KARNATAKA ELECTRICITY REGULATORY COMMISSION

Date: **4th May, 2015**

"Discussion paper on Re-determination of Tariff for grid interactive megawatt scale solar power plants"

1. Introduction:

The Commission in its tariff order dated 10th October, 2013 had determined tariff for grid connected solar photovoltaic, solar thermal power plants and rooftop solar photovoltaic and other small solar power plants. The tariff determined in this order was valid for projects entering into power purchase agreement on or after 1st April, 2013 and upto 31st March, 2018 but excluding those projects where tariff is discovered through bidding process.

The Bangalore Electricity Supply Company (BESCOM) in its review petition RP No. 7/2014 had sought review of the Commission's Order dated 10th October, 2013 on two aspects, namely:

i. Determination of Rs.691Lakhs as capital cost for Solar PV plants and;
ii. Determination of O&M cost of solar thermal projects as per CERC Order dated15th May, 2014.

On consideration of BESCOM's petition, the Commission observed that the tariff discovered through the reverse bidding for procurement of solar power by the Karnataka Renewable Energy Development Ltd., (KREDL) ranges from Rs. 6.66/Unit to Rs. 8.22/Unit. This, the Commission felt that there is substantial reduction in the capital cost after issue of the Commission's Order dated 10th October, 2013. Therefore, the Commission in its Order dated 1st January, 2015 on BESCOM's RP No.7/2014 has decided to examine the need to curtail the present control period and re-determine the tariff in separate proceedings, in due course.

Pursuant to such decision, the Commission has considered it as appropriate to float a discussion paper on the re-determination of tariff for grid interactive megawatt scale Solar Photo voltaic and Solar Thermal power plants. The tariff for kilowatt scale and rooftop solar power plants remains the same as per the existing Order of the Commission dated 10th October, 2013.

Now, the Commission, in exercise of powers conferred under Sections 61(h), 62(1) (a) and Section 86(1) (e) of the Electricity Act, 2003, and the guidelines specified under the National Electricity Policy and the Tariff Policy, proposes to re-determine tariff for grid interactive megawatt scale Solar Photo voltaic and Solar Thermal power plants for the control period from 1st April, 2015 to 31st March, 2018.

2. Status of Solar Power Generation:

The energy requirement in the State has been increasing every year and hence concerted efforts should be made to create adequate generation capacity from all available sources to meet this requirement. The State's energy requirement from FY 2011-12 to FY 2015-16 is as follows:

Figures in Million Units

FY12	FY13	FY14	FY15	FY16
52935	57605	61426	61426	62745

(Data for FY12 to FY14 is as per Annual Performance Review and for FY15 & FY16 is as per approved ARR)

The envisaged growth in FY16 as against FY12 will be 19% i.e. an annual average growth of 5%. To meet this trend of increasing energy requirement, investment in additional generation capacity especially with short gestation period, dependent on locally available resources having no adverse impact on environment need to be encouraged. Available data indicates that the States potential of solar power generation which meets all these requirements has been harnessed minimally.

The State receives an annual average daily Global Horizontal Irradiance (GHI) in the range of 5.41-6.02kWh/m^2/day and an annual average Direct Normal Irradiance (DNI) of 4.87-5.68kWh/ m2/day. The State's average GHI is 5.82 kWh/

m^2/day and DNI is 5.39 kWh/ m^2/day. KREDL has projected a solar grid connected power potential of 10000 MW for the State.

Karnataka is one of the pioneer States in the Country to build megawatt scale solar power plants but has failed to build on that early breakthrough. At present, the State has 84 MWp of Solar Photovoltaic power generation commissioned and connected to the State grid. Further, about 600 MWp generation capacity awarded to various developers on competitive bidding route is in the process of commissioning.

Pursuant to the provisions under Section 86(1) (e) of the Electricity Act, 2003 and clause 6.4 of the Tariff Policy, the Commission has notified the KERC (Power Procurement from Renewable Sources by Distribution Licensee and Renewable Energy Certificate Framework) Regulations, 2011 on 16th March 2011, stipulating that every distribution licensee in the State has to procure 0.25% of their total procurement from solar power. The Regulations provide for purchase of solar energy or solar Renewable Energy Certificates (REC) to meet the stipulated solar Renewable Power Procurement (RPO) obligations.

