

CENTRAL ELECTRICITY REGULATORY COMMISSION

New Delhi

Petition No. SM/005/2015(Suo-Motu)

**Coram: 1. Shri Gireesh B. Pradhan, Chairperson
2. Shri A. K. Singhal, Member
3. Shri. A.S.Bakshi, Member**

Date of Hearing: 19.03.2015

Date of Order: 31.03.2015

Order

Determination of Benchmark Capital Cost Norm for Solar PV power projects and Solar Thermal power projects applicable during FY 2015-16

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 FY 2012-13.
3. The first proviso of Regulation 5 of the RE Tariff Regulations, 2012 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 3rd March, 2015, proposed to determine the Benchmark Capital Cost Norm for Solar PV power projects and Solar thermal power projects for the year 2015-16 (Petition No. 005/SM/2015) and invited comments/suggestions /objections from the stakeholders. Public Notice was issued

inviting comments/suggestions/objections on 3rd March, 2015. Last date of submission of comments/suggestions/objections was 18th March, 2015.

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

- 1 Punjab Energy Development Agency (PEDA)
- 2 Himachal Pradesh Electricity Regulatory Commission (HPERC)
- 3 Orient Green Power Company Limited
- 4 Essel Infra Projects Ltd.
- 5 Root Hydrocarbons Limited
- 6 Shri. Saumendra Aggarwal
- 7 JITF Urban Infrastructure Ltd.
- 8 Federation of Indian Chambers of Commerce and Industry (FICCI)
- 9 IL&FS Energy Development Company Limited
- 10 HERO Future Energies Pvt. Ltd.
- 11 Vikram Solar Private Limited
- 12 WAAREE Energy Limited
- 13 Jindal Power Limited
- 14 Association of Power Producers (APP)
- 15 UJAAS Energy Limited
- 16 Inox Wind Limited
- 17 Green Infra Limited
- 18 Adani Power Limited
- 19 NTPC Limited
- 20 Maha Cogen Green Power Producers Association
- 21 Green Energy Association (GEA)
- 22 Cogeneration Association of India
- 23 Hindustan EPC Company Limited
- 24 Chhattisgarh State Power Distribution Company Limited (CSPDCL)
- 25 ACME Solar Energy Limited
- 26 Rudraksh Energy
- 27 Welspun
- 28 Tata Power Company Limited

6. Subsequently, a public hearing was held on 19th March, 2015 and the following stakeholders made submissions during the hearing:

- 1 ACME Solar
2. UJAAS
3. Green Energy Association

7. The Commission has considered the comments/suggestions/objections received from the stakeholders on benchmark Capital Cost of Solar PV projects and has decided as under:-

Consideration of the views of the stakeholders and analysis and findings of the Commission on important issues

I. Solar PV

A. Module Costs:

- Domestic Manufacturing prices should also be considered (**PEDA, HERO Future Energies Pvt. Ltd. IL&FS Energy, WAAREE**)
- Average trading price should be considered (0.59 US\$ for Crystalline and 0.62\$ for Thin Film)
- Freight & Insurance costs should also be considered (**HERO Future Energies Pvt. Ltd.**)
- Currently, the average Landed Cost of Module in India including the Sea and Inland Freight from Global Tier I Suppliers (As it is a statutory Requirements of Banks & Multi-Lateral Institutions to purchase Modules from Tier I suppliers with proven “Performance Track Record and Technology”) ranges from .55 to .60 USD/Wp with an average of around .57 USD/ Wp.
- In India, severe PID issues have been observed in the existing plants and a degradation of upto 30% has been observed due to severe climatic conditions in India. To counter this, most of the suppliers have upgraded the Bill of Materials to reduce this effect increasing the cost of the product.
- Despite the above mentioned material cost escalation, in the coming year 2015-16, as per the Technology Improvement Road Map and Cost Reduction Road Map from Tier I suppliers the expected reduction in the prevailing price is estimated to be maximum .01-.02 USD/Wp which is likely to bring down the cost band to .54 - .58 USD/Wp with an average of .56USD/Wp for the Module suitable for Indian climate.
- Also, the average of daily Exchange rate data available at RBI for the period starting from January 01, 2015 till March 18, 2015 is 62.20/USD and is expected to further increase.
- Hence it is requested to consider the exchange Rate of at least INR 62/ USD. (**ACME**)
- Module costs calculated are for DC capacity of 1 MW. Should be calculated for achieving 1 MW AC capacity, which should be 1.1-1.15 times of DC capacity. (**Rudraksh**).
- Average Trading prices should be considered. (**Hindustan Power**)

