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Review of tariff setting methodologies for grid-connected small power producers

In Sri Lanka, the installed capacity of the power system comprises 1660 MW of Ceylon Electricity Board (CEB) owned plants, 435 MW of independent power producers (IPPs) and 76 MW (1) of grid connected renewable energy based embedded generation (from Small power Plants, <10 MW) (2). The contribution of IPPs in annual generation during 2004 was 3252 GWh (approx. 42.7% of total power generation) while the contribution of SPPs was approximately 2.4% of total generation.

as on April 2005

Objective of this report is to review the tariff setting methodologies, including the existing methodology and to suggest an alternative methodology, if required. Based on the review, recommendations regarding different issues in tariff setting methodology have been proposed.

Types of methodologies for estimating generation tariff

There can be different methodologies of estimating generation tariffs for conventional and non-conventional power plants. However, the two main approaches for computing generation tariffs for power purchases from small power producers are – cost based tariff setting mechanisms and avoided cost based tariffs.

It is imperative to note that, in case of Sri Lanka the tariffs for IPPs based on conventional fuel have two major components – the capacity charge and the energy charge. This implies that the tariffs for IPPs are calculated on a cost based approach. However, tariffs for Small Power Plants (SPP) are computed on the basis of avoided cost principles. This implies that CEB pays tariffs to SPPs calculated as the marginal energy cost due to power generation by thermal plants.

A description of the cost based approach and the avoided cost based tariff calculation are given below.

Cost based approach of tariff calculation

The cost based approach of determining tariffs for a small power plant is commonly used in many countries. The tariff that is computed using this method, allows a project developer to cover its operating and capital costs. Besides, it ensures an assured return on capital.

This method analyses the cash flows as a result of the project activity with return on equity as one of the components of cash outflow and estimates annual cost of generation. There are some variations in the application of this method. The tariff can be given in two parts where in the initial years (typically the loan repayment period), the tariff given is higher and then lower tariff is given for the subsequent period, which covers the operational costs and the return on the investment. The cost escalations, the O&M escalation, fuel cost escalation, and incentives in terms of subsidy or other fiscal incentives can also be included while estimating tariffs by this method. The tariff calculated by this method varies from technology to technology depending upon the performance and costs. Moreover, the tariff estimation by this method solely depends on the cost and performance of the project/ technology.

In the cost based approach, ideally tariff should be estimated for each project. However, due to resource and time constraints, technology benchmarking is commonly used wherein the average parameters such as the plant factor and, capital costs, are used for estimation of tariff.

A summary of the key advantages and disadvantages of the cost based approach of tariff calculation is given below:

Advantages

- This method takes in to account the technology specific issues such as capacity factor and technology cost etc.
- It has the ability of incorporating any incentive that is introduced, for instance the return on equity (say for a particular technology) and this gets reflected in the tariff that is calculated.
- Since the tariffs can be set for a longer period, the annual exercise of tariff setting can be avoided.
- Further, depending on the developments and commercialization of a particular technology, the tariff can be revised periodically.

Disadvantages

- Tariffs, need to be estimated separately for each type of project/technology.
- The cost based approach is heavily dependant on cost and performance parameters as input data, which might be difficult to obtain or verify.
- A key disadvantage of this method of tariff calculation is that the cost and performance parameters have to be benchmarked for each technology.

Avoided cost based tariffs

Avoided cost is the incremental cost to the electric utility that the utility would either generate itself or purchase elsewhere if it did not purchase from a (renewable energy) supplier.
In the avoided cost mechanism, when a renewable energy generator is connected to the grid and delivers power to the system, some costs are avoided elsewhere in the system. First of all, the power plant, which would normally have produced the power (now being provided by the renewable generator), saves some fuel and operation costs because it reduces its power output. Besides, on a long-term basis, the power system may avoid investment in some power production capacity, if the power system can rely on the renewable energy generator to deliver power, especially during peak hours and if the power system needs to expand the production capacity. Further, some other impacts may also occur, such as avoided T&D losses because the renewable energy generator is positioned more closely to the demand.

