

**CENTRAL ELECTRICITY REGULATORY COMMISSION  
NEW DELHI**

**Petition No. 17/SM/2015**

**Coram: Shri Gireesh B. Pradhan, Chairperson  
Shri A. K. Singhal, Member  
Shri A. S. Bakshi, Member  
Shri M.K.Iyer, Member**

**Date of Order: 23<sup>rd</sup> December, 2015**

**IN THE MATTER OF**

Determination of Benchmark Capital Cost Norm for Solar PV power projects and Solar Thermal power projects applicable during FY 2016-17

**ORDER**

The Commission notified the Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2012 (hereinafter "RE Tariff Regulations") on February 6, 2012.

2. The first proviso of Regulation 5 of RE Tariff Regulations provides that the Commission may annually review the benchmark capital cost norm for Solar PV and Solar thermal power projects.

3. In exercise of powers under Regulation 5 of RE Tariff Regulations, the Commission vide Order dated 31<sup>st</sup> March, 2015, determined the Benchmark Capital Cost Norm for Solar PV power projects for the year 2015-16 (Petition No. SM/005/2015 - Suo-Motu) at Rs. 605.85 lakhs/MW, and for Concentrated Solar Power (CSP) projects at Rs.12 crores/MW.

4. Accordingly, the generic tariff for Solar PV projects notified vide Order dated 31<sup>st</sup> March, 2015, in Petition No. SM/005/2015 and applicable for the financial year 2015-16 is Rs. 7.04/unit, and Rs.6.35/unit with AD benefit. For Solar Thermal power projects, levellised tariff for 2015-16 is Rs.12.05/unit, and Rs.10.80/unit with AD benefit. Recent tariffs discovered in auctions conducted by several states (Andhra Pradesh, Madhya Pradesh, Punjab, etc) and NTPC

are in the range of Rs.4.63/unit to Rs.5.99/unit.

5. 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 and Solar Thermal power projects applicable during FY 2016-17. The details of the proposal are as below.

## 6. BENCHMARK CAPITAL COST NORM FOR SOLAR PV TECHNOLOGIES, FOR FY 2016-17

### 6.1 Module Prices

6.1.1 The chart below from Mercom Market Intelligence Report for the week of 16th November 2015 shows an 8.5% drop in module spot prices over the first ten months of 2015. However, last few months show a steady trend, possibly due to year-end drawing close.

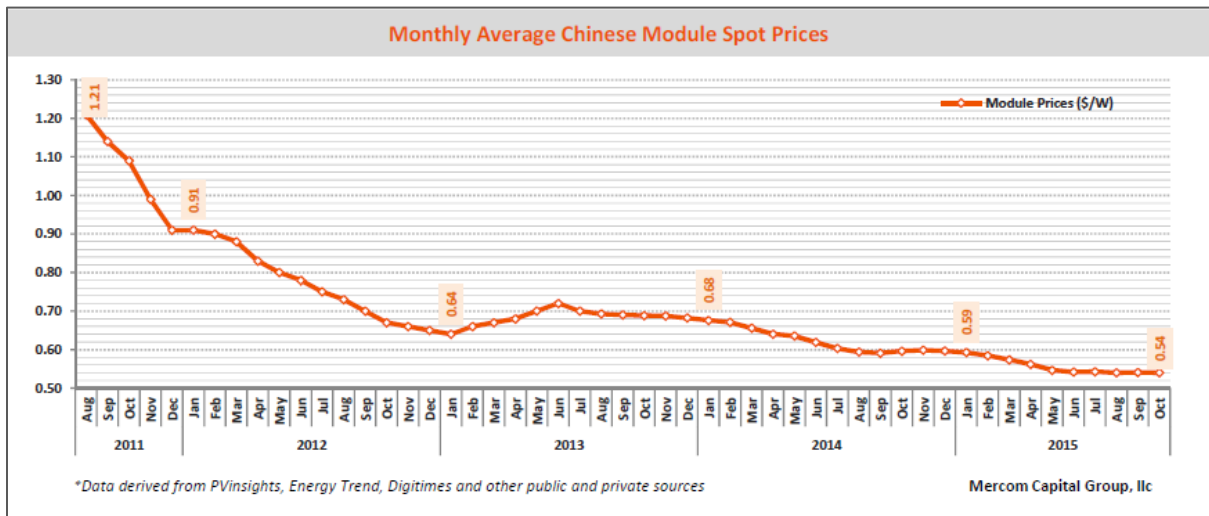


Figure 1: Monthly average Chinese module spot prices (Source: Mercom)

6.1.2 Another report from pvXchange shows varied trends over the past one year. The table below shows region-wise average monthly prices in USD/Watt for a period of twelve months, from November 2014 to October 2015.

Table 1: Monthly Module Prices (Source: [www.pvxchange.com](http://www.pvxchange.com))

Module Prices (\$/Watt)				
Month/Year	Germany	Japan, Korea	China	Southeast-Asia, Taiwan
Nov-14	0.75	0.77	0.67	0.57
Dec-14	0.73	0.76	0.65	0.55
Jan-15	0.70	0.71	0.63	0.53

Feb-15	0.67	0.69	0.61	0.52
Mar-15	0.65	0.68	0.58	0.51
Apr-15	0.65	0.69	0.59	0.52
May-15	0.67	0.73	0.62	0.55
Jun-15	0.66	0.73	0.63	0.55
Jul-15	0.64	0.72	0.63	0.55
Aug-15	0.63	0.72	0.63	0.55
Sep-15	0.65	0.72	0.64	0.54
Oct-15	0.65	0.73	0.63	0.54

The data shows that since November 2014, regional module prices dropped anywhere between 11%-15% (maximum drop), though they recovered a bit by end of year due to heavy demand from China and US.

