

**CENTRAL ELECTRICITY REGULATORY COMMISSION
NEW DELHI**

Petition No. SM/353/2013 (Suo-Motu)

Coram: 1. Shri Gireesh B. Pradhan, Chairperson
2. Shri M. Deena Dayalan, Member
3. Shri A. K. Singhal, Member
4. Smt. Neerja Mathur, Member (Ex. Officio)

Date of hearing: 11th March, 2014

Date of Order: 15th May, 2014

IN THE MATTER OF

Determination of Benchmark Capital Cost Norm for Solar PV power projects and Solar Thermal power projects applicable during FY 2014-15.

ORDER

1. The Commission notified the Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2012 (hereinafter “the RE Tariff Regulations”) on February 6, 2012.
2. The Benchmark Capital Cost Norms as stipulated under Regulation 57(1) for Solar PV power project and under Regulation 61(1) for Solar Thermal power project are applicable for solar power projects for the year FY2012-13.
3. The first proviso of the Regulation 5 of the RE Tariff Regulations provides that the Commission may annually review the benchmark capital cost norm for Solar PV and Solar thermal power projects.
4. Under Regulation 5 of RE Tariff Regulations, the Commission vide Order dated 7th January, 2014, proposed to determine the Benchmark Capital Cost Norm for Solar PV power projects and Solar thermal power projects for the year 2014-15 (Petition No. 353/SM/2013) and invited comments/suggestions /objections from the stakeholders. Public Notice was issued inviting comments/suggestions/objections on 8th January, 2014. Last date of submission of comments/suggestions/objections was 31st January, 2014.



5. In response, written comments/suggestions/objections were received from the following stakeholders:

- i. M/s NSL Renewable Power Private Limited
- ii. M/s Rassi Green Earth Energy Private limited
- iii. M/s Elcomponics Technologies (India) Private Limited
- iv. M/s Punjab Energy Development Agency
- v. M/s Larsen & Toubro Limited
- vi. M/s Kamsolar Energy Consultants
- vii. M/s Azure Power India Private Limited
- viii. M/s Green Infra Limited
- ix. M/s Hero Future Energies Limited
- x. M/s IL&FS Energy Development Company Limited
- xi. M/s Rudraksh Energy
- xii. M/s Vikram Solar
- xiii. M/s Tata Power Solar
- xiv. M/s Tata Power Company Limited
- xv. M/s Abellon Clean Energy Limited
- xvi. M/s Federation of Indian Chambers of Commerce and Industry (FICCI)
- xvii. M/s Godawari Green Energy Limited
- xviii. M/s First Solar Power (India) Pvt. Limited
- xix. M/s KVK Energy Ventures Private Limited
- xx. M/s Abengoa Solar India.
- xxi. M/s Lanco Solar Energy Private Limited
- xxii. M/s Acme Solar Energy Private Limited
- xxiii. M/s Renew Power Ventures Private Limited
- xxiv. M/s Juwi India Renewable Energy Pvt. Limited
- xxv. M/s Association of Power Producers
- xxvi. M/s Solar Energy Society of India
- xxvii. Mr. A. K. Datta, New Delhi
- xxviii. Ms. Mallika Sharma Bezbaruah, New Delhi
- xxix. Maharana Pratap Bagh Resident's Welfare Association, New Delhi
- xxx. United Residents of Delhi, New Delhi
- xxxi. M/s National Solar Energy Federation of India
- xxxii. M/s Moser Baer Engineering and Constructions Limited
- xxxiii. M/s NTPC Limited



6. Subsequently, a public hearing was held on 11th March, 2014 and the following stakeholders made submissions during the hearing:

- i. M/s Association of Power Producers
- ii. M/s National Solar Energy Federation of India
- iii. M/s Moser Baer Engineering and Constructions Limited
- iv. Mr. A. K. Datta, New Delhi

7. The Commission has analyzed the comments/suggestions/objections received from the stakeholders on benchmark Capital Cost of Solar PV projects along with analysis and decision in the following paragraphs.

8. MODULE PRICE

8.1. **Comments received:** The comments/suggestions/objections received in respect of module price have been quoted in brief as under:

8.1.1. PV Modules cost should be benchmarked at 0.59 USD/Wp. (Larsen & Toubro Limited)

8.1.2. Average pricing of modules ignores quality aspects. Therefore, only good quality modules should be considered. Module cost should be considered as 0.60 USD/Wp. Module price should also include 1.5-2.0 cents for transportation and insurance and 1-2% breakage during transportation. (NSL Renewable Power Private Limited)

8.1.3. As per our understanding, average price of various module categories available in India hovers in the range of 0.65 USD/Wp to 0.58 USD/Wp. Most of industry experts opined that module prices, after continuous fall in recent years, have stagnated at the prevailing bottom level. There is a high likelihood of prices remaining at the prevailing bottom level in near future, if not any upward movement. It is requested to consider the base module price as 0.60 USD/Wp. (Renew Power Ventures Private Limited)

8.1.4. Average prices of various module categories (Crystalline & Thin film) available in India are likely in the range of 0.60 USD/Wp to 0.62 USD/Wp. As per the industry experts, reduction in the cost of PV module in recent period, have stagnated at the prevailing bottom level, will be stable and likely to see an

- upward trend. It is requested to consider module price as 0.61 USD/Wp. (M/s Juwi India Renewable Energy Pvt. Limited)
- 8.1.5. Average module cost of 0.62 USD/Wp should be considered. (Tata Power Solar, Abelon Clean Energy Limited)
- 8.1.6. Average module cost of 0.62 USD/Wp should be considered. It is also suggested that separate cost norm and tariff for projects using domestically manufactured cells and modules should be used. (Federation of Indian Chambers of Commerce and Industry)
- 8.1.7. It is suggested to consider 10% increase in the module for DC capacity and CIF of 0.62 USD/Wp (Direct Current) DC and considering exchange rate at Rs. 64/USD including custom port clearance, local transport, insurance etc. at 3%, the fair capital cost of modules works out to ₹ 449.5 lakh per MW with Crystalline Silicon modules of 14.4 to 15% efficiency. (National Solar Energy Federation of India)
- 8.1.8. It is requested to consider solar module price at 0.65 USD/Wp average of thin film and silicon modules as PVinsights data on weekly spot price referred in the Order. (Moser Baer Engineering and Construction Limited)
- 8.1.9. It should be considered as 0.65 USD/Wp. (Acme Solar Energy Private Limited)
- 8.1.10. It should be considered at ₹ 447 Lakhs/MW considering prevailing module price and exchange rate. (Hero Future Energies Private Limited)
- 8.1.11. It is requested that the Commission should consider the benchmark price for foreign modules used in the country at 0.65 USD/Wp for Capital Cost calculation. (Solar Energy Society of India)
- 8.1.12. Average module cost should be considered at 0.657 USD/Wp. (First Solar Power)
- 8.1.13. Capital Cost for few kW/MW size project and 30-50 MW size project need to be determined separately. Proposed benchmark cost has been reduced drastically without any justification. (Punjab Energy Development Agency)
- 8.1.14. It should be considered as 0.67 USD/Wp with exchange rate of ₹ 60/USD. (Vikram Solar)
- 8.1.15. Good quality Tier-1 module suppliers are available and providing product warranties for 25 years, lowest degradation and higher efficiency at a price not less than 0.70 USD/Wp. (Azure Power India Private Limited)

- 8.1.16. Solar module prices are firming up due to growing demand in international market. Indian developers using European modules or domestic modules have average module cost of 0.70 USD/Wp. (Tata Power Company Limited)
- 8.1.17. It is suggested to consider the module price as average of Indian and Chinese manufactured modules viz. 0.735 USD/Wp i.e. ₹ 441 Lakhs/MW. It is expected that anti-dumping duty is expected to be introduced later this year. It is suggested to introduce the provision for allowing the impact of anti dumping duty, as and when introduced as a pass through. (IL&FS Energy Development Company Limited)
- 8.1.18. Prevailing module price should be considered. (Rassi Green Earth Energy Pvt. Ltd.)
- 8.1.19. Prevailing modules of most of good companies are available in the range of ₹ 38/Wp to ₹ 42/Wp. In addition VAT also needs to be considered. It is suggested that the cost of PV modules should be considered at ₹ 430 Lakhs/MW. (Elcomponics Technologies (India) Private Limited, Kemsolar Energy Consultants)
- 8.1.20. Indian cell based module prices need to be considered. CERC should take offers from domestic module manufacturers to make the proper benchmark norm. We hope that all applicable taxes & duties have been included in the considered costs. (Green Infra Limited)
- 8.1.21. Good quality of domestic cells is very expensive and is in the range of ₹ 4.5 Crore/MW for modules alone. This necessitates a separate capital cost and tariff regime. (National Solar Energy Federation of India)
- 8.1.22. Commission has considered only the present technologies of fixed tilt in arriving at the land requirement. It is submitted that there is an immediate need to promote advanced technology single/double axis trackers. Solar power plants with trackers require more land would be applied. (National Solar Energy Federation of India)
- 8.1.23. There is a lack of clarity on DC capacity of modules required to provide AC rated capacity. Minimum 10% additional modules are required to be installed in order to provide the rated capacity of Solar PV power plant. These modules are required to be insured through third party against failure or peak output for a period of 25 years. The draft order is not explicitly clear about the taxes and

duties which will be payable against some part of supply. There are products in the market with other technologies which provide higher efficiency up to 20% lower degradation and longer warranted life of 25 years. The cost of these products is higher in comparison to above and rate goes up to USD 1.3/Wp. CERC order should provide price variation mechanism with respect to these features. It is suggested that instead of taking Chinese module prices as basis of cost consideration, new principle of taking domestic cells and modules should be considered. CERC should also take into consideration that the Chinese modules might attract and are prone to levy of Anti Dumping Duty (ADD) by Govt. of India. It is also suggested that the cost of Indian made modules and cells to be considered as 17% higher than the average of the Chinese module costs making cost of Indian modules to be 0.75USD/Wp. It may also be noted that the Ministry of Commerce & Industry is considering imposition of anti-dumping duty on import of solar modules. This will further escalate the imported solar module prices. The prices of imported and domestic modules will then be in the same range. The Commission may consider revision in the module price. (Association of Power Producers, Welspun Energy Limited)

- 8.1.24. For 1 MW AC output, atleast 10% higher capacity of module (DC) may be considered. (Rudraksh Energy)
- 8.1.25. Benchmark Capital cost varies with the applicable project size, therefore size is required to be clarified by the Commission. (Larsen & Toubro Limited)
- 8.1.26. Cost per MW varies significantly with the size of projects. The project size should be categorised in five categories viz. upto 2 MW, 2 to 10 MW, 10 to 20 MW, 20 to 50 MW and above 50 MW. (Tata Power Solar, Acme Solar Energy Private Limited, Federation of Indian Chambers of Commerce and Industry)
- 8.1.27. It is suggested that the capital cost for small rooftop system may requires additional capital cost @ ₹100 Lakhs/MW. (Tata Power Company Limited)
- 8.1.28. The normative capital cost for the Solar PV projects of ₹ 612 Lakhs/MW estimated for FY 2014-15 seems to be on lower side as compared to ₹ 800 Lakhs/MW for FY 2012-13 and may also be reviewed. (Ministry of New and Renewable Energy)

8.2. **Analysis and Decision**

8.2.1. At the time of proposing the module cost, the prevailing module cost of in India which was around 0.57USD/Wp. The Commission proposed module cost at 0.54 USD/Wp for FY 2014-15 on the assumption that the tariff being proposed is for future year when the module price would further decline. Suggestions have been received from the stakeholders are as under:

- 8.2.1.1. Review module price norm (suggestions vary from 0.59USD/Wp to 0.75 USD/Wp);
- 8.2.1.2. Module price norm should be fixed as per prevailing prices in spot markets;
- 8.2.1.3. Module price also need to include transportation cost, insurance cost and breakages during transportation;
- 8.2.1.4. Separate norms for domestically manufactured modules, thin film and other technologies;
- 8.2.1.5. Allow 10% higher capacity of modules for 1 MW AC output;
- 8.2.1.6. Separate norms for different sizes of projects including Rooftop solar PV projects, projects using single/double axis trackers.