Avoided cost is the marginal cost for the same amount of energy acquired through another means such as construction of a new production facility or purchase from an alternate supplier. For instance, a megawatt-hour's avoided cost is the relative amount it would cost a utility to acquire this energy through the development of a new generating facility or procurement of power from an independent supplier. Short run avoided cost refers to the avoided cost calculated based on energy acquisition costs. Long run avoided cost factors-in necessary long-term costs including capital expenditures for facilities and infrastructure upgrades. In Sri Lanka, the avoided cost methodology that is followed by CEB is based on the principle of short run marginal cost pricing.

There are 3 mains components of an avoided cost based tariff,
(a) *Avoided energy cost* is the value of one kWh that is displaced 'at the margin' when a power purchase is made; (b) *Avoided capacity* is the cost the utility would have incurred to build capacity that is deferred as a result of a firm power purchase; (c) *Avoided network capacity cost* - the investment in network capacity may be avoided if the small power producer is located in close proximity to the load centre.

The key advantages and disadvantages of the avoided cost based tariff setting approach is discussed below:

Advantages

- Economic efficiency principles imply that the scarce resources in an economy should be allocated in such a manner that they provide the greatest benefit to the society or, they produce maximum output at the least cost. Therefore, when prices are set equal to marginal cost,

it results in market equilibrium at a certain level and pattern of electricity supply that leads to the most efficient allocation of scarce resources.
- This method of tariff calculation is technology neutral i.e. it does not differentiate between the different types of Renewable Energy Technologies (RETs).

Disadvantages

- This method requires a detailed performance data of all conventional power plants, in terms of plant availability and energy generation.
- The tariff calculation process has to be carried out every year.

The avoided cost based tariff setting methodology can have different variants. These have been discussed in the following section, which reviews the different studies on avoided cost, undertaken in Sri Lanka, to estimate generation tariffs of grid connected SPPs.

Evolution of the present method of generation tariff calculation in Sri Lanka

The tariff calculation methodology that is being followed by CEB is based on the World Bank study that was conducted in 1995. The study had suggested that to begin with, generation tariffs for small power should be based on 'energy only' avoided costs. However, the study had also suggested that the tariffs be based on a 3-year forward moving average basis (the averaging to be phased out in subsequent years) and that avoided capacity charges could be considered by the CEB at a later stage.

The present method is based on these recommendations. However, there are certain deviations, such as:
- The published tariffs are based on the backward average of three-years' avoided cost
- There is no capacity credit component
- While the tariffs are seasonal, they do not include different rating periods of peak and off-peak

In March 2000, a Committee was set up comprising CEB officials, representatives from the Grid Connected Small Power Developers Association (GCSPDA) and a Bureau of Infrastructure Investment (BII) representative to examine the capacity credit issue. Broadly, the recommendations of the Committee were to provide a capacity credit based on a levelized displacement of capacity, and an energy credit based on the avoided operation costs calculated using a simulation for the subsequent year. That is, the capacity credit would have to be paid on a kWh basis using the WASP model, whereas the energy tariff would be based on a one-year simulation of the system using either WASP or METRO model.

In June 2001, a study was commissioned by CEB, which was undertaken by an independent consultant, to review the existing method of tariff computation based on avoided costs that was being followed by CEB. This study proposed two alternatives for revising the existing tariff calculation methodology. The first alternative proposed certain changes in the existing method while the second alternative proposed a methodology to estimate the marginal savings to CEB. The detailed methodology of this study has been explained in subsequent sections.

Though a part of the recommendations of the first alternative was considered by CEB in its avoided cost calculations for the subsequent years (where the variable costs of IPPs connected at the high voltage 'HV' level were corrected for transmission losses in the HV network, 2002 onwards), recommendation of calculating avoided cost based on marginal savings to the CEB were not implemented by the Board.

