

**CENTRAL ELECTRICITY REGULATORY COMMISSION**

**NEW DELHI**

**Coram**

- 1. Dr. Pramod Deo, Chairperson**
- 2. Shri S.Jayaraman, Member**
- 3. Shri V.S.Verma, Member**

**Petition No.13/2010 (Suo Motu)**

**IN THE MATTER OF**

Determination of Benchmark Capital Cost Norm for Solar PV power projects commissioned during FY 2010-11 & FY 2011-12 and Benchmark Capital Cost Norm for Solar Thermal Power Projects commissioned during FY 2010-11, FY 2011-12 & FY 2012-13.

**ORDER (Suo Motu)**

**A. BACKGROUND**

1. In exercise of the powers vested under Section 61 read with Section 178 of the Act and after previous publication, the Commission has notified the Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2009, (hereinafter referred to as "the RE Tariff Regulations"). The RE Regulations provide for terms and conditions and the procedure for determination of tariff of the following categories of renewable energy generating stations:

- (a) Wind Power Project;
- (b) Small Hydro Projects;
- (c) Biomass Power Projects;
- (d) Non-fossil fuel-based co-generation Plants;
- (e) Solar Photo voltaic (PV) and Solar Thermal Power Projects.

2. Further, the Commission vide its public notice no. 1/3/2009-Reg.Affairs (RE Tariff – FY – 2010-11) (i)/CERC dated 19<sup>th</sup> January 2010 has also notified draft first amendment to the RE Tariff Regulation, 2009 and subsequently, after taking into consideration the comments from the various stakeholders, has notified the first amendment to the RE Tariff 2009 vide notification dated 25.02.2010. The relevant extract of notified First Amendment of RE Tariff Regulations is as under:

*“(2) Notwithstanding anything contained in these regulations,*

*a) the generic tariff determined for Solar PV projects based on the capital cost and other norms applicable for the year 2010-11 shall also apply for such projects during the year 2011-12; and*

*b) the generic tariff determined for Solar thermal projects based on the capital cost and other norms for the year 2010-11 shall also apply for such projects during the years 2011-12 and 2012-13,*

*provided that (i) the Power Purchase Agreements (PPA) in respect of the Solar PV projects and Solar thermal projects as mentioned in this clause are signed on or before 31<sup>st</sup> March, 2011; and (ii) the entire capacity covered by the PPA is commissioned on or before 31<sup>st</sup> March, 2012 in respect of Solar PV projects and on or before 31<sup>st</sup> March, 2013 in respect of Solar thermal projects.”*

3. As per first proviso under Regulation 5 of the RE Tariff Regulations, 2009, the benchmark capital cost for Solar PV and Solar thermal power projects is to be reviewed annually. The Commission, for FY 2009-10, has specified the normative capital cost for Solar PV and Solar Thermal Power Projects as Rs1700Lakh/MW and Rs1300Lakh/MW respectively.

4. The Commission vide its public notice no. 1/3/2009-Reg.Affairs (RE Tariff – FY – 2010-11) (ii)/CERC dated 19<sup>th</sup> January, 2010 has issued order (hereinafter referred as 'proposal') and explanatory memorandum on benchmark capital cost norms for Solar PV power projects to be commissioned during FY 2010-11 and benchmark capital cost norms for Solar Thermal power projects to be commissioned during FY 2010-11 and FY 2011-12 and has invited comments from the various stakeholders.
5. A public hearing was held on 10<sup>th</sup> February 2010. A statement indicating in brief the comments received from various stakeholders is enclosed in **Annexure – I**. The list of participants in the public hearing is enclosed in **Annexure – II**.

**B. COMMENT/SUGGESTION RECEIVED AND COMMISSION'S RULING –  
SOLAR PHOTOVOLTAIC POWER PROJECTS**

**6. Cost of Land**

Provision in the proposal

- 6.1. In the proposal the requirement of land for setting up solar power plant is proposed as 5 acre/MW and the cost of land has been considered as Rs 1 Lakh/Acre.

Stakeholder Comment/Suggestion

- 6.2. Majority of the stakeholders suggested that the price of the land close to the grid substation has considerably increased after the announcement of Jawaharlal Nehru National Solar Mission (JNNSM). Accordingly, the cost of land for setting up Solar PV power plant should be considered in the range of Rs 3 Lakh/Acre ~ Rs 5 Lakh/Acre. Few stakeholders have suggested that the cost of land should also include charges towards registration and reclassification.

### Commission's Analysis and Ruling

- 6.3. The Commission is of the view that the land acquired for setting up Solar Power Projects is mostly arid/barren or of no commercial use. The Commission further notes that, in order to avoid the cost of transmission lines, in most of the cases developers wish to acquire land close to the grid substation. The majority of stakeholders in their written as well as oral submissions have accepted that the cost of land near to the grid substation has considerably increased after the launch of JNNSM. In view of the above the Commission considers the views and suggestions submitted by the various stakeholders with regard to the cost of land required for setting up solar power project as appropriate.
- 6.4. With regard to the per MW requirement of land, the Commission has taken into consideration submissions of stakeholders as well as recommendations of various institutions involved in research and development for solar power and accordingly have proposed land requirement of 5 Acre/MW for setting up solar PV power plant in India. The Commission recognises that the requirement of land per MW shall vary depending on the insolation level and type of PV technology (crystalline or thin film etc.) being deployed. However, for the purpose of generic tariff determination, the Commission has considered the land requirement as 5 acre/MW which is also in line with the land requirement (i.e. 2 hectare/MW equivalents to 5 acre/MW) as outlined under the Guidelines for selection of solar projects under Jawaharlal Nehru National Solar Mission (JNNSM). The Commission further notes that with the development in technology, the solar to electricity conversion efficiency shall improve which will eventually translate to reduction in requirement of land per MW of installation. Accordingly, the Commission has considered cost of land as Rs 0.15 Cr/MW based on land requirement for solar PV project at 5 acre/MW and at estimated cost of Rs 3 lakh/acre.

## **7. Cost of PV Modules and Mounting Structure**

### Provision in the proposal

7.1. The cost of PV modules in the Proposal was considered as Rs 9.15 Crore/MWp which was based on projected PV module cost of US\$2/Wp and the foreign currency exchange rate of Rs 45.75/US\$. Further the expenditure towards the mounting structures has been considered as Rs 0.80Cr/MW.

### Stakeholder Comment/Suggestion

7.2. A majority of stakeholders have submitted that the cost of PV Modules should be considered in the range of US\$2.0/Wp ~ US\$2.5/Wp.

7.3. TATA BP Solar India Ltd. during the public hearing has presented that the cost of solar modules, backed by 25 years warranty and with 86% power availability at the end of 25<sup>th</sup> year, may be considered as US\$2.2/Wp.

7.4. Solar Energy Society of India in their written submission has presented that considering the economies of scale the selling price of modules can be fixed to Rs105/Wp (i.e. Rs 10.5 Crore/MWp).

7.5. The stakeholders have submitted that in order to achieve 19% CUF, in some states, the trackers need to be utilised and the price of mounting structures may be considered accordingly.

### Commission's Analysis and Ruling

7.6. As regards the cost of PV Modules, the Commission observes that majority of the stakeholders have submitted that the cost of PV module should be considered in the range of US\$2/W ~ US\$2.5/W. However, few stakeholders have accepted that US\$2/W may be achievable but would entail the developer having an efficient and competitive supply chain.

7.7. The Commission further observes that few of the stakeholders have submitted that the PV module prices in the range of US\$2/W may be feasible however, the developers may have to compromise with the quality and warranty over the

useful life. The Commission is of the view that assurance of the quality electricity generation over the useful life over the plant should not be compromised with employing inferior quality modules available at much lower price.

