TAMIL NADU ELECTRICITY REGULATORY COMMISSION

Consultative Paper on "Comprehensive Tariff Order on Solar Power"

(Comments/Suggestions are invited on or before 31.08.2013)

1. Introduction

1.1 The importance of Solar Energy

1.1.1. Solar energy offers clean, climate-friendly, abundant and inexhaustible energy resource to mankind. Among the various renewable sources, solar energy potential is the highest in the country. Tamil Nadu has reasonably high solar insolation (5.5 to 6 kW/m^2) with around 300 clear sunny days. Southern Tamil Nadu is considered to be one of the most suitable regions for development of solar power in the State. The cost of solar energy have been falling and are entering new areas of competitiveness. It is considered important to fully exploit the solar energy in light of the ever increasing cost of exhaustible fossil fuel.

1.2. Commission's initiative in promoting renewable energy

1.2.1 To promote generation from renewable energy sources, the Commission has so far issued nine Tariff orders in respect of various renewable sources of energy in accordance with section 86(1)(e) of the Electricity Act 2003. The Jawaharlal Nehru National Solar Mission (JNNSM) was announced on 10th January, 2009 by the Government of India through the Ministry of New and Renewable Energy (MNRE). JNNSM aims to promote the development of solar

energy for grid connected and off-grid power generation. The ultimate objective is to make solar power competitive with fossil fuel based power. In pursuance of the above, the Commission in order No. 1 and 2 dated 27/5/2010 & 8/7/2010 respectively determined the tariff for Solar PV and Solar Thermal power under the Jawaharlal Nehru National Solar Mission (JNNSM). These orders were issued for the specific purpose of the projects connected at HT level of distribution network (below 33kV) with installed capacity of 1MW and upto 3 MW under JNNSM.

1.3 Need for the Consultative paper

1.3.1 The Government of Tamil Nadu has launched the Tamil Nadu Solar Energy Policy 2012 to promote harnessing of this renewable source to the maximum extent in order to ease the power situation in the State. It has been envisioned to add about 3000MW by the year 2015 under the Policy. The Commission has also issued Order 1 dated 07/03/2013 on the “Issues related to Tamil Nadu solar energy policy 2012”. In this Order, it has been specified that the Commission will issue a separate order on the open access and other charges related to solar power. In line with the above, the Commission proposes to issue a “Comprehensive tariff order on solar power” for purchase of solar power by distribution licensees in the State and to deal with other related issues. This consultative paper has been prepared for this purpose.

2. Technology

2.1. Solar Photovoltaic Technology

2.1.1. 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 and reducing costs of these solar cells, as well as developing novel cell technologies.

2.2. Solar Thermal Technology

2.2.1 Solar thermal technologies, also known as concentrated solar thermal (CST) technologies, typically concentrate the direct component of sunlight or the direct normal incidence (DNI) to attain high temperatures and consequently generate electricity. The concentration is achieved typically through various reflection methodologies, which define these technologies. There are four primary solar thermal technologies, which include (i) parabolic trough, (ii) linear Fresnel, (iii) central receiver, and (iv) parabolic dish technologies. In addition to different construction of reflectors, these technologies also differ based on reliability, maturity, and economics.

2.2.2 One of the advantages of solar thermal technologies is that they can be designed to perform for longer hours even after sunset by incorporating storage of heat energy and hence enhancing the capacity utilization factor. Further, conventional power plants can be hybridized with solar thermal technologies to utilize the solar energy and yield higher outputs at lower conventional fuel consumptions.

2.3. Technologies and standards under consideration

2.3.1 Each of these technologies have different cost implications based on their efficiency, reliability, mounting, tracking, land, water and other requirements. The Commission has decided that the final selection of the technology shall be left to the Solar Power Developers.

2.3.2. The minimum technical requirements would be as per the specifications issued by MNRE and the developers will adhere to them.

3. Legal provisions

3.1. Related Provisions of Electricity Act, 2003

3.1.1 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

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(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 procedures as may be specified for calculating the expected revenues from the tariff and charges which he or it is permitted to recover.

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;"

3.2. Related Provisions of National Electricity Policy

3.2.1 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."

3.3. Related Provisions of Tariff Policy:

3.3.1 Relevant provisions of Tariff Policy 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 for purchase of energy from such sources taking into account availability of such resources in the region and its impact on retail tariffs. Such percentage for purchase of energy should be made applicable for the tariffs to be determined by the SERCs latest by April 1, 2006.

