

**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 Order: 3<sup>rd</sup> March 2015**

**IN THE MATTER OF**

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

**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. In exercise of the power under Regulation 5 of RE Tariff Regulations, the Commission vide Order dated 28th February, 2013, determined 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 - Suo-Motu) at ₹ 691 Lakh/MW and ₹ 1200 Lakh/MW.

4. The Commission, in due discharge of the mandate under Regulation 5 of RE Tariff Regulations, proposes to determine the benchmark Capital Cost Norm for Solar PV power projects and Solar Thermal power projects applicable during FY 2015-16. The proposal is enclosed as **Annexure- I**.

Comments /suggestions of the stakeholders on the above proposal are invited by 18<sup>th</sup> March, 2015.

-Sd/-

[A.S. BAKSHI ]

MEMBER

-Sd/-

[A.K.SINGHAL]

MEMBER

-Sd/-

[GIREESH.B.PRADHAN]

CHAIRPERSON

New Delhi

Dated the 3<sup>rd</sup> March 2015

**Benchmark Capital Cost norm for Solar PV and Solar Thermal technologies, for FY 2015-16**

The proposed benchmark Capital Cost norm for Solar PV and Solar Thermal project, for FY 2015-16 are discussed below:

**A. Solar PV Power Projects: Capital cost of Solar PV projects****1. Module Price**

1.1 PV Insights in its report dated 4/9/2013 on solar module spot price reveals that silicon module prices are being traded in the range of 0.55 US\$ to 0.99 US\$ with an average of around 0.709 US\$. The Table 1 below shows solar module spot prices in the month of August 2013.

Table 1: Solar Module spot price

Item	High USD / Watt	Low USD / Watt	Average USD / Watt
<b>Silicon Solar Module</b>	0.99	0.55	0.709
<b>Thin Film Solar Module</b>	0.94	0.49	0.606

Source: PV insight, Report dated 4/9/2013

1.1 PV Insights in its report dated 17/12/2014 on solar module spot price reveals that silicon module prices are being traded in the range of 0.54 US\$ to 0.88 US\$ with an average of around 0.619 US\$. The Table 2 below shows solar module spot prices in the month of December, 2014.

Table 1: Solar Module spot price

Item	High USD / Watt	Low USD / Watt	Average USD / Watt
<b>Silicon Solar Module</b>	0.88	0.54	0.612
<b>Thin Film Solar Module</b>	0.84	0.50	0.638

Source: PV insight, Report dated 17/12/2014

1.4 The Table 3 below shows the China /Taiwan PV module average spot prices prevailed during the month of August, 2013 and changes in prices in percentage term with respect to previous month:

Table 2: China/Taiwan PV-Spot Price in US \$ (August 2013)

Particulars	Average	% Change
<b>Poly Price (per kg)</b>	17.43	5.89%
<b>Multi-Si wafer ( 156mm)</b>	0.86	-1.15%
<b>Cell Price (Per Watt)</b>	0.39	-2.50%
<b>Module Price (Per Watt)</b>	<b>0.69</b>	-1.43%
<b>Thin Film Price (Per Watt)</b>	0.62	No Change

Source: Mercom Capital Group, Digitimes, PVinsights, August 2013

The module price shown in the above Table 3 reveals that silicon module prices are being traded in the range of 0.69 US\$/Watt.

1.4 The Table 4 below shows the China /Taiwan PV module average spot prices prevailed during the month of August, 2014 and changes in prices in percentage term with respect to previous month:

Table 2: China/Taiwan PV-Spot Price in US \$ (August 2014)

Particulars	Average	% Change
<b>Poly Price (per kg)</b>	20.43	-1.21%
<b>Multi-Si wafer ( 156mm)</b>	0.86	-3.37%
<b>Cell Price (Per Watt)</b>	0.32	-5.65%
<b>Module Price (Per Watt)</b>	<b>0.59</b>	-1.67%
<b>Thin Film Price (Per Watt)</b>	0.68	9.52%

Source: Mercom Capital Group, Energy Trend, PVinsights, August 2014

The module price shown in the above Table 4 reveals that silicon module prices are being traded in the range of 0.59 US\$/Watt.

1.5 From the above it is quite visible that the average module prices have been reduced by around 10 cents/Watt. The Mercom in its intelligence report dated 1.9.2014, observed that the anemic demand in China pushed spot module prices down. Module prices in US rise after preliminary antidumping ruling against Chinese and Taiwanese solar cells and modules. Module prices in Japan , China and EU and emerging markets are continuing to decline. Chinese module manufacturers have cut procurement of Taiwanese cells after the US antidumping ruling.

Taiwanese cell manufacturers in-turn have cut prices significantly to compensate for reduced demand. Wafer prices are down due to low demand in China and high inventories.

1.6 The prevailing module prices offered by the Chinese manufacturers in India are around 0.54/US\$. Since we are determining benchmark capital cost for the FY 2015-16, any future expected reduction cannot be ignored. Therefore, the Commission has decided the average module cost of 0.52 US\$/Wp for determination of benchmark capital cost of Solar PV for FY 2015-16. Considering the Exchange Rate at ₹ 61.06/US\$ (average of daily exchange rate data available of RBI website of past six months), the Commission propose to consider the module cost at ₹ 317.50 Lakh/MW.