7.8. The Commission understands that PV modules are critical component of the solar PV power projects. Few of the manufacturers in their written submission have accepted that the PV modules backed with 25 years warranty and with 86% power availability at the end of 25<sup>th</sup> year may be made available @ US\$2.2/W. In view of the above and in order to encourage the employment of superior quality modules to ensure grid quality power, the Commission considers the views and suggestions submitted by the various stakeholders, with regards to the cost of PV modules as US\$2.2/Wp as appropriate. This translates to PV module cost of Rs 10.19 Crore/MWp at the prevalent exchange rate of Rs 46.33/US\$. Several stakeholders have requested to consider the exchange rate of Rs 47-48/US\$ taking into consideration the volatility of the exchange rate variation over past six to twelve months. However, the Commission is of the view that projection of exchange rate based on historical variation may not be appropriate and the developers could use appropriate tools to hedge their exposure to exchange rate variation, if necessary. Besides, the cost of PV modules has been reducing over the period with advancement of technology as well as with significant improvement in global supply scenario. While the drastic reduction in PV module cost during 2009 due to recessionary trend and significant overcapacity across supply chain may not continue, the long term trend of reducing prices of PV modules to reach grid parity cannot be overlooked. Thus, the Commission has considered the cost estimate of PV modules (Rs 10.19Cr/MW) at prevalent exchange rate (Rs 46.33/US\$) and prevalent PV module prices (US\$ 2.2/Wp). Further, the Commission observes that there is significant difference in cost of crystalline PV modules vis-a-vis that

of thin film PV modules; with cost of thin film PV modules being lower than that of crystalline PV modules. Further, the conversion efficiencies of thin film (8%-10%) being lower than that of crystalline PV modules (12%-14%); for similar generation at a given site, more number of thin film PV modules with associated mounting structures, cables etc. would be necessary. On the other hand, while cost of crystalline PV modules is higher than that of thin film PV modules, other associated costs of mounting structure, cables etc. would be lower than that of thin film for equivalent MW installation at given site. Thus, for comparative analysis, it is preferred to view combined cost of PV modules per MW and mounting structures per MW as further elaborated under subsequent paragraphs. For the purpose of generic tariff determination, the Commission has considered the crystalline PV module costs (US\$ 2.2/Wp) as basis for further cost estimation.

7.9. With regard to the cost of mounting structures, the Commission observes that there is significant difference in cost of mounting structure as claimed by several developers which range from Rs 0.9 Cr/MW to Rs 1.57 Cr/MW. The Commission is of the view that mounting structure requirement is mainly influenced by the selection of technology viz. crystalline silicon or thin film and deployment of tracking system (fixed axis or with tracking). The Commission notes that the solar to electricity conversion efficiency of crystalline silicon technology is more compared to the thin film technology which translates to employing less number of modules compared with the latter to generate same units of electricity. The Commission further observes that the per Watt cost of thin film modules are less compared to the crystalline silicon module. Hence, employing thin film technology will require less cost towards modules however in order to achieve 19% CUF, due to lower solar to electricity conversion efficiency, large number of modules shall need to be employed which will increase cost towards the

mounting structure. In view of the above the Commission has taken into consideration the views and suggestions submitted by the various stakeholders and has accordingly considered the cost towards mounting structures as Rs 1.00Cr/MW.

## **8. Power Conditioning Unit**

### Provision in the proposal

8.1. The expenditure towards power conditioning unit has been considered as Rs1.80Cr/MW in the Proposal.

### Stakeholder Comment/Suggestion

8.2. The Stakeholders have submitted that poor quality power conditioning units (PCU) may require more replacement resulting in loss in generation through plant shutdowns. Further, for large scale projects it is mandatory to consider IEC/UL certified Inverters with remote communication, string monitoring feature and high conversion efficiency. The cost of PCU may be considered accordingly.

### Commission's Analysis and Ruling

8.3. While specifying the cost per MW towards power conditioning unit, the Commission has taken into consideration the cost proposed by the various developers in their detailed project reports submitted to the State Electricity Regulatory Commission which range from Rs1.6Cr/MW to Rs2.0Cr/MW.

8.4. The Commission is of the view that the overall power output from the Solar PV power plant to a large extent depends on the quality of the power conditioning unit. The Commission further observes that for continuous availability of solar PV power plant, the inverter mean time between failures should be as low as possible. In view of the above the Commission has taken into consideration the views and suggestions submitted by the various stakeholders, with regards to the cost towards power conditioning unit and accordingly considered the cost toward power conditioning unit as Rs 2.00 Crore/MW.



## **9. Evacuation Cost upto inter-connection Point (Cables and Transformers)**

### Provision in the proposal

9.1. The cost till the interconnection point defined under the RE Tariff Regulations, 2009 has been envisaged in the Capital Cost for all renewable technologies. No separate cost of laying transmission lines have been considered since it is the responsibility of the concerned licensee to make arrangement for the evacuation infrastructure. Accordingly, the proposal included a norm of Rs.0.85Cr/MW for evacuation infrastructure upto the inter-connection point.

### Stakeholder Comment/Suggestion

9.2. Future Computing and Energy Solutions Pvt Ltd submitted that the average cost of transmission line beyond inter-connection point, if assumed to be 5 km shall be about Rs17.5Lakh for 11 kV, Rs40Lakh for 33 kV and Rs150Lakh for 66kV or 132 kV. As a generic norm, the average transmission cost may be considered as Rs0.175Cr/MW. Sri Power and NTPC have submitted that the cost for transmission line and transformer for grid interfacing at more than 33kV level may be considered as Rs0.60Cr/MW. Sri Power has submitted considering 2 km evacuation lines in the capital costs.

### Commission's Analysis and Ruling

9.3. The Commission observes that as per the provisions of the Act, the evacuation planning for renewable energy projects shall be the responsibility of appropriate transmission utility. The Commission further observes that the Regulation 12 of CERC (Terms and Conditions for tariff determination from renewable energy sources), Regulations, 2009, stipulates that the Capital Cost shall include cost of capital works including plant and machinery, civil works, erection and commissioning, financing and interest during construction and evacuation infrastructure upto Interconnection Point. Further, Regulation 2(l) defines the Interconnection Point for Solar PV projects as line isolator on outgoing feeder on

HV side of Pooling Substation. Hence, the normative evacuation cost shall pertain to evacuation costs including internal cables, lines, transformer, pooling substation etc. upto point of Interconnection.

9.4. , It is envisaged that the concerned licensees shall be responsible for development of evacuation infrastructure beyond the point of interconnection. Accordingly, the Commission has considered the cost of evacuation arrangement (under the head Cables and Transformers) as Rs 0.85 Crore/MW as provided in the proposal.

## **10. Preliminary and Pre-Operative Expenses**

### Provision in the proposal

10.1. The preliminary and pre-operative expenses have been considered as Rs1.65Cr/MW in the Proposal.

### Stakeholder Comment/Suggestion

10.2. Moser Baer Clean Energy Limited submitted that the interest during construction may be considered as Rs64Lakh/MW.

10.3. Sun Edison has submitted that the insurance costs are not covered in the capital cost and are as high as 0.5% of the system costs per annum.

### Commission's Analysis and Ruling

10.4. The Commission would further like to clarify that the proposed cost towards pre-operative and preliminary expenses essentially include cost towards services related to installation and commissioning, project management, expenditure incurred in transportation of equipments, insurance, contingency, taxes and duties, interest during construction (IDC) and finance charges etc.

10.5. The Commission while specifying the cost towards pre-operative expenses has taken into consideration the submissions of various developers as well as information furnished in Detailed Project Reports (DPRs) submitted by solar developers before State Commissions or to MNRE to avail Generation Based

Incentive (GBI) under earlier scheme. The Commission observes that preliminary and pre-operative costs constitute around 8%-10% of the total capital cost of solar PV project. Further, the Commission observes that it has reviewed the capital cost norm on account of upward revision in the cost towards PV module and other capital cost components than that presented under the Proposal. Accordingly, the Commission has considered the preliminary and pre-operative cost as Rs 1.81Cr/MW for the purpose of generic tariff determination.

## **11. Civil and General Works**

### Provision in the proposal

11.1. The expenditure towards civil and general works have been considered as Rs0.90Cr/MW in the Proposal.

### Stakeholder Comment/Suggestion

11.2. Future Computing and Energy Solutions Pvt Ltd have submitted that Labour Index has indicated an increase from 134 to 147 i.e. 9.7% for 2008-09 and from 148 to 169 i.e. 14.2% for 2009-10. Accordingly, the cost of civil & General Works may be considered as Rs1.20Cr/MW.

### Commission's Analysis and Ruling

11.3. The Commission while proposing the expenditure towards civil and general works have taken into consideration the submissions made by the developers in their detailed project report submitted to the State Electricity Regulatory Commission for determining project specific tariff. Accordingly, the Commission hereby has considered cost towards Civil and General Works at Rs 0.90 Cr/MW.

