



REPORT ON BARRIERS FOR SOLAR POWER DEVELOPMENT IN INDIA

2010

South Asia Energy Unit
Sustainable Development Department

The World Bank

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Acknowledgments

This report on market assessment to understand the issues/problems and barriers that developers are facing in the solar power sector in India is part of The World Bank support on Concentrated Solar Power to the Ministry of New and Renewable Energy (MNRE). The report is based on the work undertaken by consultant, Ashish Kulkarni. It should be noted that the analysis results does not represent The World Bank view.

The World Bank would like to thank counterparts in the Ministry of New and Renewable Energy (MNRE) who provided guidance and inputs through the assignment and the several developers who were interviewed for their views. This work received Energy Sector Management Assistance Program (ESMAP) funding, for which we are grateful.

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Executive Summary

India today finds itself on the path of becoming one of the leading nations in solar energy by taking steps towards implementing large MW scale solar power projects and is poised to position itself as a one of the world's major solar producer as well as a manufacturing hub for solar power plants. The effective utilization of India's solar potential will lie in the successful implementation of the Jawaharlal Nehru National Solar Mission (JNNSM) which was announced by the Honourable Prime Minister of India, Dr Manmohan Singh on 11th January 2010. This would also mitigate the international pressure with regard to emission reductions.

There have been discussions at various forums on the actual implementation modalities and issues with regard to the NSM. The Ministry of New and Renewable Energy (MNRE) and Ministry of Power (MoP), two entities driving this Mission together have been forthcoming and welcoming in hearing the issues faced by the developers. **The details of JNNSM have been summarised in Annex I.**

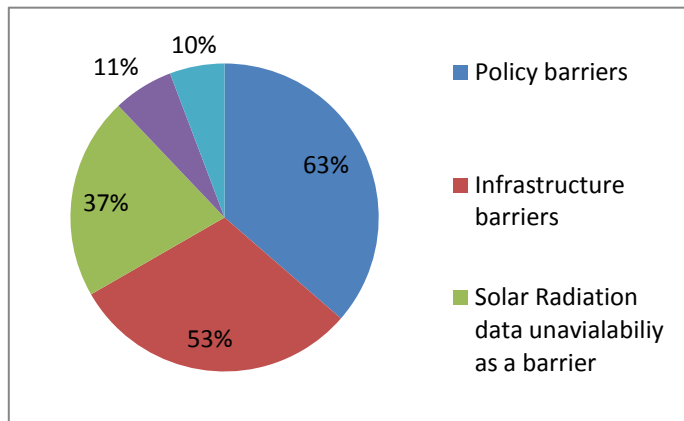
The World Bank initiated a study to understand the "ground level" barriers that the developers are facing in order to develop a comprehensive understanding of steps required to mitigate the same. During this study, twenty-five developers were interviewed on five parameters (Policy and Regulations, Technology, Solar Radiation Data, Infrastructure and Financing) which covered the development cycle of solar power project ranging from policy to financing aspects and this report is primarily based on the responses of the developers.

On the basis of the study, the five most critical barriers which could be addressed in the short term, according to the developers were

- The Power Purchase Agreement could be made bankable so that the financing of these projects would become easier.
- The minimum and maximum capacity to be developed by a single developer could be ascertained based on the prior installation experience of the developer worldwide to achieve higher success rates.
- The Domestic Content criterion could be removed for the first phase to create competition and this could possibly result in deployment of technologies which are already commercialised and have operational experience abroad.
- The state nodal agencies could be involved to a larger extent and single window clearance could be enabled to cut down on lead times faced by the developers at each step
- A single government or semi –government financing agency could act as the focal point for all applications to be processed (after detailed technical and commercial due diligence) and then other financing institutions could take up these projects for financing.

Around 63% of the developers interviewed stated that barriers in policy and regulatory aspects were the most significant barriers. Around 53% of the developers stated that along with policy barriers, the infrastructure barriers are critical too. Approximately 37% of developers viewed solar radiation data as one of the important barriers which also has a key effect on the financing of the solar power projects in the country. Figure 1 illustrates the rating of barriers according to the study.

Figure 1: Rating of Barriers



Policy and Regulatory Barriers: Amongst the policy and regulatory barriers the key issues raised by the developers were the following

- long term planning
- clarity in policy guidelines
- bankability of PPA
- inclusion of hybridization policy for solar thermal technology
- effective technical criteria which clearly focused on the success of the mission rather than giving everybody a fair chance to participate in the mission

Infrastructure Barriers: Clearly land was the most critical of all the infrastructure related barriers. The approval processes and inability of the state governments to provide single window clearance to developers made infrastructure the second most important barrier.

Solar Radiation Data related Barriers: Most of the developers were of the opinion that India needed to set up its own solar radiation data collection stations in order to facilitate accelerated development of solar power projects in the country. It is a fact that success of a solar power project depended majorly on the radiation data; it was hinged to financial closures.

Technology and Financing Barriers: Of all the barriers these two barriers were the least mentioned since, if there is a market, technology costs would eventually fall and financing of the same would become easier. Also Policy, Infrastructure and radiation data once resolved, technology and financing were certainly not a major issue for the developers.

Following the announcement of the mission document, the Government of India issued Draft Guidelines for new large-scale grid connected projects and roof top/tail-end applications on April 1st 2010. It also brought out the final guidelines for migration of existing projects in states to JNNSM.

This led to a slow down of development activities at state level since the developers viewed JNNSM to be more promising than the state policies.

Some of the other developments that took place after the draft guidelines were announced were:

- The Central Electricity Regulatory Commission (CERC) announced the benchmark capital costs for solar PV and solar thermal technologies and the proposed levelized tariffs that were higher than the state tariffs.
- The Ministry of New and Renewable Energy (MNRE) and Ministry of Power (MoP) started discussions with the developers on draft guidelines through various forums.
- The developers had various issues regarding the draft guidelines and initiated dialogues/provided feedbacks with/to both the Ministries.
- The deadlines that were set in the draft guidelines have been delayed.
- The Gujarat Government in the meanwhile approached the developers with limited timeframe for implementation of the projects providing the developers with a robust Power Purchase Agreement (PPA) which is more bankable than the Mission's draft PPA. Approximately 200MW of PPAs were signed in Gujarat and developers will commence project implementation soon.
- Some of the developers who had initially got allotment for solar thermal power projects changed their allotment to solar PV and entered into binding PPAs with Gujarat State Government even though the tariffs were lower.

