the rooftop owner leases his rooftop to the Third party developers, who in turn install PV modules on the rooftop and sell the power to the neighbours, building owner and the grid. Any tax credit or subsidy received by the government is transferred to the third party developer, who also receives the revenues generating out of the sale of electricity. The building owner receives the lease payments and/or concessional or free electricity. This idea of Public Private Partnership (PPP) has worked wonders for Gandhinagar where IFC helped the government to install first of its kind proof of concept which paved way for further such installations<sup>16</sup>. In US, Solar City<sup>17</sup> has formed a successful model of leasing for its household customers. This financing model coupled with appropriate tax incentives and clarity over net metering rules can be quite helpful in achieving India's solar targets.

#### 5. Crowd Funding

Crowd funding companies provide funding platform primarily to the distributed solar project owners. These owners can obtain funding from a large pool of individual investors. The amount contributed could be very little. Investors, in return get an annual fixed return for a certain agreed upon time period. The revenue model for the crowd funding company is the spread between the rate of return it receives from the project owner and the return it provides to the investor.

Countries around the globe have already started using this financing medium in a big way e.g. Mosaic raised successfully around US \$5.5 Million in US and Abundance Generation raised around US \$3 Million for their respective solar projects<sup>18</sup>. Global Climate Innovations Lab<sup>19</sup> which currently involves 8 countries is planning to venture into India. This lab is a country specific crowd funding platform which has the potential to bring down the debt cost by about 4.5 per cent. This again could turn out to be disruptive if used in the rooftop segment but crowd funding is still a new phenomenon in India and is struggling with the Government's neglect over its regulations and policies. A few Indian firms have started working around this phenomenon but none has used it as serious financing strategy in the Indian renewable sector to date. Indian policymakers must come out with detailed policies and regulations around this relatively new but rapidly increasing way of financing which can prove extremely helpful in achieving the Indian distribution solar targets.

#### 6. Community Funding

Community funding is similar to the crowd funding phenomenon and is nothing new to the Indian villages and small town where individual investors living in a post,

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<sup>16</sup> Public-Private Partnership Stories India: Gujarat Solar  
[http://www.ifc.org/wps/wcm/connect/d0a75c804b077348b4acfe888d4159f8/PPPStories\\_India\\_GujaratSolar.pdf?MOD=AJPERES](http://www.ifc.org/wps/wcm/connect/d0a75c804b077348b4acfe888d4159f8/PPPStories_India_GujaratSolar.pdf?MOD=AJPERES)

<sup>17</sup> <http://www.solarcity.com/residential>

<sup>18</sup> Global Trends in Renewable Energy Investment 2015, FS-UNEP Collaborating Centre

<sup>19</sup> Re-invest Daily Newsletter, Feb 17, 2015



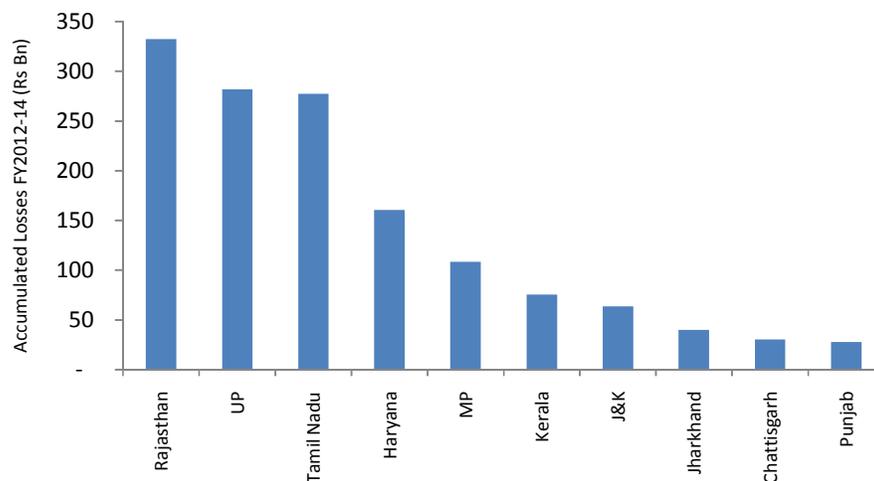
village, even colonies come together to fund a mutual goal but the idea is yet to catch the fancy of the Indian urban population who can use it for their community's/region's power demand through distributed solar medium.