The Ministry of New and Renewable Energy (MNRE) vide its letter dated 14th January 2013 has stated that, capital subsidy to the tune of 30% of the cost of the project is provided for promoting grid connected rooftop/ground mounted solar PV power plants. Considering this subsidy, the MNRE has stated that the cost of green power generation would be Rs. 6-7 per kWh in the long term. The MNRE has requested the SERCs to determine tariff for roof top systems considering 30% capital subsidy and or accelerated depreciation.

The MNRE has also issued draft Guidelines for Implementation of Scheme for Setting up of 2000 MW Grid-connected Solar PV Power Projects under Batch – III wherein it has suggested viability gap funding scheme with a levelised tariff of Rs.5.79/kwh.

The Karnataka Solar Policy 2014-21 dated 22nd May, 2014 proposes to ensure installation of grid connected solar power plants with capacity of 1600MW and roof top projects with aggregate capacity of 400MW by 2021.

3. Re-determination of tariff:

The Commission notes that CERC and other SERCs that have recently determined tariff for solar power have considered the following parameters.

i. Applicable for Solar photovoltaic plants:

State	Tamil Nadu	Rajasthan		Haryana	CERC
Date of issue	12.09.2014	21.08.2014	31.03.2015	13.08.2014	03.03.2015
Draft/Final	Final Order	Final Order	Draft Order	Final Order	Draft Order
Applicability	All solar power plants commissioned during the control period	Applicable to plants whose PPA is signed on or before 31.03.2015 and which get commissioned on or before 31.03.2016	Applicable to solar plants where PPA is signed on or before 31.03.2016 and to be commissioned on or before 31.03.2017	Plants to be commissioned in FY 2014-15 and FY 2015-16	Projects to be commissioned during FY 2015-16
Capital cost	Rs. 7Crores/MW	Rs.6.73 Crores/MW	Rs. 5.65 Crores/MW	**(a)** Solar PV Crystalline- Rs. 7.05 Crores/MW **(b)** Solar PV Thin Film- Rs. 6.81 Crores/MW **(c)** Solar PV Rooftop- Rs. 6.80 Crores/MW	**(a)** Rs. 10 Crore/MW for the FY 2012-13; **(b)** Rs. 8 Crore/MW for the FY 2013-14; **(c)** Rs. 6.91 Crore/MW for the FY 2014-15; **(d)** Rs. 5.87Crore/MW for FY 2015-16
Auxiliary Consumption	-	0.25%		-	-
CUF	19%	20% with deration factor of 0.50% of CUF for every year after second year	20% with deration factor of 0.50% of CUF for every year after second year	19%	19%

Operation and maintenance expenses	1.4% of the capital cost with 5.72 % escalation after 1st year	12.76 Lakh/MW with an escalation of 5.85% per annum	Rs. 13.00 Lakh/MW for FY 2015-16 with an escalation of 5.85% per annum over the tariff period	Rs. 1.1629 million/MW for Crystalline technology and Rs. 1.124 million/MW for thin film and roof top with an escalation of 5.72%	Rs. 13.00 Lakh/MW for FY 2015-16 (escalation of 5.72% per annum)
Life of plant and machinery	25 years	25 years	25 years	25 years	25 years
Term of Loan	10 years +1 yr Moratorium	12 years	12 years	10 years	12 years
Interest on loan	12.70%	12.71%	13.00%	13.75%	13.00%
Working Capital components	One month O&M cost and two months receivables	**(a)** O&M for one month; **(b)** Receivables equal to one and a half months of charges for sale of electricity calculated at the normative CUF; **(c)** Maintenance Spares at 15% of O&M Expenses.	**(a)**O&M expenses for one month; **(b)** Receivables equal to one and a half months of charges for sale of electricity calculated at the normative CUF; **(c)** Maintenance Spares at 15% of O&M Expenses.	**(a)**O&M for one month; **(b)** Receivables equivalent to 2 months of energy charges for sale of electricity calculated on the normative CUF; **(c)** Maintenance spare @ 15% of operation and maintenance expenses.	**(a)** O&M expenses for one month; **(b)** Receivables equivalent to 2 months of energy charges for sale of electricity calculated on the normative CUF; **(c)** Maintenance spare @ 15% of operation and maintenance expenses
Interest on working capital	13.20%	12.21%	12.50%	14.00%	13.50%
Return on equity	20% pre tax	Computed by grossing up the base rate of 16% with MAT rate (20.01% for 1st year and 19.06% for remaining 9 years) for first 10 years and normal tax rate for remaining useful life	Computed by grossing up the base rate of 16% with MAT (20.39% for 1st year; 19.06% for next 9 years) for first 10 years and normal tax =	16% on normative equity (MAT / Corporate Tax shall be separately allowed in the tariff)	20% per annum for the first 10 years, and 24% per annum from the 11th year onwards (Weighted average of ROE= 22.40%)