## **12. Capital Cost for Solar PV Power Plants**

### Provision in the proposal

12.1. The Capital cost for solar PV power plant to be commissioned in FY 2010-11 have been considered as Rs15.20Cr/MW.

### Stakeholder Comment/Suggestion

12.2. A majority of stakeholders have submitted that the capital cost for solar PV power projects being commissioned during FY 2010-11 shall be in the range of Rs16Cr/MW~Rs17Cr/MW. These include M/s Astonfield Renewable Resources Ltd, Reliance Industries Ltd, Tata BP Solar, Bhilawara Energy Ltd, Future Computing and Energy Solutions Ltd, NEDCAP, Shri Shanti Prasad, Sun Edison, Shri Power, OPG Energy etc. A number of developers have suggested that the capital cost may be reduced 3%~5% per annum. Further, a few stakeholders such as Azure Power Ltd, Kimaya Energy Ltd, Moser Baer Pvt Ltd and NTPC has claimed the capital cost for Solar PV project to be in excess of Rs 17 Cr/MW. On the other hand, Gujarat Urja Vikas Nigam Limited has submitted that solar technology innovation is likely to reduce the cost to the tune of 15-28% in year 2010. Non-module cost will go down depending on installed capacity, locational peculiarities and economy of scale. Non-Module cost may be considered as 20-25% of the capital cost. The total Capital Cost for solar PV project for year 2010-11 would be within the band of Rs12 - 13Cr/MW. Shri SP Gon Chaudhuri, WBGEDCL has submitted that the Cost of complete Solar PV Power Plant works out to around Rs15Cr/MW in current scenario. However, such cost may even go down to Rs.14Cr/MW if Chinese Solar Modules and String type inverters are used. Further, during the Public Hearing, several project developers have requested not to consider the project cost as discovered through tender process initiated by KPCL and MSPGCL as basis to derive benchmark capital cost norm. They have argued that the capital cost discovery in these tender process was undertaken as part of business entry strategy for demonstration projects but the same capital costs are not feasible on commercial scale at the prevalent cost structure across the supply chain.

#### Commission's Analysis and Ruling

**13.** The Commission understands that there is very limited experience in the field of grid connected electricity generation utilising solar PV power technology within India and projects totalling to around 5MW only have been commissioned till date in India. Majority of the projects under such category are at planning or under implementation stage.

**14.** The Commission has further observed that many project developers have approached the State Electricity Regulatory Commission for the purpose determination of tariff on case to case basis. The Commission has taken into consideration the information submitted by the developers in their project reports, while analysing the capital cost norm for solar PV power projects. For the purpose of analysing the capital cost, the Commission has also taken into consideration the details of the capital cost mentioned in the project reports submitted by the developers with the Ministry of New and Renewable Energy for the purpose of availing the Generation Based Incentive. The Commission has also taken into consideration the capital cost of the Solar PV projects which have been commissioned in the recent past.

**14.1.** The Commission has discussed the detailed cost breakup of the solar PV power projects in the Explanatory Memorandum (attached to the proposal) and it has been noted that solar PV module alone forms significant portion of the total capital cost. The Commission is of the view that the Capital Cost of the Solar PV based power projects shall be greatly influenced by the PV module prices and projections of demand/supply scenario of PV modules. The Commission has noted the views of PV industry analysts and has discussed it in detail in the Explanatory Memorandum.

**14.2.** With regard to the capital cost consideration of solar PV power projects, the Commission has examined the market development projections presented by various PV Industry analysts. Further, it has also been observed that few of the

entities, namely, Maharashtra State Power Generation Company Limited, Karnataka Power Corporation Limited, have opted for global tendering process for award of turnkey contracts (EPC contract) for setting up solar PV power projects. It has been observed that more than 20 companies, domestic as well as international have participated in the tendering process. However, the Commission also notes the submission of project developers for these projects that the price discovery through these tender processes may not be considered as basis since the same was considered as business entry strategy for demonstration purpose and the same may not be feasible on commercial scale at prevalent cost structure for the supply chain.

14.3. While the Commission notes that the capital cost for PV Modules, which contributes to large share in the total capital cost, are expected to fall in near future, it cannot be ignored that the development of solar projects in India is still at nascent stage. Accordingly, the Commission has analysed and taken into consideration the submissions made by the manufacturers of the PV module. Further to this, the Commission has also considered the detailed submissions made by the stakeholders on parameters related to the Cost of Land and Land Development, Cost towards modules & mounting structures, Power Conditioning Units, Pre-Operative Expenses, and Cost towards evacuation infrastructure. Accordingly, the Commission has reviewed the capital cost for solar PV power plants to be commissioned during FY 2010-11.

## **15. Other Parameters**

### Stakeholder Comment/Suggestion

#### ***Capacity Utilisation Factor***

15.1. The Stakeholders have submitted that the Capacity Utilisation Factor (CUF) of 19% per annum is achievable at few places in States like Rajasthan and Gujarat. However, at all other places the CUF is below 19% per annum.

### ***Degradation of Modules***

15.2. The Stakeholders have further submitted that there is year to year annual performance generation degradation in the solar farm of 0.5% to 1% each year. A normative value of 14% degradation over useful life may be considered.

### ***Applicable Tariff for Solar PV Power Plants***

15.3. The majority of Stakeholders have submitted that the present tariff (of Rs 18.44 for FY 2009-10) may be allowed to continue during the Phase I (2010-2013) of Jawaharlal Nehru National Solar Mission

### **Commission's Analysis and Ruling**

15.4. The Commission observes that the capacity utilization factor (CUF) shall depend on insolation level which varies from State to State across various locations. In the absence of more scientific assessment of solar radiation data, it may not be appropriate to undertake zone-wise classification of CUF data across India at this stage, as has been undertaken in case of wind zone mapping based on wind energy atlas prepared by Centre for Wind Energy Technology (C-WET). As regards degradation factor, while the stakeholders have claimed the benefit of degradation based on some studies, there are no standards for ascertaining such degradation for Indian conditions and no projects are yet established to verify the claim for extent of degradation. Besides, the Commission notes that the review of above performance parameters (such as CUF and degradation factor) is not the subject matter of present regulatory process which has been initiated for annual revision of benchmark capital cost for solar PV and Solar thermal projects in pursuance of Regulation 5 of CERC RE Tariff Regulations, 2009. However, with due consideration to the fact that DNI could vary from place to place and to address concerns related to degradation, during initial phase of solar project development in India, the Commission has taken slightly liberal

view on several capital cost components so that the revenue risk on account of variation in normative CUF or degradation factor would be minimal.

**C. Benchmark Capital Cost Norm for Solar PV Power Projects**

16. Based on the stakeholder views and Commission's Analysis thereon discussed in Section B, the Commission hereby determines the **Benchmark Capital Cost norm of Rs 1690 Lakh/MW** (as summarised in following table) for Solar PV power projects to be commissioned **on or before March 31, 2012** subject to the condition that Power Purchase Agreement (PPA) for such solar PV power project shall be signed before March 31, 2011 and entire capacity of Solar PV project shall be commissioned on or before March 31, 2012.

<b>S No</b>	<b>Particulars</b>	<b>Capital Cost Norm for Solar PV project (Rs Cr/MW)</b>
1	Land Cost	0.15
2	Civil and General Works	0.90
3	PV Modules	10.19
4	Mounting Structures	1.00
5	Power Conditioning Unit	2.00
6	Evacuation Cost upto Inter-connection Point (Cables and Transformers)	0.85
7	Preliminary and Pre-Operative Expenses	1.81
<b>8</b>	<b>Total Capital Cost</b>	<b>16.90</b>



**D. COMMENT/SUGGESTION RECEIVED AND COMMISSION'S RULING –**  
**SOLAR THERMAL POWER PROJECTS**

**17. Land and Land Requirement**

Stakeholder Comment/Suggestion

17.1. The Stakeholders have submitted that higher PLF plants will need more land. Accordingly, around 5ha/MW land should be considered for Solar Thermal Power Plants with heat storage. Some of the stakeholders have submitted that per MW land requirement for setting up solar thermal power plant shall be in the range of 6~8 acres.