It will take some time before non-conventional technologies can compete with conventional sources in terms of cost of electricity. Therefore, procurement by distribution companies shall be done at preferential tariffs determined by the Appropriate Commission.

(2) Such procurement by Distribution Licensees for future requirements shall be done, as far as possible, through competitive bidding process under Section 63 of the Act within suppliers offering energy from same type of non-conventional sources. In the long-term, these technologies would need to compete with other sources in terms of full costs."

3.4. Commission's Regulations on Power Procurement from New and Renewable Sources:

This consultative paper has been prepared in consonance with Commission's regulation on "Power Procurement from New and Renewable Sources of Energy Regulations 2008" notified on 8.02.2008. This regulation was subsequently amended from time to time, as required.

4. Power position in Tamil Nadu

4.1. The generating capacity connected to the TANGEDCO's grid including the allocation from Central Generating stations is 10722 MW as on 01/03/2013 comprising of 2,970 MW from TANGEDCO's four thermal stations, 516 MW from four gas turbine stations, 2224 MW from hydro stations, 17.5 MW from TANGEDCO's wind farm, 1,180 MW from private sector power projects, 274 MW as contribution to Tamil Nadu grid by sale of electricity from captive generating plants, 3519 MW as Tamil Nadu's share from central generating stations and 100 MW as external assistance.

4.2. Generating capacity from privately owned wind farms is 7114.61 MW as on 01/03/2013. The installed capacity of cogeneration in sugar mills is 576 MW and biomass power projects is 168 MW. The installed capacity of solar PV project is 7 MW.

4.3. The average power availability during the previous quarter of 2012-13 was around 9000 MW. The expected peak may vary from 11500 MW to 12000 MW which leaves a deficit of around 3000 MW. The peak power requirement is increasing at the rate of around 8% annually in the State and the demand is always exceeding the supply. Therefore any capacity addition at this time will help the State to a great extent to tide over the power shortage prevailing in the State.

5. Solar power projects in Tamil Nadu.

5.1 Solar plants commissioned/under commissioning

5.1.1 The first 5 MW grid connected solar photovoltaic power plant was commissioned in Tamil Nadu in Sivagangai District in December 2010 under the Demonstration Programme of Ministry of New and Renewable Energy (MNRE). Out of the 7 projects of 1 MW capacity each sanctioned to Tamil Nadu under the Roof Top PV & Small Solar Power Generation Programme(RPSSGP) of Jawaharlal Nehru National Solar Mission(JNNSM), 6 projects have been commissioned from June 2011 to June 2012. Under the NTPC Vidyut Vyapar Nigam (NVVN) Bundling Scheme, one 5 MW Solar PV Power Project has been commissioned in March 2012. Under REC scheme a project of 1 MW capacity has been commissioned in May 2012.

6. Applicability of the proposed order

6.1 The Order shall come into force from the date of its issue. The tariff fixed in this order shall be applicable to all solar power plants commissioned during the control period of this Order. The tariff is applicable for purchase of solar power by Distribution Licensee from SPGs. The open access charges and other terms and conditions specified in the proposed Order shall be applicable to all the Solar energy generators, irrespective of their date of commissioning.

7. Tariff Determination Process

7.1 With regard to tariff determination process, the relevant portion of Regulation 4 of the Power Procurement from New and Renewable Sources of Energy Regulation, 2008 is reproduced below:

"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) issuing general / specific tariff order for purchase of power from new and renewable sources based generators."

The Commission has prepared this consultative paper to elicit the views and suggestions of the stake holders.

8. Tariff / Pricing Methodology

8.1 Tariff / Pricing Methodology specified in Regulation 4 of the Commission's Renewable energy 2008 Regulation is reproduced below.

" 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.

(4) While determining the tariff, the Commission may, to the extent possible consider to permit an allowance / disincentive based on technology, fuel, market risk, environmental benefits and social impact etc., of each type of new and renewable source.

(5) While determining the tariff, the Commission shall adopt appropriate financial and operational parameters.

(6) While determining the tariff the Commission may adopt 1[appropriate tariff methodology]."

8.2. Project specific or Generalized Tariff

8.2.1 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. Capacity of most of the solar Photovoltaic and solar thermal projects is limited to a few MWs. Harnessing of this renewable source is still in its nascent stage. Hence it is not advisable to adopt project specific tariff in such a context. The Commission may issue a generalized tariff order for solar Photovoltaic and solar Thermal projects.

8.3. Cost-Plus Tariff Determination

8.3.1 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. It is also in line with

Regulation 4(6) of “Power Procurement from New and Renewable Sources of Energy Regulations 2008”. Therefore Cost-Plus average tariff is adopted for determination of tariff in respect of solar projects.