Having achieved various milestones like land acquisition, equity tie up and so on, the solar power project developers in India are now awaiting for the final guidelines to be rolled out. Though the developers discussed in detail the barriers, there was certainly a sense of optimism that the final guidelines would surely address most of their concerns. The following are the specific key aspects put forth by the developers which could contribute to the successful implementation of the Mission:

- Clarity with regard to long term planning, driving entities, roles and responsibilities of different entities and specifications on criteria, in the final guidelines
- Zone based tariffs across India to facilitate development of solar power projects across India
- Technical criteria to be strengthened and to be used efficiently while selection of projects rather than a tariff bidding process. Also the criterion of minimum and maximum capacity could be removed for a developer, if the technical criteria are tougher
- State Nodal Agencies should be roped in with clear instructions/responsibilities which will address the infrastructure related barriers
- The Government of India needs to establish its own radiation monitoring stations and provide data to developers so that financing becomes easier
- More research and development centres should be opened up with more incentives given to manufacturing units. Long term visibility in the policy regarding the same is a must
- Carry out capacity building exercise across all banks and financial institutions with regard to solar power and involving them in all stakeholder consultation processes

I. Objective of the Study

The World Bank initiated a study to understand the barriers faced by solar power developers in India. The main objective of the study is to understand the risk perception of the domestic and international developers/investors (both existing and potential) and how these could be mitigated. A detailed questionnaire (Annex II) was prepared and twenty-five developers were interviewed during the study, which included a mix of domestic and international solar photovoltaic (SPV) and solar thermal players¹. The list of developers interviewed has been provided in Annex III. Five important parameters were discussed in detail during the interviews, which included:

- i. Policy and Regulation,
- ii. Technology (including aspects of equipment, procurement and commissioning),
- iii. Availability of solar radiation data in the country,
- iv. Infrastructure and
- v. Financing (including CDM as possible part financing option).

These parameters were finalised in close consultation with the World Bank.

The parameter wise response given by the developers have been collated, analysed and presented in the following sections.

II. Analysis of Barriers

The summary of key findings with regards to the draft guidelines are given in Table 1. The detail analyses of barriers with regards to all the five parameters are given in the sections following the table.

Table1: Summary of key findings

Parameter	JNNSM draft guidelines	Issues from developers	Suggestions by developers
Minimum and Maximum capacity of each project	Solar PV – 5MW and 25MW with a cap of 5MW per developer in case of oversubscription Solar Thermal – 20MW and 100MW	Technically and financially strong developers should be given more capacity to develop	To strengthen the technical criterion to select Project after the EOI stage
Financial Criterion	Net Worth of Rs.2Cr/MW	The developers felt this was not necessary	The developers suggested that if the developer could

¹ 13 solar PV developers, 11 solar thermal developers and 3 EPC players were interviewed during the study

Parameter	JNNSM draft guidelines	Issues from developers	Suggestions by developers
			achieve financial closure for their project the net worth criterion should be relaxed
Technical Criterion	Developer should select a commercially established technology which has operational experience of two years	The developers opined that this was relaxed	The developers suggested that this criterion should be strengthened with developers mandated to have tie ups with technology providers. They also suggested that the developers given allotment should have mandatory experience in implementing solar power projects worldwide or should have partners having the implementing experience to make the JNNSM successful
Land /Water/Evacuation Arrangement for the Project	The developers should make arrangement for at least 50% of the land required for the Project, should have allocation of water and should have evacuation studies undertaken by the utilities	The developers stated that there were time delays during land acquisition and the draft guidelines were not specific what the arrangement meant. They also had issues with lead times in obtaining the water	The developers suggested that single window clearance be provided for all approvals and the government should allocate land after considering the type of technology to be implemented. The developers also

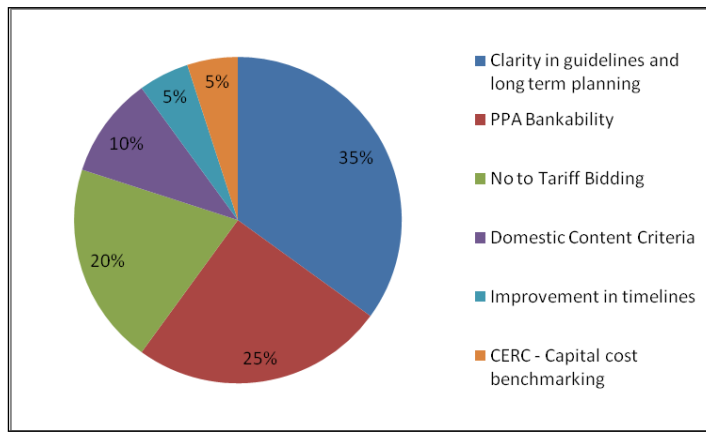
Parameter	JNNSM draft guidelines	Issues from developers	Suggestions by developers
		and evacuation approvals	opined that the government should strengthen the evacuation infrastructure and provide guarantees for the availability of the grid
Domestic Content	Solar PV players to have 100% modules manufactured in India and 30% of the total project cost utilised for domestic equipment for solar thermal developers	The developers had issues relating to manufacturing capacities in India	The developers suggested that modules imported from outside India should also be allowed for the first phase to bring in quality as well as competition
PPA with NVVN	According to the provisions of the draft PPA	Bankability was the main issue	The developers suggested that the government provides adequate guarantees for payments to make PPA bankable by creating special funds
Timelines for achieving financial closure	Draft guidelines give developers 3 months for financial closure	The developers mentioned it was too less a time period and pressurised the developers since the banks were in a better negotiating place	To remove the timelines and bring in penalties if they cannot achieve the financial closure in six months time
Other timelines	EOI Notice was to be announced by March 31 st 2010	There is a significant delay in bringing out the final guidelines	The developers are eagerly awaiting for the final guidelines

1. Policy and Regulatory Aspects

Policy and regulatory aspects took centre stage during discussions with the developers. Most of the developers opined that while the intent of the JNNSM document was ambitious, greater clarity was required both on the principles and details on which it was framed.

The most important issue which emerged after analysing the responses from the developers with regard to policy and regulatory issues was that of clarity in guidelines. Bankability of PPA with NVVN, domestic content criteria and the tariff bidding process followed the PPA issue. Figure 2 illustrates the responses of developers to the issues.

Figure 2: Opinions of developers as percentages of most important barriers in policy and regulatory aspects



Other generic issues that were emphasized during discussions were as follows

- Major issues which the developers specifically mentioned was the **lack of long term planning and visibility, lack of clarity on which entity is driving the mission, lack of clarity of the procedures and planning within the JNNSM vision document** and they were of the view that this could be mitigated by bringing out a policy document detailing out all the procedures involved in the three phases. The main issue confronting the developers is that **if the mission document did not detail out the intricacies involved in phase II, there would be no room for long term planning on the manufacturing and fund raising** for the projects which would come up in future.
- Around 10% of the developers interviewed were still contemplating on whether to go ahead with the state solar policy or wait for the final JNNSM guidelines to be issued. These developers stated that while the Gujarat state government had a bankable PPA of 25 years inbuilt in their policy, they were not happy with the tariff rates rolled out by Gujarat Electricity Regulatory Commission. Further, **the tariff bidding process as outlined in the draft guidelines which would be used in case of oversubscription has led them to go ahead with the state policy**. The migration guidelines stated that the developer should have a signed PPA with the distribution utility. Some of the developers are using this criterion and have signed the PPA with the distribution utility only as a tool to qualify under the migration scheme of the JNNSM.