- 6.1.3 Assuming a similar maximum drop over the next twelve months as in the regional table from pvXchange, i.e. 11% from year-end prices for SE Asia of \$0.54, the expected module spot price by end of next year would be \$0.48/W.
- 6.1.4 It should be noted that discovered spot prices are typically higher than bulk prices that are negotiated by companies for large MW scale projects. Additionally, from interactions with industry, it has emerged that prices for modules being deployed in the Indian market currently are in the range of \$0.43/W - \$0.50/W. Thus, it may be observed that current projects are being implemented at module prices well below existing spot market prices.
- 6.1.5 Considering the data trends above, and factoring in expected price reductions over the next year, the Commission proposes the benchmark cost of modules to be considered as **\$0.465/W for FY 16-17**.
- 6.1.6 Average exchange rate for Rupees to US\$ for the past six months (May 2015-Oct 2015) as per RBI is Rs. 64.58. This exchange rate has been considered for this exercise.
- 6.1.7 The Commission has considered module degradation as of about 0.6%, which gives a module degradation cost of Rs 9.89 lakhs/MW.



WPI index data for Zinc is as below:

Month/Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
2015	175.7	175.7	175.7	181.7	181.7	183.2	180.1	178.9	173.7	173.7

Source: [www.eaindustry.nic.in/display\\_data.asp](http://www.eaindustry.nic.in/display_data.asp)

As per market information, mounting structure cost may be set to around INR 35 lakhs/MW.

#### 6.5. Civil and General Works

Civil works include preparation of terrain for digging, levelling and mounting, building control room to house inverter and other BoS components, building approach roads, arranging water supply, lighting etc. General works include security of solar farm, setting up of power back-up generator; yard lighting, earthing kits, etc. Civil and general works cost is proposed to be set to INR 35 lakhs/MW. It could be even lower if the project developer also has in-house EPC arm, but this is being proposed assuming that most projects would get an external contractor.

#### 6.6. Evacuation Costs (cables & transformers)

This component comprises of cost for transformers and all DC and AC cabling within the solar farm. Cabling cost includes DC cabling between solar PV panels and inverters, junction boxes, AC cabling between inverter and pooling station, and earthing. Step-up transformer, breakers, isolators, protection relays, and meter are installed at the plant level. Depending on local norms for voltage level at evacuation, the costs may vary. Costs are also dependent on the size of the project. Nonetheless, given all the possible variability, a typical cost has to be assumed. Based on information from several industry sources, it is proposed to consider cabling & transformer costs at INR 40 lakhs/MW.

#### 6.7. Preliminary/pre-operative expenses

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%-1%
- ii. Interest during Construction (IDC): 3-4%
- iii. Financing cost: 1%
- iv. Project management cost: 0.5%
- v. Pre-operative Cost: 0.5%

Preliminary/Pre-operating expenses and Financing Cost contribute to around 5%-7% of total capital cost on average basis. It may be noted that construction period of these

projects is rather short, so IDC is not a major cost. Accordingly, these expenses are suggested at 5.5% of total capital cost, or Rs. 26.13 lakhs/MW. Thus, the BoS costs add up to INR 191.13 lakhs/MW.

#### 6.8. Summarizing the cost components:

S.No.	Particulars	Capital Cost norm proposed for FY 2016-17 (Rs. lakhs/MW), for Solar PV projects	% of Total Cost
1	PV Modules	310.19	61.9%
2	Land Cost	25	5%
3	Civil and General Works	35	7%
4	Mounting Structures	35	7%
5	Power Conditioning Unit	30	6%
6	Evacuation Cost up to Inter-connection Point (Cables and Transformers)	40	8%
7	Preliminary and Pre-Operative Expenses including IDC and Contingency	26.13	5.2%
	<b>Total Capital Cost</b>	<b>501.32</b>	<b>100%</b>

Considering the above facts and data into consideration, the Commission proposes to consider total cost of Solar photo-voltaic power projects for the FY 2016-17 as **INR 501.32 lakhs/MW** as benchmark project cost of Solar PV projects.

#### 7. BENCHMARK CAPITAL COST NORM FOR CONCENTRATED SOLAR POWER(CSP) PROJECTS, FOR FY 2016- 17

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:

- a) Parabolic Trough
- b) Central Receiver Tower

c) Dish Engine

d) Linear Fresnel

So far, three solar thermal power projects, spanning two of the four technologies above, have been commissioned, namely:

1. Godavari Green Energy Ltd, 50 MW, Rajasthan
2. MEIL Green Power Ltd, 50 MW, Andhra Pradesh
3. Rajasthan Sun Technique Energy Pvt Ltd, 100 MW, Rajasthan

Other projects for which PPAs were signed under National Solar Mission have been experiencing delays due to various reasons. Additionally, worldwide, deployment of CSP projects has lagged Solar PV projects, as the costs of these two technologies have diverged. Currently, 4.5 GW of CSP plants are installed across the world, with Spain and US being leaders, and in upcoming active markets such as South Africa, Morocco and UAE. Pilots are also being conducted on solar thermal with storage, as molten salts can store heat for generating electricity outside the sunlight hours.

Since the CSP technologies have not seen economies of scale yet, and based on industry interactions, the Commission proposes to retain benchmark capital cost of Solar Thermal power projects at **INR 12.0 Crore / MW** for FY 2016-17.

8. Comments /suggestions of stakeholders on the above proposal are invited by 10<sup>th</sup> January, 2016.

**Sd/-**

**(M.K.Iyer)  
Member**

**Sd/-**

**(A.S. Bakshi)  
Member**

**Sd/-**

**(A. K. Singhal)  
Member**

**Sd/-**

**(Gireesh B. Pradhan)  
Chairperson**