8.4. Single Part vs. Two Part Tariff

8.4.1. Two part tariff is generally adopted when the variable component is significant. In the case of solar energy generation, solar energy being the motive force, no variable cost like fuel cost is involved. Operations, maintenance and insurance cost could be taken care of by adopting suitable parameters. Therefore, the Commission proposes to continue with the single-part tariff for solar energy generation. In the case of Wind energy, the Commission adopted cost plus single part average tariff for tariff determination. The Commission proposed to adopt the same methodology for Solar power in accordance with Clause 4.6 of Power Procurement from New and Renewable Energy Sources Regulations 2008.

9. **Tariff Components**

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

1. Capital investment

2. Capacity Utilization Factor
3. Operation and maintenance expenses
4. Term of Loan and Interest
5. Life of plant and machinery
6. Return on equity
7. Debt-equity ratio
8. Depreciation rate applicable
9. Auxiliary consumption
10. Interest on Working Capital

9.2. Capital Investment

9.2.1. The capital cost is one of the most important parameters for Solar Photovoltaic/ Solar thermal power projects for tariff determination. The cost of the equipments involved is an important factor in determination of overall cost of the plants. The components of a photovoltaic power plant include the following:

- Photo voltaic module
- Photovoltaic inverters
- Transformers
- Module mounting structures,
- Combiner/ junction boxes
- DC and AC power cables, communication cables, and
- Engineering, civil works and labour

9.2.3. Inverters are considered to be one of the important cost components of Solar PV plant. Inverters for photovoltaic power projects are classified based on their capacity and operational philosophy, which also has an implication on its cost and performance. Similar to photovoltaic modules, the cost of inverters is also gradually decreasing with advancing research and development as well as economies of scales.

9.2.2. The land requirement for crystalline silicon solar photovoltaic power plant is considered at approximately 5 acres per megawatt (MW) of installed capacity. This land requirement increases for photovoltaic projects utilizing either lower efficiency technologies or solar tracking; however, in such instances, the cost of land as well as that of the equipments are compensated either due to a lower cost of photovoltaic modules or higher capacity utilization factors (CUF), respectively.

9.2.3. The CERC in its Terms and Conditions for determination of tariff from Renewable Energy Sources Regulations 2012 has fixed a Capital cost of Rs. 10 Crores /MW in respect of Solar Photo Voltaic Power Projects which is inclusive of the cost towards degradation and auxiliary and 13 Crores /MW for Solar thermal projects. Gujarat Electricity Regulatory Commission in its Order No.1 of 2012 for determination of tariff for procurement by the Distribution licensee and others from Solar Energy Projects has adopted a capital cost of Rs.10 crores per MW, and that of kilowatt-scale solar photovoltaic power projects at Rs.1.2 lakhs per kilowatt. The Rajasthan Electricity Regulatory Commission in its Order on

Determination of Benchmark Capital Cost for Solar PV and Solar Thermal Power Projects and resultant Generic Levellised Tariff dated 30.05.12 has fixed the Capital Cost for Solar PV at Rs. 10 Crores/MW and Rs.13 Crores/MW in respect of Solar Thermal Projects. Kerala Electricity Regulatory Commission has proposed a capital cost of megawatt scale projects at Rs. 10 crores per MW and that of kilowatt-scale (mostly roof top) projects at Rs. 1.2 lakh per kW. The comparative tabulation is as follows:

S. No	**Agencies**	**Reference**	**Capital cost**		
			Solar PV/MW	**Solar Thermal/MW**	**kW scale system**
1.	CERC	CERC Regulations, 2012.	Rs. 10 Crores	Rs. 13 Crores	
2.	GERC	Order No.1/2012	Rs 10 Crores	Rs.14 Crores	Rs.1.2 lakhs
3.	RERC	Order dated 30.5.12	Rs. 10 Crores	Rs. 13 Crores	
4.	KSERC	Discussion paper on feed-in tariff for solar projects - 2012	Rs. 10 Crores		Rs. 1.2 lakhs

9.2.4. The capital costs of Solar generators are consistently falling down. The capital cost of 10 Crores was adopted by the CERC in its Order issued on 06.02.2012 i.e. one and a half year back. The capital cost derived from the per unit cost quoted by the Solar Power developers recently in the competitive bidding process floated by the different states points to a capital cost of around 7.25 to 7.5 Crores per MW for the PV technology based Solar Power Generators(SPGs). A recent contract between PSU companies for installation of MW scale PV plant also points to a capital cost of 6.75 Crores to 7.00 Crores per