			30.90% for next 15 years		
Debt-equity ratio	70/30	70/30	70/30	70/30	70/30
Depreciation rate	3.6% on 95% of the Capital Investment	5.83% per annum and from 13th year onwards, the remaining depreciable value has been spread over the balance useful life	5.83% for the first 12 years and from 13th year onwards, the remaining depreciable value has been spread over the balance useful life	7% for first 10 years up to maximum of 90%	5.83% for the first 12 years then 1.54% for the balance useful life
Discount factor	10.07%	13.10%	10.89%	14.42%	10.81%
Tariff	Rs. 7.01/kWh	Rs. 7.50 /kWh	Rs. 6.45 /kWh	Solar PV Crystalline-7.45/kWh Solar PV Thin Film-7.20/kWh Solar PV Rooftop-7.19/kWh	Rs. 6.86/kWh
Accelerated Depreciation	Rs. 0.73/kWh	Rs. 0.87/kWh	Rs. 0.61/kWh		Rs.0.67/kWh

ii. Applicable for Solar Thermal plants:

State	**Tamil Nadu**	**Rajasthan**		**Haryana**	**CERC**
Date of issue	12.09.2014	21.08.2014	31.03.2015	13.08.2014	03.03.2015
Draft/Final	Final Order	Final Order	Draft Order	Final Order	Draft Order
Applicability	All solar power plants commissioned during the control period	Applicable to plants whose PPA is signed on or before 31.03.2015 and which get commissioned on or before 31.03.2017.	Applicable to solar plants where PPA is signed on or before 31.03.2016 and to be commissioned on or before 31.03. 2018	Plants to be commissioned in FY 2014-15 and FY 2015-16	Projects to be commissioned during FY 2015-16

Capital cost	Rs. 12 Crores/MW	Rs. 11.95 Crores/MW	Rs. 11.82 Crores/MW	Rs. 12 Crores/MW	Rs.13 Crores/MW for the FY 2012-13; Rs.12 Crore/MW for the FY 2013-14, FY 2014-15 and FY 2015-16;
Auxiliary Consumption	10%	6.50%	6.50%	10%	10%
CUF	23%	23% with deration factor of 0.25%of CUF for every year after four year	23% with deration factor of 0.25% of CUF for every year after four year	23%	23%
Operation and maintenance expenses	1.4% of the capital cost with 5.72 % escalation after 1st year	17.24 Lakh/MW with an escalation of 5.85% per annum*[1]	Rs. 17.75 Lakh/MW with an escalation of 5.85% per annum over the tariff period	Rs. 1.63 Million/MW with an escalation of 5.72% per annum over the tariff period	Rs.17.72 Lakh/MW for FY 2015-16(escalation of 5.72% per annum)
Life of plant and machinery	25 years	25 years	25 years	25 years	25 years
Term of Loan	10 years +1 yr Moratorium	12 years	12 years	10 years	12 years
Interest on loan	12.70%	12.71%	13.00%	13.75%	13.00%
Working Capital components	One month O&M cost and two months receivables	**(a)** O&M for one month; **(b)** Receivables equal to one and a half months of charges for sale of electricity calculated at the normative CUF; **(c)** Maintenance Spares at 15% of O&M Expenses.	**(a)** O&M expenses for one month; **(b)** Receivables equal to one and a half months of charges for sale of electricity calculated at the normative CUF; **(c)** Maintenance Spares at 15% of O&M Expenses.	**(a)** Operation & Maintenance expenses for one month; **b)** Receivables equivalent to 2 months of energy charges for sale of electricity calculated on the normative CUF; c) Maintenance spare @ 15% of operation and maintenance expenses.	**(a)**O&M expenses for one month; **(b)** Receivables equivalent to 2 months of energy charges for sale of electricity calculated on the normative CUF; **(c)** Maintenance spare @ 15% of operation and maintenance expenses
Interest on working capital	13.20%	12.21%	12.50%	14.00%	13.50%