- Prices should be; 0.70 US\$/ Wp for Domestic Modules and 0.60 US\$/ Wp for Foreign Modules to factor in price for Domestic Manufacturers, Cost of better quality modules. Moreover, as the Solar modules are imported and prices quoted above are on CIF basis, additional \$0.02/Watt may also be considered to cover inland transportation over and above the quoted prices. **(Renew Power)**
- Hon'ble CERC has considered 0.52 US\$/ Wp as module price and Rs. 61.06/ US\$ as exchange rate. It may be noted that the module price considered is at the lowest end of the price spectrum of modules even as per data quoted by the Hon'ble CERC. Even the Chinese, Taiwanese module spot prices depicted in the report is higher than that considered by the Commission. While the considered module prices do not reflect the existing situation, it also does not promote sourcing quality products from Tier 1 manufacturers and which would be needed to generate reliable power over a period of 25 years. Considering the average of latest traded price , we request the Honorable CERC to consider \$0.595 per Wp at present as the benchmark price for foreign modules used in the country for capex calculation instead of \$0.52 per Wp taken by the Honorable CERC. Considering the mandated domestic content based projects to come up in the country the Honorable CERC may consider the cost of Indian made modules and cells to be 15-18% higher than the average of the Chinese module costs. It is suggested that the cost of Indian made modules and cells to be 17% higher than the average of the Chinese module costs; making cost of Indian modules to be \$ 0.69 per watt. Moreover, as the Solar modules are imported and prices quoted above are on CIF basis, additional \$0.02/Watt may also be considered to cover inland transportation over and above the quoted prices. **(Welspun)**
- Project cost should be considered as Rs.6.52 Cr/MW. **(Jindal Power)**
- Good quality imported modules not available at 52 cents **(WAREE)**
- Allocated cost in modules like third party insurance, freight, customs, PID free additional charges not considered. **(WAREE)**
- Benchmark cost for Domestic Content Requirement projects should be formulized separately **(WAREE)**
- While all other RE technology costs are indexed and increased only Solar projects costs have been decreased, this will create irreparable damage to growth of this technology. Reduction in capital costs will lead to compromise of material and quality. **(Green Energy Association)**
- As per present market prices the cost of modules are as per following table **(Green Energy Association, UJAAS)**

Module Type	Basic price including freight upto Indian port (US\$/WP)	PID free, Ammonia ,Salt and Mist compliant (US\$/WP)	Third party insurance like Munich re (US\$/WP)	Cost and charges at Indian port	Freight from Indian port to site (US\$/WP)	Transit insurance (US\$/WP)	Total (US\$/WP)
Imported	0.54	0.01	0.01	0.01	0.01	0.0075	0.5875
Domestic Modules with domestic cells	0.68				0.01	0.0075	0.6975
Domestic modules with imported Cells	0.6	0.01			0.01		0.6275

- Module price should be considered at USD 0.56. (**Jindal power**).
- Module cost should be \$0.64 per Wp.
- Domestic costs should be 17% higher. (**Association of Power Producers**)
- Capital cost should be Rs. 650 lakhs/MW (**Green Infra**)
- Capital cost should be Rs. 685.69 Lakhs + 1 Cr. more for domestic (**Vikram Solar**)
- Module cost should be 1.16 times to consider conversion of DC Module capacity end to AC Contracted Capacity. (**Adani**)
- Module price should be 0.619 USD/Wp and Capital cost should be 691.09 (**NTPC**)

