TAMIL NADU ELECTRICITY REGULATORY COMMISSION

Consultative Paper for issue of Tariff order for Solar power and related issues

(Comments/Suggestions are invited on or before 01.03.2019)

1.0 Overview and need for consultative paper

1.1 Commission in exercise of the powers vested under the Electricity Act,2003 and in compliance with the mandate of the Act to promote renewable energy has been issuing tariff orders in respect of various sources of renewable energy since 2006. These orders on renewable energy sources covered tariff determination for purchase of power by the Distribution licensee, its promotional aspects and related issues.

1.2 The conducive policies of the Central and State Government for promotion of renewable power has helped the sector achieve remarkable progress.

1.3 The total capacity of renewable power in the State is 11759.58 MW of which solar power constitutes 2431.49 MW. The Government of India has fixed a target of 175,000 MW of renewable capacity by 2022. The target fixed for solar power by Government of India is 100,000 MW through deployment of 40,000 MW of rooftop solar projects and 60,000 MW of large and medium scale solar projects. The targeted capacity for this State is 8971 MW by 2022. Commission issued the last tariff order on solar power on 28.3.2018 vide Order

No.5 of 2018. The control period of Order No.5 of 2018 on solar power expires on 31.3.2019.

1.4 Preferential tariffs played a major role in promoting solar power in the initial stage. Over the last few years, there is a shift from the feed in tariff regime to tariff based competitive bidding and reverse auctions. The price per unit of solar power which was around Rs.4 fell to Rs. 2.97 per unit in February 2017 in the bidding conducted for the Rewa Solar power plant in Madhya Pradesh and fell further to Rs.2.44 per unit in the auction held for the Bhadla Solar park in Rajasthan in May 2017. Again there was a raise in the price of solar power in the auctions held in Gujarat and Karnataka where the prices increased to Rs.2.65 and Rs.2.94 per unit respectively.

1.5 Solar auction conducted by Solar Energy Corporation of India(SECI) in Uttar Pradesh(UP) in June 2018 saw a winning bid of Rs.3.32. Another auction conducted by the State agency Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) in UP in July 2018 saw the solar tariffs rise to Rs.3.48 to Rs.3.55 per unit. This auction was subsequently cancelled. Many tenders of SECI and other states were scrapped due to higher bid prices for solar power. This was followed by a cap fixed by Ministry of New and Renewable Energy (MNRE) on the Solar power tariff at Rs.2.50 per unit and Rs.2.68 per unit for the developers using domestic and imported solar cells and modules respectively. The solar auction of National Thermal Power Corporation(NTPC)

held in August 2018 fetched tariffs of Rs.2.59 to Rs.2.60 per unit which included safeguard duty. Maharashtra State Electricity Distribution Company Ltd.(MSEDCL) has recently issued a tender for procurement of 1 GW of solar power fixing a ceiling tariff of Rs.2.80 per unit. The bidding processes in the past one year show levels of volatility in solar power pricing creating uncertainty in contracting power projects through auction mode.

1.6 The tariffs obtained in the various tenders floated by Solar Energy Corporation of India and few States are encapsulated here:

- Solar Energy Corporation of India (SECI) tendered 3 GW of ISTS connected solar capacity in January 2018, for which the auction was held in July 2018. The lowest tariff obtained was Rs.2.44/unit and the tariffs quoted ranged from Rs.2.44 to 2.71 per unit.
- In April 2018, MSEDCL retendered 1 GW of grid-connected solar PV projects. The lowest tariff quoted in the auction held by MSEDCL in May 2018 was Rs.2.71 per unit. MSEDCL has issued a tender for 1 GW solar projects in December 2018 with a ceiling tariff of Rs.2.80 per unit.

- National Thermal Power Corporation (NTPC) tendered a total of 2 GW of grid-connected solar projects to be developed across the country and the tariffs quoted in the auction held in August 2018 ranged between Rs.2.59 to Rs.2.60 per unit with a lead time for procurement of 18 months. NTPC emerged as the lowest bidder by quoting Rs.3.02 /kWh to develop 85 MW

of grid-connected solar PV projects in the auction conducted by the Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) for 550 MW of grid-connected solar projects.

- UPNEDA cancelled a tender in July 2018 as the auctions held saw a lowest quote of Rs.3.48 per unit. Uttar Pradesh has announced a tender for 500 MW of grid-connected solar projects. The upper tariff ceiling is Rs.3.05/kWh and the bid-submission deadline is February 14, 2019.

- KREDL in a tender issued in October 2018 has awarded 100 MW of grid connected solar projects following a reverse auction that fetched a tariff of Rs.2.91 per unit in January 2019.

- The Grid Corporation of Odisha (GRIDCO) recently cancelled 125 MW out of its auction conducted for 200 MW of grid-connected solar projects. Many of the developers quoted tariffs of Rs.3.19, Rs.3.20 per unit.
- SB Energy quoted the lowest tariff of Rs.2.84 /kWh to develop 250 MW of solar projects in the auction conducted in January 2019 by Gujarat Urja Vikas Nigam Limited for 700 MW of solar power projects to be set up under Phase III of the Raghanesda Solar Park located in Gujarat.

- The SECI has issued a tender for 1,200 MW of interstate transmission system (ISTS)-connected solar photovoltaic (PV) projects to be developed across the country with the bid submission deadline on 12th February 2019. The upper tariff ceiling is Rs.2.65 /kWh for this tender. The deadline for bid submission is February 2019.

In most cases, the bidders have quoted tariffs below Rs.3 per unit. However, the tariff rates differ in each State. The latest tender floated by TANGEDCO for procurement of solar power has not received any bids.