8.2.2. PVinsights report on solar module spot price (last updated on 19.3.2014) reveals that silicon module prices are being traded in the range of 0.55 US\$/Wp to 0.94 US\$/Wp with an average of around 0.665 US\$/Wp.

<i>Poly Silicon Weekly Spot Price</i>					
Item	High	Low	Avg	AChg	AChg%
PolySilicon	23.50	21.00	22.250	-0.35	-1.55%
<i>Solar Wafer Weekly Spot Price</i>					
156mm Sq Poly	1.05	0.90	0.935	-0.004	-0.43%
156mm High Eff Poly	1.10	1.00	1.042	-0.013	-1.23%
156mm Sq Mono	1.35	1.18	1.230	0	0%
<i>Solar Cell Weekly Spot Price</i>					
Cell Price Per Watt	0.50	0.34	0.392	-0.002	-0.51%
156mm Sq Poly	2.25	1.40	1.677	-0.008	-0.47%
156mm Sq Mono	2.75	1.79	2.184	-0.015	-0.68%
<i>Solar Module Weekly Spot Price</i>					
Silicon Per Watt	0.94	0.55	0.665	-0.003	-0.45%
ThinFilm Per Watt	0.90	0.49	0.586	-0.001	-0.17%
Unit: US\$	<i>Last Update: 2014-03-19</i>				
<i>Source: PVinsight</i>					

8.2.3. Latest edition of the Mercom’s market intelligence report on Solar also reveals that there are no significant changes in module price from previous month and prices of silicon and wafer saw moderate increase in February, 2014.

China/Taiwan PV-Spot Price in US\$ (February 2014)		
	Avg	% Change
<i>Poly Price (Per KG)</i>	21.06	4.26%
<i>Multi-Si Wafer (156mm x 156mm)</i>	1.00	3.09%
<i>Cell Price (Per Watt)</i>	0.40	No Change
<i>Module Price (Per Watt)</i>	0.67	No Change
<i>Thin Film Price (Per Watt)</i>	0.60	-1.64%
Mercom Capital Group, llc		
<i>Data derived from: Mercom Capital Group, EnergyTrend, PVinsights and Other public and private sources</i>		

8.2.4. Above referred spot market prices show that module prices are almost stable. The Commission in its Order dated 7.1.2014 referred PVinsights report dated 4.9.2013, wherein, solar module spot prices were being traded in the range of 0.55 US\$ to 0.99 US\$ with an average of around 0.709 US\$. As per latest report, modules are being traded in the range of 0.55 US\$ to 0.94 US\$ with an average of around 0.665 US\$. It shows that in last six months average module prices reduced from 0.709 US\$ to 0.665 US\$. The rate of reduction is not same as observed in the FY 2011-12 & FY12-13 and may remain stable during the year 2014-15. Though, the average module prices are around 0.67 USD/Wp prevailing module prices been offered in the country by the leading manufacturers (world top 10 manufacturers) are on lower side. The same is also validated in the comment received from one of the stakeholders suggesting module price at 0.59 USD/Wp. MNRE has observed that the normative capital cost for the Solar PV power projects of ₹ 612 Lakhs/MW estimated for FY 2014-15 seems to be on lower side as compared to ₹ 800 Lakhs/MW for FY 2013-14. The cost of ₹ 612 Lakhs/MW for FY 2014-15 was estimated on the basis of module cost as 0.54 US\$/Wp. Considering the suggestions received from the stakeholders and MNRE as above, the Commission has decided to consider the module cost of 0.59 US\$/Wp for determination of benchmark capital cost of Solar PV for FY 2014-15 which is inclusive of custom clearing charges, transportation and unloading.

- 8.2.5. Regarding suggestion on separate project cost depending upon size of the project, the Commission would like to clarify that from the beginning, has adopted approach of specifying project cost for a MW scale project applicable to all size of MW scale projects in determination of generic tariff for a solar PV project.
- 8.2.6. Regarding suggestion on separate project cost for domestically manufactured modules, the Commission would like to clarify that from the beginning, has adopted approach of specifying project cost based on the modules available at internationally competitive rates in determination of generic tariff for a solar PV project.
- 8.2.7. Regarding suggestion on separate technology specific tariff, the Commission has adopted technology agnostic approach in determination of generic tariff for a solar PV project. Today because of the drastic reduction in the polysilicon price, the difference between the crystalline module cost and thin film module cost has narrowed down. At current module cost level, solar PV project based on thin film modules could be higher due to higher non module cost. The Commission is of the view that the solar PV project developers should go for the least Levelised Cost of Electricity (LCOE) technology.
- 8.2.8. Regarding suggestion to allow 10% higher capacity of modules for 1 MW AC output, it is to be noted that there are following two approaches of capacity rating for solar generating stations :
- 8.2.8.1. **The Peak capacity of the solar arrays:** Solar cells, modules and arrays are rated according to international standards in terms of peak watts (Wp). This is the DC output produced by the device under standard test conditions (STC) (defined in International Electrotechnical Commission standard - IEC 60904-3) of 1000 W/m² solar irradiance and 25°C cell temperature. The DC capacity of any solar power station in megawatts peak (MWp) is the accumulated peak capacity of all the solar modules which it contains.
- 8.2.8.2. **The capacity deliverable to the grid:** The second alternative capacity rating is the AC output which it is capable of delivering to the grid. In broad terms this is the lowest of:
1. the converted array capacity after inverter and transformer losses;

2. the combined rated output of the inverters
3. the rated capacity of the grid connection or the output transformers.

8.2.8.3. Because there are some losses between the solar array and the output to the grid, the AC capacity will be somewhat lower than the peak DC capacity. Some system designers consider the optimum system configuration and use inverters whose maximum capacity is somewhat less than the peak DC capacity, such that the inverters would 'clip' at times of peak array output. One can optimise the performance of the plant for maximum generation vis-a-vis cost by suitable selection of DC capacity and Inverter. Additional DC capacity MWp requirement for 1 MW AC could vary from location to location. The Commission is of the view that there is no need to consider such additional cost as enough cushion is available in the various parameters considered in the overall Capital Cost of solar PV projects.

9. EXCHANGE RATE

- 9.1. **Comments received** - The comments/suggestions/objections received in respect of Exchange Rate are as follows:
- 9.1.1. Exchange rate prevailing is ₹ 62/USD and it also needs to be hedged for the period of supply which adds around 4-6% to cost. (NSL Renewable Power Private Limited)
 - 9.1.2. It is suggested that exchange rate of ₹ 62/USD should be used for determination of capital cost of projects. (M/s Azure Power India Private Limited, Larsen & Toubro Limited, Rudraksh Energy)
 - 9.1.3. It should be considered at ₹ 62.6 /USD which is average of last 4 months. (Tata Power Solar, (Federation of Indian Chambers of Commerce and Industry)
 - 9.1.4. It should be considered at ₹ 63/USD. (Solar Energy Society of India)
 - 9.1.5. Estimated value of Dollar for the month of December, 2014 may be taken by the Commission from the reputed bankers as base. It is suggested that it should be at least considered at ₹ 66/USD. (Green Infra Limited)
 - 9.1.6. It is suggested that the exchange rate should be taken as ₹ 67/USD as most of the procurement activity will happen from the period commencing September, 2014

after the financial closure timelines of bids happening under JNNSM Phase-2 procurement. The NSE Forex Tracker for USD / INR as on 27/1/2014 suggested that from September, 2014 onwards exchange rate would be ₹ 67/USD. (Association of Power Producers, Welspun Energy Limited)

- 9.1.7. ₹ 62.3 /USD (average of daily exchange rate for last 6 months) should be considered. (First Solar Power)
- 9.1.8. It should be considered as ₹ 64/USD. (National Solar Energy Federation of India)
- 9.1.9. It should be considered at ₹ 62.3 /USD. (Acme Solar Energy Private Limited)
- 9.1.10. The Commission is requested to consider the exchange rate as past six month average exchange rate i.e. ₹ 62.51/USD. (Renew Power Ventures Private Limited)
- 9.1.11. Dollar exchange rate may be taken as average for six (6) months immediately preceding the date of final order. (Moser Baer Engineering and Construction Limited)
- 9.1.12. Reserve Bank of India (RBI) data shows that the past six month average exchange rate has been INR 62.06/US\$. Therefore, Accordingly the Commission is requested to consider the same. (M/s Juwi India Renewable Energy Pvt. Limited)
- 9.1.13. Prevailing exchange rate should be considered. (Rassi Green Earth Energy Private limited)

9.2. Analysis and Decision -

- 9.2.1. Most of the stakeholders have suggested that US Dollar Currency Exchange Rate may be taken as average for six (6) months immediately preceding the date of final order. Some of the stakeholders have also suggested to keep Exchange Rate as per NSE Forex Traker for the month of September, 2014.
- 9.2.2. In past, the Commission while determining the benchmark Capital norm for Solar PV projects, considered Exchange Rate as average for six (6) months immediately preceding the date of final order. This approach has been considered consistently. Accordingly, the Commission decided to consider US Dollar Currency Exchange Rate at ₹ 62/USD for determination of module cost in

₹ /Wp as an average of daily Exchange Rate prevailing in last six (6) months immediately preceding the date of final order.

