CENTRAL ELECTRICITY REGULATORY COMMISSION

NEW DELHI

Petition No. 242/SM//2012 (Suo-motu)

Coram: Dr. Pramod Deo, Chairperson
Shri S. Jayaraman, Member
Shri V.S. Verma, Member
Shri Deena Dayalan, Member

Date of hearing: 8th January, 2013

Date of Order: 28th February, 2013

IN THE MATTER OF

Determination of Benchmark Capital Cost Norm for Solar PV power projects and Solar Thermal power projects applicable during FY 2013-14

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. 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.

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. In exercise of the power under Regulation 5 of RE Tariff Regulations, the Commission vide Order dated 25th October, 2012 , proposed to determine the Benchmark Capital Cost Norm for Solar PV power projects and Solar thermal power projects for the year 2013-14 (Petition No. 242/SM/2012 - Suo-Motu) and invited Comments / suggestions /objections from the stakeholders.

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

1 Sun Edison Energy India Private Ltd.
2 Renew Power Ventures Pvt. Ltd.
3 Nano PV Solar Inc.
4 Tata Power Company Ltd.
5 Aditya Birla management Corporation Ltd.
6 Juwi India Renewable Energies Pvt. Ltd.
7 First Solar Power India Pvt. Ltd.
8 Moser Baer Engineering and Construction Ltd.
9 Association of Power Producers

5. Subsequently, a public hearing was held on 8th January, 2013 and the following stakeholders made oral submissions:

1 National Thermal Power Corporation
2 Moser Baer

6. The Commission has analysed the views/comments/suggestions of the stakeholders and the Commission's decisions given in the following paragraph.

Solar PV Power Projects: Capital cost of Solar PV projects

A. Module Price

7. Comments:

7.1 Average prices of various module categories available in India hover in the range of 0.68 $/Wp to 0.75 $/Wp. Most of industry experts opine that module prices, after continuous fall in recent years, have stagnated at the prevailing bottom level and it is highly likely that the prices would remain at the prevailing bottom level in near future. It has therefore been suggested that the module price should be considered as **0.70 $/Wp. (Renew Power Ventures Pvt. Ltd.)**

7.2 Trend of last 6 months shows that the drop in module price was not that steep anymore, rather it is stabilizing. It has been recommended that the base module cost should be fixed at **0.70$/Wp** which works out to ₹ 371 Lakh/MW with exchange rate of ₹ 53/US$. **(First Solar Power India Pvt.** Ltd.)

7.3 Module cost may be considered as **0.75$/Wp** instead of $0.65/Wp as envisaged by CERC. **(Association of Power Producers)**

7.4 Module cost should be considered at **$0.70/Wp** considering the trend of module cost which is expected to go up in 2013-14. **(Moser Baer)**

7.5 There should be separate capital cost norms for large utility scale Solar PV Projects and Small rooftop systems. Considering $ 0.65/ Wp as cost without Insurance, Freight & Taxes , the landed cost should be taken as $ 0.75/Wp and the total capital cost should be revised upwards to ₹ 900 Lakhs/MW for a utility scale grid connected solar PV projects. The capital cost for small rooftop systems should be 20% higher @ ₹ 1100 lakhs/MW. **(Tata Power)**

7.6 Cost of solar modules made in India should be used for the cost estimation of solar systems in India. The draft Order does not envision scenario when Chinese Panel in India are subjected to an anti dumping tax or import duty. **(Nano PV Solar Inc.)**

8. Analysis and Decision

8.1 Based on discussion with various stakeholders it is found that some of the following top ten solar PV manufacturers are currently selling their first tier crystalline modules in India at a price as low as **$ 0.60/Wp.**

2011 Ranking	Market share	Solar Module Company	Country
1	5.8%	Suntech	China
2	5.7%	First Solar	USA
3	4.8%	Yingli Solar	China
4	4.3%	Trina Solar	China
5	4.0%	Canadian Solar	China
6	2.8%	Sharp	Japan
7	2.8%	Sunpower	Philippines
8	2.7%	Hanwha Solarone	South Korea
9	2.3%	Jinko	China
10	1.9%	REC	Norway

Source: Wikipedia

8.2 Latest edition of the Mercom's market intelligence report on Solar also reveals that the prices of solar components continue to drop moderately. Report further states that even with demand from China, Japan and Germany, oversupply continues to pressure the solar component prices.