Commission's Analysis and Ruling

17.2. With regards to the per MW requirement of land, the Commission has taken into consideration submissions of stakeholders and accordingly have proposed land requirement of 6 Acre/MW for setting up solar thermal power plant in India. The Commission recognises that the requirement of land per MW shall vary depending on the insolation level and nature of CSP scheme (with or without storage) being deployed. However, for the purpose of generic tariff determination, the Commission has considered the land requirement as 6 acre/MW (without storage). Accordingly, the Commission has considered cost of land as Rs 0.18 Cr/MW based on land requirement for solar thermal project at 6 acre/MW and at estimated cost of Rs 3 lakh/acre.

17.3. The Commission would like to clarify that the generic norms under the RE Tariff Regulations 2009 have been provided for solar thermal power plants without thermal storage. In case a developer chooses to develop the system with thermal storage, the tariff determination for such system could be taken up on case-to-case basis under 'project specific' tariff determination route, if necessary based on petition filed by such developer under regulations 7 and 8 of the RE Regulations, 2009. As design of thermal storage, extent and type of thermal

storage would be unique, it is preferred to deal with such project cases on case to case basis.

## **18. Capital Cost Norm for Solar Thermal Power Plants**

### Provision in the proposal

18.1. In the proposal the capital cost norms for solar thermal power plants to be commissioned during FY 2010-11 has been proposed as Rs14.20Cr/MW (equivalent US\$3100/kW).

### Stakeholder Comment/Suggestion

18.2. NTPC has submitted that the project cost for at least 3-4 Solar Thermal Power Plants may be allowed on actual basis, subject to prudence of the Commission. Acme Tele Power Ltd. on the basis of prevailing market prices and the commercial quotations received by them has submitted that the estimated project cost should be Rs15.97Cr/MW. Forum for Advancement of Solar Thermal (FAST) has requested to consider normative capital cost in the range of Rs 16-17 Cr/MW. M/s Entegra Ltd has proposed to consider capital cost norm of Rs 16.20 Cr/MW (without storage) and Rs 17.70 Cr/MW (with storage). NEDCAP has submitted that the capital cost norm for solar thermal may be considered as Rs 16.45 Cr/MW. M/s The Tata Power Ltd has submitted that the capital cost for solar thermal is in the range of Rs 20-22 Cr/MW, whereas M/s Abengoa Energy has requested that the Capital Cost norm of Rs 28 Cr/MW may be considered.

18.3. SunBorne Energy has presented their estimation of Capital Expense as Rs 17.25Cr/MW (equivalent to US\$ 3750/kW), assuming a 50MW power plant is to be built. The detailed break-up of capital cost components as presented by M/s SunBorne Energy is summarised below:

Item Description	Est. Cost (US\$/kW)	Est. Cost (Rs Cr/MW)	%
<b>Solar Field Cost</b>	<b>2375.02</b>	<b>10.92</b>	<b>63%</b>
- Mirrors/Frames/HTF/ Receivers/BOS of solar field	1482.52	6.82	40%
- Solar field construction	892.50	4.10	23%
<b>Power Block</b>	<b>975.37</b>	<b>4.48</b>	<b>26%</b>
- STG/ Mech. Equip /Elect. Equip.	631.12	2.90	17%
- Construction for Power Block	344.25	1.58	9%
<b>Preliminary/Pre-Op. Expense</b>	<b>55.00</b>	<b>0.25</b>	<b>2%</b>
<b>Contingency</b>	<b>125.00</b>	<b>0.57</b>	<b>3%</b>
<b>IDC</b>	<b>220.00</b>	<b>1.01</b>	<b>6%</b>
<b>TOTAL Project Cost</b>	<b>3750.40</b>	<b>17.25</b>	<b>100%</b>

18.4. M/s Sunborne Energy has appreciated that the Proposal has taken note of various CSP technologies with differing maturity levels and also referred to several reputed publication sources such as ESTELA, IEA, Solar PACES to proposed revision in benchmark capital cost from Rs 13 Cr/MW to Rs 14.2 Cr/MW, however, it has submitted that based on their experience, this capital cost norm still fall short of the CSP deployment a reality in Indian context. M/s Sunborne has submitted that the capital cost norm proposed by them is based on quotations received from multiple vendors for the critical equipment of the CSP project.

18.5. M/s Abengoa Energy has submitted that international competitive tenders in Abu Dhabi, Algeria, Egypt, and Morocco has resulted in least cost bids of €4.5 Million/MW (without storage) and in Spain €6.0Million/MW. Comparative with other countries the cost of labour for construction and operation (20% of the total capital cost) in India is cheap. Considering 75% saving in labour cost in India, the capital cost shall be €3.8Million/MW (without storage) and €5 Million/MW

(with storage). Taking into consideration the international cost references of Solar Thermal Power Plants Rs.280Million/MW may be considered.

#### Commission's Analysis and Ruling

18.6. With regard to allowing the capital cost on actual basis for initial 3-4 projects, the Commission notes that the solar power development in the country is still in the nascent stage and accordingly the RE Tariff Regulation 2009 provide for determination of tariff on case to case basis wherein the financial norms except the capital cost and performance norms, shall be ceiling norms while determining the project specific tariff.

18.7. The Commission has analysed the comments made by various stakeholders in respect of benchmark capital cost norm for solar thermal power projects. The Commission observes that very few solar thermal power developers have provided component-wise cost break-up. Thus, the scrutiny and analysis of components of capital cost is constrained by the extent of information availability about solar thermal power projects in Indian context. However, the Commission has proceeded to analyse the detailed break up of capital cost components, to the extent of information furnished by various stakeholders, as summarised in the following table.

Item Description	SunBorne	Acme	NTPC	Acira			
				Domestic	Tight Pricing	Right Pricing	Imported
<b>Solar Field Cost</b>	<b>10.92</b>	<b>8.39</b>		<b>9.91</b>	<b>11.66</b>	<b>12.89</b>	<b>13.41</b>
Mirrors/Frames/HTF/Receivers/BOS of solar field	6.82	7.98	16.00	8.06	9.59	10.65	11.11
Solar Field Construction/EPC	4.10	0.40		1.85	2.08	2.24	2.30
<b>Power Block</b>	<b>4.48</b>	<b>5.63</b>	<b>5.44</b>				
STG/ Mech. Equip /Elect. Equip.	2.90	3.50	3.86	4.25	4.25	4.25	4.25
Construction for Power Block	1.58	2.12	1.58				
<b>Preliminary/Pre-Op. Expense</b>	<b>0.25</b>	<b>0.96</b>	<b>1.01</b>				
<b>Contingency</b>	<b>0.58</b>	<b>0.28</b>	<b>1.80</b>	1.34	1.49	1.60	1.65
IDC	1.01	0.71	0.78				
<b>TOTAL Project Cost</b>	<b>17.24</b>	<b>15.97</b>	<b>25.03</b>	<b>15.50</b>	<b>17.40</b>	<b>18.74</b>	<b>19.31</b>

18.8. The Commission understands that approximately 45%~55% of the total cost is towards the solar field. The Commission has also noted that the equipments pertaining to the solar field viz. concentrating mirrors, receiver tubes

etc. are still not manufactured in the country and the developers may need to import superior quality mirrors and receiver tubes and other equipments pertaining to solar block equipments. However, there could be scope in optimisation of costs towards mounting structure / construction of solar field , which forms around 10-12% of overall capital cost.

18.9. Further, the Commission observes that significant scope for indigenisation exists particularly in power block and other balance of plant/system components. The Commission also notes that the cost towards construction of power block and operation thereon will be significantly less because the cost of labour and other balance of system components in India compared to cost for similar components in other countries. It is observed that the combined cost of solar field and power block (which constitutes around 85%-91% of the total capital cost) as proposed by various solar developers varies from Rs 14.01 Cr/MW (Acme) to Rs 15.40 Cr/MW (Sunborne), to Rs 14.16 Cr/MW – Rs 17.66 Cr/MW (Acira Solar) to Rs 21.44 Cr/MW (NTPC). As submitted by some of the developers, there exists potential for reduction in capital cost to the extent of 15-20% considering domestic labour cost component and extent indigenisation proposed to be undertaken in power block, balance of systems and other equipment.

18.10. Further, the Commission also notes that the capital cost of few solar thermal projects proposed in India based on detailed reports submitted by such project developers before various State Electricity Regulatory Commissions and to MNRE for participating in the Generation Based Incentive scheme, as

summarised under Proposal and reproduced hereunder.