10. LAND COST

- 10.1. **Comments received** - The comments/suggestions/objections received in respect of Land Cost are as follows:
- 10.1.1. The Commission has proposed land cost as ₹ 18 Lakhs/MW which is quite low compared to the prevailing land costs across states. Even when land acquired for setting up solar power projects is mostly arid /barren or of no commercial use, there are several issues associated with land acquisition process and which result in extra cost. Accordingly, the Commission is requested to consider ₹ 25 Lakhs/MW for projects. (Juwi India Renewable Energy Pvt. Limited)
- 10.1.2. It should be considered as ₹ 7 Lakhs/Acre for 6 Acres/MW. (NSL Renewable Power Private Limited)
- 10.1.3. It should be considered as ₹ 5 Lakhs/Acre considering Land Acquisition, Rehabilitation and Resettlement Bill. (Rassi Green Earth Energy Private limited)
- 10.1.4. Land cost in different States is priced in excess of ₹ 5 Lakhs/Acre. Land cost of atleast ₹ 50 Lakhs/MW must be considered. (Azure Power India Private Limited)
- 10.1.5. Land price should be considered as ₹ 30 Lakhs/MW. (Elcomponics Technologies (India) Private Limited, Kemsolar Energy Consultants)
- 10.1.6. Land cost considered in the Order is not adequate for the States like Punjab. (Punjab Energy Development Agency)
- 10.1.7. It should be considered as ₹ 22 Lakhs/MW considering average land cost prevailing at ₹ 4 Lakhs/Acre. (Larsen & Toubro Limited)
- 10.1.8. It should be taken as ₹ 40 Lakhs/MW in place of ₹ 18 Lakhs/MW. For determination of tariff, land costs of states like UP/ Gujarat/Maharashtra/ Karnataka should be chosen as the base costs. (Green Infra Limited)
- 10.1.9. Land required in South India around 3.65 Acre/MW DC and in North India around 4.5 Acre/MW DC for crystalline technology. The cost of land is considered as ₹ 5-6 Lakhs/Acre. Therefore it should be considered as ₹ 25 Lakhs/MW. (Vikram Solar)

- 10.1.10. It should be considered at ₹ Rs. 6 Lakhs/Acre or ₹ 30 Lakhs/MW. (Tata Power Solar)
- 10.1.11. Land cost should be considered at ₹ 5 Lakhs/Acre and considering 5.5 Acre/MW, the total land cost should be considered at ₹ 27.5 Lakhs/MW. (Abelon Clean Energy Limited)
- 10.1.12. Promoting technologies like motorized Trackers, Seasonal Tilt and Thin Film etc. the land area should be 6 Acres/MW. It is also suggested that the land cost should incorporate the hike due to Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. The impact of this new act is such that it would push the prices of land upwards by manifold. It is requested that the Commission should revise the land cost from ₹ 18 lakhs to realistic value of ₹ 67.2 Lakhs/MW (i.e. ₹ 13.44 Lakhs/Acre). (Association of Power Producers, Welspun Energy Limited)
- 10.1.13. Land cost should be considered at ₹ 5 Lakhs/Acre and considering 5-6 Acre/MW. This cost also includes cost of procurement, registration and conversion. (Hero Future Energies Private Limited)
- 10.1.14. Land cost should be considered at ₹ 5.50 Lakhs/Acre and considering 5 Acre/MW, the total land cost should be considered at ₹ 27.5 Lakhs/MW. (IL&FS Energy Development Company Limited)
- 10.1.15. Land cost should be considered at ₹ 6.50 Lakhs/Acre and considering 5 Acre/MW, the total land cost should be considered at ₹ 32.5 Lakhs/MW. (Federation of Indian Chambers of Commerce and Industry)
- 10.1.16. Land cost should be considered at ₹ 5 Lakhs/Acre and considering 6.5 Acres/MW, the total land cost should be considered at ₹ 30-35 Lakhs/MW. (First Solar Power)
- 10.1.17. It does not reflect the current rate of cost of land. It is suggested that it should be revised upwards to ₹ 30 Lakh/MW for land of 5 Acre/MW considering ₹ 5 Lakh/Acre in the State of Rajasthan and ₹ 6 Lakh/Acre in other States for arid/barren or of no commercial use. (National Solar Energy Federation of India)
- 10.1.18. In Gujarat, land cost ranges from ₹ 15 Lakhs/Acre to ₹ 20 Lakhs/Acre. Similarly in Rajasthan, the range is from ₹ 5 lakhs/ acre to ₹ 10 Lakhs/Acre. Accordingly, the Commission is requested to consider land cost as at least ₹ 10 Lakhs/ Acre. (Renew Power Ventures Private Limited)

- 10.1.19. For promoting technologies like motorised trackers, seasonal tilt, and thin film etc. the land area should be 5.5 Acres/MW. Considering new Land Acquisition bill, local gram Panchayat fee, land use conversion, more realistic land cost should be taken as ₹ 6 Lakhs/Acre or ₹ 30 Lakhs/MW. (Acme Solar Energy Private Limited)
- 10.1.20. Due to awareness on upcoming solar projects in resource rich area, the cost of private land increased significantly. Land cost should be considered at ₹ 45 Lakhs/MW. (Tata Power Company Limited)
- 10.1.21. Solar power Generation needs huge land over which the solar panels have to be fixed and no other use can be made on that Land. Solar Power projects have become haven for middle men and real estate agents who come to know of the project in advance and acquire land from farmers at cheap rate. This has come into Public domain and several agents/individuals with connection have become Multi millionaire in land deal. The CERC may kindly act against profiteering. Solar Power Projects shall be raised on land which are barren, rocky and not used for farming, pasture or real estate and must be raised in Rajasthan/Haryana/Gujarat/MP/Tamil Nadu arid area away from town and city and land may be allotted to eligible party on lease for 10 year having expertise in plan, design, construct commission within a time frame of 18 months failing which the project should stand withdrawn and EMD forfeited. It is further submitted that the value of land should not form a part of the Capital Cost. Solar projects should be constructed on lands which are barren, rocky and not used for farming, pasture or real estate. Such projects should be constructed in arid area away from town and city in States like: Rajasthan/Haryana/Gujarat/Madhya Pradesh/Tamil Nadu. Land may be allotted to eligible party on lease for 10 years having expertise in planning, design, construction and commissioning within a time frame of 18 Months failing which the project shall stand withdrawn and EMD be forfeited. (Mr. A. K. Datta)

10.2. **Analysis and Decision**

- 10.2.1. The Commission has proposed the land requirement of 5 Acre/MW for crystalline PV project and its cost was considered as ₹ 18 Lakhs / MW. With increase in the average module efficiency, the land required for the crystalline

PV project has reduced. This is also recognised by one of the stakeholders. One of the stakeholders has suggested that average prevailing land cost is around ₹ 4 Lakhs/Acre. Rest of stakeholders have suggested land costs in the range of ₹ 25 Lakhs/MW to ₹ 67 Lakhs/MW.

- 10.2.2. The land acquired for setting up solar power projects is mostly arid/barren or of no commercial use. However, factoring in the increase in land cost and with due regard to the diversity in land prices in different States, the Commission decided to consider Land cost to ₹ 25 Lakh/MW (₹ 5 Lakh/Acre * 5 Acre/MW) for Solar PV projects.

11. GROUND MOUNT STRUCTURE

- 11.1. **Comments received** - The comments/suggestions/objections received are as follows:
- 11.1.1. We are in agreement with the Commission's proposal.(Elcomponics Technologies (India) Private Limited, Kemsolar Energy Consultants)
- 11.1.2. Proposed ground mount structure is reasonable. (Abelon Clean Energy Limited)
- 11.1.3. Ground mounting Structure cost may be taken as ₹ 50 Lakhs/MW. (Rudraksh Energy)
- 11.1.4. The cost of hot deep MMS (fixed tilt) structure for 10 MW projects should be between 48 Lakhs (south India) to ₹ 54 lakhs (North India) including Taxes. It is suggested to consider the same at ₹ 51 Lakhs/MW. (Vikram Solar)
- 11.1.5. The proposed cost may result into inferior quality plant. It is suggested to consider at ₹ 60 Lakhs/MW. (Hero Future Energies Private Limited)
- 11.1.6. The proposed cost may promote weaker low quality structures. Considering 25 years life span and wind speed it is suggested to consider ₹ 60 Lakhs/MW. (Federation of Indian Chambers of Commerce and Industry, Acme Solar Energy Private Limited)
- 11.1.7. It is suggested to consider ₹ 60 Lakhs/MW Ground Mount structures. (Tata Power Solar)
- 11.1.8. Cost of Module Mounting Structure should be considered at ₹ 70 lakhs/MW. For thin film, this cost should be considered at 15% higher. (Welspun Energy Limited)

- 11.1.9. It is suggested that the cost of Module Mounting Structure should be taken at ₹ 70 lakhs/MW. It is also suggested that for thin film, this cost should be considered 15% higher. (Association of Power Producers)
- 11.1.10. The proposed cost may promote weaker low quality structures. It is suggested to consider the same at ₹ 80 Lakhs/MW. (Larsen & Toubro Limited)
- 11.1.11. There is a reduction of 61.9% in the proposal against the norm considered for the previous year. (National Solar Energy Federation of India)
- 11.1.12. As per our extensive experience in execution of Solar PV project, for crystalline modules the module mounting structure cost- including design, manufacturing, supply, assembly and installation along with associated accessories and foundation, and shall range between ₹ 50-60 Lakh/MW depending on the configuration of structure, material type, tilt angle, type of foundation (with or w/o reinforcement) involved as per geographical and other atmospherically conditions of the site. Accordingly, the Commission is requested to consider ₹ 60 Lakhs/MW. It is suggested that for thin film modules such cost should be considered higher by ₹ 30-40 Lakhs/MW. (Juwi India Renewable Energy Pvt. Limited)
- 11.1.13. Considering rise in WPI/CPI index, cost of mounting structure should be appropriately increased. (Punjab Energy Development Agency)
- 11.1.14. It is requested to consider this cost at ₹ 105 Lakhs/MW considering that the iron and steel price have not changed significantly. (First Solar Power)
- 11.1.15. Land type and configuration differs across regions and have different requirement of concrete piling. Cost of mounting structures is also increasing due to increase in cost of material and must be considered at ₹ 110Lakhs/MW so as to accommodate inflation.(M/s Azure Power India Private Limited)
- 11.1.16. It is submitted that in the proposed norm veracity of such prices indicated by individuals need to be established before accepting the same. It is requested that there has been significant increase in iron, steel and other necessary material so that cost towards mounting structure may be considered as ₹ 115 Lakhs/MW (with escalation of 10% over previous year) or similar lines as followed in past. (Moser Baer Engineering and Construction Limited)

11.1.17. It is suggested to consider the same prices as given in 2013-14 period for ground mounting structure while finalising the benchmark capital cost for 2014-15. (NTPC Limited)

11.2. **Analysis and Decision**

11.2.1. The Commission had proposed the cost of Ground mount structure as ₹ 50 Lakhs/MW. Some stakeholders are in agreement with the Commission's proposal. Others have suggested costs in the range of ₹ 60 Lakhs to Rs.115 Lakhs/MW.

11.2.2. By considering suggestions/comments, we are of the view that the proposed cost of ground mount structure of ₹ 50 Lakhs/MW is in order.