- Solar thermal developers had a strong argument about **the mission document not mentioning hybridization or storage options for solar thermal technology. This according to them is a lacuna** which needed to be filled in as early as possible so that the power plants could be utilized to the maximum, with higher Plant Load Factors, better stability and guaranteed production of power.
- The **timelines for financial closure has put unnecessary pressure on the developers.** The financial institutions being aware of the fact that the developers need the milestone to be achieved within 3 months were in a stronger negotiating position on interest rates. Furthermore the EPC providers were negotiating better rates for themselves since the time given for technical tie up were reasonably tight.
- **The developers opined that minimum and maximum capacity per developer should not be a criterion while selecting a developer for developing solar power projects. The criteria need to be strengthened more on technical basis and the best developer from around the world who has the prior experience and the financial strength should be given more number of MW to be developed.** This would eventually result in the success of the first phase of JNNSM.
- The manufacturers on the other hand were of the opinion that the government **should also roll out the policy for increased spending on R&D in the country.**
- **The manufacturers needed more backing from the Government in the form of increased incentives** to set up more number of manufacturing facilities/lines so that India could become a hub for cell/module/solar block manufacturing in the world.

1.1 Specific issues pertaining to JNNSM

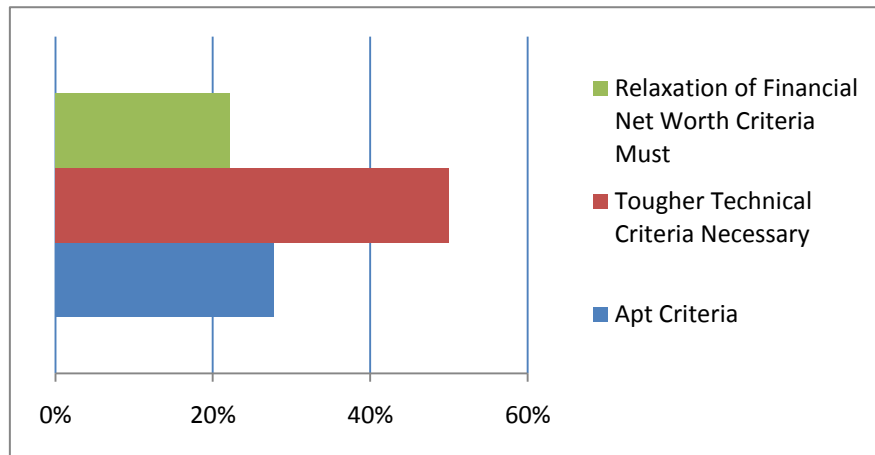
1.1.1 Selection Criteria

There was a division of opinion on the selection criteria of the JNNSM draft guidelines between the developers. Only 28% of the developers believed that the selection criteria were appropriate.

- 28% of the developers who stated that the criteria were appropriate were of the opinion that the Guidelines have been well thought of and have balanced the requirements.
- Around 22% of the developers **stated that the criteria were harsh believed that the financial criterion of net worth was not necessary.** They suggested that if the project developer could achieve the financial closure then the financial net worth criteria could be relaxed. Also the fact that the developers who would invest in these projects would have to retain their equity locked- in for at least three years was a major barrier and the developers suggested that it may be removed.
- About 50% of **the developers who were certain that the criteria were relaxed pointed out that the technical criteria like experience of installations abroad, successful operational plants and experienced manpower should be strengthened and should allow only those technologies which have a historical**

background of being tried and tested and have operational experience of at least 2-3 years.

Figure 3: Opinions of the developers on the Criteria



1.1.2 Timelines for milestones to be achieved

Approximately 90% of the developers interviewed stated that **the timelines for milestones to be achieved in the draft JNNSM guidelines were unrealistic in nature. The rest 10% of the developers were of the opinion that they had already started their development work around 1-2 years ahead in time and thus were able to match up with the timelines as given in the guidelines.**

- Developers stated that the timeline for financial closure should be increased to 6 months and they should be penalised only if the implementation schedule is not on time. The criteria to have financial closure by a certain date would put unnecessary pressure on the developers
- **The time for land acquisition also took about a year** according to developers. The developers also opined that the land related criterion (of having possession of land), as given in the draft guidelines was not clear.

1.1.3 Domestic Content Criteria

There was a difference in opinion on the issue of domestic content. **Around 60% of developers stated that the domestic content should not be included in the first phase.** They were of the view that the first phase, should focus on having the best quality equipment and components at competitive rates to be installed and commissioned successfully to achieve the target of 1000MW. This would also enhance local knowledge about implementation of solar power projects in India. The second phase could build on the learning's from the first phase and could integrate domestic content for the solar projects.

- There was also a strong distinction between the opinions of solar thermal project developers and the solar PV players. **While 90% of solar thermal developers believed that the domestic content criteria could be easily met,** rest 10% of the developers were not in favour of the criterion. These developers who were against the criteria stated that though they could achieve the

domestic content criteria, they strongly believed that India did not have the requisite knowledge or the experience in installation and commissioning of such MW size grid connected solar power plants.

- Of the PV players interviewed, **75% argued that domestic content will act as a major barrier to development of solar PV plant in the country, taking into consideration the limited manufacturing capability/capacity of PV modules in the country.** 25% of the PV developers felt that they were ready to go ahead with any domestic content criteria since they were either manufacturers or they had a technical tie up with module manufacturers of the country.

1.1.4 Issues with regard to PPA with NRVN

- **Bankability – All the developers interviewed felt that the draft PPA was not bankable.** The main concern was that NRVN did not have the requisite bankable parameters for e.g. a strong balance sheet, on which the PPA is hinged.
- **Guarantees against non payment – All the developers were of the opinion that if NRVN fails to pay the tariff amount, there should be another mechanism, such as creation of a special fund to pay the developers on time for the electricity delivered by the developer.**

1.1.5 Central Electricity Regulatory Commission (CERC) Tariff Order

- The developers had strong opinions on the CERC tariff order. There was a significant divergence in views between solar thermal developers and solar PV developers. **While 100% of PV developers stated that the CERC has come out with apt considerations on all parameters for e.g. capital costs and O&M costs, 80% of solar thermal developers argued strongly that the capital cost for solar thermal of INR 15.31Cr/MW was by far on the conservative side** and that CERC did not take into consideration the suggestions made by the solar thermal developer's on this.
- **Some of the developers specified that Plant Load Factors (PLFs) changed from region to region since it is dependent on the solar radiation data in each region; zone specific tariffs are the best way to go ahead.** They reasoned that Gujarat and Rajasthan were arguably the best sites for having higher PLFs which could not be achieved in states like Madhya Pradesh, West Bengal, Karnataka and Andhra Pradesh. Hence power projects to be implemented in states other than Gujarat and Rajasthan should have higher tariffs so as to compensate for the lower radiation levels. **This would also help solar power development across all states of India and not only be concentrated in these two states.**

1.1.6 Tariff Bidding

- **Around 90% of the developers were not in favour of tariff bidding process and had strong reasoning behind it.** According to the developers,
 - A good tariff is a market driver but the bidding process would negate the incentive provided to the developers and would not allow the market to grow.