MW. However, for solar thermal, the rate of falling down of capital cost is considered to be less due to its conventional constituent of the capital machinery. Similarly, for kW scale projects, the falling capital cost may not be in the same manner as that of MW scale projects. Therefore the Commission has proposed to adopt a Capital Cost of Rs. 7 Crores per MW in respect of solar Photovoltaic power projects and Rs. 11.50 Crores per MW for Solar Thermal projects and for kilowatt-scale projects at Re. 1 lakh per kW. The Capital cost as proposed shall be inclusive of all capital work including plant and machinery, auxiliaries, costs towards changing inverter during the life-time, civil work, erection and commissioning, financing and interest during construction, and evacuation infrastructure. The capital cost includes the cost of land and it is upto the developer to identify the appropriate land based on solar insolation and cost.

9.3. Capacity Utilization factor

9.3.1. The CUF adopted by different entities are tabulated below:

S. No	Agencies	Reference	Capacity utilization factor		
			Solar PV/MW	**Solar Thermal/MW**	**kW scale system**
1.	CERC	CERC Regulations, 2012.	19%	23%	
2.	GERC	Order No.1/2012	18%	23%	18%
3.	RERC	Order dated 30.5.12	20% with deration of 0.25% every year after 2nd year	23% with deration of 0.25% every year after 2nd year	

4.	KSERC	Discussion paper on feed-in tariff for solar projects - 2012	19%	23%	

9.3.2. The Commission proposes to adopt the rates adopted by the CERC in respect of Solar PV at 19% and Solar Thermal at 23%. It has also proposed to adopt 19% CUF for the kW scale projects. The normative CUF proposed in this paper is taking into account the de-ration of output.

9.4. Operation and Maintenance Cost

9.4.1 The provision made by CERC in respect of O&M Expenses is Rs. 11 Lakhs/ MW for the 1st year of operation with escalation of 5.72% per annum thereafter. The Gujarat ERC has adopted a rate of 0.75% of the Capital Cost as Operation and Maintenance Cost with an escalation of 5.72% annually. Rajasthan ERC has fixed O&M cost at Rs.11 lakhs/MW for FY 2012-13 with an escalation of 5.72% p.a. The O&M cost adopted by other entities are tabulated below:

S.No	Agencies	Reference	Operation and Maintenance cost
1.	CERC	CERC Regulations, 2012.	Rs.11 lakhs/MW for the 1st year of operation with escalation of 5.72% p.a.
2.	GERC	Order No.1/2012	0.75% with 5.72% annual escalation
3.	RERC	Order dated 30.5.12	Rs.11 lakhs/MW for FY 2012-13 with an escalation of 5.72% p.a.
4.	KSERC	Discussion paper on tariff for solar projects - 2012	0.5% with 5% annual escalation

9.4.2. The Commission in its last Wind Order, adopted O&M expense of 1.1% on 85% of Capital investment and 0.22% on 15% of the Capital investment with an escalation of 5% from second year onwards. Since land requirement and maintenance are more in SPG compared to WEG, the Commission proposes to adopt an O&M cost of 1.1% on the total capital cost for solar projects. This includes the insurance cost. Regarding the escalation of O&M cost after first year it has been proposed to consider 5.72% as adopted by the CERC and other Commissions.

9.5. Debt-equity ratio

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

9.6. Term of the Loan

9.6.1 The term of loan adopted by different entities is tabulated below:

S.No	Agencies	Reference	Term of loan
1.	CERC	CERC Regulations, 2012.	12 years
2.	GERC	Order No.1/2012	10 years
4.	KSERC	Discussion paper on feed-in tariff for solar projects - 2012	10 years

9.6.2 The Commission proposes to adopt the term as 10 years with 1 year moratorium as adopted by the Commission in its previous orders on Wind, Bagasse and Bio-mass power.

9.7. Rate of Interest

9.7.1 The CERC has adopted the normative interest rate as average State Bank of India (SBI) Base rate prevalent during the first six months of the previous year plus 300 basis points. The interest rates suggested / adopted by GERC is 13.00% while RERC has fixed the rate at 12.0% per annum. IREDA in its website has mentioned that the current interest rate is between 11.75% to 12.5%. The rate of interest adopted by various entities is tabulated below:

S.No	Agencies	Reference	Interest
1.	CERC	CERC Regulations, 2012.	SBI rate
2.	IREDA	Website	11.75% to 12.5%
3.	GERC	Order No.1/2012	13%
4.	RERC	Order dated 30.5.12	12%
5.	KSERC	Discussion paper on feed-in tariff for solar projects - 2012	13%

9.7.2. The Commission proposes to adopt 12% as the rate of interest as currently charged by IREDA.

9.8. Life of Plant and machinery

9.8.1 The Commission proposes a life period of 25 years for Solar power projects as adopted by CERC, GERC, RERC and KSERC.