12. CIVIL & GENERAL WORKS

12.1. **Comments received** - The comments/suggestions/objections received in respect of Civil & General Works are as follows:

12.1.1. We are in agreement with the Commission's proposal. (Elcomponics Technologies (India) Private Limited, Kemsolar Energy Consultants)

12.1.2. It should be between ₹ 19.3-22 Lakhs/MW Ac including Taxes. It is suggested to consider at ₹ 20 Lakhs/MW. (Vikram Solar)

12.1.3. Civil costs vary based on site conditions. Higher cost for sandy and black filled soil and optimum for hard soil. A practical estimate would be ₹ 50 Lakhs/MW. (Tata Power Solar)

12.1.4. It is proposed to consider it at ₹ 50 Lakhs/MW as usually waste land has natural constraint of vegetation growth, saline soil nature, sandy soil nature, rocky soil and excessive water flow streams etc. Therefore, associated land development cost is usually higher. Such cost is continued to grow up due to inflation in steel and cement. (Acme Solar Energy Private Limited)

12.1.5. The earth moving cost is a highly variable cost dependent on the land. In case of flat land this cost could be small. But as land is becoming scarce more and more projects are coming up in rocky and hilly terrain. This is significantly increasing the cost of earth moving. The foundation hole cost again depends on the land type. With soft sandy soils where the Soil SBC is low the required excavation depth is significantly higher. Also in rocky terrain there is need for special



foundations to be used resulting in higher foundation costs. The cost towards security for a land of 5 acres being manned 3 shifts and considering the experience in the past has significantly gone up. Also the cost of water for construction as they have to be bought by water tankers (since many states do not permit on site bore wells and many other locations the bore well water is of poor quality) means there is need for more cost for the same. (Acme Solar Energy Private Limited)

- 12.1.6. Considering higher labour cost and increase in material cost, it should be considered at ₹ 60 Lakhs/MW. (Abelon Clean Energy Limited)
- 12.1.7. These costs have not increased over a period of time. It will continue to rise due to inflation in steel and cement. Based on the industry experience we request to consider it at ₹ 60 Lakhs/MW. (Hero Future Energies Private Limited)
- 12.1.8. It is suggested that the cost of Civil & General Cost should be taken at ₹ 60 lakhs/MW respectively. It is also suggested that for thin film, this cost should be considered 15% higher.(Association of Power Producers)
- 12.1.9. Since many sites are in remote locations – getting skilled labours to work in those locations cost of construction equipment rentals and essentials for labour have significantly increased. Based on our project execution experience the Commission is requested to consider ₹ 65 Lakh/MW for the same. (M/s Juwi India Renewable Energy Pvt. Limited)
- 12.1.10. It should be considered as ₹ 85 Lakhs/MW. (Larsen & Toubro Limited)
- 12.1.11. Major cost components include cement and labour. Cost of cement came down by 4% during the year; however, labour cost has increased. It is requested to keep this cost component at ₹ 90 Lakhs/MW. (First Solar Power)
- 12.1.12. In the proposed norm, price escalation in Steel and Electrical Machinery and Wholesale Price Indices as considered in previous Orders. It is suggested to consider 5% escalation from previous year as ₹ 100 Lakh/MW. (Moser Baer Engineering and Construction Limited)
- 12.1.13. It should be considered as ₹100 Lakhs/MW. (Punjab Energy Development Agency)
- 12.1.14. It must be increased at ₹ 100 Lakhs/MW as the labour and material costs are increasing over the years must accommodate inflation over last years. (M/s Azure Power India Private Limited)

- 12.1.15. The waste or barren lands are most obvious choices for installation of ground mounted solar power plants. The waste land has the natural constraints such as saline/sandy soil nature, rocky terrain and sometimes excessive water flow out. In the light of the said, land development cost and associated cost is higher than what it seems. Therefore, it is suggested to review civil and general works cost. (National Solar Energy Federation of India)
- 12.1.16. As per discussion with EPC contractors during submission under JNNSM phase 2 batch-1 the cost under this comes to around ₹ 80-100 Lakhs/MW. As the prices of steel and cement have not reduced in recent times, WPI and CPI may be used to determine the benchmark cost. (Federation of Indian Chambers of Commerce and Industry)
- 12.1.17. It is suggested that such cost should be considered at ₹ 115 lakhs/MW and for thin film such cost should be kept 15% higher. (Welspun Energy Limited)
- 12.1.18. Since very little civil engineering work is involved. The ceiling of capital cost of Solar PV project should be restricted to ₹ 400 Lakhs/MW. (Mr. A. K. Datta, New Delhi)
- 12.1.19. It is suggested to consider the same prices as given in 2013-14 period for civil and general works while finalising the benchmark capital cost for 2014-15. (NTPC Limited)

12.2. **Analysis and Decision**

- 12.2.1. The cost associated with civil works includes testing of soil, preparation of soil/ground with all necessary works like earthmoving, digging holes for the foundations/pilings and levelling, fencing of the land, development of approach road, cable trenches, water supply arrangement in solar farm, control room etc. The General works include security of solar farm, setting up of power back-up generator; yard lighting, Earthling Kits, etc. The Commission has proposed the cost of Civil & General works as ₹ 40 Lakhs / MW.
- 12.2.2. Some stakeholders are in agreement with the Commission's proposal. One of the stakeholders has suggested that it should be between ₹ 19.3-22 Lakhs/MW including Taxes. Others have suggested costs in the range of ₹ 50 Lakhs/MW to ₹ 115 Lakhs/MW. Some of the stakeholders also submitted that due to presence of black cotton soil in western & southern parts of the country which is

unsuitable due to heavy water retaining capacity, there is a requirement of foundation systems which cost more as compared to rocky project sites in central & southern parts of the country requires drilling and anchoring. It is also submitted that the general contour of virgin soil will require ground leveling and it is a significant cost component in most projects as some project sites where contour level difference has been 15-20 meters from one side of the project to another side. It is also submitted that in some sites ground water table at 1 meter below ground level requiring heavier design of foundation for both module and buildings, adds to civil cost of the projects. Considering the above, the Commission has decided the cost of Civil & General Works as ₹ 60 Lakhs/MW.

13. POWER CONDITIONING UNIT (INVERTER)

- 13.1. **Comments received** - The comments/suggestions/objections received are quoted briefly as follows:
 - 13.1.1. We are in agreement with the proposed cost of Inverters. (Elcomponics Technologies (India) Private Limited, Kemsolar Energy Consultants)
 - 13.1.2. Proposed inverter cost at ₹ 50 Lakhs/MW is reasonable. (Abelon Clean Energy Limited)
 - 13.1.3. Inverter having capacity of less than or greater than 800kVA cost is around ₹ 50 Lakhs/MW including Taxes. We are in agreement with the Commission's proposal. (Vikram Solar)
 - 13.1.4. Taxes and duties on Inverters should be considered. (NSL Renewable Power Pvt. Ltd)
 - 13.1.5. Inverter cost should be considered at ₹ 55 Lakhs/MW considering overhaul/ replacement cost at 12th -14th year. (Larsen & Toubro Limited)
 - 13.1.6. Good quality inverters may not be available at a price lower than ₹ 60 Lakhs /MW. It is requested to consider the same. (Rudraksh Energy)
 - 13.1.7. Considering major overhaul /replacement in the 12th-14th year of operation, along with cost of SCADA and SMU, the benchmark cost should be revised to ₹ 60 Lakhs/MW. (Federation of Indian Chambers of Commerce and Industry)
 - 13.1.8. Most of the inverter needs a major overhaul/replacement in 12 to 14th year of operation. In order to ensure quality and availability, it is suggested that inverter

cost be taken at ₹ 60 lakhs/MW with the MW being the AC output capacity.
(Association of Power Producers, Welspun Energy Limited)

- 13.1.9. On an average Inverter prices ranges from 0.08 Euro/Wp to 0.10 Euro/Wp. This translates to an inverter pricing of ₹ 68 Lakhs/MW to ₹ 85 Lakhs/MW. Accordingly, the Commission is requested to consider, even on a conservative basis, the inverter price as ₹ 68 lakhs/ MW. (Renew Power Ventures Private Limited)
- 13.1.10. Inverter technology and market are more matured and prices are stable and have not seen a decline in the recent years. It is requested that an inverter cost of ₹ 70 Lakhs /MW be considered. (M/s Azure Power India Private Limited)
- 13.1.11. The Commission may revise the norm as ₹ 70 Lakhs/MW considering additional cost of metering, monitoring and remote data logging. (IL&FS Energy Development Company Limited)
- 13.1.12. Inverter also comprises transformer, iron parts and copper wires which has shown increasing trend. Considering depreciation of Rupees, escalation in metal price and need for replacement of inverters after 12/13 years, it should be considered as ₹ 70 Lakhs/MW. (Moser Baer Engineering and Construction Limited)
- 13.1.13. Inverter price should be considered at ₹ 75 lakhs/MW. (Rassi Green Earth Energy Private limited)
- 13.1.14. Additional cost for scheduling mechanism (SCADA and monitoring mechanism) at ₹ 15 Lakhs/MW should be considered. (Hero Future Energies Private Limited)
- 13.1.15. There is an additional component such as SCADA and monitoring system constituting additional cost of ₹ 12 to 15 Lakhs/MW. This has not been included in the cost at all. It is suggested to include this cost in the power conditioning unit. (National Solar Energy Federation of India)
- 13.1.16. Considering major overhaul /replacement in the 12th-14th year of operation, along with cost of SCADA and SRCBs, an additional cost of ₹ 12-15 Lakhs/MW should be considered. (Acme Solar Energy Private Limited)

13.2. **Analysis and Decision**

- 13.2.1. The Commission has proposed the cost of Power Conditioning Unit (Inverter) as ₹ 50 Lakhs / MW. Many stakeholders are in agreement with the Commission's proposal. Some stakeholders have suggested costs in the range of ₹ 55Lakhs to ₹ 75 Lakhs/MW.
- 13.2.2. Considering the comments received as well as taking cognizance of the cost of inverter available in the country, the Commission decided to retain the proposed cost of power conditioning unit as ₹ 50Lakhs/MW including all taxes & duties and major overhaul cost in the 12th-14th year of operation.