B. Exchange Rates

- Should be considered as 62 (INR to USD) as per recent rates. (**Rudraksh**)
- We suggest that while arriving exchange rate, forward currency market rate should be considered for arriving at conversion of module prices in INR terms. It is suggested that the exchange rate for USD/ INR be taken as INR 65.43/USD. (**Renew Power**)
- We suggest the currency future market data from NSE be taken as the basis for determination of benchmark exchange rates for future procurement for the following

reasons: a) NSE currency market is used by most of institutions/corporate for hedging purposes to manage their currency risk. b) Most of the procurement activity will happen from the period commencing September 2015 after the financial closure timelines of bids happening today. Since most of the procurement (including those for JNNSM Phase-II and various ongoing state bids) is going to commence from September, 2015, it is suggested that the exchange rate for USD/ INR be taken as Rs. 65. Similar analysis may be carried out for the exchange rate for Euro/INR. **(Welspun)**

- Present rupee to dollar price is Rs.63 and no hedging cost has been considered. **(WAAREE)**
- Module price should be considered at USD 0.56. Conversion rate for USD to INR should be considered as 1 USD = Rs.62.5. **(Jindal power Ltd.)**
- Should be for the month prior to bidding or at forward market prices **(Adani)**

C. Efficiency Degradation

- Efficiency Degradation should be 20% over 25 years and capitalization towards the same should be 33 Lakhs/MW. **(PEDA)**
- Addition of modules at 0.5% every year is impractical, degradation in performance at 0.7% per year as guaranteed by manufacturers should be considered. **(Rudraksh, Hindustan Power, Welspun)**
- Degradation should be 2.5% for first year and 0.7% thereafter. **(Hindustan Power)**
- Degradation warranties offered by the manufacturers are from the first year and we have in the past got manufacturer guarantees of 1% annual degradation for the first 10 years and 0.66% p.a. degradation for the next 15 years. This is equivalent to an annual degradation of around 0.8% annually and the same may as well be adopted by the Hon'ble Commission. This is equivalent to an additional module capacity of 200 kW for every MW of project. **(Welspun , Renew)**
- Degradation cost should be 60-70 lakh/MW **(Association of Power Producers)**

Analysis and Decision

At the time of proposing the module cost, the prevailing module cost (lowest) was in the range of 0.54 USD/Wp. The Commission proposed module cost at 0.52 USD/Wp for FY 2015 - 16 on the assumption that the tariff being proposed is for future year when the module price would further decline. As per PV insight report for March 18, 2015 the weekly spot prices are tabulated as follows;

Solar PV Module Weekly Spot Price

Item	High	Low	Average	AvgChg	AvgChg %
Poly Silicon Solar Module	0.85	0.49	0.589	↓-0.003	↓-0.51%
Thin Film Solar Module	0.81	0.49	0.624	↓-0.002	↓-0.32%

Above referred spot market prices show that the module prices have witnessed a declining trend as projected by the Commission. The stakeholders on the other hand have suggested the prices might rise in future and the prices fluctuate based on season. The stakeholders have also requested for increasing the module price with due consideration of the factors like prices difference between domestic and imported modules, incidental expenses like freight, insurance etc. The Commission has duly considered all relevant factors including the competing and counter-balancing demands dictated by the available prices trends and concerns of stakeholders about future trends and has decided to retain the module cost of 0.52 US\$/Wp for determination of benchmark capital cost of Solar PV for FY 2015 - 16 which is inclusive of custom clearing charges, transportation and unloading, and cost towards quality compliance.

Average exchange rate for Rupees to US\$ for the past six months (20th September 2014 to 19th March 2015) as per RBI is ₹ 62.05. The Commission has decided to take this rate for FY 2015-16.

Considering the Exchange Rate at ₹ 62.05/US\$ & module cost at US\$ 0.52/Wp, the Commission hereby determines the module cost at ₹ 322.66 Lakh/MW for FY 2015-16.

The Commission has found that normally manufacturers provide a guarantee with a definite margin of safety and design purpose; therefore, a degradation percentage (lower than that guaranteed) can be employed. The quality of module is of immense importance. 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.

The Commission based on the above analysis considered reasonable compensation for degradation due to ageing while determining generic tariff for FY 2015 - 16 as an additional 0.5 % of the modules cost every year after 4th year on notional basis.

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 Rs 9.69 Lakh/MW . Accordingly, the Commission determines the total module cost at ₹ 332.35 Lakh/MW.

