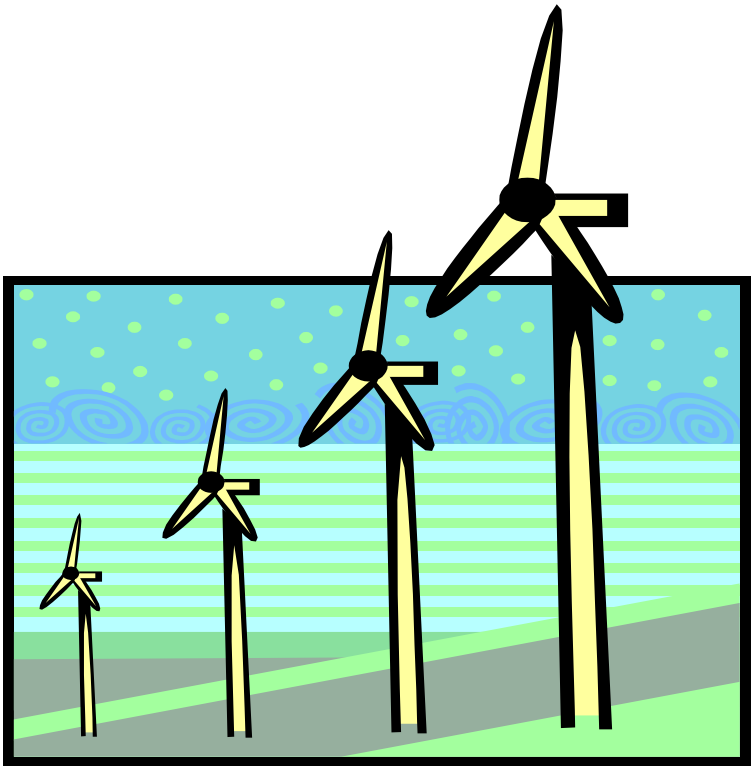
Draft Discussion Paper on

"Tariff Related Issues "

for Non Conventional Energy Sources



Tamil Nadu Electricity Regulatory Commission

Consultative Paper on "Tariff Related Issues of Non-Conventional Sources in Tamil Nadu"

Preamble :

Section 86(1)(e) of the Electricity Act of 2003 requires that the Commission shall promote renewable sources of energy through (a) ensuring that Licensees extend the grid suitably to draw power from renewables and (b) ensuring that each Licensee purchases a minimum requirement as a percentage of total consumption in his area of supply.

Section 61(h) mandates that the Appropriate Commission, shall be guided by the promotion of co-generation and generation of electricity from renewable sources of energy while specifying the terms and conditions for determination of tariff.

The conceptual issues involved in purchase of power from renewable energy sources including co-generation had already been placed in public domain and discussed in the State Advisory Committee (SAC) and views obtained. In order to formulate a comprehensive policy including the purchase rates , the Commission decided to issue another consultative paper on tariff related issues for NCE sources and obtain the views of the stakeholders , public and SAC
This consultative paper addresses the tariff related issues of the three sources under NCE viz., wind power, biomass and co-generation.

Chapter – I

General

1.1 Promoting Electricity Generation from Renewable Sources

Non-conventional / renewable energy sources such as wind, solar, mini-hydel, biomass, urban-municipal waste or other such sources as approved by Ministry of Non-conventional Energy Sources (MNES), Government of India (GoI) or

Government of Tamil Nadu and co-generation need to be encouraged in view of the advantages they offer. The MNES at the central level and various agencies at the state level promote the development of non-conventional energy sources in the country as they are renewable in nature and less polluting than conventional sources

1.2 Potential of Wind Energy in Tamil Nadu

Among the various sources of renewable energy, the estimated potential for various types in the state of Tamil Nadu is as mentioned below:

Estimated capacity for Power Generation from Renewable in Tamil Nadu

Source	Potential	Presently Installed (MW) As on 30.09.2005
Wind	**4500 MW ***	**2418.24**
Biomass	**500 MW**	**32.85**
Co-generation		**296.60**
Solar	**20 MW/ sq km**	**0.165**

* Wind Energy potential may go up because of advanced technologies and higher capacity machines.

Out of many other sources of Non conventional energy, Tamil Nadu is blessed with conducive natural meteorological and topographical settings for wind power generation. The harnessing of wind energy is the highest in Tamil Nadu with an installed capacity of 2418.24 MW as against the country's installed capacity of 3700 MW, that is Tamil Nadu's contribution is 60% of the country's capacity. The passes detailed below are endowed with heavy wind flows because of the tunneling effect.

Name of the Pass	Districts
Palghat	Coimbatore, Erode
Shencottah	Tirunelveli, Tuticorin
Aralvoimozhi	Tirunelveli, Tuticorin, Kanyakumari
Sea coast	Ovari, Tuticorin, Rameswaram, Poompuhar, Ennore

1.3 Provisions in the Electricity Act 2003

The Act provides specific reference to promotion of renewable energy sources:

Section 86. (1) The State Commission shall discharge the following functions, namely: -

(a) Determine the tariff for generation, supply, transmission and wheeling of electricity, wholesale, bulk or retail, as the case may be, within the State:

Providing that where open access has been permitted to a category of consumers under section 42, the State Commission shall determine only the wheeling charges and surcharge thereon, if any, for the said category of consumers;

(b) Regulate electricity purchase and procurement process of distribution licensees including the price at which electricity shall be procured from the generating companies or licensees or from other sources through agreements for purchase of power for distribution and supply within the State;

(c) ....
(d) ….

(e) 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; **Government Incentives to Renewables Energy Central Government Incentives to Renewables Energy**

1.4 Role of Government in Promoting Renewable Energy

Development of renewable energy technologies has a long history in India. Commission for Additional Sources of Energy (CASE) was formed in 1981 for the development and promotion of renewables. Since then the sector has undergone various stages of development. Department of Non Conventional Energy Sources (DNES) was set up in 1982, which later became the Ministry of Non-conventional Energy Sources (MNES) in 1992. CASE is now a part of MNES.

Policy development stage included provision of financial and institutional support for renewable energy technologies. MNES, in 1993, prepared policy guidelines for promoting power generation from renewable energy sources which contained important guidelines regarding pricing of renewable energy.

On the financing front, in order to overcome the burden of high initial cost and high financing risk perception of the renewable energy technologies, Indian Renewable Energy Development Agency Limited (IREDA) was established in March 1987 as a public sector enterprise to finance renewable energy projects. Loans for such projects were provided by IREDA at lower interest rates. Depending upon the commercial viability of different renewable technologies, the interest rates were increased gradually for some projects. Today, in many sectors, including wind energy, the interest rates offered by IREDA are at par with market interest rates.

The Government of India, through MNES and the various State Governments has been supporting investment in non-conventional energy through various policy measures to promote the same. These incentives are by way of:

- Fiscal and financial incentives
- Permission for wheeling, banking, third party sale and buy-back by SEB's
- Capital subsidies in some states

The MNES Guidelines suggest charging only 2% as wheeling charges, banking of energy for up to 1 year and also recommend third-party sale at remunerative prices.

1.5 Financial and Fiscal Incentives

Some of the key fiscal / financial incentives provided in the past are:

- Concessional import duty on specified wind turbines
- Accelerated depreciation up to 80% allowed in the first year
- Sales tax, excise duty reliefs

- Soft loans from the IREDA
- Income tax holiday for first five years
- 5% annual escalation in tariff was recommended to be provided
- Financial assistance of 60% of the cost of wind turbine equipment, up to a specified limit.
- Facilitate purchase of private land etc.