China/Taiwan PV-Spot Price in US$ (week of Dec 03)		
	Avg	% Change
Poly Price (Per KG)	15.94	-0.38%
Multi-Si Wafer (156mm x 156mm)	0.81	-1.22%
Cell Price (Per Watt)	0.35	No Change
Module Price (Per Watt)	0.65	No Change
Thin Film Price (Per Watt)	0.62	-1.59%
Mercom Capital Group, llc		
Data derived from: Mercom Capital Group, EnergyTrend, PVinsights and Other public and private sources		

Source: Mercom Market Intelligence Report on Solar dated 10.12.2012

8.3 PVinsights report on solar module spot price (last updated on 23.1.2013) also reveals that silicon module prices are being traded in the range of 0.55 US$ to 1.00 US$ with an average of around 0.657 US$.

Solar PV Module Weekly Spot Price

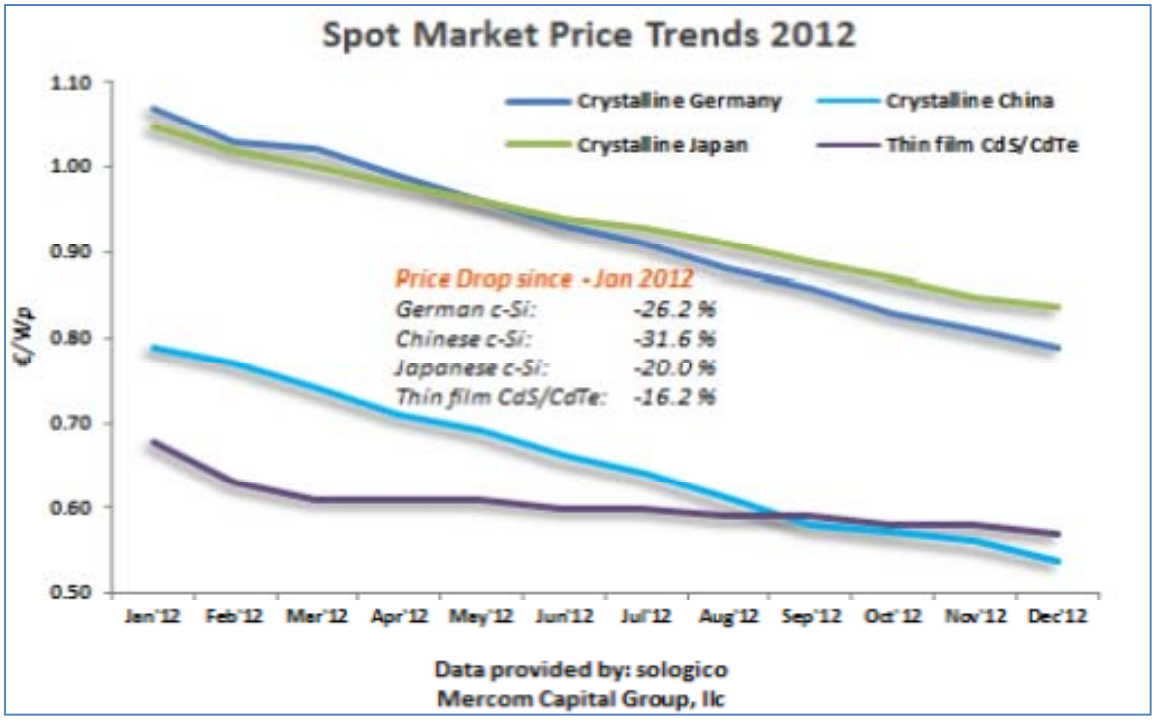
Item	High	Low	Average	AvgChg	AvgChg %
Silicon Solar Module	1.00	0.55	0.657	↑ 0.003	↑ 0.46%
ThinFilm Solar Module	0.96	0.52	0.614	- 0	- 0%
Unit: USD Per Watt				*Last Update:* 2013-01-23	

Source: PVinsight

8.4 The Table below shows the Solar PV module price trends in the year 2012 in European market.

PV Price trends in Europe - December 2012			
Module type, origin	€/Wp	Trend from November 2012	Trend from January 2012
Crystalline Germany	0.79	↘ -2.5%	↘ -26.2%
Crystalline China	0.54	↘ -3.6%	↘ -31.6%
Crystalline Japan	0.84	↘ -1.2%	↘ -20.0%
Thin film CdS/CdTe	0.57	↘ -1.7%	↘ -16.2%
Thin film a-Si	0.43	↘ -6.5%	↘ -28.3%
Thin film a-Si/µ-Si	0.53	↘ -1.9%	↘ -30.3%
Data provided by sologico		Mercom Capital Group , llc	

Source: Solar Market Intelligence Report, Mercom, January 21, 2013



Source: Solar Market Intelligence Report, Mercom, January 21, 2013

8.5 The above chart clearly shows that there is a downward trend in the last year. The rate of reduction may not remain the same as observed in the FY 2011-12. Since we are determining benchmark capital cost for the FY 2012-13, prevailing module prices offered by the manufacturers in the country and future expected reduction cannot be ignored. Therefore, the Commission has decided the module cost of 0.60 US$/Wp for determination of benchmark capital cost of Solar PV for FY 2013-14.

