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: Suo-Motu **Date of Order: 25th October, 2012**

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 has 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 the Regulation 5 of RE Tariff Regulations, the Commission hereby proposes that the Benchmark Capital Cost Norm for Solar PV power projects for the year 2013-14 shall be Rs. 800 Lakh per MW and Benchmark Capital Cost Norm for Solar thermal power projects for the year 2013-14 shall be Rs. 1200 Lakh per MW.

4. The rationale for proposing the above Benchmark Capital Cost Norm for Solar PV power projects and Solar Thermal power projects has been elaborated in enclosed Explanatory Memorandum.

5. Comments /suggestions of the stakeholders on the above proposals are invited by 23rd November, 2012.

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

New Delhi
Dated the 25th October, 2012

Explanatory Memorandum

For

Benchmark Capital Cost Norms for

Solar PV Power Projects

and

Solar Thermal Power Projects

To be applicable

For the year 2013-14

October 2012

CENTRAL ELECTRICITY REGULATORY COMMISSION
NEW DELHI

1. Premise for development of Benchmark Norms

Background

1.1 In exercise of the powers vested under Section 61 read with Section 178 of the Act and after previous publication, the Commission notified the Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2012, (hereinafter referred to as "the RE Tariff Regulations"). The RE Regulations provide for terms and conditions and the procedure for determination of tariff of the following categories of renewable energy generating stations:

(a) Wind Power Project;

(b) Small Hydro Projects;

(c) Biomass Power Projects with Rankine Cycle technology;

(d) Non-fossil fuel-based co-generation Plants;

(e) Solar Photo voltaic (PV);

(f) Solar Thermal Power Projects;

(g) Biomass Gasifier based Power Projects; and

(h) Biogas based Power Project.

1.2 As per first proviso under Regulation 5 of the RE Tariff Regulations, 2012, the benchmark capital cost for Solar PV and Solar thermal power projects is to be reviewed annually. The Commission, for FY 2012-13, specified the normative capital cost for Solar PV and Solar Thermal Power Projects as Rs1000Lakh/MW and Rs1300Lakh/MW respectively.

1.3 It has been observed that after the benchmark capital cost norms specified in the RE Tariff Regulations-2012, there has been downward trend in photovoltaic module prices. As far as Solar Thermal power is concerned no such trend is observed.

2 Benchmark Capital Cost Norm for Solar PV Power Projects for the FY 2013-14

2.1 The solar PV industry has seen significant cost reductions over the last three years showing a declining trend of over 20-22% on annual basis. While the cost of solar PV crystalline module cost was around 2 USD per Watt-peak (Wp), in 2009, now it has fallen down in the range of 0.6-0.65 USD/Wp. The remarkable reductions in module prices have been due to a combination of factors like economies of scale,

technological advances and manufacturing process advances, and over production vis-a-vis demand. There has been observed similar declining trend in terms of the price of balance of system (BoS) due to the reduction in the power electronics, inverters, streamlined installation technologies and processes. The reduced prices in the modules as well as in BoS, and the low cost financing have contributed to the low cost solar electricity sale price in the recent bids.

The allocation of solar PV projects in Phase-1 of Jawaharlal Nehru National Solar Mission (JNNSM) has been done in two batches over two financial years – 2010-2011 and 2011-2012. Solar PV projects of 150MW aggregate have already been allotted in FY 2010-11 as a part of batch I of JNNSM phase I and subsequently bidding for the remaining Solar PV Projects has been carried out through the second batch. In batch I, the range varied from ₹ 10.95/kWh to ₹ 12.76/kWh with an average bid price of Rs. 12.12/kWh[1]. The winning bids for solar PV under batch II of JNNSM phase I varied from ₹ 7.49/kWh to ₹ 9.44/kWh with an average bid price of Rs. 8.77/kWh[2].

Recently, Madhya Pradesh Power Trading Company Limited has invited bids for setting up of Solar Power Projects. The lowest two winning bidders have quoted tariff at ₹ 7.90/kWh and ₹ 8.05/kWh for 20 MW and 125 MW respectively.[3]

PV Module Cost

2.2 According to the PVinsight, the Silicon Module and Thin Film Module's weekly spot prices per watt as on 22nd August 2012 were as low as US$ 0.59 and US$ 0.60 per Watt respectively.