1.7 Therefore, Commission issues this consultative paper for fixing a feed in tariff for solar power inviting comments/suggestions from stakeholders.

2.0 Legal framework:

2.1 Related Provisions of Electricity Act, 2003

2.1.1 Relevant provisions of Electricity Act, 2003 are reproduced below:

"Section 3(1): The Central Government shall, from time to time, prepare the National Electricity Policy and tariff policy, in consultation with the State Governments and the Authority for development of the power system based on optimal utilisation of resources such as coal, natural gas, nuclear substances or materials, hydro and renewable sources of energy.

Section 61: The Appropriate Commission shall, subject to the provisions of this Act, specify the terms and conditions for the determination of tariff, and in doing so, shall be guided by the following, namely:-

……

(h) the promotion of cogeneration and generation of electricity from renewable sources of energy;

(i) the National Electricity Policy and tariff policy:

Section 62(1): The Appropriate Commission shall determine the tariff in accordance with the provisions of this Act for –

(a) supply of electricity by a generating company to a distribution licensee:

Section 62(2): The Appropriate Commission may require a licensee or a generating company to furnish separate details, as may be specified in respect of generation, transmission and distribution for determination of tariff.

Section 62(5): The Commission may require a licensee or a generating company to comply with such procedure as may be specified for calculating the expected revenues from the tariff and charges which he or it is permitted to recover.

Section 63: Notwithstanding anything contained in section 62, the Appropriate Commission shall adopt the tariff if such tariff has been determined through transparent process of bidding in accordance with the guidelines issued by the Central Government.

Section 86(1)(e): The State Commission shall promote cogeneration and generation of electricity from renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any person, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licensee;"

2.2. Related Provisions of National Electricity Policy

2.2.1 Relevant provisions of National Electricity Policy are reproduced below:

"Section 5.2.20 Feasible potential of non-conventional energy resources, mainly small hydro, wind and bio-mass would also need to be exploited fully to create additional power generation capacity. With a view to increase the overall share of non-conventional energy sources in the electricity mix, efforts will be made to encourage private sector participation through suitable promotional measures.

Section 5.12.2 The Electricity Act 2003 provides that co-generation and generation of electricity from non-conventional sources would be promoted by the SERCs by providing suitable measures for connectivity with grid and sale of electricity to any person and also by specifying, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licensee. Such percentage for purchase of power from non-conventional sources should be made applicable for the tariffs to be determined by the SERCs at the earliest. Progressively the share of

electricity from non-conventional sources would need to be increased as prescribed by State Electricity Regulatory Commissions. Such purchase by distribution companies shall be through competitive bidding process. Considering the fact that it will take some time before non-conventional technologies compete, in terms of cost, with conventional sources, the Commission may determine an appropriate differential in prices to promote these technologies."

2.3. Related Provisions of Tariff Policy

2.3.1 Relevant provisions of Tariff Policy, 2016 are reproduced below:

"Para 6.4 "(1) Pursuant to provisions of section 86(1)(e) of the Act, the Appropriate Commission shall fix a minimum percentage of the total consumption of electricity in the area of a distribution licensee for purchase of energy from renewable energy sources, taking into account availability of such resources and its impact on retail tariffs. Cost of purchase of renewable energy shall be taken into account while determining tariff by SERCs. Long term growth trajectory of Renewable Purchase Obligations (RPOs)will be prescribed by the Ministry of Power in consultation with MNRE.

…….

(i) Within the percentage so made applicable, to start with, the SERCs shall also reserve a minimum percentage for purchase of solar energy from the date of notification of this policy which shall be such that it reaches 8% of total consumption of energy, excluding Hydro Power, by March 2022 or as notified by the Central Government from time to time.

……

(iii) It is desirable that purchase of energy from renewable sources of energy takes place more or less in the same proportion in different States. To achieve this objective in the current scenario of large availability of such resources only in certain parts of the country, an appropriate mechanism such as Renewable Energy Certificate (REC) would need to be promoted. Through such a mechanism, the renewable energy based generation companies can sell the electricity to local distribution licensee at the rates for conventional power and can recover the balance cost by selling certificates to other distribution companies and obligated entities enabling the latter to meet their renewable power purchase obligations. The REC mechanism should also have a solar specific REC.

(iv) Appropriate Commission may also provide for a suitable regulatory framework for encouraging such other emerging renewable energy technologies by prescribing separate technology based REC multiplier(i.e granting higher or lower number of RECs to such emerging technologies for the same level of generation).Similarly, considering the change in prices of renewable energy technologies with passage of time, the Appropriate Commission may prescribe vintage based REC multiplier(i.e granting higher or lower number of RECs for the same level of generation based on year of commissioning of plant).

(2) States shall endeavor to procure power from renewable energy sources through competitive bidding to keep the tariff low, except from the waste to energy plants. Procurement of power by Distribution Licensee from renewable energy sources from projects above the notified capacity, shall be done through competitive bidding process, from the date to be notified by the Central Government.

However, till such notification, any such procurement of power from renewable energy sources projects, may be done under Section 62 of the Electricity Act, 2003."

2.4 Regulation 4 of the Power Procurement from New and Renewable Sources of Energy Regulation, 2008, specifies as follows:

"(1) The Commission shall follow the process mentioned below for the determination of tariff for the power from new and renewable sources based generators, namely;-

a) initiating the process of fixing the tariff either suo motu or on an application filed by the distribution licensee or by the generator.
b) inviting public response on the suo motu proceedings or on the application filed by the distribution licensee or by the generator.
c) (Omitted)
d) issuing general / specific tariff order for purchase of power from new and renewable sources based generators.