Chapter - 2

TARIFF DETERMINATION MECHANISM FOR RENEWABLES

2.1 The tariff setting mechanism must meet the following key objectives:

a) Interests of consumers

Fairness to consumers is of significant importance, which would lead to consumer welfare. One of the derivatives of this objective is that the retail tariff should not witness a significant upward revision just for the purpose of accommodating green or renewable power. It must also be ensured that the equipment and machinery used are of high efficiency, are cost effective and that investments are made in locations that offer highest Capacity Utilization Factor (CUF) and energy generation, etc.

b) Fairness to Investors

The tariff must ensure that the investor earns an adequate return on investment. This should be fair and consistent, reflecting the risks and opportunity costs. This will provide the necessary signal and incentive to potential investors to invest in green power.

c) Interests of Licensees

The power purchase tariff must also be fair to the Licensee(s) and should reflect the costs and benefits on account of the mandatory requirement to purchase power from renewables energy generators. Factors such as reliability

and availability (e.g. infirm nature of wind) could be of serious concern in case the quantum of renewables energy is large as compared to the total purchases. Inconvenience to the licensee on account of such factors should be given due consideration.

2.2 MNES Guidelines for Non-conventional Energy Tariffs

MNES had prescribed the tariffs for purchase of power from renewable sources of energy. The MNES guidelines assume 1994-95 as the base year for tariff determination and for that year, the tariff was set at 2.25 rupees / Unit with a provision for escalation of 5% per annum for the first 10 years. From the end of 10th year onwards, the price of power shall be equal to the purchase price in the 10th year. The MNES guidelines also require that the period of PPA must be a minimum of 20 years and can be extended by another 10 years.

During the initial period when the windmills were setup , and prior to formation of State Regulatory Commissions, almost all the States adopted MNES guidelines and fixed the tariff. Even under the existing regulatory regime, some of the Commissions such as Andhra Pradesh have arrived at the rate as on 1-4-2004 as Rs 3.37 , on the basis of MNES guidelines and then frozen this rate for five years.

Maharashtra Commission , in their tariff order dated 24-11-2003 have categorized the wind power generators in three groups and determined the tariffs differently as follows:

a) Group 1 : Projects commissioned before 27-12-1999, (i.e. before the Commission notified its regulations) This group is allowed the tariff of Rs 2.25 per unit in the base year 1994-95 (MNES guidelines) and allowed the purchase rate to be increased at 5% every year for the first ten years from the date of commissioning , no increase in rate for the next three years , 5 % increase for the next seven years.
b) Group 2: Projects commissioned after 27-12-1999 but before 1-4-2003. This group is allowed a tariff of Rs 2.5 / unit for the first year from date of commissioning of the project, increased at 10 ps / year for ten years.

c) Group 3 : Commissioned after 1-4-2003. This group is allowed Rs 3.50 per unit from the date of commissioning and increase of 15 paise per year for next thirteen years

2.3 Tariff Determination Process

The tariff determination mechanism could be a Cost-plus, Market Driven, Long Run Marginal Costing and Avoided Cost of Generation. The latter two are difficult to estimate accurately and require extensive data. Hence they have not been considered by most of the Commissions.

2.4 Market Determined Pricing

In a free market, where there is perfect competition market determines the price. However, there is a good reason that the market driven pricing mechanism may be difficult to apply in the case of renewables. The same is elaborated below.

Under market determined prices, the buyer of power would go in for merit-order dispatch and purchase power from the cheapest source. However, renewable power is a costlier source as compared to conventional sources of power. Adopting merit order dispatch may lead to renewable power not getting dispatched at all.

To illustrate this point in Tamil Nadu context, the cost of power from various IPPs supplying power to TNEB are given below. Unless the renewable energy generator is able to provide power at a competitive rate as also with a firm commitment , it would not be able to dispatch its power under merit order dispatch scenario.

Source	Fixed Cost (Paise per unit @ 68.49% PLF)	Variable Cost Paise / Unit
G.M.R Vasavi	163	269.46
Madurai Power Corporation	184	258.98
Samalpatti Power	191	271.57
P.P. Nallur	187	413.25
S.T.C.M.S	199	162.63

The ABT mechanism provides for marginal price determination wherein the marginal price of power depends on the current frequency of the grid. Furthermore, wind power, which is the main renewable source in Tamil Nadu, cannot be precisely dispatched depending on the conditions of the grid with present technology, since it is mainly dependent on wind flow patterns. These factors make market pricing of power purchase from renewables, difficult to implement.

2.5 Cost-Plus Tariff Determination

Cost-plus tariff determination is a more practicable method. Some of the reasons that make cost-plus tariff simpler and acceptable are:

- Can be easily designed to provide adequate return to the investor; a surety of return will lead to larger investment in renewables power.
- Costs of renewables power generation sets are reducing rapidly and since it is difficult to predict this reduction, as the cost falls, the actual cost can be reflected through the cost plus tariff mechanism.

2.6 Single Part vs. Two Part Tariff

Two part tariff is applied in order to recover fixed and variable costs through the fixed and variable components of tariff. Since wind energy is not amenable (with the existing technology) to merit order dispatch principles because of infirm nature, and all the costs of wind electric generators are fixed, the single part tariff is considered more suitable for wind power. For the Biomass and co-generation, taking into consideration, their contribution to the total generation handled by the State Grid, single part tariff appears appropriate.

2.7 Project Specific or Generalized Tariff

A Generalized tariff mechanism would provide an incentive to the investors for use of most efficient equipment to maximize returns and for selecting the most efficient site while an individual tariff determination (Project Specific tariff) would provide each investor, irrespective of the machine type and the site selected, the stipulated return on equity which, in effect, would shield the investor from the

uncertainties involved in CUF due to machine type and the site location. With nearly 5566 wind mills in Tamil Nadu, project specific tariff may not be the correct choice. In general, the tariff determination mechanism must promote efficiency in the use of machines, in identification of good sites, and in operational ease. In view of this, the method of setting up of a single tariff for wind energy projects seems to be a preferable option if computed with due consideration to all factors.

2.8 Suggestions are invited on:

- Whether the tariff could be determined on the basis of MNES guidelines, allowing percentage increases and freezing at certain stage etc.,? or ;
- Whether cost plus tariff could be adopted and if so, can it be single part tariff for the reasons explained ? or ;
- Similar to Maharashtra, can we have the existing and proposed as separate groups of wind producers and decide two different tariffs ? or;
- Whether the tariff can be project specific ?.

Chapter - 3

Tariff Design – Wind Energy

This section on tariff design discusses issues such as the structure of the tariff over the life of the project, the period for which the tariff shall be valid etc. These are important issues that have significant bearing on tariff and consequently on the investment in wind energy projects in the State.

3.1 Tariff Structure

The tariff, if determined in a cost-plus scenario, would depend significantly on the assumptions on investment costs, operating and financing costs and the CUF in a cost-plus scenario. The key drivers of cost are:

- Capacity Utilization Factor
- Capital investment

- Life of plant and salvage value
- Depreciation rate applicable
- Operation and maintenance expenses
- Debt-equity ratio
- Interest costs on debt (cost of loan / debt)
- Term of Loan
- Return on equity

3.2 Capacity Utilization Factor (CUF)

The CUF is a key factor in the tariff determination process because the projection of quantum of energy generation and the revenue earned depends critically on it. Hence, an accurate estimate of CUF is essential. The CUF depends on several factors such as wind velocity, air density, Power Law Index, the quality, capacity and age of machines, height of the hub, and length of blade (swift area).

The calculation of the CUF as per the practical data obtained from Tamil Nadu Energy Development Agency for each of the passes is shown in Annexure – 1

As mandated in the Act , it is obligatory to promote investment in efficient equipment at good sites and in this context, assumptions on CUF becomes critical to promote investment in such desirable sites. In view of this, a minimum **CUF of 24.69 %, without derating, and alternatively 25.5 % with derating after ten years is assumed** as a reasonable estimate for 'modified' category of machines. Karnataka Commission has adopted 26.50 % and MP Commission 22.50 % in this regard.

3.3 Capital Investment

There is a wide variation in the project cost estimated by different agencies / entities for investment in wind power projects. The expected investment ranges from Rs. 3.5 crore to Rs. 5 crore per megawatt. Karnataka Commission has adopted 4.25 crores/ MW and MP Commission 4.5 crs/ MW in this regard.