Silicon Cell & Module Prices

Solar PV Module Weekly Spot Price: Last Updated on 2012-08-22, in USD/Wp					
Item	High	Low	Average	Avg.Chg.	Avg. Chg %
Silicon Solar Module	1.10	0.60	0.728	↓ -0.004	↓ -0.55%
Thin-Film Solar Module	1.02	0.59	0.673	↓ -0.001	↓ -0.15%

Source: PVinsights

2.3 Similar trend in spot price is also reported by the Energy Trend. The Silicon Module and Thin Film Module's weekly spot prices per watt as on 22nd August 2012 was around as low as US$ 0.50 and US$ 0.45 per Wp, respectively.

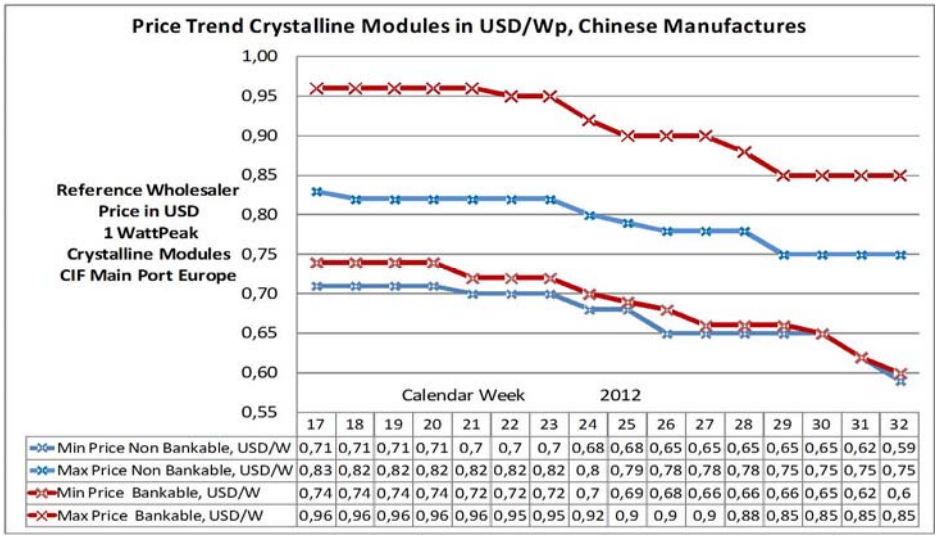
[1] http://www.eai.in,
[2] NTPV Vidyut Vyapar Nigam Limited (NVVN)
[3] EAI and Business line

PV Spot Price (US$), 2012/08/22 00:00 update, weekly)				(Price quotes updated
Item	High	Low	Average	Change
Module Price (Per Wp)	0.90	0.50	0.704	-4.22 %
Thin Film Price (Per Wp)	0.80	0.45	0.686	– 0.00 %

Source: Energy Trend

2.4 The graph below also shows average reference wholesaler price trend in Europe (Germany) for PV crystalline modules of Chinese manufacture. The chart is separated in bankable PV manufactures (i.e. Suntech, Yingli, JA Solar, Canadian Solar, ET Solar, Renesola, etc.) and non-bankable manufactures, for modules certified as per CE, IEC 61215, IEC 61730 and using "A grade" cells.

Price Trend Crystalline Photovolatic Panels, Main Port Europe (net price w/o value tax)