D. Land Cost:

- Land cost should be Rs. 125 Lakh/MW (**PEDA**)
- Land cost should be Rs. 27.5 Lakh/MW (**IL&FS**)
- Land, being a State issue, has different cost and acquisition timelines/ formalities associated with it depending upon the relevant procedures of the state and the type of land and demography. A developer may find land @ INR 25-30 Lac/ MW in Andhra Pradesh but he might find difficulty in obtaining land in states like Haryana, Punjab, Uttarakhand and Bihar where the land rate vary from 50-100 Lac/ MW.
- For promoting technologies like motorized Trackers, Seasonal Tilt, and Thin Film, etc. the land area should be 5.5 Acres/MW.
- Also, Land being a State issue, has different cost and acquisition timelines/ formalities associated with it depending upon the relevant procedures of the state and the type of land and demography. A developer may find land @ INR 30-35 Lac/ MW in Andhra Pradesh but he might find difficulty in obtaining land in states like Haryana, Punjab, Uttarakhand and Bihar where the land rate vary from 50-80 Lac/ MW. Hence the average Land price prevailing is around 40%-50% higher than the price considered in draft order which includes various expenditure like NA, Local Gram Panchayat fee, etc.
- Hence, CERC is requested to reconsider the land price as per market condition and revision in land acquisition act and revise the Cost of Land to INR 40 Lakh/MW.(**ACME**)
- As per development cost estimates from various Government agencies, total land costs should be Rs. 1.20 Cr/MW (**Hindustan Power**)
- The land cost under consideration by the Hon'ble Commission should take into account the increase in land cost due to The Right to Fair Compensation & Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. The Commission has only taken a modest 5% increase in land costs over the previously approved costs, which is not sufficient to match the increase in costs owing to the change in law. Also land close to existing evacuation infrastructure has become pricier owing to limited evacuation facilities currently available. Thus in our opinion the cost of land must be atleast 8 Lakhs/acre and considering 5 Acres per MW the land cost comes out as 50 Lakhs/MW. (**Renew Power**)
- For promoting technologies like motorized Trackers, Seasonal Tilt, and Thin Film, etc. the land area should be 6 Acres/MW. Land Cost should incorporate the hike due to The

Right to Fair Compensation & Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. (**Welspun**)

- Private land cost and registration charges have gone up. Hence it should be increased. (**WAREE**)
- Land requirement for Thin film is 7 Acres/MW against 5 Acre/MW Crystalline, Considering a constant value of Rs. 25 Lakh/MW for all projects will lead to loss for the projects opting for thin film modules. (**Adani**)
- Land cost should be Rs. 100 lakh/MW. (**Association of Power Producers**)

Analysis and Decision

The Commission has proposed the land requirement of 5 Acre/MW for crystalline PV project and its cost was considered as Rs. 25 Lakhs / MW. Stakeholders have suggested land costs in the range of Rs. 25 to Lakhs/MW to Rs. 125 Lakhs/MW.

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, and with increase in the average module efficiency, the land required for the crystalline PV project has reduced. Therefore, the Commission decided to retain the proposed land cost at Rs. 25 Lakh/MW (Rs. 5 Lakh/Acre * 5 Acre/MW) for Solar PV projects.

E. Power Conditioning Unit Cost

- Should be considered at Rs. 70 Lakh/MW (**IL&FS**)
- The range of prices of inverters available in market is Rs. 45 Lakhs to Rs 70 Lakhs per MW. Besides, most of the inverter needs a major overhaul/replacement in 12th to 14th year of operation. Monitoring system, SCADA & SRCBs, Weather stations, junction box have not been considered in the cost at all. Additional cost of about Rs. 12-15 Lakh / MW shall also be considered for the same. Requesting Hon'ble Commission to benchmark price of PCU at approx. INR 60 Lakh/MW. (**ACME**)
- Should be considered at Rs. 65 Lakh/MW, including cost of major overhaul in 13th year, based on increase in metal prices, Exchange rate and quotations received from vendors. (**Hindustan Power**)
- On an average Inverter prices ranges from 0.08 Euro/Wp to 0.10 Euro/Wp. This translates to an inverter pricing of INR 68 lakhs/MW to 85 lakhs/MW. Accordingly, the Hon'ble Commission is requested to consider, even on a conservative basis, the inverter price as INR 68 lakhs/ MW. (**Renew Power**)
- Inverters from reputed manufacturers are available in the range of Rs. 55 – 70 lakhs/ MW. To ensure quality and availability, it is suggested that inverter cost be taken at Rs.