"(2) While deciding the tariff for power purchase by distribution licensee from new and renewable sources based generators, the Commission shall, as far as possible, be guided by the principles and methodologies specified by:
(a) Central Electricity Regulatory Commission
(b) National Electricity Policy
(c) Tariff Policy issued by the Government of India
(d) Rural Electrification Policy
(e) Forum of Regulators (FOR)

(f) Central and State Governments

(3) The Commission shall, by a general or specific order, determine the tariff for the purchase of power from each kind of new and renewable sources based generators by the distribution licensee. ...
Provided where the tariff has been determined by following transparent process of bidding in accordance with the guidelines issued by the Central Government, as provided under section 63 of the Act, the Commission shall adopt such tariff.
…….”

2.5 The preamble of the Electricity Act,2003 promotes competition in the power sector. The National Electricity Policy 2005 also promotes procurement of energy from renewable energy sources and promotes purchase of renewable energy by the distribution companies through competitive bidding process. The National Electricity Policy and the Tariff Policy 2006 reconciled to the fact that it will take some time for the nonconventional energy sources to compete with conventional sources of energy and hence recommended procurement from such sources by distribution companies at preferential tariffs to be determined by the Commissions. The Tariff Policy 2016 has reckoned that to keep the tariff low, states have to endeavour to procure power from renewable energy sources, except waste to energy plants, through competitive bidding and the Distribution licensee shall procure power from renewable energy sources from projects above the notified capacity, through competitive bidding process, from the date to be notified by the Central Government.

2.6 Commission’s Regulations on Power Procurement from New and Renewable Sources of Energy provide for initiating the process for fixing the tariff suo motu or on an application by the distribution licensee or generator. The

Regulations provide for determination of tariff by generic or specific order and to adopt a tariff if the tariff has been determined by a transparent process following guidelines issued by Central Government.

2.7 The Regulations of Central Electricity Regulatory Commission does not provide for determination of annual generic tariff for Solar PV and Solar thermal power projects but provide for determination of project specific tariff and while doing so the financial and operational norms as may be specified would be the ceiling norms.

2.8 Government of India has issued guidelines for tariff based competitive bidding process for procurement of power from grid connected solar power projects vide resolution No. 23/27/2017-R&R.-1 dt.3.8.2017. According to Clause 4.3.1 of Solar Competitive bidding guidelines, *"The Procurer shall specify that the tariff quoted by the bidder cannot be more than the tariff for grid-connected solar PV power plants, notified by the Appropriate Commission, if any, for the financial year in which the bids are invited."*

2.9 This State has high solar insolation capable of attracting more number of solar power projects. Determination of project specific tariff vs generalized tariff is discussed in para 4.2 of this paper

3.0 Technology and standards for Solar photovoltaics

3.1 Photovoltaics (PV) is the direct method of converting sunlight into electricity through a device known as the "Solar Cell". Many different solar cell technologies

such as mono-crystalline and poly-crystalline silicon, thin films such as amorphous silicon, micromorph, cadmium telluride, copper indium gallium selenide and concentrator-based high-efficiency III-V, etc. are available in the market today. Further, substantial R&D efforts are also underway globally for enhancing efficiencies, developing novel cell technologies that entail in reduction of costs of these solar cells.

3.2. Standards - Each of these technologies have different cost implications based on their efficiency, reliability, mounting, tracking, land, water and other requirements. The final selection of the technology shall be left to the Solar Power Developers. The minimum technical requirements would be as per the regulations/specifications issued by the Central Electricity Authority and Ministry of New and Renewable Energy and the developers shall adhere to them. Building of a solar power plant within the committed schedule and achieving optimal performance over its life period depends on choice of various factors and these may be best left to the developer.

4.0 Tariff/Pricing methodology

4.1 Tariff / Pricing Methodology followed is as specified in Regulation 4(2) of the Power Procurement from New and Renewable Sources of Energy Regulations, 2008 reproduced in para 2.4 above.

4.2 Project specific or Generalized Tariff

4.2.1 A generalized tariff mechanism would provide incentive to the investors for use of most efficient equipment to maximize returns and for selecting the suitable site while a project-specific tariff would provide each investor, irrespective of the machine type, the stipulated return on equity which, in effect, would shield the investor from the uncertainties involved. This order provides for power purchase by distribution licensees to meet their Solar Purchase Obligation as specified in the Commission's Regulations and the commitment to promote renewable energy. The solar power plants commissioned in the State have mostly adopted similar technology with minor modifications. Hence, the Commission decides to issue a generalized tariff order for Solar Photovoltaic.

4.3 Single Part vs. Two Part Tariff

4.3.1 Two part tariff is generally adopted when the variable component is significant. In the case of solar energy generation, no variable cost like fuel cost is involved. Operation, maintenance and insurance cost could be taken care of by adopting suitable parameters. Therefore, the Commission proposes to continue with the single part tariff system for solar power generation.

4.4 Cost-Plus Tariff Determination

4.4.1 Regulation 4(6) of “Power Procurement from New and Renewable Sources of Energy Regulations, 2008” empowers the Commission to adopt “appropriate tariff methodology” to determine the tariff for solar power. Cost-plus tariff determination is a more practical method. It can be easily designed to provide adequate returns to the investor and a surety of returns will lead to larger investment in solar power plants. Commission in the last four tariff orders issued for solar power in 2014, 2016, 2017 and the latest Order No.5 of 2018 dt.28.3.2018 adopted cost plus single part levellised tariff taking into account the Accelerated Depreciation (AD) benefit as done by many other State Electricity Regulatory Commissions(SERCs). The Commission proposes to adopt the same methodology in this tariff order also.