B. Exchange Rate

9. Comments:

9.1 Exchange Rate should be considered at prevailing rate of around **₹ 55/US$** instead of ₹ 53/US$ as envisaged by CERC. **(Association of Power Producers, Moser Baer)**

9.2 RBI data shows that the past six month average exchange rate has been **₹ 54.98/US**$. Therefore, the same should be considered. **(Renew Power Ventures Pvt. Ltd.)**

10. Analysis and Decision

10.1 Comments have been noted and average of daily exchange rate data available of RBI website of past six months has been considered for arriving at module cost instead of prevailing exchange rate. It has, therefore, been decided to consider Exchange Rate at **₹ 54.32/US**$.

10.2 Accordingly, the Commission has considered the module cost at ₹325.92 Lakh/MW.

C. Module Degradation

11. Comments:

11.1 CERC should consider CUF degradation of 3% in Year 1 and 1% for each year after that for the life of the plant. **(Association of Power Producers)**

11.2 CERC earlier considered 0.5% degradation per year from 4th year of deployment and allocated an additional module cost of ₹ 4 Lakhs per year for addition of 5 kW of module per MW per year from 4th year to 25th year of operation. It is requested to consider module cost of ₹ 1.85 lakh for 5 kW on account of degradation of module performance due to aging. Accordingly, total module cost works out as ₹ 382 lakhs/MW. **(First Solar Power India Pvt. Ltd.)**

11.3 The Commission has recognized degradation in its SOR for RE Tariff Regulation 2012. Additional cost as considered in the previous tariff order needs to be added to the approved capital cost for incorporating the impact of 1% degradation. **(Moser Baer)**

11.4 Yearly degradation in generation needs to be considered. **(Aditya Birla management Corporation Limited)**

12. Analysis and Decision

12.1 The Commission would like to reiterate based on the study carried out by the Commission that normally manufacturers provide a guarantee with a definite margin of safety and for design purpose; therefore, a lower degradation percentage 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 then a maximum of 0.5% per year over the life of modules. Further, it is found that the length of warranty period is continuously increasing, indicating the increase in confidence among manufacturers, as they realize durable quality of their products, due to technology improvements and quality assurance practices. However, based on the suggestion received from the stakeholders, the Commission had considered reasonable compensation for degradation due to ageing while determining generic tariff for FY 2011-12. An additional 0.5 % of the modules cost every year after 4th year had been allowed on notional basis. On similar lines, for the year 2013-14 also, an additional module cost per year has been considered

towards addition of 5 kW of module per MW considering 0.5% degradation per year from 4th year to 25th year of operation.

D. Land Cost

13. Comments:

13.1 Land requirement should be considered as 6 acres/MW for crystalline and 7 acres/MW for thin film at ₹10lakhs/acres. Draft order considers land cost of ₹16.8Lakhs (5 acres @ ₹3.36 lakhs/acre). **(Association of Power Producers)**

13.2 Due to proposed draft Land Acquisition, Rehabilitation and Resettlement Bill, 2011 the cost of land is expected to about ₹ 17.61 lakh/Acre. Even if the above impact is not considered the land cost shall not be less than ₹ 40 lakh/MW. **(Moser Baer)**

13.3 The draft Order proposes land cost as ₹ 3.36 lakhs per acre (i.e. Rs 16.80 lakhs/MW) which is quite low compared to the prevailing land costs across states. For example, in Gujarat, land cost ranges from ₹ 12 Lakhs/ acre to ₹ 18 lakhs/ acre. Similarly in Odisha, the range is from ₹ 7 lakhs/ acre to ₹ 12 lakhs/ acre. Accordingly, the Commission is requested to consider land cost as at least ₹ 10 lakhs/ acre. **(Renew Power Ventures Pvt. Ltd.)**

13.4 The land requirement for a particular technology will be inversely proportional to its photovoltaic module efficiency. It is an accepted rule of thumb that a 1 MW solar photovoltaic power plant with poly-crystalline silicon modules of 14% efficiency fixed at optimum inclination in places with good insolation viz. Gujarat will utilize 4.5-5 acres of land. (This land requirement increases at higher latitudes, and decreases while moving towards the equator.) Similarly, a 1 MW photovoltaic power plant with 9% efficient thin-film modules will utilize 7-7.75 acres of land. It is humbly submitted that the Commission may specify norms and cost of land based on different solar zones and technology choice. **(Tata Power)**

14. Analysis and Decision

14.1 The benchmark capital cost norm for solar PV projects is a generic norm representing overall scenario in the country. The land acquired for setting up solar power projects is mostly arid/barren or of no commercial use. Therefore, the Commission has decided to retain the land cost norm of ₹ 16.80 Lakh/MW as proposed.