9.9. Interest on Working Capital

9.9.1. In the Order on Renewables by the CERC, the components of working capital have been taken as O&M expenses for one month, receivables for two months and maintenance of spares at 15% of the O&M expenses. The Interest on Working Capital was fixed at interest rate equivalent to the average State Bank of India Base Rate prevalent during the first six months of the previous year plus 350 basis points. RERC has considered one month O&M expenses, maintenance of spares at 15% of O&M expenses, receivables for 1.5 months and interest rate at 11.8%. Interest rate adopted by GERC and KSERC is 12.0% per annum. The interest adopted by various entities is tabulated below:

S.No	Agencies	Reference	Interest on working capital
1	CERC	CERC Regulations, 2012	SBI rates
2	GERC	Order No.1/2012	12%
3	RERC	Order dated 30.5.12	11.8%
4	KSERC	Discussion paper on feed-in tariff for solar projects - 2012	12%

9.9.2. It is proposed to consider one month Operation and Maintenance cost and one month receivables as working capital components and an interest rate of 12.5%.

9.10. Return on Equity

9.10.1. The CERC has adopted normative Return on Equity as, 20% per annum for the first 10 years and 24% per annum 11th years onwards. The GERC has fixed annual discount rate of 10.74% to calculate the levelized tariff over the 25 year life of the solar project. The Tariff Regulations of the Commission stipulates 14% post tax RoE for conventional fuel based generating stations. With the objective of promoting renewable energy, Commission in its new and renewable energy Tariff Orders issued during 2009 has considered 19.85% pre-tax return on equity, where in the RoE was adopted linking it to MAT and IT. Since these factors are changing frequently, the Commission in its NCES orders issued in 2012, adopted a RoE of 19.85% without linking to MAT and IT. Now it is proposed to adopt a RoE of 20% (pre tax) per annum for SPG without linking it to MAT and IT.

9.11. Depreciation

9.11.1. The CERC has adopted the normative depreciation rate of 5.83 % per annum for initial period of 12 years i.e. equivalent to the loan tenure and the remaining depreciation, to cover 90% depreciable value, shall be spread over balance useful life of the project beyond the initial period of 12 years. GERC has ruled a depreciation rate of 7% for 2013-14 and a further 7% decline for 2014-15. RERC has adopted a depreciation rate of 5.83% for the first 12 years and a rate of 2.05% for the period after the first 12 years. 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. The depreciation was calculated on 85% of the capital investment. The Commission proposes to adopt the same method in this Order for the life period of 25 years . This translates into a rate of 3.6% per annum.

9.12. Auxiliary consumption

9.12.1 GERC has fixed the auxiliary consumption of 0.25% of energy generation in respect of Solar Photovoltaic plants and 10% in respect Solar Thermal projects, RERC has adopted a rate of 0.25% in respect of Solar Photovoltaic and 6.5% for solar thermal projects. Since the auxiliary consumption is considered to be negligible in the case of solar PV generators the Commission considered nil auxiliary consumption for PV generators. However, an AUX of 6% has been proposed for the Solar Thermal generation considering the auxiliaries involved in such projects.

9.13. Tariff Determinants

9.13.1 The financial and operational parameters in respect of Solar Photovoltaic and Solar Thermal projects proposed in the paper are tabulated below:

Tariff Components	Solar Photovoltaic	Solar Thermal	kW scale system
Capital cost	Rs. 7 Crores	Rs. 11.5 Crores	Rs. 1 lakh
Auxiliary Consumption	Nil	6%	Nil
CUF	19%	23%	19%
Operation and maintenance expenses	1.1% of the capital cost with 5.72% escalation after 1st year	1.1% of the capital cost with 5.72% escalation after 1st year	1.1% of the capital cost with 5.72% escalation after 1st year
Life of plant and machinery	25 years	25 years	25 years
Term of Loan	10 years +1 yr Moratorium	10 years +1 yr Moratorium	10 years +1 yr Moratorium
Interest on loan	12%	12%	12%
Working Capital components	One month O&M cost and one month receivables	One month O&M cost and one month receivables	Nil
Interest on working capital	12.5%	12.5%	Nil
Return on equity	20% pre tax	20% pre tax	20% pre tax
Debt-equity ratio	70:30	70:30	70:30
Depreciation rate	3.6%	3.6%	3.6%