14. EVACUATION COST UP TO INTER-CONNECTION POINT (CABLES AND TRANSFORMERS)

- 14.1. **Comments received** - The comments/suggestions/objections received are quoted briefly as follows:
- 14.1.1. We are in agreement with the Commission's proposal. (Elcomponics Technologies (India) Private Limited, Kemsolar Energy Consultants)
- 14.1.2. Actual cost is around ₹ 55-60 lakhs/MW. Thus the cost should be considered as ₹ 58 Lakhs/MW. (Vikram Solar)
- 14.1.3. Evacuation cost up to interconnection Point may be considered at least 5% escalation from previous year i.e. ₹ 11 Lakhs/MW. (Moser Baer Engineering and Construction Limited)
- 14.1.4. It is requested to consider ₹ 70 Lakhs/MW as cost towards Cables and transformers. There are limited numbers of transformer manufacturers and due to high demand and long lead time prices have increased over a period of time. It has also been affected by increase in prices of raw materials viz. Metals. (M/s Azure Power India Private Limited)
- 14.1.5. It is requested to consider ₹ 70 Lakhs/MW as cost towards Cables and transformers. (Solar Energy Society of India)
- 14.1.6. It is requested to consider ₹ 75 Lakhs/MW considering evacuation cost from generation switchyard to Discom/STU sub-station. (Hero Future Energies Pvt. Ltd)
- 14.1.7. It is requested to consider at ₹ 80 Lakhs/MW as DC cabling upto inverter and entire ac cabling, transformer, VCB etc. should be included. It is suggested to

- consider ₹ 8-10 Lakhs/MW for SCADA systems depending upon size of the system. (Abelon Clean Energy Limited)
- 14.1.8. Expenditure towards cables and transformers should be considered at ₹ 85 Lakhs/MW. (Rassi Green Earth Energy Private limited)
- 14.1.9. The other associated costs for LT panels, HT panels, pooling stations, SCADA weather stations, control cables, auxiliary transformers, fire safety kits, earthing and lightning arrestors, peripheral lighting, tariff meters and CCTV etc. should also be considered. Hence total cost should be considered as ₹ 85 Lakhs/MW. (Tata Power Solar, Acme Solar Energy Private Limited)
- 14.1.10. Considering rise in WPI/CPI index, evacuation expenses should be appropriately increased. (Punjab Energy Development Agency)
- 14.1.11. Increase in the copper prices and switchyards at higher evacuation level results in increase in evacuation costs. It is suggested to consider the same at ₹ 90 Lakhs/MW. (Larsen & Toubro Limited)
- 14.1.12. Based on our project execution experience the Commission is requested to consider ₹ 90 Lakhs/MW for the same. (Juwi India Renewable Energy Pvt. Limited)
- 14.1.13. The reduction in copper prices has been about 8.75% and of aluminium prices is 16.1 %. Considering the cost reduction over last year price can be assumed to have weighted average reduction of 9.4%. It is requested to consider this cost at ₹ 95 Lakhs/MW. (First Solar Power)
- 14.1.14. It is submitted that costs of earthing system, lightning protection, illumination requirement, SCADA & FO cabling, telemetry system for real time monitoring, transmission system etc. are not considered under proposed cost. It is suggested that the cost of ₹ 110 lakhs/MW be taken as against the envisaged ₹ 60 lakhs/MW. (Association of Power Producers)
- 14.1.15. It is suggested that the cost of ₹ 126 lakhs/MW be taken as against the envisaged ₹ 60 lakhs/MW. (Welspun Energy Limited)
- 14.1.16. It is suggested to consider the same prices as given in 2013-14 period for evacuation cost upto inter-connection point (Cables and Transformers) while finalising the benchmark capital cost for 2014-15. (NTPC Limited)

14.2. **Analysis and Decision**

- 14.2.1. This expenditure includes costs towards DC cabling between Solar PV panels & Inverters including junction boxes, AC cabling between Inverter & sub-station, LT panels, HT panels, earthing arrangements, step up outdoor type transformer, breaker, current transformers, potential transformers, auxiliary transformers control cables, isolators, lightning arrestors, protection relays and Time of Day (ToD) meters/ tariff meters, peripheral lighting, telemetry system for real time monitoring etc..
- 14.2.2. The Commission proposed the cost of Cable and Transformer as ₹ 60 Lakhs/MW. Some of the stakeholders are in agreement with the Commission's proposal. One of the Stakeholders has submitted that the actual cost is around ₹ 55-60 Lakhs/MW and accordingly such cost should be considered as ₹ 58 Lakhs/MW. Others have suggested that such costs are in the range of ₹ 80Lakhs to ₹ 126 Lakhs/MW.
- 14.2.3. Considering the above, the Commission is of the view that the proposed cost of Cable and Transformer (evacuation cost up to inter-connection point) as ₹ 60 Lakhs/MW is reasonable and therefore decided to retain it.

15. **PRELIMINARY AND PRE-OPERATIVE EXPENSES, IDC ETC.**

- 15.1. **Comments received-** The comments/suggestions/objections received are quoted briefly as follows:
- 15.1.1. We do agree with the proposal. (Vikram Solar)
- 15.1.2. We are in agreement with the Commission's proposal of ₹ 60 lakhs/MW. (Elcomponics Technologies (India) Private Limited, Kemsolar Energy Consultants)
- 15.1.3. IDC and other pre-operative expenses would increase on pro-rata basis. (NSL Renewable Power Private Limited)
- 15.1.4. IDC needs to be considered at 10% instead of 5%. Financing cost needs to be considered at 2%. (Rassi Green Earth Energy Pvt. Ltd.)
- 15.1.5. Financing cost must be increased to 1.5% of the project cost and project management cost must be increased to 2.5% of the project cost as per current market prices. (Azure Power India Private Limited)
- 15.1.6. Such expenses should be kept at ₹ 75 Lakhs/MW. (Larson & Toubro Limited)

- 15.1.7. For Large companies, the preoperative expenses are lower and should be increased by ₹ 20 Lakhs/ MW. (Green Infra Limited)
- 15.1.8. It should be considered at 10 % of total cost of ₹ 67 lakhs/MW. (Abelon Clean Energy Limited)
- 15.1.9. We suggest to consider the percentages of capital cost for: Insurance Cost: 0.5%, Contingency: 3%, Interest during Construction (IDC): 9% per annum, Financing cost: 1% and Incidentals (including project management + pre-operative costs) : 3% (for expenses towards items like CTE, NOC for construction & buildings, NA conversion for land in some states, Electrical Inspector fees for drawings + electrical construction clearances etc) (Welspun Energy Limited)
- 15.1.10. Preliminary/preoperative expenses and financing cost: Financing cost needs to be considered at 2% of debt fund, project management cost should be considered at 1.5-2% of project cost and IDC at 8%. In addition contingency is higher due to local factors, higher transportation cost on remote locations. Considering the same proposed norm should be reconsidered.(Acme Solar Energy Private Limited, Federation of Indian Chambers of Commerce and Industry)
- 15.1.11. It may be considered as 10% of the corresponding project cost. (Moser Baer Engineering and Construction Limited)
- 15.1.12. Upfront financing cost should be considered at 1.5% of the debt amount instead of 1% of project cost and Preliminary / Pre-operating expenses and Financing Cost should be specified at ₹ 85.00 Lakh/MW.(M/s Juwi India Renewable Energy Pvt. Limited)
- 15.1.13. Other Charges: In the State like Rajasthan there is a grid connectivity charge of ₹ 2 Lakhs/MW and the State Nodal Agency is also charging ₹ 10 Lakhs/MW as development charges as per State Policy. These may also be considered. (Rudraksh Energy)
- 15.1.14. Labour Cost: The Commission has not made any provision of labour cost that will be incurred by the developers in setting up a plant. The same should be considered at ₹ 10 Lakhs/MW. (Solar Energy Society of India)
- 15.1.15. Following other costs need to be considered:
- (i) Almost 3% of module needs to be replaced every year for which approximate cost is 1.5% of the cost of project;

(ii) Cost of SCADA, Electronic Surveillance, cleaning and trenching have not been taken into account;

(iii) Civil works and evacuation of power are variable factors. (Solar Energy Society of India)

15.1.16. Considering rise in WPI/CPI index, preoperative expenses should be appropriately increased. (Punjab Energy Development Agency)

15.2. Analysis and Decision

15.2.1. The preliminary/pre-operating expenses include transportation of equipment, storage of equipment at site, insurance, contingency, taxes and duties, IDC and finance charges etc. The Commission has proposed such cost as ₹ 60 Lakhs/MW.

15.2.2. Many stakeholders are in agreement with the Commission's proposal. Considering the same, the Commission has decided that the cost of preliminary/pre-operating expenses shall be 10% of the total Capital Cost of the project.

16. DEGRADATION

16.1. **Comments received** - The comments/suggestions/objections received are quoted briefly as follows:

16.1.1. Cost of Degradation for 21 years works out to 10.5% i.e. ₹ 33.02 Lakhs and hence total module cost should be ₹ 334 Lkhs/MW. (Punjab Energy Development Agency)

16.1.2. Instead of allowing upfront increase in cost due to degradation, it may be considered to allow degradation while determining tariff. (Rudraksh Energy)

16.1.3. Module degradation should be considered for first three years as 2.8% (1st year), 0.8% (2nd year) and 0.8% (3rd year) (Vikram Solar)

16.1.4. From simplicity and practicability perspective, a pragmatic approach for capturing impact of degradation on tariff would be to consider reduced generation annually considering annual degradation of 0.5% from second year onwards. This approach is not only logical but also captures natural degradation process of reduction in generation of modules over the life of project. (Moser Baer Engineering and Construction Limited)

- 16.1.5. As per the opinion of various industry experts, crystalline silicon modules degrades annually at 0.7% p.a. to 0.8% p.a. while thin film modules degrades by around 2% in the first year and 0.7% p.a. thereafter, i.e. an average degradation of 0.75% p.a. Therefore, we request the Commission to consider an annual degradation of at least 0.7% per annum. (Renew Power Ventures Private Limited)
- 16.1.6. The module manufacturer gives Performance Guarantee as 1% annual degradation for first ten years and 0.66% per annum degradation for the next 15 years. It is very difficult to get a better schedule of performance warranty in the current market. It is requested to factor the annual degradation for Solar PV by way of reducing PLF every year instead of providing an additional Capex. Accordingly, the impact of degradation in terms of PLF for ₹ 71 lakhs/MW should be allowed instead of presently envisaged ₹ 10 Lakhs/MW. (Association of Power Producers, Welspun Energy Limited)
- 16.1.7. It is suggested that 0.5% deration factor from 2nd year onwards should be considered. (Tata Power Company Limited)

16.2. **Analysis and Decision**

- 16.2.1. The study carried out by the Commission, has revealed that normally manufacturers provide a guarantee with a definite margin of safety and for design purpose; therefore, a degradation percentage (lower than that guaranteed) can be employed. The quality of module is of immense importance. Therefore, it is safe to assume no degradation for the first three years and considering 0.5% degradation per year from 4th year to 25th year of operation. Further, it is found that the length of warranty period is continuously increasing, indicating increase in confidence among manufacturers, as they realize durable quality of their products, due to technology improvements and quality assurance practices.
- 16.2.2. The Commission based on the above referred study considered reasonable compensation for degradation due to ageing while determining generic tariff for FY 2014-15 as an additional 0.5 % of the modules cost every year after 4th year on notional basis.
- 16.2.3. Most of the stakeholders have suggested that the impact of degradation on tariff should be considered by reducing generation annually by 0.5% from second year

onwards. Since the RE Tariff Regulations do not provide norms for degradation, the Commission decided to consider module degradation as allowed in the past on notional basis based on the study carried out by the Commission as ₹ 11.29 Lakh/MW.