5.0 Tariff components

5.1 The Commission has carried out a detailed analysis of the existing policies/procedures and commercial mechanisms in respect of solar power generation. The tariff determined in a cost plus scenario, would depend significantly on the following operating and financial parameters:

1. Capital cost
2. Capacity Utilization Factor
3. Operation and Maintenance expenses
4. Insurance cost

5. Debt-Equity ratio

6. Term of Loan and Interest

7. Life of plant and machinery

8. Return on Equity

9. Depreciation rate applicable

10. Interest and Components of Working Capital

11.Discount factor

12.Auxiliary consumption

5.2 Capital cost

5.2.1 The cost of the equipments involved is an important factor in determination of overall cost of the plants. The main components of a photovoltaic power plant are the photo voltaic modules, inverters, module mounting structures, cables, control panels, switchyard etc. Apart from the above, erection of power plant involves cost of land, civil works and evacuation infrastructure.

5.2.2 Market reports indicate a decline in price of solar PV cells from the date of issue of the previous tariff order in 2018. Literature on solar pricing and reports in leading magazines show a transition in module pricing from the place of origin to efficiency of modules. There is a wide range of availability of solar modules at different prices. The price of a solar module depends on quality, energy yielding capacity, availability and the demand in the market. With high degree of automation, economies of scale and day to day advancements in technology,

manufacturers are able to produce less expensive products with good efficiency, meeting strict quality requirements. Therefore, the right choice of solar modules, technology rest with the developer. Considering the prevalent trend in prices of solar modules (reports in PV insight trends) and other costs involved including safeguard duty, Commission proposes a capital cost of Rs.3.35 crores per MW.

5.2.3 Karnataka ERC issued a tariff order for solar power on18.5.2018 and Maharashtra ERC issued the tariff order for renewable energy on 18.8.2018. Rajasthan ERC issued an order in October 2017. Orders of other Commissions are dated prior to 2017. MERC adopted two approaches for determination of tariff in that if the tariff obtained through competitive bidding in Maharashtra is lesser than the feed in tariff, the tariff discovered through competitive bidding tariff would be the generic tariff/feed in tariff. The capital cost adopted by MERC was also based on the bid tariffs that reflected the prevalent market trends. The capital costs adopted by the Karnataka ERC, Maharashtra ERC and Rajasthan ERC are as below:

Sl.No.	Order of State ERCs	Capital Cost per MW Rs. in Crores
1.	Karnataka ERC – Order dt.18.5.2018	3.5
2.	Maharashtra ERC Order dt.18.8.2018	2.62
3.	Rajasthan ERC Order dt.9.10.2017	3.5836

5.2.4 The Capital cost as proposed is inclusive of all capital works i.e plant and machinery, auxiliaries, costs towards changing inverter during the life-time, land, civil work, erection and commissioning, financing and interest during construction, and evacuation infrastructure. The capital cost fixed for solar PV is inclusive of cost of module degradation. It is upto the developer to identify the appropriate land based on solar insolation and cost.

5.2.5 Commission had not determined any tariff for the solar thermal power plants in the last solar tariff order of 2018. In view of cost effective prices in solar PV power plants, Commission has not proposed any generic tariff for solar thermal power plants.

5.3 Capacity Utilisation Factor(CUF)

5.3.1 The CUF considered by other SERCs are as follows:

Sl.No.	Order of State ERCs	CUF
1.	Karnataka ERC – Order dt.18.5.2018	19%
2.	Maharashtra ERC Order dt.18.8.2018	19%
3.	Rajasthan ERC Order dt.9.10.2017	20%

5.3.2 The CUF considered in the earlier tariff orders on Solar power issued by the Commission was 19% for Solar PV power plant. The Commission proposes to adopt the same in this order also. The normative CUF proposed in this paper is taking into account the deration of output.

5.4 Operation and Maintenance(O&M) cost

5.4.1 The operation and maintenance cost considered by other SERCs are as follows:

Sl.No.	Order of State ERCs	O&M cost in Rs. per MW
1.	Karnataka ERC – Order dt.18.5.2018	4.5 Lakhs ;escalation at 5.72%
2.	Maharashtra ERC Order dt.18.8.2018	7.65 Lakhs; escalation at 4.27%
3.	Rajasthan ERC Order dt.9.10.2017	7.41 Lakhs; escalation at 5.85%

5.4.2 The Commission in its last four orders on Solar Power, adopted O&M expense of 1.4% of capital cost of solar projects with an escalation of 5.72% from the second year. The Commission proposes to adopt the same

5.5 Insurance cost

5.5.1 In the previous tariff orders for Solar power issued by the Commission, 0.35% of net asset value as insurance cost was adopted by the Commission. The Commission proposes to adopt the same .

5.6 Debt and Equity

5.6.1 The Tariff Policy lays down a debt equity ratio of 70: 30 for power projects. The Commission proposes to adopt this ratio as specified in its Tariff Regulations 2005 and as adopted in the earlier Orders on new and renewable power.

5.7 Term of loan and Rate of interest

5.7.1 The term of loan and rate of interest considered by other ERCs are as follows:

Sl.No.	Order of State ERCs	Term and rate of interest
1.	Karnataka ERC – Order dt.18.5.2018	13 years,10%
2.	Maharashtra ERC Order dt.18.8.2018	12 years,11.06%
3.	Rajasthan ERC Order dt.9.10.2017	12 years,12.30%
4.	CERC in RE tariff regulation dt. 17.4.2017	13 years, normative interest rate of two hundred (200) basis points above the average State Bank of India MCLR (one year tenor) prevalent during the last available six months
5.	CERC's draft RE Tariff order 2019-2020	. Interest rate 10.41%

5.7.2 Commission proposes term of loan of 10 years with one year moratorium as adopted in the previous orders of solar power. CERC in its RE tariff Regulations 2017, for the purpose of computation of tariff has specified normative interest rate of two hundred (200) basis points above the average State Bank of India Marginal Cost of Funds based Lending Rate (MCLR)(one year tenor) prevalent during the last available six months.