60 lakhs/ MW with the MW being the AC output capacity (at the receiving substation). It is important that the inverter capacity is pegged to the output capacity rather than the installed DC capacity. Another reason for a higher benchmark is that most of the inverter needs a major overhaul/ replacement in 12th to 14th year of operation. (**Welspun**)

- Cost for system and service for proper monitoring, forecasting and scheduling should be included in Capital costs. (**Green Energy Association, WAAREE**)
- Inverter cost should be considered at Rs.50 lacs/ MW. (**Jindal Power**)

Analysis & Decision

The Commission has proposed the cost of Power Conditioning Unit (Inverter) as Rs 45 Lakhs / MW. Some stakeholders have suggested costs in the range of Rs. 50 Lakhs to Rs. 85 Lakhs/MW.

Considering the comments received as well as taking cognizance of the cost of inverter available in the country, the Commission has decided to retain the proposed cost of power conditioning unit as Rs. 45 Lakhs/MW including all taxes & duties and major overhaul cost in the 12th - 14th year of operation.

F. Auxiliary Consumption:

- Should be taken into consideration. Earlier order considered effect of efficiency degradation and Auxiliary consumption in capital cost to the effect of 0.7%. (**PEDA**)
- Should be taken into consideration at 1%. (**IL&FS**)
- Auxiliary power consumption should be 2%. (**Association of Power Producers**)

Analysis and Decision

From the experiences of JNNSM phase I, it has been observed that auxiliary consumption is very miniscule in the case of Solar PV power plant. Therefore, the Commission has decided not to consider auxiliary consumption.

G. Civil & General Works,

- Appropriate Indexation should be considered such as WPI for civil, Steel & Electrical machinery etc (**PEDA, HERO Future Energies Pvt. Ltd, Hindustan Power**)
- CERC has approved Cost of Civil and General Works for current year at INR 60 Lakh/MW. In the last one year the WPI (as per Data from Office of Economic Advisor) for Machinery used in civil works has increased by 2.1% and considering a nominal increase of 5%-8% in Labour cost, the cost of Civil and General Works has increased to around Rs. 63 lakh/ MW. It is requested to consider the Cost of Civil

Works at least Rs. 63 Lakh/MW following the same principle as followed by CERC while determining Benchmark Cost for Wind power plant, Biomass plant, co-generation and SHPs. (ACME)

- Development of solar projects across various geographic & climatic conditions entails wide variations in costs of civil works i.e. foundation, Mounting Structure, etc. The following ground realities need to be taken into consideration:
 - a) Ground Soil Condition (Bearing Capacity) – Presence of black cotton soil in western & southern parts of the country which is unsuitable due to heavy water retaining capacity requires foundation systems with a cost of more than Rs. 60 Lacs/MW. Whereas rocky project sites in central & southern parts of the country requires drilling and anchoring costing Rs.50 Lacs/MW.
 - b) General Contour of virgin ground - General contour of virgin soil will require ground leveling and it is a significant cost component in most projects. We have project sites where contour level difference has been 15-20 meters from one side of the project to another side, which increased the cost by around Rs. 10 lacs / MW.
 - c) Ground Water Table – We have encountered ground water table at 1 meter below ground level requiring heavier design of foundation for both module and buildings. This adds to civil cost of the projects.
 - d) Basic wind speed - Basic wind speed varies from 33 m/s to 55 m/s in India. We have implemented projects in all conditions requiring heavier design of structure against uplift and other conditions. The requirement of structure varies from 70 MT/MW to 100 MT/MW depending on wind speed as well as type of modules. Therefore cost of structure can vary from Rs. 50 Lacs/MW to Rs. 70 Lacs/MW depending on location etc.
 - e) Presence of aggressive chemicals, salt in weather (in Civil Engineering terms “Severe Exposure Condition”) - Presence of salt in air/soil require special treatment of concrete as well as more zinc thickness in steel structure to make it durable. Again, the cost will vary based on site exposure.
 - f) Availability of basic raw material for civil works - Civil works depend on local material like sand, aggregate, stone blocks, tiles, good earth, Granular Sub Base, bitumen etc. Depending on source and distance from source to the site, cost varies in a big way. Distance of sand source from site including local royalty for collecting those materials will be varying across states because royalty is a state subject. Depending on all these basic inputs cost of civil component will vary beyond standard assumptions.
 - g) Basic input price of major material like steel and cement - Cement and reinforcing steel are other two major components of civil works. Price of cement varies time to time depending on demand of industry and location of project. While cost of cement is around Rs. 300- 340 per bag in east and south of India, it is Rs.240-280