- No other country has ever gone for tariff bidding at such an early stage
 - Some of the developers compared solar to wind technology and opined that even though wind is a proven and well established market, there is no tariff bidding as of today.
 - A few developers opined that the quality of the power projects would suffer since the developers who have opted and won the bid would use low quality equipment/modules to realise profits from the project
 - The developers argued that while competition is good for any market development it needs a mature market and solar market in India had not yet matured and that the tariff bidding process should be implemented in the second phase.
 - The developers also suggested that the selection criteria should be strongly based on strict technical criteria. The developers who have a proven and well established technology and who are already in contractual agreement with technology provider should be given preference over others.
- The other 10% of the developers were of the opinion that the bidding would not lead to any problems. **In their opinion, ultimately it is the developers who bids the tariff, and will have to perform as per the prescribed terms and conditions and if they fail to perform they would be liable to pay penalty to NVVN.** This according to them was a huge risk which would prevent the developers from bidding very low.

1.2 Specific issues pertaining to migration

Approximately 78% of developers were opting for migration. 22% of developers did not want to migrate and were going ahead with developing projects in Gujarat or Rajasthan under the state government policies. The developers opting for migration had all the criteria satisfied and were looking forward to migrate to JNNSM since they were of the opinion that the state government tariffs were not very encouraging.

1.3 Suggestions by developers

The developers suggested the following

- Tariff Bidding be removed for the first phase
- Strict Technical Criteria to be put in place with technology experience along with operational data for 1-2 yrs should be a prerequisite.
- Cost of solar thermal projects to be revised in the CERC benchmarking exercise and thus tariffs for solar thermal power projects to be revised upwardly
- Policy for hybridization/storage with extra incentives for the same to be in place. Hybridization needs to be considered on an accelerated scale, particularly for CSP and an enabling regulatory framework needs to be evolved with appropriate safeguards for hybrid technologies.

2. Technology Aspects

The REN21's Renewables Global Status Report 2009 states that the World's solar PV installed capacity grew to 13,000MW by the end of 2008. According to the World Watch Institute, the year 2009 saw an installed capacity of approximately 7,300MW of solar PV installed. Germany alone installed 3,800MW of capacity in 2009 which was more than 50% of the total share. The mad rush to install solar PV based power plants in Germany was mainly due to the change in policy. **Germany reduced its solar feed-in tariffs by fifteen percent and allowed developers to develop projects with no cuts till December 2009. France reduced its feed in tariffs by 24% from the date of announcement and Spain followed them. The annual solar PV installations in Spain fell from 2700MW in 2008 to about 70MW in 2009. The economic crisis in Europe has hit the sales of solar PV and has almost stalled the solar market development.**

Despite many challenges, a record growth of 20% in solar PV installation worldwide was achieved in the year 2008-2009. While solar PV installations around the World soared at a mammoth **21,000MW of installed capacity**, solar thermal technology seemed to be catching up. A total number of 127 MW installed capacity of solar thermal power plants were set up in 2009, taking the total number of solar thermal installed capacity around the World to around **630MW**.

With the announcement of JNNSM, India excited the interests of all the technology providers in the World. Major transactions took place in the solar industry. Joint Ventures, Technology tie-ups and MoU's are being signed and India could possibly emerge as a big market place for solar power generation as well as equipment production.

2.1 Specific considerations by developers while selecting technology – PV Vs CSP

The developers have considered a number of parameters while selection of technology (PV or solar thermal). Some of them are

- **The technology experience and installed capacities** (domestically and internationally) in each type of the technology has been the most important parameter the developers considered. Since PV technology has a larger penetration than solar thermal, there are a large number of PV developers than the solar thermal developers
- Most of the developers who have chosen solar thermal as their technology choice have joint ventures (JV) with technology providers
- The mandate from the investors and the business plans was one of the key parameters on which technology was selected.
- The tariffs by CERC have been crucial in changing some of the decisions/ mandates of both the investors and developers
- **The developers have taken into consideration the availability of manufacturing capacities** (domestically and internationally) for both the technologies.

2.2 Expected PLFs in India

The developers were of the view that the expected PLFs of PV plants in India are in the range of 17-19% whereas for solar thermal plants ranges between 22-24%. Only one solar thermal developer is going for storage and hence the developer is expecting a PLF of 40%.

2.3 Lead times for technology tie up

The information regarding lead times for technology tie up was gathered only from discussion with the solar thermal developers. Solar PV developers are still contemplating on whether to go with a domestic PV module supplier or an international supplier. **The decision of most of the PV developers would be based on the final policy guidelines** and clarity on domestic content criteria.

Around 80% of the developers interviewed had undertaken their due diligence study on various technologies approximately two years back and had entered into a JV once the JNNSM document was released. Around 10% of the developers had their own technology and the rest 10% had entered into a JV with a technology provider in less than six months.

2.4 Equipment Procurement and Commissioning (EPC) issues and lead times

EPC players all over the World are foraying into Indian market and the developers are obtaining many offers. However, the lead times to prepare request for quote, obtain a quote, negotiate and sign off on a contract has taken developers 4-8 months. About 10% of the interviewees were themselves EPC players and hence skipped this step under project development. Both the solar PV and solar thermal EPC players stated that while the timelines for implementation of the project were fine, **the main bottleneck was the availability of steam turbine in the power block for solar thermal power plant. The lead time required to procure a steam turbine of the requisite size and capacity could vary anywhere between 18 – 24 months.** The lead time to procure the solar block as well as the heat exchangers, etc from the power block would vary between 6-8 months.

2.5 Analysis of issues and suggestions by developers

- 100% of the developers were confident of the technology chosen by them since only proven technologies which have operational data have been adopted by the developers.
- While 50% of the developers felt that they had the requisite manpower and technical support from technology providers/EPC players to undertake 1000MW of solar power projects, 50% of the developers opined that there would be issues related to availability of skilled man power and technical support

3. Solar Radiation Data Aspect

Detailed solar and weather condition assessments are necessary to understand project economics for solar power systems. In Solar PV plants for example, the plant's operating capacity is highly sensitive to global horizontal irradiance ("GHI") and the consequent bearing on the project cost is significant. For a given MW capacity, the GHI will determine the plant size (number of panels required, land requirement etc.), capacity factor and plant costs. A change in GHI directly impacts the electricity production and in turn, the revenues realized. **It is to be noted that understanding the project costs and returns after accounting for the impact of solar radiation levels will have an impact on tariff expectations.** Similarly, a detailed understanding of direct normal irradiance ("DNI") is critical for solar thermal systems and consequently it is a critical component of the technical analysis for the development of the solar park. The dependence of project risks and returns on the solar resource availability at a particular site will also impact lender's perception of these projects and affect overall bankability.