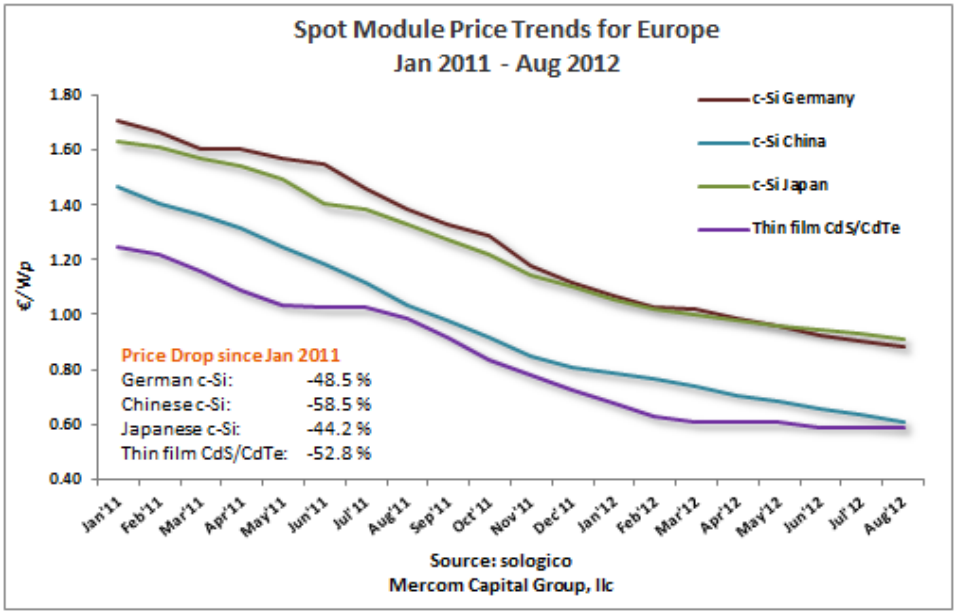
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Min Price Non Bankable, USD/W	0,71	0,71	0,71	0,71	0,7	0,7	0,7	0,68	0,68	0,65	0,65	0,65	0,65	0,65	0,62	0,59
Max Price Non Bankable, USD/W	0,83	0,82	0,82	0,82	0,82	0,82	0,82	0,8	0,79	0,78	0,78	0,78	0,75	0,75	0,75	0,75
Min Price Bankable, USD/W	0,74	0,74	0,74	0,74	0,72	0,72	0,72	0,7	0,69	0,68	0,66	0,66	0,66	0,65	0,62	0,6
Max Price Bankable, USD/W	0,96	0,96	0,96	0,96	0,96	0,95	0,95	0,92	0,9	0,9	0,9	0,88	0,85	0,85	0,85	0,85

Source: A-E-S Europe GmbH

2.5 According to the Mercom's Market Intelligence Report dated 24th September, 2012, wherein they have compared price trends since the beginning of the year: in the "crystalline Germany" category where it is found that the module price decreased by 17.8% than at the beginning of the year. Price for crystalline modules of Japanese manufacturers is, on average, lowered by only 13.3% compared to that at the beginning of the year. While the price for crystalline modules of Chinese manufacturers is, lower by 22.8% in comparison to that at the beginning of the year. The report further anticipates an additional slump in prices of 6% to 9% in both categories by the end of 2012.

PV Price trends in Europe - August 2012			
Module type, origin	€/Wp	Trend since July 2012	Trend since January 2012
Crystalline Germany	0.88	↘ -3.3%	↘ -17.8%
Crystalline China	0.61	↘ -4.7%	↘ -22.8%
Crystalline Japan	0.91	↘ -2.2%	↘ -13.3%
Thin film CdS/CdTe	0.59	↘ -1.7%	↘ -13.2%
Thin film a-Si	0.50	↘ -2.0%	↘ -16.7%
Thin film a-Si/µ-Si	0.57	↘ -3.4%	↘ -25.0%
Data provided by sologico		Mercom Capital Group , llc	

Source: Mercom Capital Group



Source: Mercom Capital Group

2.6 The above analysis reveals that the current thin film module price per Wp varies in the range of $0.4 to $1.0 and crystalline module price varies in the range of $0.50 to 1.0. The tables shown in para 2.2 and 2.3 reveal that the prevailing average crystalline module price is around $0.7 / Wp. Further, the crystalline PV price, have shown downward trend globally in the range of 13.3% to 22.8% since January 2012 to August 2012. Most of the international studies reveal that the prices are expected to decline in future. Considering the same, the Commission proposes to consider base module cost at $0.65/Wp (CIF) i.e. cost, insurance, freight and taxes, for the determination of benchmark capital cost for solar PV projects for FY2013-14. With the exchange rate of Rs. 53/US$, the module cost works out to Rs. 344.5 Lakh/ MW

for the FY 2013-14 for determination of benchmark cost for Solar PV projects for FY 2013-14.