It is proposed to allow **Rs. 4.5 Cr. / MW** as a reasonable estimate for cost of investment in a 1 MW project.

3.4 Life of Plant

Generally the plant/project life of a wind power generation is considered as 20 years for tariff determination process. Other states like Andhra Pradesh and Maharashtra, too have assumed the plant life to be as 20 years. International experience also suggests the expected project life for a wind energy project to be 20 years. Based on these inputs and experiences elsewhere, the plant life of **20 years** looks reasonable for wind power generation units for tariff determination purposes.

3.5 Depreciation Rate

The Income Tax (Twenty Forth Amendment) Rules, 2002 allow accelerated depreciation for wind mills up to a maximum of 80% of the asset value in a year. However, for the purpose of tariff determination, it may be prudent to take depreciation on a Straight Line Method (SLM) wherein the asset life is to be depreciated to a residual value of 10% of its initial value over the entire asset life of 20 years. This translates to an SLM depreciation of **4.50 %** per annum. In this context, Karnataka Commission has adopted 7% and MP Commission 4.50 % .

3.6 Operation and Maintenance Expenses

O&M expenses comprise of:

- Manpower expenses
- Insurance expenses
- Spares and repairs
- Consumables
- Other expenses (statutory fees etc.)

Considering various factors, it looks appropriate to charge **1.25% of the capital cost of the project as O&M expense for the first five years,** and increased thereafter with a simple escalation of 5% per year, Karnataka Commission has adopted 1.25 % with 5% escalation every year and MP Commission 1 % for the first five years and 5 % escalation every year thereafter in this regard.

3.7 Debt-equity ratio

The debt-equity ratio of a Wind Energy project has been assumed as **70:30**. This has been adopted by most of the Commissions

3.8 Interest Costs on Debt

Interest rate on debts can be as per the IREDA norms for renewables. Accordingly, the interest rate on IREDA loans for wind energy projects which is 10.5 % is suggested to be adopted for tariff determination purposes.

The investor can be allowed the freedom to take a cheaper loan, and any benefits may be retained by them.

3.9 Term of Loan

Loans are assumed to be available for **10 years with a moratorium of 1 year.** IREDA loans are available with this term structure.

3.10 Return on Equity (RoE)

The investors perceive a high risk and having a long pay back period in such project and therefore there should be an adequate return to the investor. Accordingly the RoE may be fixed at the rate of **16%, pre-tax**. The payment to the developer is secured as per the payment provisions described later. Most of the Commissions have adopted 16 % RoE only.

3.11 Tariff Review Period / Control Period

In the case of wind power, the primary cost is the cost of debt. With interest rates apparently unstable, though with a clear downward trend in the past few years, setting of the tariff period for a very long time horizon, may not be in the interest of the investors. Apart from the interest rates, the cost of investment per unit of energy generated seems to be on a downward path.

In view of the above, a review period of a longer duration (such as five years) might not be desirable as the interest costs, costs of investment etc could change significantly in this period. On the other hand, a short review period of 1 year would cause high uncertainty for the investors with respect to the tariff rates. Accordingly, the **control period is suggested to be three years**.

At the end of the control period, the tariff determination process may be reviewed**.** Tariff decided in a particular control period shall apply to all projects that shall come up within that control period.

3.12 Cost Plus Tariff - Single part for Wind Energy Projects

Typical computations of the tariff for windmill generation with the basic assumptions detailed for each and as discussed in previous sections has been provided in Annexure 2-A and 2-B

a) First case : Assumptions

- Capacity Utilization Factor as 24.69 % (which in turn has been arrived at on the basis of 92 % grid availability, 95 % machine availability, 95 % array efficiency and 2 % internal losses)
- Capital investment as 4.50 crs / MW
- Life of plant as 20 years
- Depreciation rate as 4.50 % under SLM up to 90 %
- Operation and maintenance expenses as 1.25 % of capital cost for the first five years and 5 % / year as escalation thereafter
- Debt-equity ratio as 70 :30
- Interest costs on debt as 10. 50 % (cost of loan / debt)
- Term of Loan as 10 years with a moratorium of one year
- Return on equity as 16 % pre tax

Average unit cost of wind energy (levellised) is Rs. 2.79 / unit

	Year 1	Year2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Tariff (Rs/Unit)	**3.724**	**3.724**	**3.571**	**3.418**	**3.265**	**3.126**	**2.986**	**2.848**	**2.710**	**2.573**
	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Tariff (Rs/Unit)	**2.436**	**2.301**	**2.319**	**2.338**	**2.359**	**2.380**	**2.402**	**2.425**	**2.450**	**2.476**

a) Alternate case : Assumptions

- Capacity Utilization Factor as **25.50** % (which in turn has been arrived at on the basis of **95 %** grid availability, **95 % machine availability for the first ten years and 1 % reduction due to ageing, for each year thereafter till twenty years,** 95 % array efficiency and 2 % internal losses)
- Capital investment as 4.50 crs / MW
- Life of plant as 20 years
- Depreciation rate as 4.50 % under SLM upto 90 %
- Operation and maintenance expenses as 1.25 % of capital cost for the first five years and 5 % / year as escalation thereafter
- Debt-equity ratio as 70 :30
- Interest costs on debt as 10. 50 % (cost of loan / debt)
- Term of Loan as 10 years with a moratorium of one year
- Return on equity as 16 % pre tax

Average unit cost of wind energy (levellised) is Rs. 2.77 / unit

	Year 1	Year2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Tariff (Rs/Unit)	**3.606**	**3.606**	**3.458**	**3.310**	**3.162**	**3.026**	**2.891**	**2.757**	**2.624**	**2.491**
	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Tariff (Rs/Unit)	**2.383**	**2.273**	**2.314**	**2.357**	**2.401**	**2.447**	**2.495**	**2.545**	**2.597**	**2.650**

3.13 Suggestions are invited on :

a) The basic assumptions narrated above which have a direct bearing on the tariff rates .

b) Whether the tariff can be a levellised one or front loaded

Note : In case of adoption of front loaded tariff , it is needed to take care of the generators, winding up the project before the agreed period of 20 years. It is proposed that an amount equivalent to 4% of RoE may be deducted in two equal installments from the monthly bill of September and March of each financial year for the first five years. This amount will be deposited in a bank account in the joint names of the developer and the utility. The interest accrued on the deposited amount shall be allowed to be paid to the developer on a yearly basis.

The developer will be able to withdraw this amount only at the end of 10th year based on the clearance of the utility. In case the developer winds up his project / disposes of the business before the completion of the ten year period, the amount of deposit will revert back to the utility.

Chapter - 4
Tariff Design – Biomass Energy

4.1 Assuming a cost-plus tariff as a design base, the tariff would depend significantly on the assumptions on investment costs, operating and financing costs, fuel cost and PLF. The key drivers of cost are:

- Capital cost
- Plant Load Factor
- Auxiliary Consumption
- Operation and maintenance expenses
- Cost of Fuel
- Fuel Consumption
- Cost of loan / debt

- Debt equity ratio
- Return on equity
- Working Capital
- Depreciation

4.2 Cost of the Project:

The capital cost as Rs 4.00 Crs/ MW has been considered for Biomass projects. In this context, it may be noted that, the Uttar Pradesh Commission has adopted Rs 3.5 crs/ MW, Karnataka Commission Rs 4.00 crs / MW and Andhra Pradesh Commission Rs 4.00 Crs / MW

4.3 Plant Load Factor:

PLF of 80% is proposed as threshold for fixed cost coverage. In this context, it may be noted that, the Uttar Pradesh Commission has adopted 60%, Karnataka Commission 75 % and Andhra Pradesh Commission 80 %

4.4 Auxiliary consumption:

Compared to conventional power projects where 9% auxiliary consumption is allowed, the non-conventional power projects have less auxiliary system. Further, these plants should be properly audited and operated efficiently to minimize losses and maximize production as enunciated by the Energy Conservation Act. Hence the auxiliary consumption is considered as 9%. In this context, it may be noted that, the Uttar Pradesh Commission has adopted 8.5 %, Karnataka Commission 9 % and Andhra Pradesh Commission also 9 %

4.5 O & M Expenditure:

It needs to be recognized that there are no guidelines of CEA for the operating norms for the NCE Projects. Considering the fact that the biomass based projects are labour-intensive, still in the development stage and the technology is to be further perfected, it is reasonable to fix the O & M expenditure including insurance as 5 % with escalation of 5 % every year. In this context, it may be noted that, the Uttar Pradesh Commission has adopted 2.5 % with 4 % escalation, Karnataka Commission 4 % with 5 % escalation and Andhra Pradesh Commission 4 % with 4 % escalation .