Return on equity	20% pre tax	RoE is computed by grossing up the base rate of 16% with MAT rate (20.01% for 1st year and 19.06% for remaining 9 years) for first 10 years and normal tax rate for remaining useful life	Computed by grossing up the base rate of 16% with: 1)MAT =20.39% for first year; 2)MAT = 19.06% for 9 years; 3) normal tax = 30.90% for 15 years	16% on normative equity and MAT / Corporate Tax shall be separately allowed in the tariff	20% per annum for the first 10 years, and 24% per annum from the 11th year onwards (Weighted average of ROE= 22.40%)
Debt-equity ratio	70/30	70/30	70/30	70/30	70/30
Depreciation rate	3.6% on 95% of the Capital Investment	5.83% per annum and from 13th year onwards, the remaining depreciable value has been spread over the balance useful life	5.83% for the first 12 years and from 13th year onwards, the remaining depreciable value has been spread over the balance useful life	7% for first 10 years up to maximum of 90%	5.83% for the first 12 years then 1.54% for the balance useful life
Discount factor	10.07%	13.10%	10.89%	14.42%	10.81%
Tariff	Rs. 11.03/kWh	Rs. 11.67/kWh,	Rs. 11.46/kWh	Rs. 11.34/kWh	Rs.12.05/kWh
Accelerated Depreciation	Rs. 1.15/kWh	Rs. 1.40/kWh	Rs. 1.16/kWh		Rs. 1.25/kWh

Further, the Commission notes that the recent bids opened by KREDL on 29th October, 2014 for procurement of 500MW solar power indicates the quoted tariff is ranging between Rs.6.71/Unit to Rs.7.12/Unit.

Considering the present tariffs determined in other States and tariff discovered in the bidding process by KREDL, revision of tariff for grid connected solar power plants is proposed as discussed in the following paragraphs.

3.1. Re-determination of Tariff for Megawatt scale Solar PV and Solar Thermal power plants

The Commission proposes the following parameters for re-determination of tariff of Megawatt scale Solar PV and Solar Thermal power plants:

i) Life of the Plant:

It is proposed to continue with the life of plant currently fixed at 25 years for the purpose of determination of tariff.

ii) Term and Tariff design:

Since the life of the plant is being considered as 25 years, in order to ensure certainty of revenue streams to the investors, the Commission proposes to continue with current provision of levelized tariff for a period of 25 years.

iii) Capacity Utilisation factor:

The Commission in its tariff order dated 10th October, 2013 had considered CUF of 19% for solar photovoltaic plants and 23% for solar thermal plants. The Commission proposes to continue with same levels of CUF.

iv) Capital Cost:

The Commission in its tariff order dated 10th October, 2013 had considered capital cost of Rs.8.30 Crores per MW for solar PV and Rs.12.00 Crores per MW for solar thermal plants.

The capital costs considered by other Commissions are as follows:

Particulars	CERC (draft)	HERC	RERC(draft)
Solar PV	Rs. 5.87 Crores/MW	Rs.6.81-7.05 Crores / MW	Rs. 5.65 Crores / MW
Solar Thermal	Rs. 12.00 Crores / MW	Rs.12.00 Crores / MW	Rs.11.82 Crores / MW

It is observed that the CERC in their Draft Order dated 3rd March, 2015, in the matter of determination of benchmark capital cost norm for Solar PV power projects and Solar Thermal power projects, has carried out detailed analysis for evolving the benchmark capital cost norm for Solar PV Power Projects applicable during FY 2015-16.

The CERC in the above order, has considered the average module cost of 0.52 US$/Wp for determination of benchmark capital cost for FY 2015-16 and considering an average of exchange rate of Rs. 61.06/US$ of past six months, CERC arrived at module cost of Rs. 317.50 Lakh/MW. Further, the CERC in the above mentioned Order has considered the benchmark capital cost for Solar PV power projects as Rs. 5.87 Cr/MW for determination of tariff. The break up of capital cost is as under:

Break-up for capital cost considered by CERC

Sl. No.	**Particulars**	**Capital cost Norm for Solar PV project (Rs. Lakhs/MW)**
1	PV Modules (@ Rs. 62/ US $)	327.33
2	Land Cost	25
3	Civil and General Works	50
4	Mounting Structures	50
5	Power Conditioning Unit	45
6	Cables and Transformers	50
7	Preliminary and Pre-operative expenses IDC etc.	40
8	**Total Capital Cost**	**587. 33**

The Commission notes that on similar lines the PV Insights Report dated 8th April, 2015 indicates the following module prices:

Item	**High USD / Watt**	**Low USD / Watt**	**Average USD / Watt**
Silicon Solar Module	0.84	0.48	0.584
Thin Film Solar Module	0.8	0.49	0.62

The Commission notes that the cost of modules has come down further from 0.52USD/MWp obtaining during December, 2014 to 0.48 USD/MWp in April, 2015. Considering the average cost at 0.50 USD/MWp and an exchange rate of Rs.62.393 per USD (average of one month i.e. from 15th March, 2015 to 15th April, 2015), the cost of solar PV modules works out to Rs. 311.965 Lakhs per MW.