17. Analysis and Decision

17.1. The table below presents the breakup of benchmark capital cost norm for Solar PV projects for the FY 2014-15:

Sr. No	Components	Capital Cost Proposal ₹ Lakh/MW	Capital Cost considered ₹ Lakh/MW
	Module Cost in USD/Wp	0.54	0.59
	Exchange rate in ₹/USD @ average of last six months	60.00	62.00
1	Module Cost ₹ Lakhs/MW	324.00	365.80
2	Degradation in ₹ Lakhs/MW	10.00	11.29
3	Land Cost	18.00	25.00
4	Civil and General Works	40.00	60.00
5	Mounting Structure	50.00	50.00
6	Power Conditioning Unit	50.00	50.00
7	Cables and Transformers	60.00	60.00
8	Preliminary and operative expenses , IDC etc.	60.00	69.00
	Total Capital Cost	612.00	691.09

17.2. In view of the above, the capital cost of Solar Photo Voltaic power projects is arrived after rounding off at ₹ **691.00 Lakh/MW** as benchmark project cost of Solar PV projects for determination of tariff.

18. OTHER COMMENTS

18.1. **Consent of Forum of Regulators (FOR) and Central Advisory Committee(CAC)**

18.1.1. U/s 166 of the Electricity Act, 2003, Regulatory Forum is to make necessary review of the tariff order & other orders, highlighting, especially the efficiency improvements of the Utilities. Since the matter was not even discussed in the FOR and no truing up of previous period has been made, therefore the draft Regulations are illegal and is to be called back immediately. The draft Order should be discussed in the Forum of Regulators and in the CAC meeting and then to place before the public for discussion. (Mr. A. K. Datta, Mallika Sharma

Bezbaruah, Maharana Pratap Bagh Resident's Welfare Association, United Residents of Delhi, New Delhi)

18.2. Procurement of solar power through Competitive bidding only

18.2.1. Since the solar PV sector has not stabilized and cost of equipments not standardized, the bench marking norm need not be finalized. Bench Marking of Capital cost and Tariff Fixing of non-conventional energy is against provision of Section 63 of the EA 2003 and Clause 6.4(2) of the Tariff Policy. The proposed regulations are to be re-drafted considering all legal aspects & taking into consideration of National Tariff Policy. (Mr. A. K. Datta, New Delhi)

18.3. Information dissemination

18.3.1. There was neither any press advertisement for the comments/suggestions/objections nor any communication informing the Commission Order dt.07.01.2014 in petition to 353/SM/2013 & 354/SM/2013 by 31.01.2014. It is not right on the part of the CERC to ask for comment from Stakeholders and no information is disseminated. The only method of communication shall therefore be through publishing in the Newspaper. This aspect is repeatedly being overlooked by CERC. (Mr. A. K. Datta, New Delhi)

18.4. Analysis and Decision

18.4.1. The Commission has been taking up issues, as it considers necessary before FOR and CAC at regular intervals. The Commission follows a detailed and transparent process before issuing suo-motu Orders on determination of benchmark capital cost and tariffs for various renewable energy technologies as mandated under the RE Tariff Regulations. To start with, Orders are prepared for inviting comments/suggestions/objections from the stakeholders on determination of benchmark capital cost for solar projects and tariffs for various renewable energy technologies. Such Orders are then given publicity by uploading on the Commission's website for inviting comments and suggestions from the stakeholders. On receipt of the comments, open public hearings was held to discuss the issues threadbare. Based on the comments received and the discussions in the public hearing, the Commission has finalises the Orders. The Commission has followed the same process in past also for determination of benchmark capital cost for solar power projects and tariffs for various renewable energy technologies.

18.4.2. As regards requirement of competitive tariff under Section 63 of the Electricity Act and Tariff Policy. it is mentioned that the Electricity Act, 2003 under Section 79 assigns specific functions of the tariff fixation to the Central Electricity Regulatory Commission, among others, as under :-

a) to regulate the tariff of generating companies owned or controlled by the Central Government;

b) to regulate the tariff of generating companies other than those owned or controlled by the Central Government specified in Clause(a), if such generating companies enter into or otherwise have a composite scheme for generation and sale of electricity in more than one State;

18.4.3. The Commission exercises this power in conjunction with section 62 of the Act. Further, APTEL in its judgment dated 31.03.2010 in Appeal No. 106 & 107/2009 has held that "sections 62 and 63 provide two alternate methods/routes of power procurement by a distribution licensee from a generating company, where section 62 is the rule and section 63 is an exception". Pertinently, Clause 6.4 of Tariff Policy entrusts the responsibility on the Central Commission to frame guidelines for pricing of non-firm power especially from nonconventional sources for the cases when procurement is not through the competitive bidding process. Section 61 of the Act empowers the Commission to specify, by regulations, the terms and conditions for the determination of tariff in accordance with the provisions of the said section and the National Electricity Policy and Tariff Policy. In terms of clause (s) of sub-section (2) of section 178 of the Act, the Commission has been vested with the powers to make regulations, by notification, on the terms and conditions of tariff under section 61. As per section 178(3) of the Act, the Central Commission is required to make previous publication before finalizing any regulation under the Act. Thus as per the provisions of the Act, the Central Commission is mandated to specify, through notification, the terms and conditions of tariff of the generating companies covered under clauses (a) ,and (b) of sub-section (1) of section 79 of the Act after previous publication. In exercise of powers conferred under Section 61 read with Section 178 (2) (s) of the Electricity Act, 2003 (36 of 2003), the Commission framed the Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources)

Regulations, 2012 dated 6.2.2012. The Control Period specified was of five years ending on 31.03.2017.

18.4.4. Clause (1) of Regulation 8 of the RE Tariff Regulations provides that “the Commission shall determine the generic tariff on the basis of suo-motu petition at least six months in advance at the beginning of each year of the Control period for renewable energy technologies for which norms have been specified under the Regulations”. The Commission, in due discharge of the mandate under Regulation 8(1) of the RE Tariff Regulations has determined the generic tariff of the RE projects for the third year of control period (i.e. FY 2014-15). Moreover, the first proviso of the Regulation 5 of the RE Tariff Regulations provides that the Commission may annually review the benchmark capital cost norm for Solar PV and Solar thermal power projects. The Commission, in due discharge of the mandate under Regulation 5 of the RE Tariff Regulations determining the benchmark capital cost of solar power projects.

19. OTHER COMMENTS RELATED TO SOLAR PV PROJECTS WHICH ARE NOT RELEVANT IN CURRENT REGULATORY PROCESS

19.1. Debt: Equity Ratio:

19.1.1. It should be considered as 75:25.

19.2. Interest Rate on Debt:

19.2.1. Proposed draft order has considered an interest rate of the 12.75% on loan for Solar PV projects. All national/state level solar programs and incentives have created an ambitious and encouraging environment in the country. But on the contrary nationalized banks are not keen to offer loans to solar power developers at the normative rate. It is difficult to get the loan from banks at the rate 12.75%. Also interest rate must be specified at State Bank rate plus 600 basis points as even the best companies with excellent credit rating are unable to get the finance at 300 basis points. In our opinion, interest rate of 13.5% should be considered while determining the tariff. It should be considered at 13.5%. (Larsen & Toubro Limited)

19.3. **Interest Rate on Working Capital:**

19.3.1. Proposed draft order has considered an interest rate of the 13.20% for working capital purpose. In our opinion, interest on working capital should be SBI rate plus 600 basis points or 14% and the same should be considered while determining the tariff. (Juwi India Renewable Energy Pvt. Limited)

19.4. **Operation & Maintenance Cost**

19.4.1. The Solar Power system needs very little human effort to generate & supply power and hence the system needs auto match. O&M cost should therefore be restricted to ceiling of ₹ 1.00 lakh/MW/year. (Mr. A. K. Datta, New Delhi)

19.5. **Escalation rate**

19.5.1. Escalation rate should not be fixed for the control period. Change in CPI and WPI during previous year should be considered for determining the rate of escalation for next year.

19.6. **Cost of transmission lines:**

19.6.1. Cost of transmission lines should be considered at ₹ 25 lakhs/MW for 10 MW size projects. (Tata Power Solar)

19.6.2. Additional cost of ₹ 15 Lakhs should be considered for evacuation line. (Rudraksh Energy)

19.6.3. Cost of transmission lines should be considered at ₹ 25 lakhs/MW for 10 MW size projects. (Acme Solar Energy Private Limited)

19.6.4. We hope that costs of Right of Way (RoW) and transmission line have been included in the considered project costs. (Green Infra Limited)

19.6.5. It is suggested that the cost of power evacuation beyond interconnection point as ₹ 0.5 Cr./MW should also be considered in Capital Cost. (NTPC Limited)

19.7. **Auxiliary Consumption**

19.7.1. It is requested to consider Auxiliary Consumption at 0.25% of total energy generation. (First Solar Power)

19.7.2. It is suggested that 1% Auxiliary Consumption should be considered while calculating tariff as the solar PV based power plant having certain auxiliary loads such as air conditioning in inverter, control room and lighting room at night.(National Solar Energy Federation of India)

19.7.3. Auxiliary consumption needs to be considered. (Rassi Green Earth Energy Private limited)

- 19.7.4. It is suggested that auxiliary consumption of 0.5% should be factored in determination of tariff. (Tata Power Solar)
- 19.7.5. It is suggested that 1% Auxiliary Consumption should be considered. (Larsen & Toubro Limited)
- 19.7.6. For low capacity projects of 1-2 MW, auxiliary consumption of AC system, lighting, tube well and drainage etc. is very high in percentage terms and needs to be considered. (Punjab Energy Development Agency)
- 19.7.7. The Commission may consider Auxiliary Consumption norm as 1% of the energy generated. (IL&FS Energy Development Company Limited)
- 19.7.8. It is suggested that auxiliary consumption of 1% should be factored in determination of tariff. The Commission may consider norms adopted by RERC allowing 0.25% auxiliary consumption. (Tata Power Company Limited)

19.8. Capacity Utilisation Factor (CUF):

- 19.8.1. It is suggested that the CUF may be notified for across India from 16 to 19% with increment of 0.5% in CUF.(National Solar Energy Federation of India)
- 19.8.2. CUF degradation of 3% in year one and 1% for each year until the life of the plant need to be considered.(Rassi Green Earth Energy Private limited)
- 19.8.3. Zone wise CUF level need to be notified i.e.15%,16%,17%,18%,19% and 20%. (Larsen & Toubro Limited)
- 19.8.4. The CUF should be considered on Zone basis viz. 16%,17%,18% and19% in lieu of uniform 19% across India. (Solar Energy Society of India)
- 19.8.5. Since CERC tariff is norm for entire country, a more appropriate CUF figure of 18% may be adopted rather than considered 19%. Else, the country be divided into different zones (West / South/ North/ East) to represent different CUF tariffs. (Green Infra Limited)
- 19.8.6. It is suggested to map entire India into different Solar zones with different CUF. (Tata Power Solar)
- 19.8.7. The Commission may consider providing state wise CUF and State wise tariff may be determined by the Commission. (IL&FS Energy Development Company Limited)
- 19.8.8. We request to classify at least four different solar zones and derive corresponding tariffs based upon available radiation. (Hero Future Energies Private Limited)

- 19.8.9. It is suggested to specify norm and cost based on different solar zones, geographies and technology used. (Tata Power Company Limited)
- 19.8.10. Incident solar energy is not uniform over the country – the annual average Global Horizontal Irradiance (GHI) ranges from less than 3kWh/m²/day to more than 6 kWh/m²/day depending on the exact geographical location. The India Solar Resource Map prepared by the Solar Energy Center (now NISE) in association with NREL, USA available at MNRE website may be referred to in this regard. Since the power output of SPV modules is almost in direct proportion to the irradiance levels, the actual annual electricity generation from an SPV power plant or its CUF will depend on the solar radiation zone in which it is located. Accordingly, if a uniform benchmark tariff is fixed for all SPV power plants irrespective of their geographic location, plants located in higher solar radiation zones will have a higher CUF and be economically more viable than those in lower solar radiation zones. It is, therefore, felt that a graded solar tariff structure that is linked to the solar radiation zones, be adopted. This will facilitate solar power development in all parts of the country, rather than in only certain regions having high solar radiation that the developers find commercially more attractive. Tentative calculations in this regard for projects not availing AD are given in Appendix and a similar approach could be followed for those availing AD benefit.