Table : Summary of Capital Cost estimate for Solar Thermal Power project by Developers (all fig. in Rs Lakh / MW)

Sr. No.	Particulars	Project (P1)	Project (P2)	Project (P3)	Project (P4)	Project (P5)	Project (P6)	Project (P7)
		Rajasthan	Rajasthan	Andhra Pradesh	Maharashtra	Gujarat	Chhattisgarh	Madhya Pradesh
Plant Capacity, (MW)		10 MW	10 MW	5 MW	5 MW	5 MW	5 MW	5 MW
Technology Option		Solar Tower	Parabolic Trough	Parabolic Trough	Parabolic Trough	Parabolic Trough	Parabolic Trough	Parabolic Trough
1	Land	0	0	50	50	50	50	50
2	Civil and Structural Works	64	129	46	46	46	46	46
3	Solar Field	976	2198	1290	1290	1290	1290	1290
4	Power Block	335	672					
5	Thermal Storage System	0	576	0	0	0	0	0
6	Preliminary/Pre-operative and Other Costs (incl. IDC & Contingency)	119	351	376	376	376	376	376
7	<b>Total Capital Cost</b>	<b>1494</b>	<b>3926</b>	<b>1763</b>	<b>1763</b>	<b>1763</b>	<b>1763</b>	<b>1763</b>

Source : MNRE & Petitions before SERCs

18.11. From above table, it is observed that the cost of solar field and power block has been estimated to be around Rs 12.90 Cr/MW. The Commission understands that the developers of such projects have explored opportunities to procure equipments indigenously to the extent possible.

18.12. Further, it has also been noted by the Commission that the indirect cost which primarily constitute preliminary project expenses, technology supervision, contingency, site preparation and infrastructure arrangements, interest during construction together constitute to approximately 10%~15% of the direct cost. The direct cost components include expenditure towards Solar field and Power Block, land, civil and structural works etc.

18.13. Taking into consideration the aforesaid facts, the views and suggestions submitted by the various stakeholders, the Commission has determined the capital cost norm for solar thermal power plants as summarised under **Section-E** of this Order.

## 19. Other Technologies

### Stakeholder Comment/Suggestion

19.1. Dalmia Solar Power Limited has submitted that the benchmark Capital Cost Norm is not representative of all the possible technologies and may be reviewed for upward revision. Stirling Engine Cycle is available at substantially higher capital cost (Rs 2300Lakh/MW). Stirling Engine may be recognised as third category and its benchmark cost norm may be set separately

### Commission's Analysis and Ruling

19.2. The Commission would like to clarify that the Regulation 60 RE Tariff Regulations, 2009, provides for applicability of norms for concentrated solar power technologies viz. line focusing or point focusing, as may be approved by MNRE. Further the Solar Thermal Power Plants based on Dish Stirling Engine essentially qualify under point focus technology. The Commission understands that the development of solar power technologies in India are still at nascent stage and hence the enabling provision for determination of project specific tariff has been made under Regulation 7 of the RE Tariff Regulation, 2009. The developers of Solar Dish Stirling Engine based power plants and any other technology may approach the Commission for determination of tariff on case to case basis, if necessary.

## **20. Other Parameters**

### ***Capacity Utilisation Factor***

#### Stakeholder Comment/Suggestion

20.1. The Stakeholders have submitted that the Capacity Utilisation Factor (CUF) of 23% per annum (without Storage) is difficult to achieve.

#### Commission's Analysis and Ruling

20.2. The Commission has explained the detail rationale of specifying the CUF in the Statement of Object and Reasons published with the RE Tariff Regulations 2009. However, the Commission would again like to clarify that the CUF has been specified after taking into account recommendation of MNRE and the submissions of the developers for Solar Thermal Power Plants.

20.3. The Commission observes that the capacity utilization factor (CUF) shall depend on insolation level (direct radiation in case of solar thermal) which varies from State to State across various locations. The Commission understands that Solar Energy Centre, MNRE is in the process of developing solar energy atlas

for India with relevant data across various States. In the absence of more scientific assessment of solar radiation data, it may not be appropriate to undertake zone-wise classification of CUF data across India at this stage, as has been undertaken in case of wind zone mapping based on wind energy atlas prepared by Centre for Wind Energy Technology (C-WET). Besides, the Commission notes that the review of above performance parameters (such as CUF) is not the subject matter of present regulatory process which has been initiated for annual revision of benchmark capital cost for solar PV and Solar thermal projects in pursuance of Regulation 5 of CERC RE Tariff Regulations, 2009. However, with due consideration to the fact that DNI could vary from place to place and to address concerns related to degradation, during initial phase of solar project development in India, the Commission has taken slightly liberal view on several capital cost components so that the revenue risk on account of variation in normative CUF would be minimal.

**E. Benchmark Capital Cost Norm for Solar Thermal Power Projects**

**21.** Based on the stakeholder views and Commission's Analysis thereon discussed in Section D, the Commission hereby determines the **Benchmark Capital Cost Norm of Rs 1530 Lakh per MW** (as summarised in following table) for Solar thermal power projects to be commissioned **on or before March 31, 2013** subject to the condition that Power Purchase Agreement (PPA) for such solar thermal power project shall be signed before March 31, 2011 and entire capacity for such solar thermal power project shall be commissioned on or before March 31, 2013.



<b>S No</b>	<b>Particulars</b>	<b>Capital Cost Norm for Solar Thermal (Rs Cr/MW)</b>
<b>A</b>	<b>Direct Cost</b>	<b>13.48</b>
1	Solar Block	12.90
2	Power Block	
3	Land	0.18
3	General Civil and Structural works	0.40
<b>B</b>	<b>Indirect Cost</b>	<b>1.82</b>
1	Preliminary & Pre Operative Expenses	1.82
2	Contingency	
3	IDC	
<b>C</b>	<b>Total Capital Cost</b>	<b>15.30</b>

( V.S. Verma )  
Member

( S. Jayaraman )  
Member

( Dr. Pramod Deo )  
Chairperson

New Delhi, \_\_\_\_\_ February, 2010

## Annexure -1

### Summary of Comments Received from Stakeholders Solar PV Power Projects

#### Cost of Land and Land Requirement

1. The 5acre/MW should not be construed as a necessary guideline in land allocation in different States, as this will limit the thin film technology option. **(Applied Materials India)**
2. Cost of land may be considered as Rs3Lakh/Acre. **(Arbutus Computers & Consultants Pvt Ltd)**
3. Cost of land in Haryana, Karnataka, and Punjab etc. is between Rs5-7Lakh/Acre. Accordingly the land cost may be considered as Rs0.25Cr/MW. **(Azure Power (India) Pvt. Ltd.)**
4. The cost of land varies from place to place and State to State. In the States of Punjab and Haryana the cost of barren land may range from Rs18Lakh/Acre to Rs28Lakh/Acre, which translates to around Rs0.9Cr/MW to Rs1.40Cr/MW. Accordingly the average cost of land may be considered as Rs 1Cr/MW. **(Future Computing & Energy Solutions (P) Ltd)**
5. Land cost varies from Rs 3-5 Lakh/acre depending upon the region, owner profile, and land type. Average land requirement per MW shall be around 6 acres for c-Si and 12 acres for thin film solar PV power plants. **(India Semiconductor Association)**
6. Cost of Land varies between Rs3~5Lakh/Acre in most of the States and the same may be considered. **(Lanco Solar Private Limited)**
7. The requirement of land is in the range of 6 ~ 8 acres/MW and the cost of land may be considered as Rs8~10Lakh/acre. **(Moser Baer Clean Energy Limited)**
8. Cost of Land in and around high voltage sub-station is in the order of Rs3L/Acre to Rs4L/Acre. Accordingly, land cost may be taken as Rs20L/MW. **(NEDCAP)**
9. The average land requirement per MW is around 6-7 acre and the Land Cost to be considered Rs 3-5 Lakh/acre. **(Reliance Industries Limited)**
10. Land Cost in most states is in the range of Rs4lakh/acre. **(Sun Edison)**
11. The prices of land closer to the grid substations have gone up considerably after the launch of JNNSM. The cost of land may be considered as Rs4~5Lakh/Acre. **(TATA BP Solar India Ltd.)**