5.7.3 Commission proposes to adopt the latest MCLR rate of 1 year of 8.55% notified by the State Bank of India in January 2019 plus 200 basis points which is 10.55%.

5.8 Life of Plant and Machinery

5.8.1 Commission considers a life period of 25 years as adopted in its earlier orders for solar power.

5.9 Return on Equity (RoE)

5.9.1 The Return on Equity considered by other SERCs:

Sl.No.	Order of State ERCs	RoE
1.	Karnataka ERC – Order dt.18.5.2018	14%
2.	Maharashtra ERC Order dt.18.8.2018	1st 10 years - 20.39%;11th year onwards 22.57%
3.	Rajasthan ERC Order dt.9.10.2017	16%
4.	CERC in RE tariff regulation dt. 17.4.2017	14% grossed up with prevailing MAT on 1st of April of previous year.
5.	CERC's draft RE Tariff order 2019-2020	17.60%

5.9.2 In the Solar tariff order of 2018, Commission adopted RoE of 17.56% as adopted by CERC in its RE Tariff Regulations and in its RE tariff order of 2017-18. Commission proposes to adopt normative RoE of 17.60% as proposed by CERC in its draft RE Tariff order for 2019-20.

5.10 Depreciation

5.10.1 The Depreciation considered by other ERCs:

Sl.No.	Order of State ERCs	Depreciation
1.	Karnataka ERC – Order dt.18.5.2018	1st 13 years – 5.38% p.a; Balance spread over remaining years.
2.	Maharashtra ERC Order dt.18.8.2018	1st 12 years - 5.83% p.a; Balance 1.54% p.a.
3.	Rajasthan ERC Order dt.9.10.2017	1st 12 years - 5.83% p.a; Balance 1.54% p.a.
4.	CERC in RE tariff regulation dt 17.4.2017	5.28% per annum for first 13 years; Balance spread over remaining useful life.

5.10.2 The Commission in its Orders on Wind, Bio-mass and Bagasse based energy issued during the year 2012 has depreciated the value of plant and machinery to 90% of the initial value for the life period using the straight line method which translates to 3.6% per annum. The same method was adopted in the tariff orders issued for solar power. Depreciation was calculated on 95% of the capital investment in the last four orders on solar power. The Commission proposes to adopt the same method for the life period of 25 years.

5.11 Interest and Components of Working Capital

5.11.1 The interest and components considered by other SERCs :

Sl.No.	Order of State ERCs	Interest and Components
1.	Karnataka ERC – Order dt.18.5.2018	11%;receivables -2 months
2.	Maharashtra ERC Order dt.18.8.2018	11.56%; O&M – 1 month, maintenance spares-15%; receivables – 2 months
3.	Rajasthan ERC Order dt.9.10.2017	11.8%; O&M – 1 month, maintenance spares-15%; receivables – 1.5 months
4.	CERC in RE tariff regulation dt. 17.4.2017	O&M – 1 month, maintenance spares-15%; receivables – 2 months. Normative interest rate of three hundred (300) basis points above the average State Bank of India MCLR (one year tenor) prevalent during the last available six months
5.	CERC's draft RE Tariff order 2019-2020	11.41%

5.11.2 CERC in its RE Tariff Regulations 2017 has specified that Interest on Working Capital shall be at interest rate equivalent to the normative interest rate of three hundred (300) basis points above the average State Bank of India MCLR

(One Year Tenor) prevalent during the last available six months for the determination of tariff.

5.11.3 Commission proposes to adopt the latest MCLR rate of 1 year of 8.55% notified by the State Bank of India in January 2019 plus 300 basis points which is 1155% with one month Operation and Maintenance cost and two months receivables as working capital components.

5.12 Auxiliary consumption

5.12.1 Auxiliary consumption considered to be negligible in Solar PV generation, Commission has not considered auxiliary consumption in Solar PV generation in its earlier orders and proposes to do the same in this order.

5.13 Discount factor

5.13.1 A discount factor of 9.53% equal to the post tax weighted average cost of the capital on the basis of normative debt: equity ratio (70:30) is adopted for the purpose of levellised tariff computation.

6.0 Tariff Determinants

6.1 . The financial and operational parameters in respect of Solar Power projects proposed in the paper are tabulated below:

Tariff Components	Values
Capital cost	Rs. 3.35 Crores/MW
CUF	19%

Operation and maintenance expenses	1.4% of Capital cost with escalation at 5.72% p.a from second year
Insurance	0.35% of net asset value
Debt-Equity ratio	70:30
Life of plant and machinery	25 years
Return on Equity	17.60%(pre-tax)
Term of Loan	10 years with 1 year moratorium period
Interest on loan	10.55%
Depreciation	3.6% on 95% of Capital cost
Working Capital components	one month O&M cost and two months receivables
Interest on working capital	11.55%
Discount factor	9.53%

7.0 Solar Power Tariff

7.1 Solar power tariff is computed with reference to the determinants listed above. The tariff works out to Rs.3.04 per unit without accelerated depreciation and Rs.2.80 per unit with Accelerated Depreciation(AD). The tariff rates of other SERCs are tabulated below:

Sl.No.	Order of State ERCs	Tariff
1.	Karnataka ERC – order Dt. 18.5.2018	Rs.3.05
2.	Maharashtra ERC Order dt.18.8.2018	Rs.3.02 without A.D; Rs.2.81 with A.D
3.	Rajasthan ERC Order dt.10.7.2017	Rs.3.93 without A.D; Rs.3.66 with A.D

8.0 Issues related to power purchase by Distribution licensee:

1. Quantum of power purchase by the Distribution licensee
2. Plant capacity limitations
3. CDM benefits
4. Billing and Payments
5. Energy Purchase Agreement
6. Control Period /Tariff Review Period

8.1 Quantum of power purchase by the Distribution licensee

8.1.1 The distribution licensee can purchase solar power from the Solar Power Generators(SPGs) to meet the Solar Power purchase Obligations(SPO) requirement. If the rates obtained are comparable and below the variable cost of power from conventional fuel based power sources, the licensee may procure over and above the limit of the SPO.