We believe that any or all of these options can provide a boost to financing for Indian solar industry and help tackle its biggest challenge.

## DISCOMS' FINANCIAL HEALTH COULD DERAIL THE GOVERNMENT PLANS

State policies are going to be the key factor in achieving or at least reaching close to the aspirational target of 100 GW solar installations by 2022. It is not just the solar radiation/ insolation of a state that would make it an attractive destination for the solar power developers, but also the general stability in the operating environment of the players, especially with respect to the buyer of solar power, which in this case will be the state distribution companies. Essentially, power producers and investors need to be reasonably assured about their power being sold for a certain threshold price and hassle-free compensation, for them to invest in any meaningful way. However, India's state owned distribution companies are marked by lack of profitability and high indebtedness.

Exhibit 6 – Accumulated Losses of India's State Electricity Boards (Top 10 States)



Source: Planning Commission Annual Report 2014, Equitorials Research

The financial ill-health of the state Discoms, as well as their poor track record, puts serious doubts over their ability to timely and regularly clear solar power producers' dues. It is unreasonable to expect any serious investor to set up solar power generating capacity in a big way given these uncertainties. In order to succeed at the solar capacity addition plan, steps must be taken to enhance the creditworthiness of the state Discoms through a combination of the following means.

- An escrow account: that can guarantee the project cash flows to the investor
- Partial credit Enhancement<sup>20</sup>: in which the RBI allows banks to provide partial credit enhancement to the corporate bonds which would provide confidence to investors and help raise more funds
- Partial Guarantee<sup>21</sup>: could be provided to the bonds issued by the special purpose vehicles of the operational solar projects

<sup>20</sup>[http://www.business-standard.com/article/finance/rbi-for-20-credit-enhancement-by-banks-to-corporate-bonds-114052001358\\_1.html](http://www.business-standard.com/article/finance/rbi-for-20-credit-enhancement-by-banks-to-corporate-bonds-114052001358_1.html)

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## POLICY MEASURES FOR A STABLE OPERATING ENVIRONMENT

Global experience has shown that one of the most important factors in the expansion of solar power is a stable policy regime, besides regulations that provide a clear visibility, especially to investors. The following policy measures can be taken to provide stability to the operating environment for Solar players.

- Consistent policies – Policies should be consistent and not change with every batch's notification. The initial stage of India's Solar power venture have been marked by a large number of policies, which might have been necessitated by the need to experiment initially. However, now, it is imperative that there is a set of consistent policies, so as to provide clarity to various stakeholders in India's solar power sector.
- Scope for Enhancing Priority Sector Status of Renewable Energy – In a recent notification, RBI has accorded priority sector status to bank loans upto Rs 15 cr to Solar power generators. For rooftop solar, loans of upto Rs 10 lakh to individual borrowers have been accorded this status. We believe it is a good start by the RBI. But when seen in the light of the 100 GW targets and the big projects envisaged for bidding, the effort seems quite less. Nevertheless, it will encourage SMEs to include renewables in their portfolio for captive consumption and decentralized uses. We recommend gradual increase in the lending limits to bring it to a level where it can make significant contributions to achieve the ambitious targets for renewable sector.
- Steps to improve the Credit rating of discoms/offtakers – The general financial status of discoms will need to be improved, or other mechanisms will need to be introduced, so that the sellers/investors are more assured of getting timely compensation for the power.

### Policy Lessons For India From Global Experience

Globally, solar power has been largely installed by developed nations. Germany led the way with nearly 39 GW capacity<sup>22</sup>, followed by China at 33 GW<sup>23</sup>, Japan at over 25 GW<sup>24</sup> and US at 20 GW<sup>25</sup>.