12. The current prices of land ranges from Rs3.5Lakh/acre to Rs 4.5Lakh/acre. To cover shadow effect, the land with tracker system will have to be a minimum of 7acre/MW. **(Solar Semiconductor (P) Limited)**
13. The land costs should include Rs. 2.6 Lakh/acre; and Rs. 0.4 Lakh/acre for registration and land reclassification charges. Total cost of Land/MW is 5 acres at Rs. 3 Lakh per acre i.e. 0.15 Cr. **(Sri Power)**
14. The land required for PV thin film a-Si technology is minimum 6 acre. **(Zenith Solar Energy Limited)**

**Expenditure towards PV Module**

1. Module price of \$2/W is feasible but would entail the developer having an efficient and competitive supply chain. There should not be any direct linkage between module price and balance of system costs. **(Astonfield Renewable Resources Ltd.)**
2. Due to large increase in demand of the PV Modules and limited supplies there may not be substantial reduction in cost of PV Modules/Non-Module Costs. Accordingly, the benchmark cost shall be maintained at Rs17Cr/MW for the Solar PV projects to be commissioned in FY 2010-11. **(Emco Power Limited)**
3. Global tender floated by MSPGCL or KPCL does not reflect the real market position. Taking into consideration the impact of exchange rate variation, transportation, insurance and handling charges the cost of PV module may be considered as Rs10.53Cr/MW. **(Future Computing & Energy Solutions (P) Ltd)**
4. The module price of USD 2.4-2.5 per Watt to be maintained during the Phase I (2010-13) of JNNSM. **(India Semiconductor Association)**
5. Module prices are stabilizing to around \$2.50/W-\$3.00/W. **(Reliance Industries Limited)**
6. The module price of USD2.4~2.5/W may be taken into consideration. **(Moser Baer Clean Energy Limited)**
7. The cost of PV Modules will be slightly higher than \$2/W for 2010. **(Shri Shanti Prasad)**
8. Taking into consideration the economies of scales, the price of module should not be fixed lower than Rs105/W. **(Solar Energy Society of India)**
9. The demand for PV modules will increase in near term and thus the benchmark capital cost needs upward review. **(Swiss Park Vanijia (P) Ltd., OPG Energy)**

10. Silicon Wafer prices are in upward trend. The cost of solar module may be considered as \$2.2/W. These Modules are backed by 25 years warranty with 86% power availability at the end of 25<sup>th</sup> year. **(TATA BP Solar India Ltd.)**
11. The Prices of module have come down in 2009. **(Juwi Solar)**
12. The cost of module should be fixed keeping into consideration that there is a variance of rates from low for Chinese or other inferior equipment to higher rates for superior equipments from Europe and US. **(Zenith Solar Energy Private Limited)**

#### **Cost of Mounting Structure**

1. The cost of Module Structure may be considered as Rs1.57Cr/MW. **(Astonfield Renewable Resources Ltd.)**
2. To achieve PLF of 19% in some states, trackers need to be utilised. The cost towards mounting structure may be considered as Rs1.85Cr/MW. **(Azure Power (India) Pvt. Ltd.)**
3. The price of structuring steel has been fluctuating and the labour index has increased 14.2% during the calendar year 2009-10. Accordingly, the cost of Module Structures may be considered as Rs0.90Cr/MW. **(Future Computing & Energy Solutions (P) Ltd)**
4. Real world costs for land preparation & mounting structure can be significant. Indian projects have seen additional real costs of up 1.5 - 2 Cr/MW. **(Juwi Solar)**

#### **Power Conditioning Unit**

1. The Cost of PCU may be considered as Rs2.09Cr/MW. **(Astonfield Renewable Resources Ltd.)**
2. The PCU contributes roughly 11-12% of the project cost. It may be considered as Rs0.99Cr/MW. **(Azure Power (India) Pvt. Ltd.)**
3. Any poor quality inverter/transformer may require more replacements resulting in loss of generation/revenue through plant shutdowns. The cost of PCU may not be considered as a percentage of total capital cost. The cost of PCU may be considered as Rs2Cr/MW. **(Future Computing & Energy Solutions (P) Ltd)**
4. Supply side constraints result in upward trend in base metal prices resulting in increased prices of structures and cables and the same should be taken into consideration while finalizing the capital cost. Global inverter market is strong both in terms of demand and prices. **(Reliance Industries Limited)**

5. For large scale projects it is mandatory to consider IEC/UL certified Inverters with remote communication, string monitoring feature and high conversion efficiency. Accordingly, the cost of PCU may be considered as Rs.2.20Cr/MW. (**TATA BP Solar India Ltd.**)
6. The cost of establishing a 33kV substation will be Rs1.2Cr. The cost of line may be considered as Rs8Lakh/km. Further, 132/33 kV substations can take maximum of 10MW size project and any project greater than 10MW need to be interconnected to 220/132kV grid substation. The cost of 132kV dual line per km is approximately Rs60Lakh. Keeping the above facts into consideration, CERC should mandate that laying line from power to nearest substation should be the responsibility of the State government. (**Solar Semiconductor (P) Limited**)

#### **Evacuation Cost**

1. The Cost towards Cables and transformers may be considered as Rs1.04Cr/MW. (**Astonfield Renewable Resources Ltd.**)
2. The average cost of transmission line, if assumed to be 5 km shall be about Rs17.5Lakh for 11 kV, Rs40Lakh for 33 kV and Rs150Lakh for 66kV or 132 kV. As a generic norm, the average transmission cost may be considered as Rs0.175Cr/MW. (**Future Computing & Energy Solutions (P) Ltd**)
3. The cost for evacuation of power may be considered as Rs50Lakh/MW. (**Moser Baer Clean Energy Limited**)
4. Cost of Power Evacuation may be assumed as Rs1.50Cr/MW. (**NEDCAP**)
5. The cost for transmission line and transformer for grid interfacing at more than 33kV level may be considered as Rs0.60Cr/MW. (**NTPC**)
6. The Power Evacuation Arrangement for grid interface for the identified solar zone must be ensured under policy guidelines. (**Shyan Dakhera & Associates, Shri Gopal Somani**)
7. The evacuation line varies depending on the site from 1~5 km. It is proposed to include 2 KM evacuation lines in the capital costs. Total evacuation line costs per MW is Rs.0.60 Cr. (**Sri Power**)
8. Grid connection at higher voltage 66/132KV increases project costs but is advantageous for off-take security and stability. (**Juwi Solar**)

#### **Preliminary and Pre-Operative Expenses**

1. The interest during construction cost may be considered as Rs64Lakh/MW. The cost towards insurance may be considered as half percent of the project cost. The

- cost of spare parts may be considered as 2% of the EPC cost. The expenses towards taxes and duties for the components may be around 6~8% of the EPC cost. The margin for EPC contractor may be considered as 10% of the EPC cost. The development cost for the project may be pegged at Rs10Lakh/MW. (**Moser Baer Clean Energy Limited**)
2. An insurance cost of 0.25% of the EPC cost may be considered while determining the tariff. (**Moser Baer Photovoltaic Limited**)
  3. Around Rs0.50Cr should be included towards VAT. (**Sri Power**)
  4. Insurance costs are not covered in the capital cost and are as high as 0.5% of the system costs per annum. (**Sun Edison**)

#### **Expenses towards Civil and General Works**

1. Civil & General works contributes to around 6% of the project cost. The Cost towards Civil & General Works may be considered as Rs.1.23Cr/MW. (**Azure Power (India) Pvt. Ltd.**)
2. Labour Index has indicated an increase from 134 to 147 i.e. 9.7% for 2008-09 and from 148 to 169 i.e. 14.2% for 2009-10. Accordingly, the cost of civil & General Works may be considered as Rs1.20Cr/MW. (**Future Computing & Energy Solutions (P) Ltd**)