4.6 Cost of Fuel

Cost of fuel is the most important parameter that determines the cost of generation in a Biomass power plant. The Biomass plant uses a mix of fuels like rice husk, woody Biomass, cotton stacks, chilly stacks etc. and to some extent coal, as permitted by MNES. The price of rice husk may vary depending on the season. The price of other Biomass fuels are also variable in nature depending on the seasons. A mix of 50-60% rice husk and balance from other fuels has been assumed. Considering the weighted average price of rice husk and other materials (60:40), the price of fuel works out to about Rs. 1000 / MT. The current rate of inflation is around 4% per annum but as the fuel is procured from unorganized sector, the escalation of fuel price may be fixed at the rate of 5%. In this context, it may be noted that, the Uttar Pradesh Commission has adopted Rs 740 / MT and 4 % escalation , Karnataka Commission and Andhra Pradesh Commission Rs 1000/ MT with 5 % escalation.

4.7 Fuel Consumption

Non-conventional power projects should improve the operational efficiency, notwithstanding the fact that they are under privileged category of power projects for promotion. The burden of higher fuel consumption by the Power Projects resulting in higher costs cannot be passed on to the consumers. Considering the fact that the technology is in a development stage, we can provide for a station heat rate of 3700 kcal / kWh and fuel calorific value of 3200 kcal / kg, which corresponds to a fuel consumption of 1.16 kg / kWh. This is similar to what is adopted in Karnataka and Andhra

4.8 Debt - Equity Ratio

Debt-equity ratio is mainly determined by the Financial Institutions for approving project loans. As these projects are mainly financed by IREDA / Financial Institutions and they insist on debt-equity ratio of 70 : 30, a debt-equity ratio of 70 : 30 is assumed. Further all the Commissions adopt this ratio only.

4.9 Return on Equity

It needs to be recognized and emphasized that, the NCE projects are fraught with risks and uncertainties. In order to provide an element of security as well as incentive for promotion of NCE sources, ROE at 16% (pre tax) for the existing projects as well as for the new projects has been assumed. This is also in line with what the other Commissions have adopted.

4.10 Working capital

Regarding the working capital, the storage of fuel stock beyond one month is dependent on various factors like non-availability of stock on continuous basis, storage facilities, the actual practice followed by the developers and the price during season / off-season. In the absence of all these details, two month's stock of fuel and two months O&M expenses is apportioned towards the working capital component. Regarding interest rate on working capital, 11.00 % is considered a reasonable rate of interest on working capital. In this context, it may be noted that, the Uttar Pradesh Commission has adopted 10.25 %, Karnataka Commission 12.5 % and Andhra Pradesh Commission 12 %.

4.11 Interest on Term Loan

Interest on term loan is assumed as 10.50 % for both the existing and new projects as per IREDA norms for renewables. The investor can be allowed the freedom to avail a cheaper loan and he may retain any benefits. In this context, it may be noted that, the Uttar Pradesh Commission has adopted 10.25 %, Karnataka Commission 11.00 % and Andhra Pradesh Commission 12.00 % .

4.12 Depreciation

The depreciation rate of 7.84% is as per the rates approved for Independent Power Producers (IPPs) so that this amount can be used for repayment of loans. A uniform rate of depreciation could be allowed both for existing as well as new projects, at the rate of 7.84% per annum till the depreciation allowed accumulates to 90% of the project cost. In this context, it may be noted that, the

Uttar Pradesh Commission has adopted 7.00 %, Karnataka Commission 7.00 % and Andhra Pradesh Commission 7.84 %

4.13 Tariff Review Period / Control Period

A review period of a longer duration (such as five years) might not be desirable as the interest costs, costs of investment etc could change significantly in this period. On the other hand, a short review period of 1 year would cause high uncertainty for the investors with respect to the tariff rates. Accordingly, the **control period is suggested to be three years**.

At the end of the control period, the tariff determination process may be reviewed**.** Tariff decided in a particular control period shall apply to all projects that shall come up within that control period.

4.14 Typical tariff computation / Biomass generation

Single part cost plus tariff is considered to be the better choice for Biomass generation also. Taking into consideration the technical and financial parameters as discussed above, the levellised tariff for the Biomass Power Projects works out to Rs 3.17 as detailed in Annexure 3

Chapter - 5

Tariff Design – Bagasse based Co-generation Plants

This section discusses the tariff for Bagasse based Co-generation Plants

5.1 Capital Cost

An amount of Rs. 3.50 Crs / MW is assumed as the project cost for Bagasse based Co-generation projects without distinguishing between old and new projects. In this context, it may be noted that, the Uttar Pradesh Commission has adopted Ra 3.50 crs / MW , Karnataka Commission 3.0 crs / MW and Andhra Pradesh Commission Rs 3.25 crs /MW.

5.2 Auxiliary Power Consumption:

Compared to conventional power projects, the NCE projects have less auxiliary system. These projects should be operated efficiently to minimize losses and maximize production as provided in the Energy Conservation Act. Hence the auxiliary consumption is considered at 9% . In this context, it may be noted that, the Uttar Pradesh Commission has adopted 8.50 %, Karnataka Commission 8.00 % and Andhra Pradesh Commission 9.00 %

5.3 Fixed cost coverage

The threshold Plant Load Factor (PLF) has to be arrived at for fixed cost coverage. In case of Bagasse based Co-generation Plants, the PLF depends mostly on availability of Bagasse in the crushing season. Assuming that the projects can run for 130 days during the crushing season and another 100 days during non-crushing season (with the stored Bagasse and other Biomass fuels), the average PLF that can be achieved is around 55% when the project runs at a capacity of 90%. Hence a threshold level of PLF at 55% worked out on the basis of the availability of fuel, is reasonable**.** In this context, it may be noted that, the Uttar Pradesh Commission has adopted 60 %, Karnataka Commission 60 % and Andhra Pradesh Commission 55 %

5.4 Cost of Fuel

The power is basically generated out of the Bagasse produced by crushing of sugar cane in the manufacture of sugar. The price of Bagasse is the key parameter influencing the project economics and determination of tariff. The fuel for the Co-generation plant during crushing season is virtually free. However, if Co-generation plant does not exist, the Bagasse will fetch some price. As such the issues like calorific value of Bagasse, Station Heat Rate (SHR) and its linkage to sugar cane prices need to be addressed adequately. As Co-generation is an efficient process where the cycle efficiency is high, it needs to be encouraged. In such a context, Gross Calorific Value of 2300 Kcal / Kg is reasonable for price determination of Bagasse.

There cannot be any relationship between price of sugar cane that is being fixed by Govt., and the price of Bagasse. Bagasse is also in demand by other

industries like paper, cattle feed etc., and accordingly market forces determine the price of Bagasse. For determination of Bagasse price, equivalent heat value of coal can be adopted. The pit head cost and calorific value of coal have been considered to arrive at the fuel price linked to heat content. The fuel price in terms of Rupee / tonne equivalent to gross calorific value of 2300 kcal / kg works out to around Rs. 562 / MT. Therefore Rs. 575 / MT is considered as a reasonable and fair price for Bagasse. The current rate of inflation is around 4% per annum but as the fuel is procured from un-organized sector, escalation for fuel price at the rate of 5% is assumed. In this context, it may be noted that, the Uttar Pradesh Commission has adopted Rs 740 / MT with 4.00 % escalation, Karnataka Commission Rs 800 / MT with 5.00 % escalation and Andhra Pradesh Commission Rs 575 / MT with 5.00 % escalation.