The German and Japanese solar capacity additions have been driven by the Feed-in-Tariff (FiT) policies<sup>26,27</sup>, whereas the US capacity additions have been driven by tax incentives and state-wise renewable purchase mandates<sup>28</sup>. These two different

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<sup>21</sup><http://www.iifcl.co.in/Content/ceps.aspx>

<sup>22</sup> <http://www.bloomberg.com/news/articles/2015-04-15/german-power-grid-expects-a-season-of-record-solar-output>

<sup>23</sup> <http://earthtechling.com/2015/04/china-solar-power-surges/>

<sup>24</sup> [http://www.pv-magazine.com/news/details/beitrag/world-to-add-57-gw-of-solar-pv-in-2015--says-ihs\\_100018839/#axzz3awP4DO00](http://www.pv-magazine.com/news/details/beitrag/world-to-add-57-gw-of-solar-pv-in-2015--says-ihs_100018839/#axzz3awP4DO00)

<sup>25</sup> <http://www.seia.org/research-resources/us-solar-market-insight>

<sup>26</sup> <http://www.greentechmedia.com/articles/read/why-germanys-solar-is-distributed>

<sup>27</sup> <http://www.forbes.com/sites/williampentland/2015/01/13/utilities-push-back-as-solar-industry-booms-in-japan/>

<sup>28</sup> [http://www.nytimes.com/2012/06/02/opinion/how-to-make-renewable-energy-competitive.html?pagewanted=all&\\_r=4&](http://www.nytimes.com/2012/06/02/opinion/how-to-make-renewable-energy-competitive.html?pagewanted=all&_r=4&)

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policies has led to slightly different trajectories for these countries. While Germany and Japan have higher proportion of distributed solar in their overall installed Solar power, US has more centralised generation<sup>2930</sup>.

While there appear to be large benefits of the FiT policy, with respect to promoting distributed solar power installation, Germany is witnessing its downside too. Since FiT policy is based on long term contracts, Germany finds itself stuck with higher cost tariffs from capacities built earlier<sup>31</sup>. However, it is this long term nature of the contract that provides stability to solar tariffs for an investor and makes the investment in solar less risky, thereby attracting cheaper capital. It is this cheaper capital and the resulting economies of scale that that has helped progressively and sustainably cut down the price of solar power in Germany.

On the other hand, in the US, the policy incentivises solar production in the form of a 30% cash tax break. Consequently, solar has attracted primarily those investors who have sufficient tax liability to avail of these incentives. This has encouraged mainly large players to invest in Solar power, as indicated by the fact that US has more centralised solar power generation. A downside of the US policy is that it has led to solar prices that are higher than those in Germany<sup>32</sup>.

Recently, China has also adopted the FiT route to enhance its solar capacity additions. Initially this saw significant deployment of centralised utility scale solar projects, but the Government has been redesigning the FiT to incentive significantly more distributed solar installations.

From the above, it is clear that the policies that India adopts will impact the expansion of solar power generating capacity not only quantitatively, but also qualitatively given the limitations of the current weak transmission and distribution grid system.

### **Renewable Purchase Obligations and Renewable Energy Certificates in India**

One mechanism that was expected to promote solar energy in the country was the Renewable Purchase Obligations (RPO) and Renewable Energy Certificates (REC). However, the market for the solar RECs has failed to take off due to a lack of consistent policy compliance and enforcement.

#### **Solar REC Markets marked by Low Volumes and Low Prices**

For most of the Solar REC market's existence, the price of RECs has been at the floor set by the CERC. The chief reason for this is the sellers heavily outnumbering buyers. While the number of REC sellers on the power exchanges has consistently risen, buyers have dwindled. In fact, the number of Buy bids for solar RECs was lesser in April 2015, the last month for which trading happened, compared to June 2012, the

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<sup>29</sup> <http://www.greentechmedia.com/articles/read/why-germanys-solar-is-distributed>