10. Solar Power Tariff

10.1. Solar power tariff is computed with reference to the determinants listed above. The tariff works out to Rs.5.78 per unit for Solar PV projects, Rs.8.34 per unit for Solar Thermal projects and Rs.8.15 per unit for kW scale projects. The above tariff rates along with the tariff of other states and CERC are tabulated below:

S.No	State/ Entity	Date of Order	Tariff(Rs./Unit)		
			Solar PV	Solar thermal	Solar kW scale
1	CERC	27.03.2012	9.35 (with *AD)	11.22 (with AD)	
			10.39 (without AD)	12.46 (without AD)	
2	GERC	27.01.2012	9.28 (with AD)	11.55 (with AD)	11.14 (with AD
			10.37 (without AD)	12.91(without AD)	12.44(without AD)
3	RERC	30.05.2012	8.42 (with AD)	10.45(with AD)	
			9.63 (without AD)	11.95 (without AD)	
6	TNERC	Consultative paper	5.78 with no escalation (Average Tariff)	8.34 with no escalation (Average Tariff)	8.15 with no escalation (Average Tariff)

(*) AD – Accelerated Depreciation

11. Other issues related to power purchase by distribution licensee from SPGs.

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

11.1. Quantum of solar power purchase by the distribution licensee

The distribution licensee can purchase solar power at the rate determined by the Commission from SPG for his RPO requirement on “first come first served basis”.

For any procurement in excess of RPO, specific approval shall be obtained from the Commission.

11.2. CDM Benefits

11.2.1 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."

11.2.2. The Commission accepted the formula recommended by the Forum of Regulators in its earlier order No. 6 of 2012 dated 31-07-2012. The Commission proposes to adopt the same formula in this order also. The distribution licensee shall account for the CDM receipts in the next ARR filing.

11.3. Billing and payment

11.3.1. 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 within 30 days of receipt of the bill. Any delayed payment beyond 30 days is liable for interest at the rate of 1% per month.

11.4. Energy Purchase Agreement (EPA)

11.4.1 The format for Energy Purchase Agreement (EPA) shall be evolved as specified in the Commission's regulation on Power procurement from New and Renewable source of energy regulations 2008 and amended from time to time. The agreement shall be valid for 25 years. The distribution licensee shall execute the Energy Purchase Agreement or convey his decision in line with this order within a month of receipt of the proposal from the generator for selling his power. The agreement fees are governed by the Commission's Fees and fines regulation.

11.5. Control period / Tariff Review Period.

11.5.1 Clause 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.*"

As the Capital cost is volatile and not yet stabilized, in respect of Solar Power Plants, the Commission decides the control period of this order as one year from the date of issue of this Order and the tariff period is 25 years.

12. Issues related to open access

1. Open access charges and 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 power evacuation.
11. Harmonics

12.1. Open access charges and line losses

12.1.1 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 proposes to adopt 30% (in each) of the transmission, wheeling and scheduling and system operation charges as applicable to the conventional power to the Solar power. 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 amended from time to time.

12.2. Cross subsidy surcharge

12.2.1 The Commission in its other tariff orders related to different renewable power, has ordered to levy 50% of the cross subsidy surcharge for third party open access consumers. Commission proposes to adopt the same for Solar power generators also.

12.3. Reactive Power Charges

12.3.1 Commission has proposed to adopt the reactive power charges as specified in its Order on Open Access charges issued from time to time.

12.4. Grid Availability Charges

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

12.4.1.1. The question of start up power does not arise for solar PV generators. However, the solar PV generator may require power for maintenance of power station especially during night hours. In case of Solar Thermal generators, the start-up may be frequent. Therefore, the drawal of such energy by the Solar Power generator from the distribution licensee shall be adjusted against the generated energy for every billing period.

12.4.2. Stand by charges

12.4.2.1. If adequate generation does not materialize or if drawal by the captive / third party consumer exceeds generation, the energy charges and

demand charges shall be regulated as per the Commission's Open Access regulation and Commission's Order on ABT and other relevant orders.

12.5. Energy Accounting and Billing Procedure

12.5.1 The energy accounting shall be regulated by the Commission's Regulations on open access, Order on open access, Order on ABT and Order on Tamil Nadu Solar Energy Policy 2012. Till such time the ABT is implemented in the State, if a solar energy 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 should record the slot wise generation and consumption during the billing period. Slot-wise adjustment shall be made for the billing period. Peak hour generation and normal hour generation can be adjusted against lower slot 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. After the billing period, the balance energy may be sold at the rate of 75% of the energy charges of that category of the consumer.