In addition to the above proposed module cost, the Commission also proposes to consider an additional 0.5 % of the modules cost (i.e. 5 kW of module per MW) every year after 4th year to 25th year of operation on notional basis considering module degradation as allowed in the past based on the study carried out by the Commission. Accordingly, the Commission proposes to consider the total module cost at ₹ 327.33 Lakh/MW.

## **2. Non-Module Cost Component:**

The non-module cost components comprise cost towards land, civil & general works, ground mounting structures, power conditioning unit, cabling & transformer/ switchgears and preliminary/pre-operating expenses & financing costs. Each component of above referred non-module cost of Solar PV based power plant is estimated as under for the determination of benchmark capital cost of Solar PV projects for FY2015-16.

### **2.1 Land Cost**

The land requirement for Solar PV based power project depends upon the technology employed i.e. Crystalline or Thin film, conversion efficiency and solar radiation incident in respective area. The Commission, while determining the benchmark capital cost for Solar PV projects for the year 2014-15, had considered land requirement of 5 Acre/MW for crystalline PV project and its cost was considered as ₹ 25 Lakh / MW. The Commission also considered that the land acquired for setting up solar power projects is mostly arid/barren or of no commercial use. Therefore, the Commission proposes the same normative land cost considered for FY2014-15 at ₹ 25 Lakh/ MW (₹ 5 Lakh/Acre \* 5 Acre/MW) for the determination of benchmark capital cost of Solar PV projects for FY2015-16.

## **2.2 Power Conditioning Unit (Inverter)**

Power conditioning equipment is an important component of the balance-of-system. Power conditioners process the DC power produced by a photovoltaic system to AC power and match the same with utility's power. The Commission proposes to consider normative inverter cost at ₹ 45 Lakhs/MW including all taxes & duties and major overhaul cost in the 12th-14th year of operation.

## **2.3 Civil and General Works:**

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 leveling, 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 proposes to consider the cost for Civil and General work as ₹ 50.00 lakh/MW, for determination of benchmark capital cost of Solar PV projects for FY2015-16.

## **2.4 Ground Mounting Structures:**

This expenditure includes cost associated with manufacturing, delivery, installation and calibration of hot galvanized steel structures including all necessary material, works and installation on prepared foundations/pilings. The Commission proposes to consider ₹ 50.00 Lakh/MW towards the cost for Ground Mounting Structures for benchmark capital cost of Solar PV projects for FY2015-16.

## **2.5 Cables and Transformers**

This expenditure includes EPC cost towards DC cabling between Solar PV panels & Inverters including junction boxes, AC cabling between Inverter & sub-station, Earthling arrangements and Transformer. The transformer cost includes the EPC cost of a step up outdoor type transformer, breaker, Current Transformers, Potential Transformers, Isolators, LAs, protection relay and TOD meter. The Commission proposes to consider ₹ 50 Lakhs/MW as expenditure towards cables and transformers for solar PV projects for the determination of benchmark capital cost of Solar PV projects for FY2015-16.

## 2.6 Preliminary/Pre-operating expenses and Financing Costs

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 proposed as under:

- i. Insurance Cost and Contingency: 0.5%
- ii. Interest during Construction (IDC): 4%
- iii. Financing cost & Project management cost: 1%
- iv. Pre-operative Cost: 0.5%

Preliminary/Pre-operating expenses and Financing Cost contribute to around 6% of total capital cost on average basis. Accordingly, Rs. 40.00 Lakh/MW is proposed to be considered as preliminary /Pre-operating expenses and Financing cost.

The Table 5 below presents the breakup of benchmark capital cost norm for Solar PV projects for the FY 2015-16:

Table 5: Breakup for Capital cost projection

Sr. No.	Particulars	Capital Cost Norm for Solar PV project (Rs. Lakh/MW)	% of total cost
1	PV Modules	327.33	55.7%
2	Land Cost	25	4.3%
3	Civil and General Works	50	8.5%
4	Mounting Structures	50	8.5%
5	Power Conditioning Unit	45	7.7%
6	Evacuation Cost up to Inter-connection Point (Cables and Transformers)	50	8.5%
7	Preliminary and Pre-Operative Expenses including IDC and contingency	40	6.8%
8	Total Capital Cost	587.33	

Considering the above facts into consideration, the Commission proposes to consider total cost of Solar Photo voltaic power projects for the FY2015-16 as ₹ 587.30 Lakh/MW as benchmark project cost of Solar PV projects.

**B. DETERMINATION OF BENCHMARK CAPITAL COST FOR TYPICAL CSP (SOLAR THERMAL) PROJECTS FOR THE PERIOD 2014 – 15**

**SOLAR THERMAL OR CONCENTRATED SOLAR THERMAL (CST) TECHNOLOGIES**

Under this section, technology specific parameters such as capital cost norm, capacity utilization factor, auxiliary consumption and O&M Expenses, for solar thermal projects have been discussed. Solar Thermal technologies use systems of mirrored concentrators to focus direct beam solar radiation to receivers that convert the energy to high temperatures for power generation. There are four commercially available CSP technologies:

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

As per NREL Report the CSP projects of both parabolic trough and tower technology, as of 2011, have been deployed mostly in Spain and U.S. Some projects are also operational and under development in the Middle East and North Africa region (MENA). CSP projects that use linear Fresnel reflector and dish/Stirling Energy Systems are very few and still under developmental stage.

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, available cost data of Parabolic Trough technology , the Commission proposes the benchmark Capital cost of Solar Thermal project at ₹ 12.0 Crore / MW for FY 2015-16.

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