in west and north. This being a major single input component, it will have major impact on cost and can't be benchmarked uniformly. Reinforcing steel cost has changed from INR 35k to INR 43k (basic price) in last one year and will be difficult to predict what will happen in next one year depending on progress on major infrastructure projects.

- h) Fuel price for construction equipment and tools - Construction tools and equipments are a major component of civil costs (around 18-20%). In this cost, fuel cost is around 30% - 50% at times. This gets impacted due to constant increase in fuel price. Therefore, CERC need to consider this impact and no past price should be taken as benchmark, but it should be linked to market price.
- i) Availability of skilled labour and contractors - Skilled labour like mason, carpenter, welder, bar binder, fitter etc at a price ranging from Rs. 400/- to Rs. 600/- per day while the minimum wages set by Government for such skilled labour do not exceed Rs 275-300/- per day. Clearly, skilled labour is in short supply for such activities making overall cost higher. Manpower cost is around 12-15% of civil cost.
- j) Access and logistics for movement of material and equipment to site – Inaccessible sites add to overall cost of logistics and access.
- Based on above inputs, it is suggested that the following costs should be taken:
 - a) Total Civil & General Cost – Rs. 60 Lacs/MW
 - b) Cost of Module Mounting Structure – Rs. 70 Lacs/MW.
- The cost for Balance of System (BOS) considered Rs. 235 Lakh/MW (Sr.No 3, 4, 5, 6 & 7 put together) is substantially on the lower side. The same need to be revised as per current market scenario at least at Rs. 300 Lakh/MW. (**Welspun**)
- Civil & General work basically comprises of Cement and Steel. Cost of cement and steel has increased over last year due to inflation and taxes. However the Commission has reduced the cost and general works (**Green Energy Association**)
- Civil and General work cost should be considered at Rs. 60 lac's/MW. (**Jindal Power**)
- Civil and General Cost should Rs. 70 lakhs/MW.
- Cost of township should be considered. (**Association of Power producers**)

Analysis & Decision

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 Rs. 50 Lakhs / MW.

Some stakeholders are in agreement with the Commission's proposal. One of the stakeholders 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 has also been 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 has been further 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. The Commission has considered all aspects associated with civil works and the reasonable costs likely to be incurred on these elements and has decided to retain the cost of Civil & General Works as Rs 50 Lakhs/ MW.

H. Mounting Structures

- Appropriate Indexation should be considered such as WPI for civil, Steel & Electrical machinery etc (**PEDA, HERO Future Energies Pvt. Ltd. , Hindustan Power**)
- Steel prices and fabrication costs have never showed reverse trend in the past 5 years. The proposed cost could result in promoting low quality and weaker mounting structures. In order to increase the efficiency, solar developers use seasonal tilt structures and jack arrangement for changing the angle. India is a high wind zone, so structures have to be adequately designed to give a life of 25 years and such structures are heavy and expensive because of surface coatings and processing. Considering the 25 year life span and wind speed it is suggested to consider INR 65 lakh/MW. (**ACME**)
- Steel prices have gone up as compared to last year. Hence it should be more (**WAREE**)

Analysis and Decision

The Commission had proposed the cost of Ground mount structure as Rs. 50 Lakhs/MW. In the previous years the solar capacity commissioned in the country was less than 1 GW. Over the period the capacity size has increased and experience curve has moved up. The solar power market has matured and reduction costs are envisaged. With advancement of technology, the efficiency of solar cells has also increased. Therefore cost of mounting structure in per MW terms should also decrease.

By considering the above, the Commission is of the view that the proposed cost of ground mount structure of Rs 50 Lakhs /MW is adequate.