5.5 Specific fuel consumption

The fuel consumed in the Co-generation plant will cater to

- Production of steam to process plant.
- Supply of power to the sugar industry (Captive consumption) during crushing season.
- Delivery of power to Licensees.

The consumption of fuel intended for supply of power to licensees needs to be considered and rated. Station Heat Rate (SHR) at 3700 Kcal / Kwh for Bagasse projects has been assumed. Based on this SHR, 1.60 Kg / Kwh is the rated average of specific fuel consumption during crushing and non-crushing season. Karnataka and Andhra have also adopted 1.60 kg / unit as the specific fuel consumption.

5.6 O & M Expenditure

For thermal projects, the O & M expenditure allowed as per CEA guidelines is 2.5% per annum. But Bagasse based co-generation projects are very small in capacity and are under emerging technology. These cannot therefore be compared to bigger projects of advanced technologies. At the same time it is a fact that the O & M of the steam generator cannot be totally apportioned to power generation as part of the steam generated is utilized for the industry. The O& M

expenditure of 5 % per annum (including insurance) seems reasonable. Escalation of 5 % on O & M expenditure is reasonable as it falls in line with the rate of inflation. In this context, it may be noted that, the Uttar Pradesh Commission has adopted 2.5% with 4.00 % escalation, Karnataka Commission 3.00 % with 5.00 % escalation and Andhra Pradesh Commission 3.00 % with 4.00 % escalation.

5.7 Debt- Equity Ratio

Debt-equity ratio is mainly determined by the Financial Institutions for approving project loans. As these projects are mainly financed by IREDA / Financial Institutions and they insist for Debt-equity ratio of 70:30, the same ratio is adopted and is in line with other Commissions.

5.8 Return on Equity

Under the falling interest rates regime, the ROE should also correspondingly reduce. It is to be kept in view that GOI attaches great importance to promotion of non-conventional energy, and encourage the non-conventional power projects which are environment friendly. In order to cover risks and also to provide an incentive to promote development, ROE at 16% (pre tax) for the existing projects as well as for new projects is adopted, to provide encouragement to the non-conventional sector. This is similar to what other Commissions have adopted.

5.9 Interest on Term Loan

Interest on term loan is assumed as 10.50 % for both the existing and new projects as per IREDA norms for renewables. The investor can be allowed the freedom to avail a cheaper loan and he may retain any benefits. In this context, it may be noted that, the Uttar Pradesh Commission has adopted 10.25 %, Karnataka Commission 11.00 % and Andhra Pradesh Commission 10 % .

5.10 Working Capital

Regarding working capital, 11.0 % as interest rate is adopted for working capital and this is in line with the on-going interest rate of Banks for working capital. It is assumed that two month's stock of fuel and two months O&M expenses will constitute the working capital component. The Uttar Pradesh Commission

has adopted 10.25 %, Karnataka Commission 12.5 % and Andhra Pradesh Commission 12 % for working capital.

5.11 Depreciation:

The depreciation rate of 7.84% is as per the rates approved for Independent Power Producers (IPPs) so that this amount can be used for repayment of loans. It may be noted that the uniform rate of depreciation both for existing as well as new projects, allows depreciation at the rate of 7.84% per annum from the date of commissioning till the depreciation allowed accumulates to 90% of the project cost. In this context, it may be noted that, the Uttar Pradesh Commission has adopted 7.00 % , Karnataka Commission 7.00 % and Andhra Pradesh Commission 7.84 %

5.12 Tariff Review Period / Control Period

A review period of a longer duration (such as five years) might not be desirable as the interest costs, costs of investment etc could change significantly in this period. On the other hand, a short review period of 1 year would cause high uncertainty for the investors with respect to the tariff rates. Accordingly, the **control period is suggested to be three years**.

At the end of the control period, the tariff determination process may be reviewed**.** Tariff decided in a particular control period shall apply to all projects that shall come up within that control period.

5.13 Typical tariff computation

Taking into account the technical and financial parameters considered by the Commission in the preceding paragraphs, the single part cost plus tariff for the bagasse based co-generation is estimated as Rs 3.13 per unit as detailed in Annexure 4

Chapter – 6

Tariff Design – Solar Energy

The quantum of grid connected solar system in Tamil Nadu is at present only 0.165 MW and that of India is 47 MW. The capital cost required for installing a solar generating station is 30 times more than that of the conventional generating station. Technical advancements are being achieved in the field of tapping of solar energy. The number of grid connected solar generators is yet to take off to the desired level. Hence, the Commission can specify the cost of purchase of solar energy separately.

Chapter – 7

Other General Issues

7.1 Minimum purchase requirements

Section 86 (1) (e) of the Electricity Act of 2003 states that, the State Commission must specify a percentage of the total consumption of electricity in the area of Licensee to be procured from renewable sources.

7.2 Factors for determining minimum purchase requirement

While determining the minimum purchase requirement for the licensees, we need to consider the following factors:

- Total quantum of energy required
- Total potential for renewable energy generation in the State
- Quantum of renewable energy being generated
- Power purchase tariff for renewable energy
- Commercial and technical impact of purchase of renewable power on retail tariffs

The current wind energy generation capacity in Tamil Nadu is 2418.24 MW, which translates to 5230.28 mu at a CUF of 24.69 % (First case study) Generation from bio-mass is around 207.19 mu and that from co-generation is 1286.12 mu . Hence, the total renewable generation is equivalent to 16.68 % of

total consumption in the TNEB area of supply and procurement is 8.25 %.

It should be made obligatory for the distribution licensee to procure a minimum 10% of its total power consumption from Renewable and NCE source based plants.

As and when developers of other renewable sources of energy install plants for generation of power, the Commission can appropriately allocate this percentage among wind and other renewable sources. The Commission therefore need not prescribe the percentage figure itself.

If the licensee fulfills the minimum purchase requirements and still has offers from NCES generators, then either the licensee or the NCES generator can approach the Commission for approval of such procurement offers. The Commission therefore need not prescribe the maximum limit for the present.

7.3 Third-Party Sale

Third Party sales under Open access regime would be guided by the Open Access regulations notified by the Commission under Electricity Act 2003.

7.4 Transmission and Wheeling Charges

Transmission and wheeling charges payable at present (which includes the line losses in kind) are ;

Wind Energy Generators	5 %
Biomass	10%
Co-generation	Within 25 KM usage – 2% Beyond 25Km usage – 10%

To give encouragement for promotion of Renewable Energy and Co-generation it is proposed to have transmission and wheeling charges including the line losses in kind as :

Wind Energy Generators	5 % of energy
Biomass	Within 25 KM usage : 2 % Beyond 25 KM usage : 7 %
Co-generation	Within 25 KM usage : 2 % Beyond 25 KM usage : 7 %

Note : Sale of power to a Distribution Licensee, either the whole generation or in part will not be subject to the transmission or wheeling charges. Only the power that are sold to third party or wheeled for own use will attract the provisions of transmission and wheeling charges.

The units of energy wheeled will be adjusted in the service for which wheeling is done as follows.

- If the tariff of the service to which wheeling of energy is H.T. Tariff-I, the wheeled units will be directly adjusted.
- If the tariff rate for the energy of the wheeled service is higher than that of H.T. Tariff-I, the adjustment will be at H.T. Tariff-I rate. The difference in rates will be charged to the consumer for the units wheeled.
- If the tariff rate of energy of the wheeled service is lower than that of H.T. Tariff-I, then the wheeled units will be directly adjusted.