The significant impact that measurements of solar radiation and climatic conditions will have on a solar power projects has led investors and project developers to stress the importance of gathering detailed information for potential sites. Ideally, on the ground measurement should be collected over a period of 10 years. In addition, ground measurements should be compared and correlated to satellite based analyses to present a comprehensive understanding to project stakeholders.

Thus measured data will definitely improve the accuracy of satellite-based modelling of solar radiation and validation of solar resource forecasting methods.

3.1 Data comparison – Simulated vs. Ground measurement

At present the solar radiation data in India is available from the many different sources. The data sources from which developers are working are:

- National Renewable Energy Laboratory (NREL), USA – The NREL solar resource maps have a resolution of 10 kms. These maps have been developed using weather satellite data incorporated into a site-time specific solar mapping approach developed at the U.S. State University of New York at Albany.
- India Meteorological Department: IMD has carried out some ground measurement in Gujarat but at limited number of stations. All stations do not employ same configuration of instruments and also do not monitor the same parameters. Moreover, these stations are located at far off distances from potential solar power plant sites, thus data so collected does not provide accurate and precise input for power plant output calculations.
- METEONORM: METEONORM is Global Meteorological Database and provides comprehensive meteorological reference, incorporating climatic data obtained from IMD ground stations. In addition, they provide interpolation models and design software, and have over 23 years of experience in the field.
- 3TIER: 3TIER is a global weather resource assessment firm. Their data set is based on geostationary satellites and is high resolution (2.6 km) data obtained using patented Perez model for DNI estimation.

Except data from India Meteorological Department (IMD) all the other sources use weather models driven by weather satellite data.

Limitations of these data sources are:

- **Distance:** Data from typical measurement stations can be extrapolated over a 100 km radius and the current IMD stations are far away from the identified sites.
- **Granularity:** The NREL model is based on a 10km grid which is not considered very granular. Granularity can be increased by using more granular models and measuring ground data at multiple locations.
- **Frequency of Measurement:** Some data models are based on daily average satellite data and compute hourly estimates from it, while the recommended input is half hourly data to increase accuracy.
- **Validation of Models:** Most existing models have been built using U.S. and/or European data and need extensive validation for India, taking into account site specific atmospheric conditions e.g. Aerosol Optical Depth (AOD).
- **Correlation of Data Sources:** There is large variation in data from different sources.

The developers had mixed opinion on the solar radiation data availability in the country. Around 80% of developers stated that this was almost as big as the infrastructure barrier. These developers believed that there would be variation between the ground level data and simulated data and the variation could be anywhere between 10-15%. The rest of the developers did not have any apprehensions on going ahead with the projects based on simulated data which the developers purchase from expert data providers. There was also a significant difference of opinion between solar PV and solar thermal developers. Though 80% of the PV developers suggested that the government should provide radiation data, all the solar PV developers were comfortable in setting up their projects based on the simulated data, whereas **90% of the solar thermal developers insisted that on ground measurement is a must**. Around 20% of the solar thermal developers had already conducted on ground measurement. Around 10% of solar thermal developers were of the opinion that the Government had done its best to bring out the policy and were ready to help the government in collating data after their projects had been set up.

3.2 Analysis and suggestions by developers

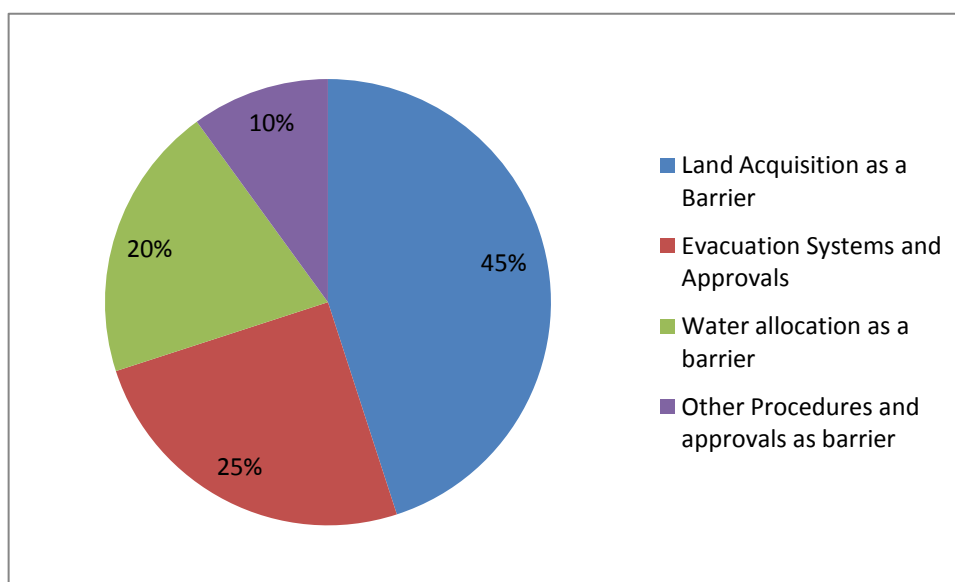
The analysis of the interviews with developers suggests the following

- While potential is generally known, it has not been accurately quantified
- Confidence in models is not very high, given limited ground data but still 80% of developers were ready to go ahead with their Projects
- Ground measurements, where they exist, are not comprehensive since some of the developers have used the diffused radiation measurements to arrive at direct radiation data
- Without confidence and validation, data cannot be considered bankable. The government needs to have its own set of database (approved and certified For E.g CWET data for Wind) so that the bankability issue of data could be resolved

4. Infrastructure Aspects

Barriers with regard to infrastructural requirements emerged as one of the most important barrier for the solar power developers in the country. **The three most important parameters in infrastructure (apart from the requisite solar irradiation) required for developing a solar power project are a) gradient – the land needs to be almost flat b) proximity to evacuation and c) accessibility. The fourth important parameter which is of critical importance specifically to solar thermal power projects is the proximity to water resource.** Around 80% of the developers have stated that it is the most important issue along with policy issues amongst the five parameters. Figure 4 illustrates the opinions on the infrastructure related barriers.

Figure 4: Opinions of developers on infrastructure related barriers



The lead times required for all the approvals were quite substantial and hence the developers have highlighted the need for government intervention to reduce the same. In some cases, **the developers of solar thermal power projects did not obtain allotment near to the water resource since the developers of PV projects were already allotted the land near the water resource.** These types of issues have made the developers raise questions on the knowledge of the state agencies which are allotting the land to solar power developers.