8.2 Plant Capacity limitations

8.2.1 The Commission in the last tariff order for solar power had limited the purchase by the distribution licensee from solar power plants of 1 MW capacity and above. The Commission proposes to adopt the same in this order also.

8.3 CDM benefits

8.3.1 In the earlier orders issued on renewable energy, the Commission adopted the following formula for sharing of CDM benefits as suggested by the Forum of Regulators (FOR):

"The CDM benefits should be shared on gross basis starting from 100% to developers in the first year and thereafter reducing by 10% every year till the sharing becomes equal (50:50) between the developer and the consumer in the sixth year. Thereafter, the sharing of CDM benefits will remain equal till such time the benefits accrue."

8.3.2 The Commission accepted the formula recommended by the Forum of Regulators in its earlier order. The Commission proposes to adopt the same formula. The distribution licensee shall account for the CDM receipts in the next ARR filing.

8.4 Billing and Payments

8.4.1 When a solar generator sells power to the distribution licensee, the generator shall raise the bill every month for the net energy sold after deducting the charges for power drawn from distribution licensee, reactive power charges etc. The distribution licensee shall make payment to the generator in 60 days of receipt of the bill. Any delayed payment beyond 60 days is liable for interest at the rate of 1% per month.

8.5 Energy Purchase Agreement (EPA)

8.5.1. The format for Energy Purchase Agreement (EPA) shall be evolved as specified in the Commission's "Power procurement from New and Renewable sources of energy Regulations 2008" and amended from time to time. The agreement shall be valid for 25 years or life of the plant specified in the respective tariff order. The distribution licensee shall execute the Energy Purchase Agreement or convey its decision in line with this order within a month of receipt of the proposal from the generator for selling the power. The agreement fees are governed by the Commission's Fees and Fines regulation.

8.6 Control Period /Tariff Review Period

8.6.1 Regulation 6 of the Power Procurement from New and Renewable Sources of Energy Regulations, 2008 of the Commission specifies that the tariff as determined by the Commission shall remain in force for such period as specified by the Commission in such tariff orders and the control period may ordinarily be two years.

8.6.2 As considered in the earlier orders of solar power, Commission proposes a control period of one year from 01.04.2019 and tariff period is 25 years.

9.0 Other related issues:

1. Open access charges – Transmission and Wheeling, Line losses
2. Cross subsidy surcharge
3. Reactive power charges
4. Grid availability charges

5. Energy Accounting and Billing Procedure
6. Energy wheeling agreement and fees
7. Security Deposit
8. Power factor disincentive
9. Metering
10. Connectivity and evacuation of power
11. Harmonics
12. Parallel Operation charges

9.1 Open access charges and line losses

9.1.1 Transmission, Wheeling and Scheduling & System Operation charges are generally regulated by the Commission's Tariff regulations, Open access regulations and Commission's order on open access charges issued from time to time. However, as a promotional measure, under section 86(1) (e) of the Act, the Commission in the first three tariff orders adopted 30% in each of the transmission, wheeling and scheduling and system operation charges and in the order dt.28.3.2018, Commission adopted 40% in each of the charges. Commission proposes to adopt 50% of the charges applicable for conventional power in each of the charges i.e transmission, wheeling charges, scheduling and system operation charges.

9.1.2 In respect of the plants availing Renewable Energy Certificates (REC), 100% of the respective charges as specified in the relevant orders shall apply.

9.1.3 Apart from these charges, the SPGs shall have to bear the actual line losses in kind as specified in the respective orders of the Commission and as amended from time to time.

9.2 Cross subsidy surcharge

9.2.1 The Commission in its other tariff orders related to different sources of renewable power and in the orders for solar power has ordered to levy 50% and 60% of the cross subsidy surcharge for third party open access consumers. Commission proposes to withdraw the incentives in phases every year by reducing the same by 10% every year as followed in the last solar tariff order of 2018 and in tariff orders of other sources of renewable energy. Commission proposes levy of 70% of cross subsidy surcharge applicable to conventional power.

9.3 Reactive Power Charges

9.3.1 Commission proposes to adopt the reactive power charges as specified in its Order on Open Access charges issued from time to time.

9.4 Grid Availability Charges

9.4.1 Charges for the start-up power supplied by the distribution licensee

9.4.1.1 The question of start up power does not arise for Solar PV generators.

9.4.2 Stand by charges

9.4.2.1 If the drawal by the captive user or third party buyer exceeds generation, the energy charges and demand charges shall be regulated as per the Commission's Open Access regulation and Commission's regulations on Deviation Settlement Mechanism(DSM) and other relevant orders.

9.5 Energy Accounting and Billing Procedure

9.5.1 The energy accounting shall be regulated by the Commission's Regulations on open access, DSM and Order on open access. Till such time the DSM is implemented in the State, if a solar power generator utilizes power for captive use or if he sells it to a third party, the distribution licensee shall raise the bill at the end of the billing period for the net energy supplied. The licensee shall record the slot wise generation and consumption during the billing period. Slot wise adjustment shall be for the billing period. Peak hour generation can be adjusted to normal hour or off peak hour consumption of the billing period and normal hour generation can be adjusted to off peak hour consumption of the billing period. Excess consumption will be charged at the tariff applicable to the consumer subject to the terms and conditions of supply.