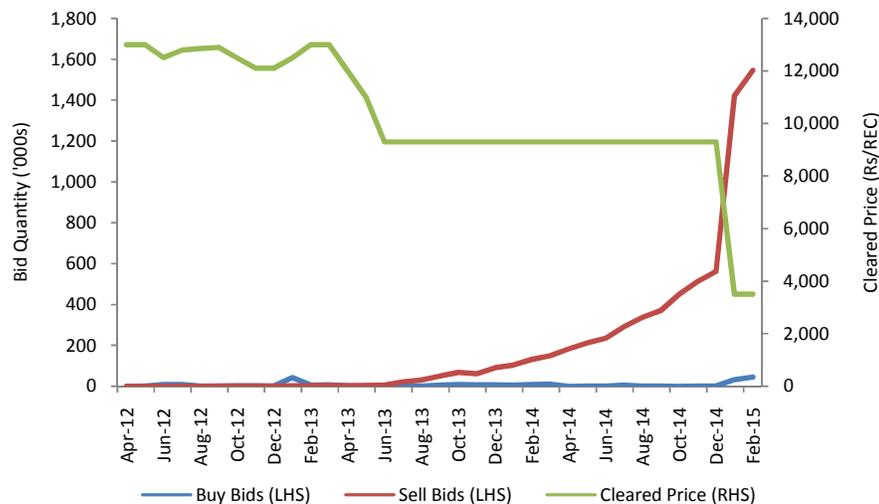
<sup>30</sup> <http://www.forbes.com/sites/williampentland/2015/01/13/utilities-push-back-as-solar-industry-booms-in-japan/>

<sup>31</sup> <http://www.greentechmedia.com/articles/read/germany-moves-to-reform-its-renewable-energy-law>

<sup>32</sup> <https://financere.nrel.gov/finance/content/germany-solar-feed-in-tariff-FIT-insolation-resource-comparison>

third month in the history of Solar REC trading. In comparison, the selling bids have increased from 563 to nearly 1.8 mn in the same time period, an increase of nearly 3,16,000%.

**Exhibit 7 – REC Market in India – Buy & Sell bids and Clearing Volume**



Source: MNRE, Equitorials Research

### Weak Compliance Enforcement risking further investments in sector

One of the major reasons for the lack of buyers in the market is the failure of Electricity Distribution Companies to comply with their solar RPOs. One of the reasons for this failure of the Discoms to comply could be their financial weakness. For their part, the regulators have failed to penalise these Discoms sufficiently. Some states, like Uttarakhand, have penalised the Discoms in the past for non-compliance<sup>33</sup>. However, these states are in a minority.

An additional issue with RECs is that they come with an expiry date, making it crucial for generators to sell them within 2 years. The failure to sell RECs has led to a situation in the past where the investments in Solar power have been affected negatively<sup>34</sup>.

<sup>33</sup> <http://mnre.gov.in/file-manager/UserFiles/Workshop-RPO-RECs-FIE-24042014/Sushanta-Chatterjee-CERC.pdf>

<sup>34</sup> [http://articles.economicstimes.indiatimes.com/2012-11-22/news/35300733\\_1\\_energy-certificates-solar-power-producer-renewable-energy](http://articles.economicstimes.indiatimes.com/2012-11-22/news/35300733_1_energy-certificates-solar-power-producer-renewable-energy)

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## **EXPANDING THE DOMESTIC CAPACITY AND RESEARCH FOR SOLAR MODULES MANUFACTURING**

### **Manufacturing Capacity**

Indian solar policies thus far have mandated at least a part of the entire solar installation to be manufactured in India. Going ahead, it appears that there will be even more emphasis on enhancing domestic solar manufacturing capacity, since that expansion plan flows in well with the PM's ambition to make India a manufacturing hub. An associated investment will have to be made in the related Research and Development capabilities.

Recent policies suggest that at least 25% of the overall solar capacity addition will be bound by Domestic Content Requirements (DCR). We estimate the peak Solar Power Capacity addition to be 17 GW. Accordingly, it may be expected that at the very least, 4.25 GW of solar capacity added would fall under DCR mandates. However, given the Government's impetus on utilising its solar plans to promote domestic manufacturing, it would not be a surprise if the DCRs are increased much above 25%.

In comparison, in mid-2014, the total Solar Cells and Solar Module manufacturing nameplate capacity in the country were only 1.26 GW and 2.35 GW, respectively. More importantly, only 0.66 GW of the installed 2.35 GW module production capacity was operational<sup>35</sup>.

The Indian Solar Cell manufacturing sector is extremely fragmented, with none of the companies being vertically integrated. PV Manufacturing is mostly concentrated at the downstream of Module assembly. For instance, there are 38 players in the downstream Solar modules, but only 13 in the solar cell manufacturing. The technology development is also relatively low.

Additionally, these facilities are non-integrated and rely on imported wafers for solar cell manufacturing. It will take some time for part of non-operational solar cell capacities to manufacture the solar cells at a price that makes the project viable.