Single Window Clearance for solar power project was one of the most important issues which was debated by the developers. It is possible to bundle the land evacuation and water related approvals under one clearance and the developer would have to approach just one entity to avail this clearance provided he meets the criteria set by the guidelines. But this is a step to be taken up by the state governments. While 90% of the developers were for it, 10% of the developers opined that it was not always possible for the states to provide for a single window clearance. One of the developers stated that it would be easier for Rajasthan to provide single window clearance since they had already identified government

land banks for solar power development whereas Gujarat had a very few government land pockets. The developer suggested that since purchase of land in Gujarat is mostly private the government could provide single window clearance for other approvals required.

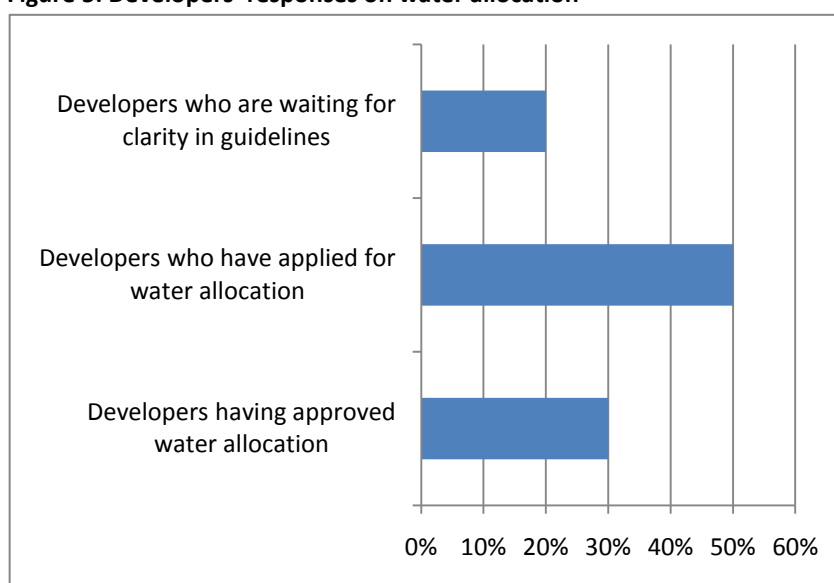
4.1 Specific issues with relation to land

Land related issues were the most discussed of all the infrastructure related issues with the developers. The process of land acquisition differed from state to state. While Gujarat gave a free hand to developers to choose based on the developers criteria (the type of land they needed), Rajasthan adopted a different path of first identifying government waste land for developing solar power projects and then allotting them to various developers. **The lead time to acquire land in states by the developers could range anywhere between 6-12 months and in some cases more than a year.** Land was the most important barrier as stated by 45% of developers as far as infrastructure issues are considered. The rest of the developers own the land on which they are developing the Projects and hence did not face any barrier.

4.2 Specific issues with relation to water

The canals in Gujarat and Rajasthan are the only water resource available to the solar power developers. The developers apply to the local authorities to disburse annual estimated amount of water to them. The authorities then analyse and gauge the current water usage pattern and also account for future usage either for irrigation or domestic use and then allocate the amount of water needed for the power project. Around 30% of the developers had already received allocation from the state authorities for water usage. While another 50% of developers had applied, they were still waiting to hear from the concerned authorities on the allocation. The rest 20% are waiting for the clarity in guidelines to obtain water allocation. The lead times required for acquiring this approval ranged from 3 – 6 months.

Figure 5: Developers' responses on water allocation



4.3 Issues related to evacuation

The developers need to submit an application to the nearest sub-station to evacuate the power. The state conducts load flow studies and then either strengthens the grid or gives evacuation approval to the developers.

The developers insisted that evacuation system was one of the most critical barriers next to land issues. According to developers, even if there is land available with requisite amount of solar irradiation, the absence of a 66/132kV grid network in certain areas to evacuate power has made it difficult for the developers to choose the land. **This has also led to a sharp price rise in those areas where the transmission line/substations are available.** However, the developers opined that obtaining the evacuation approval (once the evacuation sub-station was identified) was relatively easy since there was clarity on how to go about it. The lead time according to developers for obtaining evacuation approval was 3-4 months.

4.4 Issues related to other approvals

The developers needed to seek other approvals too, other than land, water and evacuation. The list of other approvals required for setting up of solar power projects are:

- Approval from Land Usage Authorities
- Approval from Pollution Control Board
- Approval from Aviation ministry
- Approval from local authorities on water usage

While the land usage authority's approval is a one-time exercise, the approvals from pollution control board and water usage have to be renewed every year.

The lead time for all these approvals is 3-4 months.

4.5 Suggestions by developers

The following were the suggestions given by the developers

- Single Window Clearance with the government acquiring land and providing evacuation to the same and then transferring it to the developers
- The evacuation network to be strengthened and guaranteed availability of transmission line to be provided by the utilities.
- Land to be allotted according to technology

5. Financing Aspects

Historically, renewable energy projects have faced financing problems because of various reasons. The main reasons are:

- High Capital Costs
- Low Plant Load Factors
- Intermittency or infirm nature of the power generated
- Access to funds/Subsidy from government
- Policy and Regulatory issues – low tariffs, low or no access to markets
- Knowledge barriers among financing institutions/banks on renewable energy technologies.

The focus of the government on clean energy by providing incentives, experience gained in renewable energy by the developers and also competition between developers has led the markets to overcome many of these barriers in India with specific relation to wind and biomass sector. Since solar is still in its nascent stages of development, some of these barriers still do exist.

5.1 Debt to Equity Structures with which developers are working in India

100% of the developers stated that the expected D: E ratio was 70:30. While developers were of the opinion that since it is a new technology to India, the ratio should have been 80:20.

5.2 Equity and Debt financing issues

- About 80% of the project developers had their equity tied up and the rest 20% were still in process of forming a consortium.
- The developers already having a JV with technology providers were the most comfortable with equity tied up and waiting eagerly for the final guidelines to be announced
- Around 20% of the **developers opined against the draft guidelines which states that the investors can exit from any equity participation only after three years of successful operation of the projects.** According to these developers, these guidelines would prevent some of the venture capitalists/angel investors from investing in solar energy sector.
- All the developers were in talks with lenders both in domestic as well as international markets. Around 80% of the developers felt very strongly about debt closure and **stated that the 3 month timeline given by the draft guidelines for financial closure was very tight.**
- The developers also **opined strongly that the Indian banks and financial communities should have been involved right from the beginning of the process to disseminate knowledge on solar power** so that they would have been more welcoming to the sector as a whole.

- Around 20% of the developers stated that the debt tie up would become difficult because they were only looking at international markets for lenders and the recent economic crises had put pressure on many financial institutions abroad.
- While **equipment leasing option always remained very exciting to the developers, the developers insisted that the technology providers were hesitant with regard to the bankability of the PPA.** The lenders were also weary on the timelines the government has taken to bring out the final guidelines of JNNSM.