I. Cable & Transformer

- Appropriate Indexation should be considered such as WPI for civil, Steel & Electrical machinery etc (**PEDA, HERO Future Energies Pvt. Ltd. , Hindustan Power**)
- Copper price, which is a major component of cables and transformer has moved up significantly. The proposed costing could promote poor evacuation infrastructure, cables and hence higher downtime. Apart from cables and transformers, the other associated costs are connectors, junction box, inline fuse protection, cable markers, trenches, cable trays, trench civil / brick lining, trench back filing, earthing, lightning arrestor, peripheral lighting, MV transformers, HV transformers, DC Cables, LT Cables, HT Cables, switchgears and protection, auxiliary transformers, UPS, fire safety kits, communication cables, tariff meters, installation of all equipments. There are also various costs associated such as type tests, several approvals / government approvals etc. Hence the total cost should be INR 75lakhs/MW. Requesting Hon'ble Commission to consider INR 75 Lakh/MW as the cost for cables and transformers. (**ACME**)
- The followings things/costs are not considered:
 - a) Earthing system for DC Plant (very necessary for module life longevity)
 - b) Early Lightning protection. (necessary for wide open area of solar field to protect inverters and solar panels)
 - c) Illumination requirements – i.e. required to prevent theft of Copper and night time maintenance & module cleaning.
 - d) Plant internal SCADA & FO cabling. (necessary for plant operation)
 - e) Telemetry system for real time data monitoring by SLDC under RRF Mechanism.
 - f) Transmission Line & switchyard for various voltage levels.
 - g) Remote end bay extension + Metering requirement.
 - h) Module Cleaning/Washing system.
 - i) Water sourcing & system cost.
 - j) Water conditioning system. (to maintain water PH to prevent module top cover glass deteriorate)
- It is suggested that a cost of Rs. 110 lakhs/ MW be taken against the envisaged Rs. 50 lakhs/ MW. (**Welspun**)
- Cable and Transformer cost should be considered at Rs.60 lacs/MW. (**Jindal Power**)
- As metering is at receiving end of STU, capital cost should include transmission line and line losses up to the same point, which may be about Rs. 20 Lakh/MW. (**Rudraksh, Welspun**)
- Due to increase in price of metal, oil, labour costs, costs of raw material the overall costs of evacuation has gone up. (**Green Energy Association**)

Analysis & Decision

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.

The Commission proposed the cost of Cable and Transformer as Rs. 50 Lakhs/MW. In view of the suggestions received from the stakeholders; the Commission determines the cost of Cable and Transformer as Rs 55 Lakhs/ MW.

J. Pre-operative and Preliminary Expense:

- Should be 10% of Capital Cost (**PEDA**)
- Should be Rs. 20 Lakh/MW (**HERO Future Energies Pvt. Ltd.**)
- Financing cost need to be considered @ 2% of debt fund and for project management, it has to be considered in between 1.5-2% of project cost. We proposed CERC to increase IDC rates to 8% from 6%. It is requested to consider INR 60 lakh/MW as the cost for Preliminary/Pre- operating expenses and Financing Costs. (**ACME**)
- Preoperative costs, project management costs, financing costs are independent of capital costs and hence as capital costs increase their proportions will also increase. Thus Pre-operative and Preliminary Expense should be 10% of total costs.
- It is suggested that the Preliminary/Pre-operating expenses and Financing Costs may be considered as 8-10% of the corresponding project cost. (**Renew Power**)
- It is suggested that the Preliminary/Pre-operating expenses and Financing Costs may be considered as 10% of the corresponding project 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% instead of 4% considered by the Commission. In addition contingency is higher due to local factors, higher transportation cost on remote locations. Considering the same proposed norm should be reconsidered.
- Other Charges like in the State like Rajasthan there is a grid connectivity charge of Rs. 2 Lakhs/MW and the State Nodal Agency is also charging Rs. 10 Lakhs/MW as development charges as per State Policy. These may also be considered. Moreover, 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 Rs. 10 Lakhs/MW. It is also suggested that following other costs need to be considered:
- Almost 3% of module needs to be replaced every year for which approximate cost is 1.5% of the cost of project. (**Welspun**)