12.6. Energy Wheeling Agreement and fees

12.6.1 The format for Energy Wheeling Agreement, application and agreement fees, procedure and terms & conditions are governed by Commission's following regulations in force.

1. Intra State Open Access Regulation 2005
2. Power procurement from New and Renewable source of energy regulations 2008.

12.7. Security deposit

12.7.1 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.

12.8. Power Factor disincentive

12.8.1 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.

12.9. Metering

12.9.1 The Commission proposes that metering and communication shall be in accordance with the following regulation in force.

(1) Central Electricity Authority (Installation and Operation of Meters) Regulations
(2)Tamil Nadu Electricity Distribution and supply Codes
(3) Tamil Nadu Electricity Grid Code
(4)Tamil Nadu Electricity Intra State Open Access Regulations

12.10. Connectivity and Evacuation of power

12.10.1 The connectivity and power evacuation system shall be provided as per the Act / Codes/ Regulations/orders in force.

12.11. Harmonics

12.11.1 Since the SPGs use inverters for power conversion, they are prone to generate harmful harmonics. Therefore, SPGs shall take necessary steps to restrict the harmonic generation within the limit prescribed by the CEA Standards for connectivity to the Grid Regulations, 2007 applicable to the distribution system and bulk consumers. If the SPGs inject the harmonics beyond the limit, the SPGs shall pay a compensation of 15% of applicable preferential tariff rate to the licensee to whom the SPG is connected.

(By Order of the Commission)

sd/-

Secretary
Tamil Nadu Electricity Regulatory Commission

Solar PV MW scale

Proj. cost	70000000
PLF	19.00%
Depreciation	3.60%
Interest	12% (10 + 1) yr.
Dt:Eq.	70 &30
O & M	1.1% with 5.72 % escl.
Residual value	10%
ROE	20.00%
Life of Plant	25 Yr.
Aux.consump.	0%
W.Cap.	O&M 1m +Receivables 1m.
Inst. On W.Cap.	12.50%

Tariff Details--- Solar.(P/V)

Gross Gen	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400
Net Gen.	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400	1664400
Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
ROE	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000	4200000
Depriciation	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000	2142000
Interest on Loan	5880000	5880000	5292000	4704000	4116000	3528000	2940000	2352000	1764000	1176000	588000														
O & M	770000	814044	860607	909834	961877	1016896	1075062	1136556	1201567	1270297	1342958	1419775	1500986	1586842	1677610	1773569	1875017	1982268	2095654	2215525	2342253	2476230	2617870	2767612	2925920
IOWC	144863	145790	140581	135428	130334	125303	120338	115443	110622	105880	101220	96648	98358	100165	102076	104096	106232	108490	110877	113401	116068	118889	121871	125023	128356
Total	**13136863**	**13181834**	**12635189**	**12091262**	**11550211**	**11012199**	**10477401**	**9945999**	**9418189**	**8894176**	**8374178**	**7858423**	**7941343**	**8029007**	**8121686**	**8219665**	**8323249**	**8432758**	**8548531**	**8670926**	**8800322**	**8937119**	**9081741**	**9234636**	**9396276**
	7.893	**7.920**	**7.591**	**7.265**	**6.940**	**6.616**	**6.295**	**5.976**	**5.659**	**5.344**	**5.031**	**4.721**	**4.771**	**4.824**	**4.880**	**4.939**	**5.001**	**5.067**	**5.136**	**5.210**	**5.287**	**5.370**	**5.456**	**5.548**	**5.645**
IOWC																									
O & M	64167	67837	71717	75820	80156	84741	89589	94713	100131	105858	111913	118315	125082	132237	139801	147797	156251	165189	174638	184627	195188	206352	218156	230634	243827
Receivables	1094739	1098486	1052932	1007605	962518	917683	873117	828833	784849	741181	697848	654869	661779	669084	676807	684972	693604	702730	712378	722577	733360	744760	756812	769553	783023
Total	1158905	1166323	1124650	1083425	1042674	1002425	962705	923546	884980	847039	809761	773183	786861	801321	816608	832769	849855	867919	887015	907204	928548	951112	974968	1000187	1026850
IOWC	144863	145790	140581	135428	130334	125303	120338	115443	110622	105880	101220	96648	98358	100165	102076	104096	106232	108490	110877	113401	116068	118889	121871	125023	128356
Av.cost/unit																									**5.775**