Clearly, there is a lot to be done in terms of manufacturing for India to be able to support the solar capacity targets.

### Prices to continuously decline in next five years

Over the past few years, the cost of solar modules globally has declined significantly due to improvements in technology and economies of scale. Module prices, both crystalline silicon and thin film, are projected to fall moderately in 2015 and continue to decrease over the next decade by 5-10% annually. Canadian Solar has

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<sup>35</sup> <http://mnre.gov.in/file-manager/UserFiles/manufacturing-capacity-of-solar-cells-and-modules.pdf>

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indicated that they target reducing the cost of solar modules by ~23% to \$.36/w by the end of 2017<sup>36</sup>.

### Signs of Aggression

Recently though, Indian players have started to look more aggressive in terms of capacity addition plans. There were some large projects announced this year, expected to commission by 2018.

- Mundra (Gujarat) project – Adani and SunEdison signed an MoU in January 2015 to establish the largest, vertically integrated PV manufacturing facility in India. The total investment planned is about \$4 billion<sup>37</sup>.
- The Essel Group has entered into a joint venture (JV) agreement with JA Solar, one of China's leading solar energy firms, to launch a solar cell and module manufacturing company in India. The JV will set up a manufacturing facility in India with an estimated capital expenditure of US \$150 million. The facility is expected to generate 500 MW of power per annum<sup>38</sup>.
- Trina Solar of China had signed an MoU with Welspun Energy of India to set up a 500MW pa solar cell and module manufacturing facility in India. However, we note this is very preliminary given that neither Trina Solar nor Welspun Energy have yet made any commitments or even announcements / references in notices to shareholders.<sup>39</sup>

Being an emerging sector, Solar power is marked by newer technologies owing to continual research and development efforts being put in by organisations across the globe. Amongst other things, these R&D activities are targeted at developing thinner wafers to make them more cost effective, increasing the solar module conversion efficiency and making the Balance of System more cost effective. This is one of the reasons why solar power costs have witnessed a fall in the recent years.

If India is to become a serious player in Solar module manufacturing, there will need to be an appropriate investment in R&D as well, or access to world leading technologies through the joint venture strategy mentioned above.

The Chinese government spent nearly two-thirds of their R&D budget on solar in 2014. Chinese companies added another \$485 million to this \$1.1 bn R&D cost. Overall, China spent a quarter of the global total expenditure on R&D, compared to the 70% share it has in the PV capacity installed worldwide.

According to Bloomberg New Energy Finance, this R&D and process improvements has the potential to reduce Chinese module costs by 30% by the end of the decade, over and above the 75% reduction in price witnessed since 2009.

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<sup>36</sup> Canadian Solar Investor Day Presentation, 21 May, 2015

<sup>37</sup> [http://www.business-standard.com/article/companies/sunedison-adani-to-build-solar-pv-manufacturing-facility-in-mundra-115011100778\\_1.html](http://www.business-standard.com/article/companies/sunedison-adani-to-build-solar-pv-manufacturing-facility-in-mundra-115011100778_1.html)

<sup>38</sup> [http://www.business-standard.com/article/companies/essel-group-forms-jv-with-china-s-j-a-solar-to-set-up-manufacturing-facility-in-india-115051801182\\_1.html](http://www.business-standard.com/article/companies/essel-group-forms-jv-with-china-s-j-a-solar-to-set-up-manufacturing-facility-in-india-115051801182_1.html)

<sup>39</sup> <http://timesofindia.indiatimes.com/India/Complete-list-of-business-agreements-signed-by-India-China/articleshow/47306097.cms>



Most R&D effort is concentrated on cost efficiencies of the crystalline silicon cell, besides thin-film PV and other disruptive technologies such as triple junction cells. New techniques like diamond wire saw, that makes thinner wafers, increasing the number of 'busbars' on a solar cell, which increases the energy output of solar cells, fluidised bed reactor technology, make solar modules more cost effective and efficient.

There are significant efforts also being made globally to improve the solar cell conversion efficiency. Global major Canadian Solar has targeted increasing the cell conversion efficiency to 20% by the end of 2017, up from 18.5% at the end of 2014<sup>40</sup>.