- The preoperative costs is mainly related to cost of manpower and related expenses. Over the last year average increase in cost of manpower has been around 10-15%. These are further subjected to increase due to inflation. (**Green Energy Association, WAAREE**)
- Preliminary and preoperative cost should be considered at 10% of total Capital Cost. (**Jindal Power**)
- ROE during construction period should be considered else effective return on equity will reduce from 16% to 12.5% (**Adani**)

Analysis & Decision

One of the stakeholders has suggested that these costs should be around Rs. 20 lakh/MW. The Commission had proposed Rs. 40 lakh/MW. Many stakeholders have suggested to increase the costs. PV is now a mature, proven technology that is rapidly approaching grid parity. It is a secure energy source with very high plant reliability and is not exposed to any fuel price volatility. PV has made remarkable progress in reducing costs with a focused, forward looking and innovative fiscal and financial policies adopted by Ministry of New and Renewable Energy, Government of India and various State Governments. With these fiscal and financial policies, the soft cost related with PV power plant has reduced significantly. The preliminary/pre-operating expenses include transportation of equipment, storage of equipment at site, insurance, contingency, taxes and duties, IDC and finance charges etc. Detailed breakup of Preliminary and Pre-operative expenses and financing cost, lump sum in percentage of total capital cost is as under:

- i. Insurance Cost: 0.5 %
- ii. Contingency: 0.5%
- iii. Interest during Construction (IDC): 5%
- iv. Financing cost: 1%
- v. Project management cost: 0.5%
- vi. Pre-operative Cost: 0.5%

Based on assessment of projects under various modes, the Commission feels that it would be reasonable to consider Preliminary/Pre-operating expenses and Financing Cost to constitute around 8% of total capital cost on average basis. Accordingly, Rs. 48.50 Lakh/MW is determined to be the preliminary /pre-operating expenses and financing cost.

II. Solar Thermal

K. Capital Cost

- Capital cost should be Rs. 13.77 Cr/MW.
- Constituent-wise breakup on the lines of storage of capital costs should be provided and considered for capital cost benchmarks. Analysis of factors such as DNI, storage, IDC, Long gestation period of 36 months, Forex variation for the period etc should be considered and be based on data received from projects already installed. **(Diwakar Solar Projects)**

Analysis & Decision

As has been mentioned in order proposing capital cost for solar thermal, there are four commercially available CSP technologies:

1. Parabolic Trough
2. Central Receiver Tower
3. Dish Engine
4. Linear Fresnel

Parabolic Trough technology has achieved close to full commercial status while cost data for the power Tower, Fresnel and Dish Stirling technologies are in the process of being established. Therefore, with the available cost data of Parabolic Trough technology, the Commission determines the benchmark Capital cost of Solar Thermal project at ₹12.0 Crore / MW for FY 2015-16.

III. Other points for consideration which are not relevant to the current regulatory process

- We propose that Commission should not alter benchmark capital cost of the solar PV projects with imported modules and rather allow quality technology to dominate the sector with more concentration on
 - a) Better/ higher efficiency
 - b) Reliable technology
 - c) Better monitoring
 - d) Better grid synchronization and scheduling and forecasting**(Green Energy Association)**
- Loan tenure should be 14 years because of tight liquidity condition. **(Association of Power Producers)**

8. To sum up, the Commission has decided the capital cost for solar PV for 2015-16 as under:

Sr. No.	Particulars	Capital Cost Norm for Solar PV project (Rs. Lakh/MW)	% of total cost
1	PV Modules	332.35	54.9%
2	Land Cost	25	4.1%
3	Civil and General Works	50	8.3%
4	Mounting Structures	50	8.3%
5	Power Conditioning Unit	45	7.4%
6	Evacuation Cost up to Inter-connection Point (Cables and Transformers)	55	9.1%
7	Preliminary and Pre-Operative Expenses including IDC and contingency	48.50	8.0%
8	Total Capital Cost	605.85	

9. The Commission has decided the capital cost for solar thermal for FY 2015-16 at Rs 12.0 Cr/MW.

Sd/-
(A.S. Bakshi)
Member

Sd/-
(A. K. Singhal)
Member

Sd/-
(Gireesh B. Pradhan)
Chairperson

New Delhi
Dated the 31st March, 2015