E. Auxiliary Consumption

15. Comments:

15.1 An auxiliary consumption of 2% should be considered of the gross generation. **(Association of Power Producers)**

15.2 Auxiliary consumption needs to be considered which has impact on the IRR. Degradation in generation yoy needs to be considered. **(Aditya Birla management Corporation Limited)**

15.3 Commission should consider Auxiliary Consumption @ 0.25% of gross energy generation for the purpose of determination of tariff for Solar PV plants. **(Moser Baer)**

16. Analysis and Decision

16.1 A photovoltaic power plant consumes minimal energy for auxiliary purposes. Auxiliary power may be required for air-conditioning in inverter and control rooms, cleaning water softening and pumping system, security night lighting and general office lights and fans. The RE Tariff Regulation-2012 does not specify norm for auxiliary consumption. Since the auxiliary consumption requirement being small, the same is not considered for determination of tariff.

F. Inverter Price

17. Comments

17.1 Inverter prices range from 0.12 Euro/Wp to 0.16 Euro/Wp. This translates to an inverter pricing of ₹84 lakhs/MW to ₹112 lakhs/MW. Further, the Inverter technology and market are more mature and prices are unlikely to fall in near future. Accordingly, the Honorable Commission is requested to consider, even on a conservative basis, the inverter price as ₹84 lakhs/ MW. **(Renew Power Ventures Pvt. Ltd.)**

17.2 The average spot price for PV inverter on 1.11.2012 was $0.21/kW and average contract price in October was $0.23/kW. Even if lowest price of $0.15/kW is considered for determination of inverter prices in 2013-14, it works out as ₹79.5 Lakh/MW. It is requested to increase cost of inverter to ₹ 80 lakh/MW from ₹60 lakh/MW. **(First Solar Power India Pvt. Ltd.)**

17.3 It is proposed that 10% reduction over the previously approved cost of ₹98 lakh/MW i.e. ₹88 lakh/MW may kindly be considered. **(Moser Baer)**

17.4 Inverter comes with 5 year warrantee, with a provision for a 10/20 year extended warrantee at 8%-10% of inverter cost per year. Since the expenses are more capital intensive in nature due to replacement especially between 12^{th} to 15^{th} year, considering this as a full

replacement at present value, which comes to approx. ₹22 lakh/MW should be considered while determining the capital cost of the project.

18. Analysis and Decision

18.1 Based on the interaction with various solar PV project EPC service provider it is found that currently in the country various prominent Inverter suppliers are supplying inverters in the range of ₹40 Lakhs to ₹50 Lakhs/MW. Some of the inverter manufacturers have started manufacturing in the country. Even after if the considering the replacement cost of inverter after 12 to 15 years, the inverter cost proposed in the draft Order at ₹60 Lakhs/MW seems reasonable.

G. Preliminary and Pre-Operative Expenses including IDC and contingency

19. Comments

19.1 Upfront financing fees should be considered as 1.5% of the debt amount instead of 1% of project cost as envisaged by CERC. **(Association of Power Producers)**

19.2 Interest During Construction (IDC) needs to be considered at ₹80 Lakhs/MW. **(Aditya Birla management Corporation Limited)**

20. Analysis and Decision

20.1 Considering the low gestation period required for solar PV projects, the proposed Preliminary and Pre-Operative Expenses including IDC and contingency expenses at ₹80 Lakhs/MW is considered reasonable.