5.3 Risks involved in financing and their mitigation measures adopted by the developers

The main risks as perceived by the developers for financing include the PPA risks and Solar Radiation Data risks. To reduce these risks the developers have approached MNRE with a petition to **make the PPA bankable and are positive that the Government of India would provide some sort of guarantees of payment with regard to electricity delivered by the power projects (either through GOI bonds or through creation of special fund(s) specifically designed to minimize the risk).** Some of the developers have already started on **ground measurement** to ascertain the simulated radiation data in order to satisfy the financial institutions.

5.4 CDM as a possible part-financing option

All the developers interviewed, both solar PV and solar thermal were interested in obtaining carbon credits for their power plants. Around 70% of solar thermal developers were going ahead on their own to get their project registered under the UNFCCC. The rest 30% of the solar thermal developers stated that in case a viable and good Programme of Activity (PoA) backed model of carbon financing was available, they would definitely be a part of the PoA. **All Solar PV developers agreed that since the cost accrued to registering their project at UNFCCC would render claiming carbon credits unviable, PoA was the best solution.**

Addendum to the Report on “Barriers to Solar Power Development in India”

The final JNNSM guidelines for solar power developers have been released on 25th July 2010 by the Government of India. The study “Barriers to Solar Power Development in India” was primarily undertaken before the release of the final guidelines and this addendum attempts to bring in a perspective on certain issues which have been added/modified in comparison to the draft guidelines which were released on April 1st 2010.

First Phase Allocation

The first phase allocation for PV is limited to 150 MW for FY 2010-11 taking into consideration the migration projects. The remaining capacity of 500MW – Migration projects – 150MW will be selected for the second phase of 2011-12.

Capacity of Project

The capacity of each PV project per developer will be limited to 5MW+/-5%. This could potentially still be an issue with developers since it would not bring in scalability and reduction in PV module prices in the future. On the other hand for Solar thermal the maximum capacity has been increased to 100MW which is a welcome sign.

Net Worth Criterion

The Net Worth Criteria for each project has been increased to 3Cr/MW for PV developers and for solar thermal it remains the same till 20MW. Beyond 20 MW the solar thermal developers will have to show an additional net worth of 2cr/MW. This criterion will remain an issue though some of the serious developers feel that this may bring in only serious developers.

Bid Bonds

Bid bonds have been introduced so as to discourage adventurous bids. This definitely is a positive step.

Domestic Content

Another welcome step which the final guidelines have brought about is that for thin film technologies no domestic content has been mandated. This would surely bring in more completion and reduce down prices in the PV field.

Financial Closure Timeline

The financial closure timeline has been extended to six months from the date of signing of PPA. This is a good development and the developers concerns regarding the same have been taken care of.

Technical Criteria

The JNNSM final guidelines have very well defined technical criteria and definitely would result in successful implementation of the projects.

Bankability of PPA

According to the developers, the draft PPA between the developer and NRVN was not Bankable. The Government has communicated that the final PPA would be bankable but it needs to be ascertained.

Annex I: Background

Solar energy sector in India has received great impetus since the announcement of the Gujarat Solar Policy in January 2009, which was a milestone in India's solar energy development programme. Government of Rajasthan also entered into the foray by announcing its own policies. Under these state policies, MoU's to the tune of 716MW (from 34 developers) and 72MW (from 11 developers) were signed by Government of Gujarat and Rajasthan respectively.

On the other hand, India came under immense international pressure on emission reductions with the initial rounds of discussions taking place in various countries leading to the Copenhagen talks in December 2009.

The National Action Plan on Climate Change (NAPCC) initiated by the Prime Minister's office, paved a path to seven national missions targeting voluntary emission reductions of which the 'National Solar Mission' was arguably the most ambitious missions amongst others.

The Government of India announced the Jawaharlal Nehru National Solar Mission (JNNSM) on 23rd November 2009. The Honorable Prime Minister of India, Dr Manmohan Singh officially launched the mission on 11th January 2010. The JNNSM is a major initiative of the Government of India and State Governments

to promote ecologically sustainable growth while addressing India's energy security challenge.. The mission seeks to kick-start solar generation capacities, drive down costs through local manufacturing and Research and Development (R&D) in order to accelerate the transition to clean and secure energy.

Objectives and Targets of JNNSM

- To create an enabling policy framework for the deployment of 20,000 MW of solar power by 2022
- The Mission will adopt a 3-phase approach; Implementation of Phase 1 would end in 2013; Phase 2 in 2017 and Phase 3 in 2022. The target for Phase 1 is 1,000 MW, an additional 3,000 MW through capacity enhancements are expected to be driven by the solar-specific RPOs and the use of Feed in Tariffs in Phase 2. Based on the 'learning' of the first two phases, the expectation is that solar power will be close to achieving grid parity and this will allow build up of the remaining capacity required to meet the 20,000 MW target by 2022.
- To make India a global leader across the value chain in solar manufacturing with a targeted 4-5 GW equivalent of manufacturing capacity by 2020. This includes dedicated poly silicon manufacturing capable of producing 2 GW equivalent manufacturing capability on an annual basis

Table2: Targets - National Solar Mission Targets for Grid-Interactive Plants

Application segment	Target for Phase I (2010-13)	Target for Phase 2 (2013-17)	Target for Phase 3 (2017-22)
Utility grid power, including roof top	1,100 MW	4000-10,000 MW	20000 MW

Mission Strategy

Salient features of the JNNSM relevant to the development of grid-interactive solar power projects are outlined below:

- The Mission has developed a power sale strategy for solar projects in Phase 1. The mechanism is to bundle solar power with power from the unallocated quota of central thermal stations and selling this bundled power to state distribution utilities. NTPC Vidyut Vyapar Nigam Ltd. (NVVN), a wholly owned subsidiary company of NTPC, will be designated as a nodal agency for the purchase of solar power and the consequent sale to state power distribution utilities.
- The key driver promoting solar power would be the solar-specific Renewable Purchase Obligations (RPO's). Technology agnostic, PV or Solar Thermal, solar-specific RPOs will be critical to the development of utility scale power generation. The solar power purchase obligation for States may start with 0.25% in the phase I and to go up to 3% by 2022. Developers will have the option to participate either in the solar-specific Renewable Energy Certificate (REC) mechanism or availing benefits from the Feed in Tariff. The RECs will also allow states with relatively poor solar resources meet their RPO commitments.
- The mission also promotes the development of low cost high quality solar PV manufacturing, including balance of system components. In addition, it supports the development of manufacturing capacities for advanced solar collectors at low temperature and concentrating solar collectors and their components for medium and high temperature applications. The Mission recommends several incentives like zero import duty on capital requirement and raw materials; duty exemptions; low interest rate loans to support these priorities.
- Research & Development initiatives towards improvement of efficiencies and reduction of costs are promoted by the Mission.
- An ambitious human resource development program will be established to support an expanding and large-scale solar energy program for both applied and R&D sectors.
- The Mission also identifies six demonstration projects to be implemented in Phase 1.