#### **Benchmark Norm for Capital Cost**

1. Capital Cost consideration for Solar PV Power Projects for the year 2010-11 should be Rs.17Cr/MW. A reduction of 5% per annum in capital cost may be considered. (**Akshunya Energy Pvt. Ltd., Asiatics Solar Power Pvt. Ltd., Bhanaji Solar Power Pvt. Ltd., Elixir Solar Power Pvt. Ltd., India Solar Ray Power Pvt. Ltd., Jain Irrigation Systems Ltd., Kaihatsu Techno Centre Pvt. Ltd., and Velox Energy Consultants Pvt. Ltd.**)
2. The gestation period of the projects may extend up to 24 months, accordingly the capital cost norm shall be declared for the projects to be commissioned during FY 11, FY 12 and FY 13. (**Arbutus Computers & Consultants Pvt Ltd**)
3. The Capital Cost may be considered as Rs.16.97Cr/MW. (**Astonfield Renewable Resources Ltd., Reliance Industries Limited, TATA BP Solar India Ltd.**)
4. Lowering the benchmark cost of Solar PV project from Rs1700Lakh/MW to Rs1520Lakh/MW is not justified in the actual scenario of cost related to Solar PV. (**Avant Garde RE Energy Limited**)

5. Capital Cost for Solar Projects in India under current market conditions are Rs17.08Cr/MW. (**Azure Power (India) Pvt. Ltd.**)
6. BHEL has been awarded an order for installation of 1MW+2MW Solar Power Plant by KPCL for its facility at Raichur district. This order has been secured under the “Swiss Challenge” process in which BHEL was given option to secure or leave the order at L1 price quoted by the party. The price trend in this particular tender was low. This was exceptional situation and so this single case should not be considered for the purpose of establishing the capital cost of the projects. (**BHEL**)
7. It would be prudent if capital cost is not reduced for the time being and a policy of wait and watch for another 1-2 years may be adopted, whereby the price trends for modules become more realistic. (**Bhilwara Energy Limited**)
8. The capital cost may be reduced 3%~5% per annum. (**Euro Solar Power Private Limited**)
9. Capital Cost & Generic Tariff already notified for FY 2009-10 may continue for FY 2010-11 as no authentic data of the cost components is available. (**Future Computing & Energy Solutions (P) Ltd**)
10. Solar technology innovation would likely to reduce the cost to the tune of 15-28% in year 2010. Non-module cost will go down depending on installed capacity, locational peculiarities and economy of scale. Non-Module cost may be considered as 20-25% of the capital cost. The total Capital Cost for solar PV project for year 2010-11 would be within the band of Rs12 - 13Cr/MW. (**Gujarat Urja Vikas Nigam Limited**)
11. The capital cost quoted by the bidders / winners in the earlier bids should not be used as these are only for a few projects and cannot serve as a reference base for calculating the normative capital costs. The aggressive bids may have been quoted as a business strategy by the bidders (to gain entry, project learning experience etc). (**India Semiconductor Association**)
12. There is not much substantial fall in the module cost in the international market and every year there is constant rise in Land Cost, R&R Cost, Labour cost, Freight Cost etc. and accordingly Capital Cost of Rs1800Lakh/MW may be considered. (**Kimaya Energy Limited**)
13. Capital Cost may be considered as Rs19.645Cr/MW~Rs20.705Cr/MW. (**Moser Baer Clean Energy Limited**)

14. The EPC cost is still Rs15-15.5Cr/MW. The demonstration projects have been done either to prove the technology or as a specific marketing tool for market penetration. **(Mosser Baer Photovoltaic Limited)**
15. Capital cost for Solar PV power projects may be Rs16Cr/MW. **(NEDCAP)**
16. The Commission needs to clearly define the items of the capital cost while benchmarking the costs and calculations for determination of tariff. **(Noesis Strategic Consulting Services)**
17. Based on the budgetary offers received from prospective bidders for 5 MW solar PV based project, the cost is around is Rs1729Lakh/MW. **(NTPC)**
18. The Capital Cost for Solar PV projects may be considered as Rs16.50Cr/MW. **(Shri Shanti Prasad)**
19. The criteria of benchmark should be based on the market trends in India and not on the trends of Europe of the US. India is still in infant stage of development in Solar power and it deserves its due liberal support by regulators for couple of initial years. **(Shri Subodh Kumar Bhatnagar)**
20. Separate Capital cost norms for fixed tilt, single axis and dual axis tracking systems should be stipulated. The capital cost varies significantly based on the tracking systems. Installed system cost for fixed tilt good quality solar PV power plants is estimated to be Rs16.9Cr/MW **(Sun Edison)**
21. With lowering the capital cost, the project developer may be compelled to purchase solar PV modules from cheap sources that may not meet the required technical standards of efficiency, performance and lifetime of the module. **(Tata Power)**
22. The cost and efficiency of the technology would vary depending on the solar cell technologies used. **(TERI)**
23. Cost of complete Solar PV Power Plant works out to around Rs15Cr/MW in current scenario. However, such cost may even go down to Rs.14Cr/MW if Chinese Solar Modules and String type inverters are used. **(Shri SP Gon Chaudhuri, WBGEDCL)**
24. Cost of Solar PV as well as Solar Thermal Power Projects has come down below Rs10Cr/MW however, because of involvement of people at different level (Advisor/Broker/Consultant) the capital cost quoted is Rs15Cr/MW. Tariff should be fixed at Rs5/kWh for the next 25 years to drive down the cost. **(Shri Shishir Vignesh)**
25. MNRE, PFC, MOP, NTPC & BHEL should concentrate and discover the real cost on technology options, EPC, PCU and Indian resource which could be thrown in



- for cost reduction for a scalable development. (**Shyan Dakhera & Associates, Shri Gopal Somani**)
26. The capital cost for Solar PV Power Plant should be Rs16.40Cr/MW. (**Sri Power**)
27. Capital Cost may be fixed as Rs16-17Cr/MW or otherwise preferential tariff of Rs17-18/kWh to encourage investment. (**Swiss Park Vanijia (P) Ltd., OPG Energy**)

### **Other Parameters**

#### **Degradation of Modules**

1. Solar PV panels have an annual derating factor ranging from 0.5% to 1%. Accordingly, the solar PV panels will perform at 80-85% of their original capacity by the end of their life at around 25 years. This should be factored into the calculations while deriving the generic tariff. (**India Semiconductor Association, Reliance Industries Limited**)
2. There is year to year annual performance generation degradation in the solar farm of 0.5% to 1% each year. Annual degradation of 1% each year may be considered. (**Lanco Solar Pvt. Ltd.**)
3. The degradation in the PLF may be considered at 1% per annum. (**Moser Baer Clean Energy Limited**)
4. Annual degradation of 1% may be considered while determining the tariff. (**Moser Baer Photovoltaic Limited**)
5. Permissible annual degradation of 0.5% and 0.8% may be considered for c-Si technology and a-Si & Cd-Te technologies respectively. (**Sri Shakti**)
6. Degradation factor needs to be included at 0.5-0.6% per annum. (**Sun Edison**)
7. A normative value of 14% degradation over useful life (25 years) may be considered. (**TATA BP Solar India Ltd.**)

#### **Global Solar Insolation and Capacity Utilisation Factor**

8. CUF of 19% p.a. is achievable at few places in States like Rajasthan and Gujarat. However, at all other places the CUF is below 19% p.a. (**Astonfield Renewable Resources Ltd.**)
9. In the Indian conditions, the average PLF / CUF achieved in solar PV power projects is in the range of 15%-16%. This should be taken into account while calculating the generic tariff. (**India Semiconductor Association, Reliance Industries Limited**)
10. The Capacity Utilisation Factor will be lower than 19%. A CUF of 18% may be considered. (**Kimaya Energy Limited**)

11. The achievement of 19% CUF is unsustainable. CUF of 16%-17% is more realistic and the same may be considered. **(Lanco Solar Pvt. Ltd.)**
12. Capacity utilisation factor (CUF) of 19%, as specified for Solar PV projects, may be available in North-West part of India and more than 70% of Indian locations would not be able to achieve the assumed level. Thus tariff determination guidelines shall appropriately consider the solar insolation as one of the key determinants/factors of tariff fixation. **(Microsol International LL Fze)**
13. 16% PLF would be more appropriate for the Solar Projects as a general guideline. **(Moser Baer Clean Energy Limited)**
14. A benchmark PLF of 16% may be considered for Solar PV projects. **(Moser Baer Photovoltaic Limited)**
15. The site with lower global insolation may require higher cost of PV cells, Land, Civil Works etc. to produce same peak watt output. MW scale PV projects has not been in operation and insolation data is based on remote sensing/IMD data and impact of the site/region specific aspects are yet to be established. This uncertainty/risk is required to be considered in capital cost for initial 2-3 years of solar PV plant installations. In this regards 5% variation may be considered to account for insolation uncertainty. **(Shri Shanti Prasad)**
16. Apart from capital cost, solar insolation level of the area where the plant is located is crucial in determining the tariff. Regional tariff for Solar PV programme may be considered to ensure equitable distribution of government resources through the country. **(Shri SP Gon Chaudhuri, WBGEDCL)**
17. MNRE and IMP should map the solar potential sites and identify solar zones where solar installation is technically feasible. **(Shyan Dakhera & Associate, Shri Gopal Somani)**
18. The unavailability of 19% CUF at the grid feed point affects ROI. **(TATA BP Solar India Ltd.)**