Solar Thermal

Proj. cost	115000000
PLF	23.00%
Depreciation	3.60%
Interest	12% (10 + 1) yr.
Dt:Eq.	70 &30
O & M	1.1% with 5.72 % escl.
Residual value	10%
ROE	20.00%
Life of Plant	25 Yr.
Aux.consump.	6%
W.Cap.	O&M 1m +Receivables 1m.
Inst. On W.Cap.	12.50%

Tariff Details--- Solar.(Thermal)

Gross Gen	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800	2014800
Net Gen.	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912	1893912
Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
ROE	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000	6900000
Depriciation	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000	3519000
Interest on Loan	9660000	9660000	8694000	7728000	6762000	5796000	4830000	3864000	2898000	1932000	966000														
O & M	1265000	1337358	1413855	1494727	1580226	1670615	1766174	1867199	1974003	2086916	2206287	2332487	2465905	2606955	2756073	2913720	3080385	3256583	3442860	3639791	3847987	4068092	4300787	4546792	4806868
IOWC	237989	239513	230955	222489	214121	205855	197698	189657	181737	173946	166290	158779	161587	164557	167696	171015	174524	178233	182155	186301	190684	195318	200217	205396	210871
Total	**21581989**	**21655871**	**20757810**	**19864216**	**18975346**	**18091470**	**17212872**	**16339856**	**15472740**	**14611861**	**13757578**	**12910266**	**13046493**	**13190512**	**13342769**	**13503735**	**13673909**	**13853816**	**14044014**	**14245092**	**14457671**	**14682410**	**14920003**	**15171188**	**15436739**
	11.395	**11.434**	**10.960**	**10.488**	**10.019**	**9.552**	**9.089**	**8.628**	**8.170**	**7.715**	**7.264**	**6.817**	**6.889**	**6.965**	**7.045**	**7.130**	**7.220**	**7.315**	**7.415**	**7.522**	**7.634**	**7.752**	**7.878**	**8.011**	**8.151**
IOWC																									
O & M	105417	111447	117821	124561	131685	139218	147181	155600	164500	173910	183857	194374	205492	217246	229673	242810	256699	271382	286905	303316	320666	339008	358399	378899	400572
Receivables	1798499	1804656	1729817	1655351	1581279	1507622	1434406	1361655	1289395	1217655	1146465	1075855	1087208	1099209	1111897	1125311	1139492	1154485	1170335	1187091	1204806	1223534	1243334	1264266	1286395
Total	1903916	1916102	1847639	1779912	1712964	1646840	1581587	1517255	1453895	1391565	1330322	1270229	1292700	1316456	1341570	1368121	1396191	1425867	1457240	1490407	1525472	1562542	1601733	1643165	1686967
IOWC	237989	239513	230955	222489	214121	205855	197698	189657	181737	173946	166290	158779	161587	164557	167696	171015	174524	178233	182155	186301	190684	195318	200217	205396	210871
Av.cost/unit																									**8.338**

Kw level Solar PV

Proj. cost	100000

PLF	19.00%
Depreciation	3.60%
Interest	12% (10 + 1) yr.
Dt:Eq.	70 &30
O & M	1.1% with 5.72 % escl.
Residual value	10%
ROE	20.00%
Life of Plant	25 Yr.
Aux.consump.	0%
W.Cap.	Nil
Inst. On W.Cap.	12.50%

Tariff Details--- KW Solar.(P/V)

Gross Gen	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664
Net Gen.	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664
Years	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
ROE	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
Depriciation	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060	3060
Interest on Loan	8400	8400	7560	6720	5880	5040	4200	3360	2520	1680	840														
O & M	1100	1163	1229	1300	1374	1453	1536	1624	1717	1815	1919	2028	2144	2267	2397	2534	2679	2832	2994	3165	3346	3537	3740	3954	4180
IOWC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**18560**	**18623**	**17849**	**17080**	**16314**	**15553**	**14796**	**14044**	**13297**	**12555**	**11819**	**11088**	**11204**	**11327**	**11457**	**11594**	**11739**	**11892**	**12054**	**12225**	**12406**	**12597**	**12800**	**13014**	**13240**
	11.151	**11.189**	**10.724**	**10.262**	**9.802**	**9.344**	**8.890**	**8.438**	**7.989**	**7.543**	**7.101**	**6.662**	**6.732**	**6.805**	**6.883**	**6.966**	**7.053**	**7.145**	**7.242**	**7.345**	**7.454**	**7.569**	**7.690**	**7.819**	**7.955**
Av.cost/unit																									**8.150**