Solar Zone	GHI (kWh/sq.m./day)		Estimated electricity generation (MU)/year			CUF (%)			Tariff (₹/kWh) for Solar PV
	Greater than	Less than or equal to	Greater than	Less than or equal to	Avg.	Greater than	Less than or equal to	Avg.	
Solar Zone-I		4.5		1.28			14.58		9.11
Solar Zone-II	4.5	5.0	1.28	1.46	1.37	14.58	16.67	15.63	8.50
Solar Zone-III	5.0	5.5	1.46	1.64	1.55	16.67	18.72	17.69	7.51
					1.66*			19.0*	6.99*
Solar Zone-IV	5.5	6.0	1.64	1.83	1.74	18.72	20.89	19.81	6.71
Solar Zone-V	6.0	6.5	1.83	2.01	1.92	20.89	22.95	21.92	6.06
Solar Zone-VI (if any)	6.5		2.01			22.95			5.79

*As per present Draft Tariff Order
(Ministry of New and Renewable Energy)

19.9. **Township Cost**

19.9.1. It is suggested to consider cost of township at ₹ 25 Lakh/MW. (Association of Power Producers)

19.10. **Discount Factor**

19.10.1. Appeal No. 225 of 2013 pertaining to Discount Factor computation by CERC is pending before Hon'ble APEL. In the meantime, the Commission may consider the Discount rate for bid evaluation for levelling the tariff for solar PV projects. (Moser Baer Engineering and Construction Limited)

19.11. **Two Part Tariff**

19.11.1. RE tariff for Solar PV and Wind must be made two part tariff in place of existing single part tariff. (Green Infra Limited, (IL&FS Energy Development Company Limited)

19.12. **Radiation risk as uncontrollable factor**

19.12.1. It is suggested to consider introducing provision of radiation risk as uncontrollable factor. The Commission may allow tariff revision on such projects retrospectively. (IL&FS Energy Development Company Limited)

19.13. **RLDC Charges applicable for Solar projects**

19.13.1. The Commission may consider waiver of RLDC Charges for solar projects connected through ISTS network.

19.14. **Analysis and Decision**

19.14.1. Although, the above comments are beyond the scope of the present proceedings before the Commission, the Commission has specifically noted the suggestion received from various stakeholders to specify CUF norms based on different solar zones. However, this would require amendment to RE Tariff Regulations. The incident solar energy is not uniform over the country and the annual average GHI ranges from 3 to 6 kWh/m²/day across the country. The Commission in the RE Tariff Regulations, 2012 specified normative CUF for wind energy projects for different Wind Zones based on Wind Power Density as per the Wind Atlas prepared by the Centre of Wind Energy Technology (CWET). On similar lines, the RE Tariff Regulations, 2012 need to be amended for specifying CUF for Solar PV projects based on different GHI band as per India Solar Resource Map prepared by the National Institute of Solar Energy (NISE) in association with

NREL, USA. The Commission directs the staff to initiate the process of amending RE Tariff Regulations in this regard.

19.14.2. The Solar PV projects has useful life of 25 years. Concerns have been raised that there are no standards for deferent items like ground mount structures etc. Instead, developers and installers manage the components of the value chain as they deem appropriate. This poses a challenge to assess the overall quality of a product, as there is no formal guarantee of the processes to which the various companies are adhering. The Commission directs the staff to initiate process towards developing such standards in consultation with the Ministry of New and Renewable Energy and propose suitable amendments in the Regulations for mandatory requirement of adhering such standards.

20. The Commission has analyzed the views/comments/suggestions received from the stakeholders on benchmark Capital Cost of Solar Thermal projects along with analysis and decision in the following paragraphs.

21. Direct Normal Irradiance (DNI)

21.1. Comments received

- 21.1.1. It is requested to consider the DNI as 1700 kWh/m²/year. (Rudraksh Energy)
- 21.1.2. Solar Resource Assessment: Solar assessment report has been jointly developed by the CWET, MNRE and GIZ where long term solar resource is determined at 1676 kWh/m²/year based on SARA ground data from Bodana village. (Acme Solar Energy Private Limited)
- 21.1.3. Since low DNI is observed by all developers, in order to provide a level playing field it is strongly recommended that a lower DNI value (CWET data) will be more appropriate for consideration of CERC. (Federation of Indian Chambers of Commerce and Industry)
- 21.1.4. CWET has put 51 stations at various locations. CERC may kindly consider the actual ground measurement data instead of estimated value considered i.e 1847 kWh/m²/year. (Godawari Green Energy Limited)
- 21.1.5. Since low DNI has been observed by Phase-I CSP developers, in order to provide a level playing field it is strongly recommended that a lower DNI value

of 1700 kWh/m²/year will be more appropriate for consideration of CERC. (KVK Energy Ventures Private Limited, Lanco Solar Energy Pvt. Ltd.)

21.2. Analysis and Decision

21.2.1. The solar resource from following different sources was considered in the proposal:

Source	NREL	CIEMAT	Meteonorm	NASA	Ground	CWET
Annual DNI (Kwh/m²/year)	2,084	1,847	1,794	2,044	1,893	1,678
Comment	02 - 07 average	TMY	Average	22 year average	2011	2012

21.2.2. The solar resource data of one of the CSP projects allocated in Phase I of JNNSM located in Western Rajasthan was estimated based on sophisticated satellite modelling developed by Spanish R&D organization under Spanish Ministry of Science & Innovation (CIEMAT) and ground measured data received from one of the developers, which was quality checked, compared with other satellite estimated data, corrected by the Linke Turbidity factor (a measure of the Aerosols and water vapour in the atmosphere). The Commission had proposed DNI of 1,847 KWh/m²/year for solar thermal projects based on this data.

21.2.3. The Direct Normal Irradiance (DNI) value of higher than or equal to 5 kWh/m²/day (i.e. ≥ 1825 kWh/m²/year) is widely considered in the literature to be the minimum for a solar thermal plant to be economically viable. The DNI data of 5 different sources has been obtained and reasonable DNI level of 1,847 KWh/m²/year has been considered minimal DNI for feasible solar thermal / CSP project for determination of Capital Cost of project and determination of Capacity Utilization Factor.

22. Separate Capital Cost norm for each Solar Thermal Technology

22.1. Comments received

22.1.1. The costs of parabolic trough technology have been taken as the base costs in CSP calculations. We submit that as all four technologies compete in CSP for the same project, for norms the costs of the technology that has maximum costs

should be considered. We opine to consider the costs of central receiver Tower type technology for CSP projects. (Green Infra Limited)

22.1.2. We suggest CSP projects with all four technologies should be considered for bench mark capital cost and the maximum costs should be considered. It is suggested that separate tariff should be pronounced for each technology. It is suggested that the costs of central receiver tower type technology for CSP projects should be considered for defining the cost. (National Solar Energy Federation of India)

22.2. Analysis and Decision

22.2.1. Parabolic Trough technology is proven with over 2,000 MW installation globally and considered to be fully commercially viable while cost data for the Power Tower, Fresnel and Dish Stirling technologies are in the process of being established in the country.

22.2.2. Therefore, available cost data of Parabolic Trough technology is considered for determination of benchmark capital cost norm for solar thermal projects for the year 2014-15. The Commission is of the view that solar thermal project developers should go for the most bankable solar thermal technology.

23. Project Cost

23.1. Comments received

23.1.1. Capital cost for Parabolic Trough may be considered as under:

Sr. No.	Capacity	DNI kWh/m ² /Year	Storage	No. of loops	CUF	Total Cost Rs. Crore/MW
1	100 MW	1732	0 hours	240	23%	15.98
2	100 MW	1732	4 hours	320	32%	19.98

23.1.2. Capital cost for CLFR technology may be considered as under:

Sr. No.	Capacity	DNI kWh/m ² /Year	Storage	CUF	Total Cost Rs. Crore/MW	Land (Acres)
1	100 MW	1800	0 hours	23%	11-12	500
2	100 MW	1800	4 hours	32%	14-15	700

(Federation of Indian Chambers of Commerce and Industry)

23.1.3. Capital cost for Parabolic Trough may be considered as under:

Sr. No.	Capacity	DNI kWh/m ² /Year	Storage	No. of loops	CUF	Total Cost ₹ Crore/MW
1	100 MW	1732	0 hours	250	23%	16.47

2	100 MW	1732	4 hours	320	34%	20.47
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- 23.1.4. Land requirement for 100 MW CSP plant with 4 hours of storage and CUF of 35% with DNI @1730 kWh/m²/year will be 1168 acres. (KVK Energy Ventures Private Limited)
- 23.1.5. The Commission has considered reference DNI of 1847 kWh/m²/year but while designing their solar fields but while designing solar fields by projects under JNNSM Phase-1 have considered 15-20% higher DNI i.e. around 2200 kWh/m²/year and CERC has used same design for optimum size of solar field (3,92,400 m²-120 loops) to derive Capital Cost. In view of above, solar field has to be increased by around 20%. Considering proportionate increase in solar field, HTF and piping (even without increase in BOP) the cost per MW increases to ₹14.55 Crore/MW. It is requested to revise Capital cost according to newly established plant to attract the good economic feasible proposal. The proposed benchmark tariff is very low for development of CSP projects in India. **(Abengoa Solar India)**
- 23.1.6. Land requirement: It is requested to consider 7 Acre/MW for 23% CUF and further 0.4 Acre/MW for every 1% increase in CUF. CSP project will require 36 to 42 months time and accordingly will call for EDC, IDC, cost of inter-connection with grid apart from contingences. Project cost should be considered as ₹ 17.8 Crore/MW to be considered with CUF of 23%. The cost of storage is still very high and will impact the cost estimation according to size of project. (Lanco Solar Energy Pvt. Ltd.)
- 23.1.7. It is requested to consider plant capacity for capital cost calculation as 50 MW as per output and not as per gross turbine nameplate rating which is inconsistent with CUF calculation. Accordingly, Capital cost may be increased by ₹ 13.2 Crore/MW. It is requested that typical CUF as per long term solar resource 1676 kWh/m²/year for plant capacity vs. Generation inputs should be considered for Capital cost and tariff calculation. (Acme Solar Energy Private Limited)
- 23.1.8. It is requested to consider plant capacity for capital cost calculation as 50 MW which is inconsistent with CUF calculation. Accordingly, Capital cost may be increased by ₹ 13.77 Crore/MW. Exchange rate of ₹ 62/USD and ₹ 83/Euro should be considered. The Commission should consider Preliminary and Pre-operative cost including IDC and contingency at 10% of the project cost.