9.5.2 When DSM is implemented, the licensee shall record the time block wise generation and consumption during the billing period. Time block wise adjustment shall be made for the billing period. Excess consumption will

be charged at the tariff applicable to the consumer subject to the terms and conditions of supply.

9.5.3 After the billing period, the balance energy may be sold at the rate of 75% of the respective solar tariff fixed by the Commission in the respective orders to the generators.

9.6 Energy Wheeling Agreement and fees

9.6.1 The format for Energy Wheeling Agreement, application and agreement fees, procedure and terms & conditions shall be governed by Commission's following regulations in force and as amended from time to time:

1. Tamil Nadu Electricity Regulatory Commission's Grid Connectivity and Intra State Open Access Regulations, 2014

2. Power Procurement from New and Renewable Sources of Energy Regulations, 2008.

9.7 Security deposit

9.7.1 As regards the security deposit to be paid by captive /third party user, the Commission proposes to retain the present arrangements i.e. charges corresponding to two times the maximum net energy supplied by the distribution licensee in any month in the preceding financial year shall be taken as the basis for the payment of security deposit.

9.8 Power Factor disincentive

9.8.1 Power factor disincentive may be regulated for the power factor recorded in the meter at the user end as specified in the relevant regulations/orders in force.

9.9 Metering

9.9.1 The Commission proposes that metering and communication shall be in accordance with the following regulations in force and any specific orders of the Commission on metering and ABT whenever issued:

(1) Central Electricity Authority (Installation and Operation of Meters) Regulations 2006 and as amended from time to time.
(2) Tamil Nadu Electricity Distribution and Supply Codes
(3) Tamil Nadu Electricity Grid Code
(4) Tamil Nadu Electricity Regulatory Commission's Grid Connectivity and Intra State Open Access Regulations, 2014

9.10 Connectivity and Evacuation of power

9.10.1 The provisions contained in Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations,2007 and Central Electricity Authority (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations,2013, and its amendments shall be complied with. The connectivity and power evacuation system shall be provided as per the Act/ Codes/ Regulations/orders in force.

9.11 Harmonics

9.11.1 The SPGs shall follow the CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations, 2013 in respect of harmonics. It is the responsibility of the generator to provide adequate filtering mechanism to limit the harmonics within the stipulated norms. It shall be done before connecting the generator to the grid and the harmonics shall be measured by the respective distribution licensee during the commissioning. If the SPGs inject the harmonics beyond the stipulated limit, they shall pay a compensation of 15% of applicable generation tariff rate to the distribution licensee in whose area the plant is located till such time it is reduced within the stipulated limit. The distribution licensee is responsible for measurement of harmonics with standard meters and issue notices for payment of compensation charges if the harmonics is beyond the stipulated limit. A minimum of 15 days notice period shall be given for payment of compensation charges.

9.12 Parallel operation charges

9.12.1 SPGs who opt for parallel operation with the grid shall pay 50% of applicable parallel operation charges to the distribution licensee as specified in relevant regulations/orders of the Commission.

10.0 Applicability of this order

10.1 This Order shall come into force on expiry of the control period of order No.5 of 2018 dt.28.3.2018. The tariff proposed to be fixed shall be applicable to all solar power plants commissioned during the control period of the Order. The tariff is applicable for purchase of solar power by Distribution Licensee from Solar Power Generators(SPGs). The open access charges and other terms and conditions specified shall be applicable to all the SPGs, irrespective of their date of commissioning.

(By order of Tamil Nadu Electricity Regulatory Commission)

(S.Chinnarajalu)
Secretary
Tamil Nadu Electricity Regulatory Commission

Annexure I

Solar PV MW scale

Capital cost	33500000
PLF	19.00%
Depreciation	3.60%
Interest	10.550% (10 + 1) yr.
Dt:Eq.	70 &30
O & M	1.4.% with 5.72 % escl.
Insurance	0.35 % of net asset value
Residual value	10%
ROE	17.60%
Life of Plant	25 Yr.
Aux.consump.	0%
W.Cap.	O&M 1m +Receivables 2m.
Inst. On W.Cap.	11.55%
Discount factor	9.53%

Tariff Details--- Solar.(PV)

Gross Gen	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400
Years	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
ROE	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800
Depreciation	1145700	1145700	1145700	1145700	1145700	1145700	1145700	1145700	1145700	1145700	1145700
Insurance cost	117250	113240	109230	105220	101210	97200	93190	89180	85170	81160	77151
Interest on Loan	2473975	2473975	2226578	1979180	1731783	1484385	1236988	989590	742193	494795	247398
O & M	469000	495827	524188	554172	585870	619382	654811	692266	731863	773726	817983
IOWC	121874	122585	118485	114433	110432	106484	102593	98761	94992	91290	87658
Total	**6096599**	**6120127**	**5892981**	**5667505**	**5443795**	**5221951**	**5002081**	**4784297**	**4568718**	**4355471**	**4144690**
	3.663	**3.677**	**3.541**	**3.405**	**3.271**	**3.137**	**3.005**	**2.874**	**2.745**	**2.617**	**2.490**
IOWC											
O & M	39083	41319	43682	46181	48823	51615	54568	57689	60989	64477	68165
Receivables	1016100	1020021	982163	944584	907299	870325	833680	797383	761453	725912	690782
Total	1055183	1061340	1025846	990765	956122	921940	888248	855072	822442	790389	758947
IOWC	121874	122585	118485	114433	110432	106484	102593	98761	94992	91290	87658
Discount Factor	1	0.91	0.83	0.76	0.69	0.63	0.58	0.53	0.48	0.44	0.40
Present Value	**3.66**	**3.36**	**2.95**	**2.59**	**2.27**	**1.99**	**1.74**	**1.52**	**1.33**	**1.15**	**1.00**
Levelised tariff	**3.04**										