7.5 Demand charges payable to Licensee by the user, when the power generated is transmitted / wheeled for own use

Consider the cases when the power generated (through Bio mass / co-generation sources) by a person is transmitted for own use (own use as notified by GoI applicable to captive sources) by availing the transmission / distribution system of the Licensee. A part or the full demand of the user at his HT service is met from his own generation. Further the power generation from these sources are firm in nature and hence it is obvious that the user should be compensated for the portion of demand met from his own generation. The problem lies in computation of the demand met at various slots of time interval since the generation and the actual demand at site will vary. Accordingly suggestions are invited as to how we can implement this concession or simply allow them a percentage based on the generated units.

7.6 Metering and Billing

The energy delivered to the grid will be metered in accordance with the provisions of the relevant codes. Billing of the metered energy will be carried out

on a monthly basis. Energy accounting for energy delivered to the grid will be carried out at the point of metering.

7.7 Settlement Mechanism and Payment Security

Wind energy being infirm in nature, situations will arise where the actual generation is different from contracted generation. On account of this expected variation, modalities of sale of wind energy in terms of settlement of bills need to be determined clearly.

It is proposed to prescribe a settlement period of 30 days, which should be followed stringently in order to ensure that the developer has an assurance of cash inflow for the energy, which he delivers to the grid.
To reduce this incidence of default, it is suggested to provide two options to the developers:

(i) Utility at the cost of, and option of the developer, shall open a Revolving Irrevocable Letter of Credit in favor of the Developer for an amount equivalent to the average monthly bill, computed at the end of each previous financial year. For the first year of operation, such bills would be assessed based on the parameters defined in this Order.

(ii) To provide the compensation in case of delay beyond the 30 days payment period, the utility will pay interest on outstanding amount at the short term lending rate of the State Bank of India.

7.8 Prerequisites for commercial agreements

The NCES Generators / distribution companies/ other parties that are willing to sign commercial agreements, for a period of at least 20 years, for supply/purchase of NCES power shall, prior to finalizing any commercial agreement, send a copy of the draft agreement to the Commission for vetting,

along with the fees determined by the Commission from time to time. The Commission shall approve the terms and conditions of the agreement after due scrutiny. Only an agreement, duly vetted by the Commission, shall hold legal validity.

7.9 Model PPA

TNEB will frame and file a model PPA for approval of the Commission. This should include a clause for penalty in case the developer winds up his operation before the 20 year power purchase agreement period.

Annexure - I

Wind Regime

Location	Latitude	Longitude	Mean Sea Level	Mast	Power Law Index	Air Density	Wind Power Density /50
	deg N	deg E	(m)	(m)		(g/cum)	(w/sqm)
Muppandal Pass							
Kanan Kulam	8.20	77.58	20	25	0.22	1169	374.6
Sankaneri	8.2	77.7	28	25	0.2	1168	387.7
Muppandal	8.25	77.55	42	20	0.22	1152	712.3
Shenbaka Raman Pudur	8.27	77.52	40	20	0.17	1152	475.7
Kumara Puram	8.27	77.58	158	25	0.17	1155	407.8
Kattadi Malai	8.28	77.53	35	20	0.16	1167	488.1
Panakudi	8.3	77.58	140	20	0.11	1147	469.2
Puliyamkulam	8.35	77.73	10	20	0.23	1152	342.9
Shencotta Pass							
Nettur	8.25	77.55	100	20	0.1	1151	419.3
Thalayuthu	8.78	77.65	125	20	0.12	1149	422.1
Gangaikondan	8.85	77.77	60	20	0.17	1155	338.4
Alagia Pandipuram	8.9	77.65	70	20	0.2	1154	487.2
Ottapidaram	8.9	78.02	15	20	0.19	1160	377.8
Kayattar - II	8.92	77.73	90	25	0.12	1151	356.3
Kayattar - I	8.95	77.77	105	20	0.11	1145	413.7
Achankutam	8.97	77.47	120	20	0.18	1159	437.3
Onamkulam	8.97	77.85	100	25	0.1	1151	291.9
Ayakudi	9.02	77.33	182	20	0.23	1153	536.1
Mangapuram	9.05	77.37	196	20	0.12	1152	422.8
Naduvakurichi	9.08	77.47	172	20	0.18	1144	244.4
Palaghat Pass							
Myvadi	10.6	77.32	341	20	0.18	1127	376
Andiyur	10.6	77.17	392	20	0.18	1122	270.6
Pucharipatti	10.67	77.12	380	25	0.19	1123	254
Pulavadi	10.75	77.27	390	20	0.2	1115	444.9
Arasan Pallayam	10.82	77.05	385	20	0.15	1123	291.1
Sulthanpet	10.9	77.22	398	20	-0.01	1115	206.1
Edayarpalayam	10.9	77.05	445	20	0.14	1117	398.2
Kethanur	10.9	77.28	404	20	0.14	1121	375.6
Mettukadai	10.92	77.33	365	20	0.17	1119	280.7
Pongalur	10.93	77.38	365	20	0.16	1125	309.4
Tennerpandal	10.97	77.32	380	20	0.35	1123	
Sea Coast							
Ovari	8.28	77.87	21	20	0.14	1167	221.4
Tuticorin	8.83	78.13	3	20	0.19	1155	244.9
Rameswaram	9.28	79.33	4	20	0.24	1167	604.4
Poompuhar	11.13	79.85	2	20	0.06	1165	149.2
Ennore	13.27	77.53	6	20	0.19	1164	243.3

Estimated Annual Generation for Higher Capacity Machines

Corrected for Air Density, Array Efficiency, Grid & Machine Availability and Internal Losses

Location	SUZLON 1250 KW H=65 D=64 (Pitch)	NEG 750 KW H=55 D=48.2 (Stall)	ENERCON 600 KW H=56.85 D=44 (Pitch)	NEG 1650 KW H=78 D=82 (Stall)	GE WIND 1500 KW H=65 D=70.5 (Pitch)	PIONEER 850 KW H=65 D=58 (Pitch)	CHIRANJEEVI 750 KW D=51.5 (pitch)
Muppandal Pass							
Kanan Kulam	3202827	1628924	1413537	4900636	3750857	2243687	1815119
Sankaneri	3451177	1765938	1534391	5268364	4047019	2428292	1974110
Muppandal	4416505	2327682	2008363	6430864	5225924	3022398	2537671
Shenbaka Raman Pudur	3403383	1747313	1521325	5130744	4003455	2386181	1971061
Kumara Puram	3076372	1577788	1366113	4745571	3596618	2212365	1772374
Kattadi Malai	3896682	1991109	1739243	5884891	4586386	2760132	2262984
Panakudi	3189564	1712959	1496650	4687561	3754403	2180030	1900182
Puliyamkulam	2963237	1488895	1299903	4632268	3478559	2112725	1660821
Average	3449968.375	1780076	1547440.625	5210112.4	4055402.63	2418226.3	1986790.25
For 1000 KW	2759974.7	2373434.67	2579067.708	3157643.9	2703601.75	2844972.1	2649053.667
Average for 1 MW for this Pass			**2723964.1**				
CUF for this Pass			**31.10** Corrected to Hub height of 50 M				
Shencotta Pass							
Nettur	2883763	1539787	1334233	4082584	3413688	1871505	1736118
Thalayuthu	2483619	1349360	1148912	3545611	2908854	1670574	1476699
Gangaikondan	2413543	1276316	1097937	3463406	2826705	1622014	1407021
Alagia Pandipuram	3191647	1705083	1467419	4576922	3774362	2098925	1862494
Ottapidaram	2458097	1283910	1105469	3673186	2867679	1687623	1418032
Kayattar - II	2446798	1292001	1118003	3545060	2864417	1652756	1451907
Kayattar - I	2676459	1426675	1228974	3852424	3141089	1780353	1597984
Achankutam	2774557	1482849	1274840	3884339	3275966	1812064	1627636
Onamkulam	2278005	1201180	1037596	3378972	2659469	1570374	1369770
Ayakudi	3710023	1960292	1705997	5343643	4399755	2411729	2148317
Mangapuram	3291703	1740286	1503391	4763848	3875167	2216306	1953105
Naduvakurichi	1980751	1102074	969004	3412698	2541493	1559015	1248139
Average	2715747.083	1446651.08	1249314.583	3960224.4	3212387	1829436.5	1608101.833
for 1000KW	2172597.667	1928868.11	2082190.972	2400136	2141591.33	2152278.2	2144135.778
Average for 1 MW for this Pass			**2145971.2**				
CUF for this Pass			**24.50** Corrected to Hub height of 50 M				
Palaghat Pass							
Myvadi	2820648	1482499	1278269	4087443	3314212	1886054	1643671
Andiyur	2597233	1325478	1148805	3981544	3028128	1821364	1492636
Pucharipatti	2406758	1199719	1042219	3848077	2786040	1794121	1357393
Pulavadi	3229658	1704126	1472185	4694174	3814840	2147500	1877340
Arasan Pallayam	2680715	1353577	1177056	4169738	3114481	1974238	1553446
Sulthanpet	1647412	883735	758741	2495628	1902474	1268045	1057423
Edayarpalayam	3101280	1612606	1396831	4564045	3628343	2116766	1826691
Kethanur	2854378	1482807	1284010	4209905	3337265	1958520	1678917
Mettukadai	2318485	1188819	1034378	3493407	2713844	1615268	1343508
Pongalur	2522864	1305183	1130500	3747482	3582486	1728159	1782474
Tennerpandal	3138104	1585320	1424141	4189769	3714576	2010198	1760478
Average	2665230.455	1374897.18	1195194.091	3952837.5	3176062.64	1847293.9	1579452.455
for 1000KW	2132184.364	1833196.24	1991990.152	2395659.1	2117375.09	2173287	2105936.606
Average for 1 MW for this Pass			**2107089.8**				
CUF for this Pass			**24.05** Corrected to Hub height of 50 M				
Sea Coast							
Ovari	2188006	1121937	969501	3408532	2526277	1592698	1276648
Tuticorin	2226792	1113484	968611	3573824	2586608	1642127	1258830
Rameswaram	4420505	2261136	1967475	6633016	5215450	3027124	2500230
Poompuhar	1260164	655295	559173	2052190	1416429	990948	774162
Ennore	2472880	1220081	1058927	4112896	2853158	1886607	1375939
Average	2513669.4	1274386.6	1104737.4	3956091.6	2919584.4	1827900.8	1437161.8
for 1000KW	2010935.52	1699182.13	1841229	2397631.3	1946389.6	2150471.5	1916215.733
Average for 1 MW for this Pass			**1994579.3**				
CUF for this Pass			**22.77** Corrected to Hub height of 50 M				