Most of these techniques are either already commercial, or being commercialised. We believe that India would need significant R&D investments to become globally competitive in solar PV and solar thermal manufacturing.

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<sup>40</sup> Canadian Solar Investor Day Presentation, 21 May, 2015

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## ROOFTOP SOLAR POWER – THE OTHER WHEEL

An important pillar of the drive to add solar power is Distributed Solar power. It may be argued that the ability of Solar power to be distributed is its key strength in the Indian context, as Distributed solar can be the answer to India's Grid related issues, particularly as residential and commercial storage technologies are commercialised over the next 5 years. In a scenario where nearly 25% of the population lives in non-electrified regions, distributed solar with storage can be a boon.

The MNRE has so far sanctioned 361 MWp aggregate capacity of grid connected rooftop solar systems in the country, of which 42 MWp have been commissioned.

Further additions can be achieved through active policy support from the States. Recent developments, such as falling solar panel prices and increases in efficiency rates, have made solar rooftops increasingly economical.

### Government incentives are the key catalysts for rooftop solar power

As has been witnessed globally, Government incentives can significantly influence how Distributed solar takes off vis-a-vis Centralised solar power. In India, there is a provision of Central Financial Assistance (CFA) of 15% of the total cost or Rs. 12 per watt or Rs. 1.20 crore per MWp under the Grid Connected Rooftop and Small Solar Plants Programme of the MNRE. This stands in comparison to the average cost of grid connected rooftop solar systems of about Rs. 8.0 crore per MWp capacity. Besides, there are provisions of concessional import duty/excise duty exemption, accelerated depreciation and tax holiday for setting up of grid connected rooftop power plants.

In terms of channelizing finances into Distributed solar, in addition to the RBI's inclusion of renewable energy in Priority Sector Lending norms, Public Sector Banks have also been instructed to encourage home loan/ home improvement loan seekers to install rooftop solar PV plants and include cost of system in their home loan proposals. These policies are important to promote the adoption of Distributed solar in India, especially since the current Indian solar market is comprised mostly of large-scale projects.

Besides, consumers can be offered either solar leases (leasing the panel and its energy for a fixed periodic payment) from a solar company, power purchase agreements (purchase each unit of electricity produced by the panel at an agreed upon rate), or solar loans (the consumer, rather than the service provider, owns the panel; effectively a solar panel mortgage).

### New battery technology is a potential Game Changer

Solar energy's value proposition increases significantly with the introduction of more effective batteries that can store electricity, such as the Powerwall, launched by Tesla in April 2015. While economies of scale and regulatory issues have not made this sufficiently cost-effective for the residential sector yet, batteries are already



being used in commercial and industrial sectors (particularly for backup and peak load management), where extra charges for using energy during high-demand periods can make up 30% of electric bills.

#### Path Ahead

Going ahead, policymakers must provide a fillip to policies like net metering and Feed-in-Tariff to encourage rooftop solar power, given the strong impact that these policies have been found to have in promoting Distributed solar globally. Net metering already exists in some cases, like in Chandigarh, where bus stands are proposed to have solar power with gross metering system. The system may also be useful for industrial units.

Net metering aside, there are other types of local solar that can help reduce costs and negate structural, shading, or ownership issues associated with rooftop installations. Community solar allows customers to “subscribe” to larger solar arrays located in their neighbourhood. The subscribers then get a credit on their electricity bill for the energy produced from these community solar projects through a process called virtual net metering. This model is particularly attractive to renters, apartment dwellers, and low-income communities, who may not otherwise be able to participate in this process.



## CONCLUSION

India's solar plans are a strongly positive development not only from the perspectives of its energy security, its environmental and climate change standpoints. It is also a great opportunity to start India's push to become a manufacturing hub. It is clear that India's goal of adding 100GW of annual solar capacity by 2022 is difficult, but it is not unachievable. However, there are a number of issues that need to be fixed before this goal can be achieved. The biggest challenge in front of the Government is to channelize sufficient investments in this sector. This can only be achieved if investors are provided clarity in the operating environment, as well as mechanisms to assure fair, timely and regular compensation by the buyers, i.e. Discoms. Policy measures will need to balance the growth between centralised and distributed solar, while also creating sufficient manufacturing and research capacity in the country to cope up with the rapid expansion of solar power capacity in India.



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