Annex II: Questionnaire to Solar Power Developers in India

Structure of the Questionnaire

The questionnaire is structured around six parameters which in our opinion are considered necessary for successful development of solar power project. If it is thought that there are some parameters / issues have been left out these may be included at your end. Your response would help in systematically analyzing and structuring improvements to fast track the development of Solar Power Projects .

General Project Details

Name of the Power Project		
Capacity		
Type of Technology	Solar Thermal/Solar PV/CPV	
Details of Technology	Parabolic Trough/Tower/Thin Film/Mono crystalline/Polycrystalline	
Location	State	District
Have you obtained allocation from the state	Yes/No	
Are you migrating to JNNSM	Yes/No Please provide reasons	
Is the Project a Joint Venture with Technology Provider	Yes/No Please provide details with whom are you collaborating?	
Developers Location	India/Abroad. If abroad please specify the country	

A) Policy and Regulations:

A 1) Specific issues / suggestions related to Guidelines for Selection of New Grid Connected Solar Projects under Phase 1 of JNNSM to reduce perceived risks w.r.t.

1. **Scope of the Guidelines**
2. Portfolio of Solar PV and Solar Thermal Technology Projects
3. Minimum and Maximum Capacity of Each Project
4. Expression of Interest for Short-listing and Selection of Projects
5. Qualification Criteria for Short-Listing of New Projects
 - Financial Criteria Net Worth
 - Technical Criteria
 - Land Arrangement for the Project
 - Connectivity with the Grid
6. Water Arrangement
7. Domestic Content
8. Short-listing of Projects
9. Role of State Level Agencies

10. Selection of Projects
11. MoU between Project Developer and NVVN
12. Power Purchase Agreement and Power Sale Agreement
13. Performance Guarantee
14. Minimum Equity to be held by the Promoter
15. Financial Closure of the Project
16. Commissioning
17. Power to remove difficulties
18. Time Schedule for the Process
19. Capital Costs and levelized tariff notified by CERC

A2) Specific issues / suggestions related to Guidelines for Migration of Existing Under Development Grid Connected Solar Projects from Existing Arrangements to the Jawaharlal Nehru National Solar Mission (JNNSM) to reduce perceived risks w.r.t. :

1. Eligibility Criteria for the Projects
 - a. Execution of Power Purchase Agreement and Determination of Tariff
 - b. Connectivity with the Grid
 - c. Land for the Project
 - d. Water Arrangement
2. Contractual Arrangement between NVVN, Project Developer and the Distribution Utility
3. Performance Guarantee
4. Minimum Equity to be held by the Promoter
5. Financial Closure of the Project
6. Commissioning Time Schedule for the Process
7. Capital Costs and levelized tariff notified by CERC
8. Procedure for migration of the project
9. Suggestions for improvement of Policy Guidelines.
10. What are the other clearances required other than the JNNSM guidelines

B) Infrastructure

1. Important infrastructural requirement for the development of the solar power project both with regards to Solar PV and Solar Thermal. Suggestions if any in this regard
2. Type of land the Project is utilizing for development – Govt/Private/Owned.
3. Lead time required for land procurement and suggestions to reduce the same.
4. Specific issues faced while procuring land and suggestions to resolve the same.
5. Availability of power evacuation infrastructure near the project Site.
6. Issues (if any) pertaining to NOC from the state utility to connect it to the evacuation network and Status of NOC.
7. Thoughts on hybridization (for Solar Thermal) and issues pertaining to fuel supply, etc.
8. Water requirement for the Project and Source of water for the Project?
9. Clearances/tie ups required for water usage, lead times for obtaining the water usage clearance and tariff (per MCMD) for the same, and current status.

C) Solar Radiation Data:

1. Exact location of the project(s)
2. DNI/Insolation levels at the Project Site
3. Source of Data - NREL/NASA/Simulated/On Ground measurement.
4. If direct measurement was done, duration of measurements and co-relation between direct measurement and other sources of Data.
5. Should the GoI develop an accurate data base on solar radiation? If yes the accuracy levels required and its format.
6. Suggestions regarding alternative mechanisms for obtaining reliable data.

D) Technology

1. Technology selected and broad reasons for the selection:
2. Mature Technology (possibility of indigenization)
3. Efficiency
4. Availability of Manufacturing capacity
5. Storage provided if yes type of storage and expected impact on PLF
6. Hybridization considered and issues pertaining to hybridization, impact on Project cost and economics.
7. Cooling methodology – Wet / Dry
8. Expected PLF
9. De-rating factors
10. O&M Cost as a percentage of Project Cost.
11. What are the EPC guarantees that the technology providers are willing to provide

E) Procurement Methodology

1. EPC, expected lead time for EPC, issues if any especially pertaining to import of equipment.
2. Technology tie up / Joint Venture, expected Lead time for Technology tie up / JV, issues if any
3. Indigenization percentage w.r.t. Project Cost and its impact on Project Cost. Thoughts on increasing indigenization percentage.

F) Financing

1. Type of Funding D: E ratio, issues pertaining to Funding, suggestions if any regarding funding.
2. Issues pertaining to raising of equity – domestic / International sources.
3. Issues pertaining to raising of debt – domestic / International.
4. Is equipment leasing / supplier credit options available and if yes these have been used.
5. Issues pertaining to Financial Closure and lead time for the same. Suggestions to reduce the same.
6. Impact of foreign exchange variation on project economics / viability.

G). Carbon Finance

1. Do you intend to seek carbon finance benefits?
2. If not what are the reasons?
3. If yes what steps have you taken to seek carbon benefits?

4. What barriers do you expect the CDM to help mitigate?
5. Would you be interested in working with the Bank and other partners on developing a national CDM solar program?

Annex III: List of Developers Interviewed

SI No	Developer Name	Technology
1	Astonfield	Solar PV
2	Sunborne	Solar Thermal and PV
3	Suryachakra	Solar Thermal
4	T Solar	Solar PV
5	C step	Solar Thermal
6	Green Infra	Solar PV
7	Eros International	Solar PV
8	FAST	Solar Thermal
9	Cambridge Energy	Solar PV
10	Acme	Solar Thermal
11	Moserbaer	Solar PV
12	Tata BP	Solar PV
13	Azure	Solar PV
14	Acciona	Solar Thermal
15	Entegra	Solar Thermal
16	NTPC	Solar Thermal and PV
17	Reliance	Solar PV
18	MSM Energy holdings	Solar Thermal
19	Coromandel Infra	Solar Thermal
20	Teesra Solar	Solar PV
21	CCL Optoelectronics	Solar Thermal
22	Acira Solar	Solar Thermal
23	Lanco Solar	Solar PV
24	MEMC Sun Edison	Solar PV
25	JK Group of Industries	Solar PV