The current methodology for calculation of SPP tariffs is based on estimation of *marginal energy cost* due to power generation by thermal plants.

(Recently, the 'Budget Statement of Sri Lanka for 2005' guaranteed an 'all inclusive tariff rate of US$ 0.06 per unit', for mini hydro projects. Further, it has been stated that the Treasury would share such expenditure.)

A summary of the different studies that have been conducted in the past and a synopsis of the strengths and weaknesses of each of these tariff calculation methodologies are described in the following sub-sections.

Summary of various studies commissioned to establish and review avoided cost based tariffs

This sub-section discusses the summary of the different studies that have been commissioned in the past to review the generation tariff calculation methodology for grid-connected SPPs (which have all recommended different variants of the avoided cost based tariffs) along with their key advantages and disadvantages.

A) Published Small Power Purchase Tariff for Sri Lanka, World Bank, December 1995

The World Bank study *(3)*, commissioned in 1995 to determine the methodology of calculating small power purchase tariffs, proposed 3 optional tariff designs based on the principle of avoided cost, namely, (a) avoided cost based on seasonal and time-of-day rating periods; (b)

but with low-peak hour or seasonal availability, would not avoid the network investment by CEB.

Advantages

- The avoided cost based tariff as outlined in this study, is an adaptation of the marginal cost based pricing mechanism and hence is economically more sound method.
- An avoided cost calculation based on seasonal and time of day rating period differentiation, will provide appropriate economic signals in terms of the value of power from alternative sources at a particular time, to all parties involved
- It is technology neutral i.e. it does not differentiate between wind, mini hydro, biomass, etc.

Disadvantages

- The forward averaging of avoided energy costs is suggested to derive the tariff. However, sudden fluctuations in oil prices would not be accounted for in this method. Also, this would require the CEB Long Term Generation Expansion Plan (LTGEP) to be run for 3 years ahead with exact knowledge of the future power plant availability and demand.
- For calculating avoided generation capacity cost, differentiated by the Time of Day rating period, it is necessary to have information with regard to total peak and off-peak kWh energy delivered during a particular month. This would require the monthly estimation of peak and off-peak energy delivered by the proxy plant (a gas turbine based power plant used in this study).
- Further, calculation of avoided generation capacity cost is based on the assumption that for SPPs to be able to receive capacity payments equivalent to the full-avoided cost, they should be available for the same duration of time that the proxy plant would operate for.

B) Summary Results of Capacity Credit Studies, March 2000

The Capacity Credit Committee comprising CEB officials, representatives of GCSPDA and a BII representative concluded its deliberation in March 2000, with three different reports. The Committee attempted at calculating energy and capacity charges based on the avoided cost principles of using a Differential Revenue Requirement method, which re-optimizes the entire expansion plan and estimates the incremental difference in the present value of the two expenditure streams.

The summary of the conclusions were[1],

(i) CEB members reported that the simulations using WASP showed that the overall avoided cost as a result of 21 mini hydroelectric plants commissioned between years 1999 and 2002 was 3.73 US cents/kWh (break-up: 2.11 US cents for capacity and 1.62 US cents for energy). It was reported that GCSPDA proposed that the capacity credit be based on WASP and the avoided energy costs be calculated using METRO.

(ii) GCSPDA members were of the view that CEB had fixed several large power plants to be commissioned in specified years, which were not necessarily in the pipeline owing to various problems with their implementation. In summary, their view was to provide a capacity credit based on a levelised displacement of capacity, and an energy credit based on the avoided operation costs calculated using a simulation for the subsequent year. Both the calculations would use the WASP model.

(iii) The BII member was of the view that the peaker method as proposed in the World Bank study had to be analysed while calculating capacity credits to CEB, due to SPPs. According to him, the CEB electricity generating system is an example of an energy-constrained system, whereby gas turbines are not necessarily present in the system as peaking units, but rather they function more on the lines of back-up units. Hence, any assumption that the SPPs would be replacing gas turbine capacity in the margin cannot be defended.