Non-Module Cost Component:

2.7 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 FY2013-14.

Land:

2.8 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 2012-13, had considered land requirement of 5 Acre/MW for crystalline PV project and its cost was considered as Rs. 16 Lakh / MW. The Commission proposes to escalate the normative land cost of FY2012-13 at 5% and proposes the land cost at Rs. 16.80 Lakh/ MW for the determination of benchmark capital cost of Solar PV projects for FY2013-14.

Civil and General Works:

2.9 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, while determining the benchmark capital cost for Solar PV projects for the year 2012-13, had considered the civil and general works together as Rs. 90.00 Lakh /MW. After allowing cost escalation of 5% over the last year's cost the Commission proposes to consider 94.50 lakh/MW as the cost for Civil and General work for benchmark capital cost of Solar PV projects for FY2013-14.

Ground Mounting Structures:

2.10 This expenditure includes cost associated with manufacturing, delivery, installation and calibration of either hot galvanized steel or aluminum structures

including all necessary material, works and installation on prepared foundations/pilings. The Commission, while determining the benchmark capital cost for Solar PV projects for the year 2012-13, had considered the cost of ground mounting structure as Rs. 100.00 Lakh/MW. After allowing cost escalation of 5% over the last year's cost the Commission proposes to consider Rs. 105.00 Lakh/MW towards the cost for Ground Mounting Structures for benchmark capital cost of Solar PV projects for FY2013-14.

Power Conditioning Unit (inverter)

2.11 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. While specifying the benchmark capital cost for solar PV projects in 2012-13, the Commission had considered ₹ 98 Lakh/MW as cost towards Power conditioning unit. Considering the reduction of inverter prices globally and in India it is proposed that expenditure towards Power conditioning unit to be considered as Rs. 60.00 Lakh/MW.

Cables and Transformers

2.12 This expenditure includes EPC cost towards DC cabels 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, while determining the benchmark capital cost for Solar PV projects for the year 2012-13, had considered the cost of cables and transformers and other associated equipments as Rs. 100.00 Lakh/MW. After allowing cost escalation of 5% over the last year's cost, the Commission proposes that Rs. 105 Lakh/ MW may be considered as expenditure towards cables and transformers for solar PV projects for the determination of benchmark capital cost of Solar PV projects for FY2013-14.

Preliminary/Pre-operating expenses and Financing Costs

2.13 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: 0.5%
ii. Contingency: 0.5%
iii. Interest during Construction (IDC): 5%
iv. Financing cost: 1%
v. Project management cost: 1%
vi. Pre-operative Cost: 1.0%

2.14 Preliminary/Pre-operating expenses and Financing Cost contribute to above 10% of total capital cost on average basis. In past years, while determining the benchmark capital cost for solar PV projects, the Commission had considered 10% of total capital cost as preliminary /Pre-operating expenses and Financing cost. Accordingly, Rs. 80.00 Lakh/MW is proposed to be considered as preliminary /Pre-operating expenses and Financing cost.

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

Table: Breakup for Capital cost projection

Sr. No.	Particulars	Capital Cost Norm for Solar PV project (Rs. Lakh/MW)	% of total cost
1	PV Modules	344.50	43%
2	Land Cost	16.80	2%
3	Civil and General Works	094.50	12%
4	Mounting Structures	105.00	13%
5	Power Conditioning Unit	060.00	7%
6	Evacuation Cost up to Inter-connection Point (Cables and Transformers)	105.00	13%
7	Preliminary and Pre-Operative Expenses including IDC and contingency	080.00	10%
8	Total Capital Cost	805.80	100%

2.16 Considering the above the total cost of Solar Photo voltaic power projects for the FY2013-14 is proposed to be considered at Rs. 800.00 lakh/MW as benchmark project cost of Solar PV projects.

3 Benchmark Capital Cost for solar Thermal Power Projects

3.1 As per first proviso under Regulation 5 of the RE Tariff Regulations, 2012, the benchmark capital cost for Solar thermal power projects is to be reviewed annually. The Commission specified the normative capital cost for Solar Thermal Power Projects in past are shown in table given below:

Year	FY 09-10	FY 10-11	FY 11-12	FY 12-13
Capital Cost : ₹ Lakh /MW	1300	1530	1500	1300

3.2 Under the National Solar Mission (NSM), the total aggregated capacity 500 MW of grid connected Solar thermal Projects in Phase 1 proposed to be developed. Bidders of the Solar Thermal Projects were required to submit proposals offering maximum discount on the CERC approved applicable tariff for grid connected solar power projects for FY 2010-11.