With this cost, considering the other components of the capital cost as determined by CERC, the capital cost for Solar PV plants will be as follows:

Break-up for capital cost considered by KERC

Sl. No.	Particulars	Capital cost Norm for Solar PV project (Rs. Lakh/MW)
1	PV Modules (@ Rs. 62.393/ US $)	311.965
2	Land Cost	25
3	Civil and General Works	50
4	Mounting Structures	50
5	Power Conditioning Unit	45
6	Cables and Transformers	50
7	Preliminary and Pre-operative expenses IDC etc.	40
8	**Total Capital Cost**	**571.965**

Accordingly, the Commission proposes to consider capital cost of Rs.572 Lakhs per MW for Solar PV plants.

As regards the capital cost for solar thermal power plants, since no new data is available and capital cost considered by CERC and other State ERCs are comparable with the current levels fixed by it, the Commission proposes to retain the capital cost at Rs.12.00 Crores per MW.

v) Debt-Equity Ratio

The Commission proposes to consider a debt equity ratio of 70:30 as currently fixed for the purpose of factoring loan and equity.

vi) Operation & Maintenance Cost:

The operation and maintenance cost consists of employee cost, administrative and general expenses and Repairs & Maintenance expenses. The Commission in its present order has considered O & M expenses of Rs.12.00 lakhs / MW for solar PV plants and Rs.18.00 lakhs / MW for solar thermal plants with an annual escalation of 5.72%.

CERC has considered O & M expenses of Rs.13.00 lakhs / MW for solar PV plants and Rs.17.72 lakhs / MW for solar thermal plants with an annual escalation of 5.72%.

The Commission is of the view that it would be appropriate to consider a percentage of the capital cost as O & M expenses duly providing annual escalation to meet the inflationary costs.

vi) Auxiliary consumption:

The Commission in its present order has considered auxiliary consumption of 8% of the gross generation by solar thermal plants and 0.25% for solar photovoltaic plants. CERC has considered auxiliary consumption of 10% for solar thermal and no auxiliary consumption for solar photovoltaic.

The Commission considers that there is a need to review the quantity of auxiliary consumption to be considered for determination of tariff based on the suggestions/comments it receives.

vii) Interest and Tenure of Debt:

Considering the normative tenure of long term debts, the Commission proposes to consider the tenure of debts as 10 years. The Commission needs to review the interest on debt based on the prevailing interest rates applicable for solar power projects.

viii) Working Capital:

The Commission in its present tariff order has considered two months receivables as working capital. The Commission proposes to fix the appropriate working capital suitable for solar power projects based on the suggestions / comments it receives.

ix) Interest on Working Capital:

The Commission in its present Order has considered interest on working capital at 13.00%. Considering the prevailing base rates and interest rates on short term loans, the Commission proposes to decide suitably the allowable interest on working capital.

x) Depreciation:

Since the Commission has proposed 70% of the capital cost to be financed by debt component and the tenure of debt being 10 years, the Commission proposes to continue with annual depreciation at 7% for first 10 years to provide adequate depreciation to meet the loan repayment and annual depreciation at 1.33% for the balance period of 15 years.

xi) Return on Equity:

The Commission in its present tariff order has allowed RoE of 16% and the actual tax component as a pass through. The Commission proposes to continue with the same

xii) Discount Rate:

This factor is required to compute the time value of money. Since the financing of capital cost is based on 70% debt and 30% equity, the Commission is of the opinion that it would be appropriate to consider weighted average cost of capital (WACC) as the discount factor.

The revised tariff to be determined will be applicable to the solar plants entering into power purchase agreement between 1st April, 2015 and on or before 31st March, 2018 but excluding those projects where the tariff is discovered through bidding process.

3. Suggestions/Comments/Views:

As per the above discussions, the Commission proposes to determine tariff on a generic basis for solar power plants. Suggestions/comments/views of the stakeholders and the general public are invited on the following issues:

1. Capital cost per MW for Solar PV and Solar thermal plants;
2. The annual O&M expenses and escalation to be allowed;
3. Any other issue considered relevant for tariff determination.

The Commission requests all stakeholders and the general public to furnish their views/suggestions/comments before 5th June, 2015. The stakeholders are requested to furnish any documents or material as may be available in support of their proposals / views so as to enable determination of tariff in a reasonable manner.