Grid Availability - 95%
Machine Availability - 95%
Array Efficiency - 95%
Internal Losses - 2%

Estimated Annual Generation for Lower Capacity Machines

Corrected for Air Density, Array Efficiency, Grid & Machine Availability and Internal Losses

Location	FLOVEL 600 KW H=50 D=43	KENETECH 410 KW H=36.5 D=33	REPL 320 KW H=40 D=33	ELECON 300 KW H=40 D=30	NORDIAMK 300 KW H=30.5 D=31	NORDEX 250 KW H=41 D=29.7	DIS 250 KW H=36.5 D=27	AMTL 250 KW H=31 D=25	NEPC 250 KW H=30 D=27.6	NEPC 225 KW H=30 D=28.6	TTG 250 KW H=31.3 D=28.5	VESTAS 225 KW H=31.5 D=27
Muppandal Pass												
Muppandal	1793548	1097326	986339	863386	812355	763110	711487	706244	693338	674343	648863	631790
Shenbaka Raman Pudur	1326347	773446	749727	638331	593847	579479	530000	530566	514493	528973	475953	477255
Kumara Puram	1520882	909909	856744	732338	689150	657973	610959	610108	591544	592263	550402	545825
Kattadi Malai	1509551	876004	864536	730670	684190	663574	606376	608007	589153	610868	544468	548362
Puliyamkulam	1114730	602073	619179	509991	451426	479521	428251	422035	394335	410902	366718	373795
Average	1453011.6	851751.6	815305	694943.2	646193.6	628731.4	577414.6	575392	556572.6	563469.8	517280.8	515405.4
For 1000 KW	2421686	2077442.927	2547828.125	2316477.33	2153978.667	2514925.6	2309658.4	2301568	2226290.4	2504310.2	2069123	2290690.7
Average for 1 MW for this Pass			**2311165**									
CUF for this Pass			**26.38** Corrected to Hub height of 50 M									
Shencotta Pass												
Nettur	1239343	851844	701972	640585	631163	539740	524657	534332	548431	523383	504212	485481
Thalayuthu	1067387	700631	583809	524618	519566	469938	446261	458411	446954	416747	419616	400568
Alagia Pandipuram	1329145	842678	715439	647306	606857	564341	532974	526572	526766	507790	488786	473955
Kayattar - II	1113012	720406	623240	553819	535559	488422	464740	471349	467272	454689	431612	421637
Onamkulam	944893	590668	544105	463951	448796	427887	399268	413616	398093	397448	366619	364121
Ayakudi	1516391	937430	819639	735298	671488	636263	594594	582926	581682	572867	540035	592574
Average	1201695.2	773942.8333	664700.6667	594262.833	568904.8333	521098.5	493749	497867.67	494866.33	478820.67	458480	456389.33
for 1000KW	2002825.3	1887665.447	2077189.583	1980876.11	1896349.444	2084394	1974996	1991470.7	1979465.3	2128091.9	1833920	2028397
Average for 1 MW for this Pass			**1988803.4**									
CUF for this Pass			**22.70** Corrected to Hub height of 50 M									
Palaghat Pass												
Poosaripatti	995652	514289	549584	447028	393360	437936	383756	382388	346465	369574	323513	334196
Pulavadi	1318345	815095	711483	637690	591218	561474	524749	517735	516278	505986	477495	467040
Arasan Pallayam	927563	508890	540453	435432	411582	428776	382903	394966	363219	387871	336025	345778
Sulthanpet	723072	443169	444840	363830	374917	350640	325335	347441	330615	347774	300750	306304
Edayarpalayam	1255051	761940	695775	609163	565704	550212	506078	512631	498449	502304	461414	458744
Kethanur	1194692	732914	662809	581457	546352	525251	487484	491953	480034	481730	444365	4401230
Mettukadai	906025	521977	499106	427842	394769	397180	360614	359771	347125	357140	319468	321266
Pongalur	937276	579352	539373	466395	435890	428491	393730	369454	381084	385827	352862	352917
Average	1032209.5	609703.25	580427.875	496104.625	464224	459995	420581.13	422042.38	407908.63	417275.75	376986.5	873434.38
for 1000KW	1720349.2	1487081.098	1813837.109	1653682.08	1547413.333	1839980	1682324.5	1688169.5	1631634.5	1854558.9	1507946	3881930.6
Average for 1 MW for this Pass			**1859075.6**									
CUF for this Pass			**22.33** Corrected to Hub height of 50 M									

Grid Availability - 95%
Machine Availability - 95%
Array Efficiency - 95%
Internal Losses - 2%

56812.8831
23.85261883

Abstract

Muppandal Pass

CUF for Large Machine 31.10
CUF for Small Machine 26.38
Average CUF 28.74

Weighted Average CUF using CUF for Larger machine 27.46

Shencotta Pass

CUF for Large Machine 24.50
CUF for Small Machine 22.70
Average CUF 23.6

Weighted average CUF using CUF for small machince 23.85

Palaghat Belt

CUF for Large Machine 24.05
CUF for Small Machine 21.22
Average CUF 22.635

Weighted average CUF using average CUF 25.66

Sea Coast

CUF for Large Machine 22.77
CUF for Small Machine 22.33
Average CUF 22.55

Average 25.66

Grid availability is considered as 95%. Due to constraints in evacuting power from wind electric generators, the developers are asked by TNEB to backdown their WEG offen. Considering this aspect the following grid availability, corresponding CUF and rates are arrived at