3.3 Seven Solar Thermal power projects (470 MW) have been selected through the bidding process under JNNSM Phase–I and its PPAs signed with NVVN by 10th January, 2011. The Commissioning of such Solar Thermal Projects are scheduled by May, 2013.

3.4 List of the Solar Thermal projects selected and discount offered on CERC determined tariff of Rs. 15.31/kWh as follows:

SL No	Name of Bidder	Discount offered (Paisa)	State (Project)	MW (Capacity)	Tariff Quoted ₹/kWh
1	Lanco Infratech	482	Rajasthan	100	10.49
2	KVK Energy Ventures Pvt Ltd	411	Rajasthan	100	11.20
3	Megha Engineering & Infrastructure	400	Andhra Pradesh	50	11.31
4	Rajasthan Sun Technique Energy	334	Rajasthan	100	11.97
5	Aurum renewable Energy Pvt Ltd	312	Gujarat	20	12.19
6	Godawari Power & Ispat Ltd	311	Rajasthan	50	12.20
7	Corporate Ispat alloys Ltd	307	Rajasthan	50	12.24
			Weighted Average	470	11.48

Source: Data collected from NVVN

3.5 Apart from the above referred 470 MW, 30 MW of solar thermal projects are likely to be put up for migration. One project uses PowerTower technology put-up under migration scheme, of 2.5 MW size.

3.6 Developers of solar thermal projects in India are reported to be facing some problems especially in terms of lack of availability of solar irradiation data which is essential for planning and optimizing a solar thermal power project. Due to much lower DNI vis a vis initial estimate, solar field re-engineering is reported to have been carried out by some of the developers. Generation of revised technical specifications and modification of relevant orders placed on various suppliers may cause the delay on the commissioning of the projects.

3.7 Lack of authentic solar irradiation data and lack of data on project costs of projects under commissioning in India, electricity generation potential of typical sites and knowledge of performance of technology in India, and possible impact of rupee depreciation on project cost are the issues before the Commission while determining the benchmark capital cost of the solar thermal project.

3.8 The International renewable energy Agency (IRENA) has in its report on Renewable energy technologies: Cost analysis series – Concentrating Solar Power (June 2012) mentioned that the estimated cost of CSP plants varies significantly, depending on the capacity factor, which in turn depends on the quality of the solar resources, thermal energy storage levels and the technical characteristics of CSP plant. The said report also states that based on the data analysis, for parabolic trough plants without thermal storage, cost could be as low as USD 4600/kW with capacity factor in the range of 20-25%. Report also estimated possible cost reduction by 2015.

	2011		2015	
	2010 USD/kW	Capacity factor (%)	2010 USD/kW	Capacity factor (%)
Parabolic trough				
No storage	4 600	20 to 25	3 900 to 4 100	20 to 25
6 hours storage	7 100 to 9 800	40 to 53	6 300 to 8 300	40 to 53
Solar tower				
6 to 7.5 hours storage	6 300 to 7 500	40 to 45	5 700 to 6 400	40 to 53
12 to 15 hours storage	9 000 to 10 500	65 to 80	8 100 to 9 000	65 to 80

Source: International renewable energy Agency (IRENA)

3.9 However in Indian context the total installed cost is quite lower in comparison to US and Europe market. Reason of variance could be cheaper labour cost etc.

3.10 Though there are opportunities for cost reductions for CSP plant, the fact remains that the commercial deployment of CSP is still in its infancy in India. As experience is gained, R&D advances, mass production of components occurs and increased competition in technology providers develops, costs will come down. However, significant investment in further R&D and deployment will be required to realize these cost reductions.

3.11 Considering the expected reduction in cost of thermal power projects globally as well as the tariff quoted by the bidders selected under JNNSM, the Commission proposes the benchmark capital cost of solar thermal project as ₹ 1200 Lakh/MW for FY 2013-14.

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