H. Capital Cost of Solar PV Projects

21. Comments

21.1 The Commission is requested to take into consideration the decreasing trend in solar technologies and aspects like economies of scale, optimization of production and technology development and benchmark the solar capital cost norm accordingly so that levellised tariff does not exceed the market based competitive rates. **(Gujarat Urja Vikas Nigam limited)**

21.2 Proposed capital expenditure is based on the gradual reduction in the cost of PV modules. But, at the same time we are of the view that the prices of modules will start witnessing stabilization in a little while as the overcapacity is going out of the system. It has been predicted that price drop will be stopped in second quarter of 2013. Concurrently, effect

of price drop of module prices is being wiped out by the price increment of steel, copper, aluminum etc which are the fundamental elements of the mounting structure and rest of the system. Moreover, possible upward surge in Dollar appreciation against Rupees is likely to reduce the effect of falling module prices on the capital cost. **(Sun Edison Energy India Private Limited, juwi India Renewable Energies Pvt. Limited)**

21.3 There are enough solar farm site examples in the country today available for the analysis of the actual cost involved in executing solar project. Such cost data need to be analysed with real numbers instead of estimations. **(Nano PV Solar Inc.)**

21.4 It is requested and proposed to assume the capital expenditure as **₹850 Lakhs/MW** in the final tariff order. **(Sun Edison Energy India Private Limited)**

21.5 It is requested and proposed to retain earlier benchmark capital cost of **₹1000 Lakhs/MW** in the final tariff order. (**juwi India Renewable Energies Pvt. Limited**)

21.6 The Commission may allow a capital cost of **₹950 Lakhs/MW** for solar PV projects. **(Moser Baer)**

21.7 Non-module cost should be technology specific. 15% higher for thin film than crystalline. **(Association of Power Producers)**

21.8 Reduction in Module cost and Inverter cost is justified but the escalation of 5% allowed on balance of plant is much lower and it should be in the range of 10-15% based on the WPI and CPI data. **(NTPC)**

22. Analysis and Decision

22.1 For the non-module cost components like: land, civil & general works, ground mounting structures, and cabling & transformer/ switchgears, the Commission has considered the cost escalation of 5% over the last year's cost. The escalation of 5% is quite reasonable based on the average escalation of Steel and Electrical Machinery Wholesale Price Indices in the calander year 2012 over the 2011.

22.2 Regarding suggestion on separate technology specific tariff, the Commission has adopted technology agnostic approach in determination of generic tariff for a solar PV project. If we see the module cost break up, we find that the raw materials for c-Si PV amount to 72 percent of the total cost structure, with polysilicon as the single largest contributor to underlying costs. In contrast, CdTe feedstock contributes only 10 percent to the total cost structure of a CdTe thin film panel. 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.

22.3 The table below presents the breakup of benchmark capital cost norm for Solar PV projects for the FY 2013-14:

Sr. No.	Particulars	Capital Cost Norm for Solar PV project (₹ Lakh/MW)
1	PV Modules	325.92
2	Additional module cost as against degradation	009.79
3	Land Cost	016.80
4	Civil and General Works	094.50
5	Mounting Structures	105.00
6	Power Conditioning Unit	060.00
7	Evacuation Cost up to Inter-connection Point (Cables and Transformers)	105.00
8	Preliminary and Pre-Operative Expenses including IDC and contingency	080.00
	Total capital Cost	**797.01**

22.4 In view of the above, the capital cost of Solar Photo Voltaic power projects is arrived after rounding off at ₹ **800.00 Lakh /MW** as benchmark project cost of Solar PV projects for determination of tariff.

Capital Cost of Solar Thermal projects

23. Comments

23.1 Since no CSP project has been commissioned, there is no adequate basis to justify reduction in capital cost as considered for the FY 2012-13. It is suggested that an additional capital cost of ₹ 0.25 Crore/MW should be allowed considering exchange rate at ₹ 55/ US$ instead of ₹ 53/ US$ as considered by the Commission. It is also suggested that the cost for township development should be considered as part of capital cost at ₹ 0.25 Crore/MW. Taking both of the above into account, the capital cost for solar thermal project should be increased to ₹ 13.50 Cr per MW. **(Association of Power Producers)**

24. Analysis and Decision

24.1 In the study report on "Concentrated Solar Power: Heating Up India's Solar Thermal Market under the National Solar Mission- September, 2012", prepared by Council on Energy, Environment and Water and Natural Resources Defense Council reported that the cost of a parabolic trough CSP plant in India ranges from ₹10.5 crore to ₹13 crore per MW (approximately $1.9 million to $2.3 million per MW) in capital cost, according to Indian developers consulted. It is also mentioned that storage increases the capital cost further but also increases electricity generation. Considering the same, we retained the project cost as proposed in the draft Order at ₹12.0 crore / MW.

Sd/-	**Sd/-**	**Sd/-**	**Sd/-**
[M. Deena Dayalan]	**[V. S. Verma]**	**[S. Jayaraman]**	**[Dr. Pramod Deo]**
Member	**Member**	**Member**	**Chairperson**

New Delhi
Dated the 28th February, 2013