- 23.1.9. Evacuation cost beyond ₹ 20 Lakh/MW beyond plant boundary should be considered. Land cost may be revised to ₹ 10 Lakhs/MW. Water system cost should be considered at 5% of total cost. Town ship cost of ₹ 25 Lakhs/MW should be considered. Taking all the above into account, the Capital Cost per MW be increased to ₹17.91 Crore/MW. (Association of Power Producers)
- 23.1.10. Different costs considered under various head like: HTF System, interconnection piping, site development cost are not matching with actual project cost incurred by us. Project cost and generation figures should be DNI indexed. Some of the cost like: preliminary and preoperative charges, IDC are not considered for solar thermal projects. Cost of laying raw water pipelines and transmission lines should also be considered. The Capital Cost per MW should be increased to ₹17.2 Crore/MW. (Godawari Green Energy Limited)

Preliminary and preoperative charges, IDC etc.

- 23.1.11. Many stakeholders have suggested that some of the costs like: preliminary and preoperative charges, IDC are not considered for solar thermal projects. It is suggested to consider the same at 10% of the total Capital cost.

Gross capacity v/s Net Capacity

- 23.1.12. Some of the stakeholders suggested that the plant capacity for capital cost calculation should be considered at 50 MW as per output and not as per gross turbine nameplate rating of 55.55 MW. Accordingly, the Capital Cost of the project should be considered at ₹ 13.2 Crore/MW.

23.2. Analysis and Decision

- 23.2.1. One of the stakeholders (Godawari Green Energy Limited) has suggested higher capital cost for solar thermal projects. Cost of solar field is based on 120 loops (similar to Godavari project) for 55 MW (gross capacity) / 50 MW (Net Capacity) at ₹ 12.00 Crore / MW. A comparison of Capital Cost as considered by the Commission and the Capital Cost as per M/s Godawari Green Energy Limited (GGEL) is as under:

Capital cost as proposed in the Order dated 7.1.2014

CAPITAL COST AS PROPOSED BY THE COMMISSION					
Particulars	Unit	Rate	No.		
Plant Capacity	MW	55.55			
Euro conversion	₹/Euro	76.55			
US \$ conversion	₹/\$	60			Cost in Rupees
Loops	\$/loop	5,50,000	120	Loop	3,96,00,00,000
HTF System	\$/m2	70	392,400	m2	1,64,80,80,000
Interconnect piping	\$/m2	10	392,400	m2	23,54,40,000
Turbine	Euro/kW	120	55.55	MW	51,02,82,300
BOS	₹/MW	8,000,000	55.55	MW	44,44,00,000
			Sub Total		6,79,82,02,300
Land	₹/Acre	200,000	350	Acre	7,00,00,000
Site development	₹/Acre	50,000	350	Acre	1,75,00,000
TOTAL COST				In Rs.	6,88,57,02,300
Cost / MW				₹ / MW	12,39,55,037
Cost / MW				₹ Crores/ MW	12.39

CAPITAL COST SUGGESTED BY M/S GODAWARI GREEN ENERGY					
Particulars	Unit	Rate	No.		Total
Plant Capacity	MW	55.55			
Euro conversion	₹/Euro	86.26			
US \$ conversion	₹/\$	63.10			Cost in Rupees
Loops	\$/loop	5,35,673.9	120	loop	4,05,61,22,632
HTF System	\$/m2	33.79	392,400	m2	83,54,93,372
Interconnect piping	\$/m2	0.55	392,400	m2	1,36,14,172
Turbine	\$/kW	4,86,650.99	50	MW	1,53,53,83,606
BOS	₹/MW	1,35,225.7	50	MW	42,66,37,160
			Sub Total		6,86,72,50,943
Land	₹/Acre			Acre	
Site development	₹/Acre	8,96,213	400	Acre	35,84,72,943
EPC & other cost					1,37,92,41,057
TOTAL COST					8,60,49,77,261
Cost / MW				₹ / MW	17,20,99,545
Cost / MW				₹ Crores/ MW	17.2

23.2.2. CERC cost projections of major project components “match” Godavari’s project costs. From the above comparison, it appears that the cost of main items like Loops, Heat Transfer Fluid (HTF) system, interconnect piping, turbine, generator and balance of system, considered by the Commission and GGEL are almost same.

- 23.2.3. Overall cost differences are found in (i) Cost of land, (ii) Cost of site development, (iii) Additional EPC cost, (iv) Cost of transmission line, (v) Cost of infrastructure for water required for steam turbine
- 23.2.4. The Cost of land is not considered by the GGEL. On the other hand cost of site development considered by the GGEL is on higher side. It is almost 4 times higher than the land cost considered by the Commission. It appears that it includes cost of infrastructure for water required for steam turbine.
- 23.2.5. The Commission is of the view that there is enough scope for reduction in major project components like loops, HTF system, turbine, generator, structure etc. Even considering the cost of infrastructure for water required for steam turbine i.e. storage pond and piping cost as well as preliminary and preoperative charges, IDC etc., the total project cost per MW would be around ₹ 12 Crore/MW.
- 23.2.6. Regarding comments received from the stakeholders for higher normative cost for solar thermal project with storage, the Commission is of the view that storage increases the capital cost further but also increases electricity generation. The Commission is of the view that the Solar Thermal project developers should go for the least LCOE technology including storage system.

Transmission cost

- 23.2.7. Regarding comments received on transmission cost, the CERC RE Tariff Regulations, 2012 inter alia define the term “interconnection point” and the proposed capital cost has been calculated by factoring in the cost upto this point. Responsibility of evacuation beyond the “interconnection point” rests with concerned transmission /distribution licensee as the case may be. Therefore, the Commission has not considered such cost in the benchmark Capital Cost of solar thermal projects. Accordingly, the Commission decided to retain the project cost as proposed in the Order at ₹ 12 Crore/MW for determination of tariff.

Gross Capacity v/s Net capacity

- 23.2.8. For the purpose of estimating the yield and capital cost, following parameters were considered for a Solar Thermal Project based on parabolic trough technology

Yield Estimation

Yield (Electricity Output)	Particulars
Turbine nameplate capacity	55.55 MW
Loops	120
Storage (hours)	0
CUF (%)	23.60%
Gross Generation (MUs)	114.84
Auxiliary Consumption	10%
Net Generation (MUs)	103.27

23.2.9. It is important to point out that in CSP technology, unlike PV projects, the size of the solar field (expressed in terms of “number of loops”) determines the yield, project cost and capacity utilization factor (CUF). We have considered the yield, costs and CUF based on an optimal design which in turn was based on the solar resource. In the RE Tariff regulations-2012, CUF of 23% has been specified. The Commission has therefore considered capital cost for a 55.55 MW plant based on the solar field size of 392400 m² in determination of benchmark capital cost while maintaining CUF of 23.6%. The Gross capacity of 55 MW also includes Auxiliary consumption.

24. ADDITIONAL POINTS FOR CONSIDERATION WHICH ARE NOT RELEVANT TO THE CURRENT REGULATORY PROCESS

24.1. Use of Fossil Fuel

24.1.1. The Commission is requested to allow 15% gas use to increase efficiency and lower the generation cost of Solar. The Commission may allow separate tariff for electricity generated from solar steam fed into normal operating power plant and upto 75% of biomass/coal use to reduce risk of project, increase efficiency, reduce grid fluctuation and optimise the use of capital in power generation. (Federation of Indian Chambers of Commerce and Industry)

24.1.2. The 90% of operational large size CSP plants across the globe are based on Parabolic Trough Technology. These plants are allowed fossil fuel (Natural Gas) backup to the extent of 15-30% for sustained operations. (KVK Energy Ventures Private Limited).

24.1.3. The Commission is requested to allow 15% gas use to increase efficiency and lower the generation cost of Solar Thermal Power Plant. (Abengoa Solar India)

24.1.4. The Commission may suggest capital cost benchmarks solar steam hybridized with fossil fuel or biomass and allow upto 75% of biomass/coal use to reduce risk of project, increase efficiency, reduce grid fluctuation and optimise the use of capital in power generation. (Acme Solar Energy Private Limited)

24.1.5. 90% of operational large size CSP plants across the globe are based on Parabolic Trough Technology. These plants are allowed fossil fuel (Natural Gas) backup to the extent of 15-30% for sustained operations. (Lanco Solar Energy Pvt. Ltd.)

24.2. **Auxiliary Consumption**

24.2.1. Auxiliary Consumption of actual running plant of Godawari is in the range of 12-15% depending on the time of the year. (Godawari Green Energy Limited)

24.2.2. Solar Thermal Plant requires daily start and stop operation due to unavailability of the source of energy in the night. Considerable start-up power has been drawn from the grid which is later adjusted from the generation of the plant on kWh to kWh adjustment basis. Hence, start-up power must be part of Auxiliary Consumption. It is requested to consider 3% additional in the head of Auxiliary Consumption for drawing from the grid during daily start and stop operation. (Abengoa Solar India)

24.3. **Capacity Utilization Factor (CUF)**

24.3.1. Estimated CUF would be around 21%. Actual data of M/s Godawari Green Energy can be considered. (Rudraksh Energy)

24.3.2. SAM Model considers constant HTF temperature from evening to next morning, whereas in practice it drops by 80-120 during the time. A 10-12% reduction in generation value has to be considered from what SAM predicts and accordingly CUF is to be considered. (Godawari Green Energy Limited)

24.3.3. In order to achieve 23% CUF larger field size is required due to lower DNI values in India. (KVK Energy Ventures Private Limited)

24.3.4. The Commission has considered 100% availability of plant and 100% availability of grid. We believe this is impossible to maintain as plant need to be shut down for routine and annual maintenance and same will be implied to availability of grid too, which decreases the CUF. Further, annual plant

performance degradation of 0.5% per year upto maximum of at least 6% over 25 years due to turbine degradation and absorber degradation and heat exchanger fouling must be taken into account. It is requested to consider CUF of 18% during stabilization period and 20% for one year of operation after stabilization period and 23% from thereafter. (Abengoa Solar India)

24.3.5. The Commission should consider revising CUF from 23 to 20%. Degradation in CUF of 1% should also be considered. (Association of Power Producers)

24.4. Allowing installation of Solar PV Plant

24.4.1. The Commission may consider installation of Solar PV Plant (10% of rated capacity of CSP Plant) to cover parasitic or night operation of the plant which will improve viability and economic interest for developers. (KVK Energy Ventures Private Limited)

**Sd/-
(Neerja Mathur)
Member (E.O.)**

**Sd/-
(A. K. Singhal)
Member**

**Sd/-
(M. Deena Dayalan)
Member**

**Sd/-
(Gireesh B. Pradhan)
Chairperson**

New Delhi
Dated the 15th May, 2014