#### **Miscellaneous**

19. The tariff of Rs18.44/kWh (without accelerated depreciation) and Rs17.14/kWh (with accelerated depreciation) may be maintained for FY 11, FY 12 and FY 13. **(Arbutus Computers & Consultants Pvt Ltd)**
20. Frequent change of norms in the initial phase needs to be avoided. From a project developer perspective it is very important to have a measure of stability and consistence in the regulatory tariff for a reasonable duration. Since CERC solar PV tariff notification is as recent as December 3<sup>rd</sup>, 2009, the same should be applied for FY 2010-11 as well. **(C&S Electric)**

21. The present tariff (of Rs 18.44 for FY 2009-10) may be allowed to continue during the Phase I (2010-2013) of Jawaharlal Nehru National Solar Mission. (**India Semiconductor Association**)
22. There is a need to have clarity in respect of the applicability of the tariff in case the commissioning of the capacity of generation is staggered over differing control periods. The CERC has to indicate a time period within which all approvals should be given by the authorities in the States as well as Center. (**Noesis Strategic Consulting Services**)
23. The cost towards establishing power evacuation facility may be considered as Rs0.25Cr/MW. (**TATA BP Solar India Ltd.**)
24. Crystalline technology and thin film technology should not be considered under the same group of PV technologies. (**Solar Semiconductor (P) Limited**)

## Solar Thermal Power Projects

### Land and Land Requirement

1. Higher PLF plants will need more land. Around 5ha/MW land should be considered for Solar Thermal Power Plants with heat storage. (**Jindal India Thermal Power Ltd.**)

### Benchmark Norm for Capital Cost

1. International competitive tenders in Abu Dhabi, Algeria, Egypt, and Morocco resulted in least cost bids of €4.5 Million/MW (without storage) and in Spain €6.0Million/MW. In comparison with other countries the cost of labour in India for construction and operation (20% of the total capital cost) is cheap. Considering 75% saving in labour cost in India, the capital cost may be taken as €3.8Million/MW (without storage) and €5 Million/MW (with storage). Taking into consideration the international cost references of Solar Thermal Power Plants Rs.280Million/MW may be considered. (**Abengoa Energy**)
2. Solar radiation at the projects site in US is around 2600 – 2800kWh/sqm/year compared to 2122kWh/sqm/year for best sites in India and around 2000kWh/sqm/year at all sites in Spain. The projected capital cost for solar thermal projects in US is \$3.6 Million/MW (with 6 hours storage) and in Spain Euro 5.5Million/MW (without storage). The same may be considered while specifying the capital cost. (**Acira Solar Private Limited**)
3. According to the prevailing market price and commercial quotations obtained (for major equipments) the estimated project cost for would be around Rs15.97Cr/MW. (**Acme Tele Power Limited**)
4. Benchmark Capital Cost Norm is not representative of all the possible technologies and may be reviewed for upward revision. Stirling Engine Cycle is available at substantially higher capital cost (Rs2300Lakh/MW). Stirling Engine may be recognised as third category and its benchmark cost norm may be set separately (**Dalmia Solar Power Limited**)
5. Capital cost without storage may be Rs1620Lakh/MW and with storage Rs1770Lakh/MW. Capital Cost vary significantly between technologies which incorporate storage, Capital Cost in conjunction with associated CUF may be specified. (**Entegra Limited**)
6. The normative capital cost for solar thermal power plants should be in the range of Rs.16.0 -17.0Crore/MW. (**FAST**)

7. On account of technology development the price of solar project shall be reduced significantly during the control period. Doubling the size of project, capital cost will be reduced to the tune of 12 to 14%. **(Gujarat Urja Vikas Nigam Limited)**
8. Sufficient data should be captured before deciding capital cost and tariff. **(Jindal India Thermal Power Ltd.)**
9. Capital cost may be Rs1350Lakh/MW (without storage) and Rs1600Lakh/MW (with storage). **(Kimaya Energy Limited)**
10. Capital Cost for Solar Thermal Power Projects may be Rs16.45Cr/MW. Fixation of benchmark capital cost for 2010 to 2012 may not be realistic since there is no installation under solar thermal category. **(NEDCAP)**
11. The project cost for at least 3-4 Solar Thermal Power Plants may be allowed on actual basis, subject to prudence of the Commission. The IDC & Financing charges and cost of transmission facilities for grid interfacing & contingencies may also be considered while setting the benchmark capital cost. **(NTPC)**
12. The Capital Cost for Solar PV projects may be considered as Rs15.50Cr/MW. **(Shri Shanti Prasad)**
13. The cost estimates for the 140MW ISCC Mathania Project for which CEA has approved project cost including IDC, O&M for initial 2 years and mandatory spare at Rs8226.85Million may be considered while finalising the capital cost for solar thermal power plants. **(Shri Subodh Kumar Bhatnagar)**
14. Capital expense per MW, assuming a 50MW power plant is to be built, is estimated to be around Rs17.25Cr/MW. **(SunBorne Energy)**
15. The current capital cost of a solar thermal project is Rs20-22Cr/MW. **(Tata Power)**
16. The use of different technologies would impact the cost of technology and efficiency of the system. **(TERI)**

**List of Stakeholders submitted Written Comments/Suggestions and/or made  
Oral Submission at Public Hearing**

<b>S. No.</b>	<b>Name of Objector</b>
1.	Abengoa Solar
2.	Acciona Energy
3.	Acira Solar Private Limited
4.	Acme Tele Power Limited
5.	AES Solar
6.	Akshunya Energy Pvt. Ltd.
7.	Applied Material India
8.	Asiatics Solar Power Pvt. Ltd.
9.	Avant Garde RE Energy Limited
10.	Azure Power (India) Pvt. Ltd.
11.	BGR Energy Systems Limited
12.	Bhanaji Solar Power Pvt. Ltd.
13.	Bharat Heavy Electricals Limited
14.	C&S Electric
15.	Dalmia Solar Power Limited
16.	Elixir Solar Power Pvt. Ltd.
17.	Emco Power Limited
18.	Euro Solar Power Private Limited
19.	Forum for the Advancement of Solar Thermal
20.	Future Computing & Energy Solutions (P) Ltd.
21.	India Semiconductor Association
22.	India Solar Ray Power Pvt. Ltd.
23.	Jain Irrigation Systems Ltd.
24.	Jindal India Thermal Power Ltd.
25.	Juwi Solar

<b>S. No.</b>	<b>Name of Objector</b>
26.	Kaihatsu Techno Centre Pvt. Ltd.
27.	Kimaya Energy Limited
28.	Lanco Solar Private Limited
29.	Microsol International LL Fze
30.	Moser Baer Clean Energy Limited
31.	Moser Baer Photovoltaic Limited
32.	Neosis Strategic Consulting Services
33.	NTPC
34.	Reliance Industries Limited
35.	Shri Gopal Somani
36.	Shri Shanti Prasad
37.	Shri Shishir Vignesh
38.	Shri Subodh Kumar Bhatnagar
39.	Shyam Dakhera & Associates (CA)
40.	Solar Energy Society of India
41.	Solar Millennium
42.	Solar Semiconductor (P) Ltd.
43.	Sri Power
44.	Sri Shakti
45.	Sun Borne Energy Technologies Pvt. Ltd.
46.	Sun Edison
47.	TATA BP Solar India Ltd.
48.	TATA Power Company Limited
49.	TERI
50.	Velox Energy Consultants Pvt. Ltd.
51.	West Bengal Green Energy Development Corporation Limited
52.	Zenith Solar Energy Private Limited