Determination of accelerated depreciation benefit

Depreciation amount	90%										
Book depreciation rate	5.28%										
Tax depreciation rate	40%										
Income Tax (Normal rate)	27.820%										
Capital Cost	33500000										
Years	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Book Depreciation	2.64%	5.28%	5.28%	5.28%	5.28%	5.28%	5.28%	5.28%	5.28%	5.28%	5.28%
Bk dep in lakhs	884400	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800
Accelerated Depreciation											
Opening	100%	70%	35%	21.00%	12.60%	7.56%	4.54%	2.72%	1.633%	0.98%	0.59%
Allowed	30%	35%	14.00%	8.40%	5.04%	3.02%	1.81%	1.09%	0.65%	0.39%	0.24%
Closing	70%	35%	21.00%	12.60%	7.56%	4.54%	2.72%	1.63%	0.98%	0.59%	0.35%
Accelerated Depreciation	10050000	11725000	4690000	2814000	1688400	1013040	607824	364694.40	218816.64	131289.98	78773.99
Net dep benefit	9165600	9956200	2921200	1045200	-80400	-755760	-1160976	-1404106	-1549983	-1637510	-1690026
Tax benefit	2549870	2769815	812678	290775	-22367	-210252	-322984	-390622	-431205	-455555	-470165
Discount factor	1.00	0.91	0.83	0.76	0.69	0.63	0.58	0.53	0.48	0.44	0.40
Average discount factor	1.00	0.96	0.87	0.80	0.73	0.66	0.61	0.55	0.51	0.46	0.42
Net Energy gen	832200	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400
Energy gen with DCF	832200	1591991.84	1453475.61	1327011.42	1211550.65	1106135.90	1009893.08	922024.18	841800.58	768557.09	701686.38
Tax benft with DCF	2549870	2649317	709690	231832	-16282	-139731	-195974	-216392	-218090	-210358	-198215
AD benefit	0.23										
Levelised tariff with AD	**2.80**										

Tariff Details--- Solar.(PV)														
1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400
12	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	
1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800	1768800	
1145700	1145700	1145700	1145700	1145700	1145700	1145700	1145700	1145700	1145700	1145700	1145700	1145700	1145700	
73141	69131	65121	61111	57101	53091	49081	45071	41061	37051	33041	29031	25021	21011	
864772	914237	966531	1021817	1080265	1142056	1207381	1276444	1349456	1426645	1508249	1594521	1685728	1782151	
84101	85479	86940	88489	90131	91872	93716	95671	97742	99935	102259	104721	107327	110087	
3936514	**3983346**	**4033092**	**4085916**	**4141996**	**4201518**	**4264678**	**4331685**	**4402759**	**4478132**	**4558050**	**4642773**	**4732576**	**4827750**	
2.365	**2.393**	**2.423**	**2.455**	**2.489**	**2.524**	**2.562**	**2.603**	**2.645**	**2.691**	**2.739**	**2.789**	**2.843**	**2.901**	
72064	76186	80544	85151	90022	95171	100615	106370	112455	118887	125687	132877	140477	148513	
656086	663891	672182	680986	690333	700253	710780	721948	733793	746355	759675	773795	788763	804625	
728150	740077	752726	766137	780355	795424	811395	828318	846248	865242	885362	906672	929240	953138	
84101	85479	86940	88489	90131	91872	93716	95671	97742	99935	102259	104721	107327	110087	
0.37	0.34	0.31	0.28	0.26	0.23	0.21	0.19	0.18	0.16	0.15	0.13	0.12	0.11	
0.87	**0.80**	**0.74**	**0.69**	**0.64**	**0.59**	**0.55**	**0.51**	**0.47**	**0.44**	**0.40**	**0.38**	**0.35**	**0.33**	

12	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
5.28%	5.28%	5.28%	5.28%	5.28%	5.28%	2.88%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1768800	1768800	1768800	1768800	1768800	1768800	964800	0	0	0	0	0	0	0
0.35%	0.21%	0.13%	0.08%	0.05%	0.03%	0.02%	0.01%	0.006%	0.004%	0.002%	0.001%	0.000	
0.14%	0.08%	0.05%	0.03%	0.02%	0.01%	0.01%	0.00%	0.002%	0.001%	0.001%	0.000	0.00	0.00
0.21%	0.13%	0.08%	0.05%	0.03%	0.02%	0.01%	0.01%	0.004%	0.002%	0.001%	0.000	0.00	0.00
47264.39	28358.64	17015.18	10209.11	6125.47	3675.28	2205.17	1323.10	793.86	476.32	285.79	342.95	68.59	13.72
-1721536	-1740441	-1751785	-1758591	-1762675	-1765125	-962595	1323.10	793.86	476.32	285.79	342.95	68.59	13.72
-478931	-484191	-487347	-489240	-490376	-491058	-267794	368	221	133	80	95	19	4
0.37	0.34	0.31	0.28	0.26	0.23	0.21	0.19	0.18	0.16	0.15	0.13	0.12	0.11
0.38	0.35	0.32	0.29	0.27	0.24	0.22	0.20	0.19	0.17	0.15	0.14	0.13	0.12
1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400
640633.96	584893.60	534003.11	487540.50	445120.51	406391.41	371032.06	338749.25	309275.32	282365.85	257797.73	235367.23	214888.37	196191.33
-184342	-170151	-156359	-143309	-131144	-119900	-59697	75	41	22	12	13	2	0