Grid availability		CUF	Rate (Rs)
95%		25.66%	2.69
92%		24.69%	2.79
90%		24.16%	2.85

Annexure - 2 A

Average Unit Cost (Wind Energy) based on cost

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
O & M Charges 1.25%	562500	562500	562500	562500	562500	590625	620156	651164	683722	717908
Interest On Loan 10.5%	3307500	3307500	2976750	2646000	2315250	1984500	1653750	1323000	992250	661500
Depreciation 4.5%	2025000	2025000	2025000	2025000	2025000	2025000	2025000	2025000	2025000	2025000
ROE 16%	2160000	2160000	2160000	2160000	2160000	2160000	2160000	2160000	2160000	2160000
Total Cost	8055000	8055000	7724250	7393500	7062750	6760125	6458906	6159164	5860972	5564408.4
Generation Units (24.69%)	2162844	2162844	2162844	2162844	2162844	2162844	2162844	2162844	2162844	2162844
Per Unit Cost	3.724	3.724	3.571	3.418	3.265	3.126	2.986	2.848	2.710	2.573

	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
O & M Charges 1.25%	753804	791494	831069	872622	916253	962066	1010169	1060678	1113712	1169397
Interest on Loan	330750									
Depreciation	2025000	2025000	2025000	2025000	2025000	2025000	2025000	2025000	2025000	2025000
ROE 16%	2160000	2160000	2160000	2160000	2160000	2160000	2160000	2160000	2160000	2160000
Total Cost	5269554	4976494	5016069	5057622	5101253	5147066	5195169	5245678	5298712	5354397
Generation Units (24.69%)	2162844	2162844	2162844	2162844	2162844	2162844	2162844	2162844	2162844	2162844
Per Unit Cost	2.436	2.301	2.319	2.338	2.359	2.380	2.402	2.425	2.450	2.476

The Sum of the per unit cost for 20 years = 55.832

The average per unit cost = 2.79

Assumptions:

1. Grid Availability -92%
2. Array Efficiency -95%
3. Machine Availability - 95%
4. Internal Loss -2%

Annexure - 2 B

Average Unit Cost (Wind Energy) based on cost

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
O & M Charges 1.25%	562500	562500	562500	562500	562500	590625	620156	651164	683722	717908
Interest On Loan 10.5%	3307500	3307500	2976750	2646000	2315250	1984500	1653750	1323000	992250	661500
Depreciation 4.5%	2025000	2025000	2025000	2025000	2025000	2025000	2025000	2025000	2025000	2025000
ROE 16%	2160000	2160000	2160000	2160000	2160000	2160000	2160000	2160000	2160000	2160000
Total Cost	8055000	8055000	7724250	7393500	7062750	6760125	6458906	6159164	5860972	5564408
Generation Units (25.5%)	2233800	2233800	2233800	2233800	2233800	2233800	2233800	2233800	2233800	2233800
Per Unit Cost	3.606	3.606	3.458	3.310	3.162	3.026	2.891	2.757	2.624	2.491

	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
O & M Charges 1.25%	753804	791494	831069	872622	916253	962066	1010169	1060678	1113712	1169397
Interest on Loan	330750									
Depreciation	2025000	2025000	2025000	2025000	2025000	2025000	2025000	2025000	2025000	2025000
ROE 16%	2160000	2160000	2160000	2160000	2160000	2160000	2160000	2160000	2160000	2160000
Total Cost	5269554	4976494	5016069	5057622	5101253	5147066	5195169	5245678	5298712	5354397
Generation Units (25.5%)	2211462	2189387	2167487	2145850	2124388	2103101	2082077	2061228	2040642	2020231
Per Unit Cost	2.383	2.273	2.314	2.357	2.401	2.447	2.495	2.545	2.597	2.650

The Sum of the per unit cost for 20 years = 55.394

The average per unit cost = 2.77

Assumptions:

1. Grid Availability -92%
2. Array Efficiency -95%
3. Machine Availability - 95% for the first 10 years, thereafter 1% reduction in every year due to aging
4. Internal Loss -2%

Annexure - 3
Tariff - Biomass Plants

Year	Interest 10.5% for 10 years & One year Moratorium	O&M Exp (5% with 5% escl	Depreciation 7.84%	ROE 16%	Fuel Consumption 1.16kg/unit	Fuel Cost (Rs.1000/Mt with 5% escl)	Interest on Working Capital 11.0 %		
							O & M (Two Months)	Fuel (Two Months)	Total
1	2940000	2000000	3136000	1920000	8129280	8129280	36667	149037	185703
2	2940000	2100000	3136000	1920000	8129280	8535744	38500	156489	194989
3	2646000	2205000	3136000	1920000	8129280	8962531	40425	164313	204738
4	2352000	2315250	3136000	1920000	8129280	9410658	42446	172529	214975
5	2058000	2431013	3136000	1920000	8129280	9881191	44569	181155	225724
6	1764000	2552563	3136000	1920000	8129280	10375250	46797	190213	237010
7	1470000	2680191	3136000	1920000	8129280	10894013	49137	199724	248860
8	1176000	2814201	3136000	1920000	8129280	11438713	51594	209710	261303
9	882000	2954911	3136000	1920000	8129280	12010649	54173	220195	274369
10	588000	3102656	3136000	1920000	8129280	12611181	56882	231205	288087
11	294000	3257789	3136000	1920000	8129280	13241741	59726	242765	302491
12		3420679	1504000	1920000	8129280	13903828	62712	254904	317616
Total	19110000	31834253	36000000	23040000		129394778	583628	2372238	2955866

1. Interest	19110000
2.O & M Expenses	31834253
3. Depreciation	36000000
4. RoE	23040000
5. Fuel Cost	129394778
6. Interest on WC	2955866
7. Total	242334897
8. Average	20194575
9. Generation	6377280
10. Average cost per unit	3.17

Project Cost	Rs. 4.00 Crs
PLF	80%
Generation units	7008000
Aux.consumption 9%	630720
Net Generation	6377280

Annexure - 4

Tariff - Bagase Based Co-generaion Plants

Year	Interest 10.5% for 10 years & one year moratorium	O&M Exp (5% with 5% escl)	Depreciation 7.84%	ROE 16%	Fuel Consumption 1.6kg /kWh	Fuel Cost (Rs.575/Mt with 5% escl.	Interest on Working Capital 11.0 %		
							O & M (Two Months)	Fuel (Two Months)	Total
1	2572500	1500000	2744000	1680000	7708800	4432560	27500	81264	108764
2	2572500	1575000	2744000	1680000	7708800	4654188	28875	85327	114202
3	2315250	1653750	2744000	1680000	7708800	4886897	30319	89593	119912
4	2058000	1736438	2744000	1680000	7708800	5131242	31835	94073	125907
5	1800750	1823259	2744000	1680000	7708800	5387804	33426	98776	132203
6	1543500	1914422	2744000	1680000	7708800	5657195	35098	103715	138813
7	1286250	2010143	2744000	1680000	7708800	5940054	36853	108901	145754
8	1029000	2110651	2744000	1680000	7708800	6237057	38695	114346	153041
9	771750	2216183	2744000	1680000	7708800	6548910	40630	120063	160693
10	514500	2326992	2744000	1680000	7708800	6876355	42662	126067	168728
11	257250	2443342	2744000	1680000	7708800	7220173	44795	132370	177164
12		2565509	1316000	1680000	7708800	7581182	47034	138988	186023
Total	16721250	23875690	31500000	20160000		70553618	437721	1293483	1731204

1. Interest	16721250
2.O & M Expenses	23875690
3. Depreciation	31500000
4. RoE	20160000
5. Fuel Cost	70553618
6. Interest on WC	1731204
7. Total	164541762
8. Average	13711814
9. Generation	4384380
10. Average cost per unit	3.13

Project Cost	Rs. 3.50 Crs
PLF	55%
Generation units	4818000
Aux.consumption 9%	433620
Net Generation	4384380