Advantages

The key advantage of this method is that actual contributions from SPPs are modelled into the generation planning system and this results in the computation of the present value of savings (as a result of SPP inputs) and of the energy delivered by the SPPs. The two consecutive simulations of the generation planning model (WASP) can help in computing per unit capacity and energy charges, separately.

Disadvantages

This method would be more appropriate if the proposed purchase from SPPs represents a significant proportion of the installed capacity of the system. However, the allowable capacity of SPPs connected to the CEB grid is limited due to reasons of economic operation, supply quality, system and network stability (approx. in the range of 5-6% of demand) and the amount of purchase is not assured (not dispatchable on demand). Further, in the current context, this capacity cannot significantly postpone any investment for future plants. Keeping these in

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[1] Due to unavailability of the Capacity Credit Committee Report, these conclusions have been taken from the 'Report on Study on Grid Connected Small Power Tariff, Sri Lanka, June 2001'

view, this method would be more appropriate in estimating avoided costs of large-scale IPPs.

C) Study on Grid-connected Small Power Tariff, Sri Lanka, June 2001

In June 2001, a study was conducted by an independent consultant to review the existing method of tariff computation based on avoided costs that was being followed by CEB. In this study two alternatives for revising the existing tariff calculation methodology were suggested *(4)*. The first alternative proposed certain changes in the existing method including (a) consideration of forced and planned outages - recommendation was to change the actual plant factors to effective plant factors that would reflect forced outages and scheduled outages and (b) consideration of Losses – recommendation was that the costs of IPPs connected at the high voltage (HV) level should be corrected for transmission losses in the HV network and a revision in the calculation of total losses.

The second option of the tariff calculation methodology was based on the estimation the marginal savings to CEB. This was carried out by running two simulations of the METRO model, whereby actual contributions from SPPs were modelled into the system using the METRO model, and the energy savings from each power plant were calculated. Monthly energy savings from each power plant were then multiplied by their respective variable costs (adjusted for losses up to 33 kV level), to obtain the annual avoided cost (in million Rupees). The annual avoided cost is then divided by the annual SPP energy contribution (in GWh) to arrive at the avoided specific cost.

Further, in case of a change in hydroelectric generation due to the SPP input (obtained by running two simulations of the METRO model), monthly variation in the storage in CEB reservoirs was obtained (with and without SPP contribution, in GWh). If the SPP contribution leads to a positive change in annual reservoir storage (implying a reduced hydroelectric generation from CEB plants), then the remaining storage at the end of the year in the METRO model i.e. the End of Year (EOY) storage is credited to the thermal plant with the lowest operating cost. Further, this method suggests that the benefits of reduction in unserved energy should be credited proportionally to all power plants.

After adjusting for the credit for EOY storage (in GWh) and the reduction in unserved energy from each thermal plant, the total energy saving from each thermal plant is then multiplied by the respective per unit operating costs to obtain the Annual Avoided Cost. This Avoided Total Cost (in million Rupees) is then divided by the SPP contribution (in GWh) to get the Avoided Total Specific Cost.

Advantages

- Actual contribution from SPPs are modeled into the short term generation planning model thereby taking their capacity contribution into account. The monthly forecasted peak demand is reduced by the equivalent amount. This method has the advantage of taking into account capacity benefits due to SPPs indirectly and calculating marginal savings due to the SPP inputs.
- Another advantage of this method is that it defines Upper and Lower bounds, within which the tariff could vary. The Upper bound as per this method has been defined as the variable cost of operation of a typical IPP, while the Lower bound has been set as per the specific cost of a CEB long term base load candidate power plant (Coal Power Plant has been used in the study)

Issues

- While deciding on the Upper and Lower Bounds, the definition of a typical IPP has been considered as a diesel engine operating on furnace oil. This might have to be reconsidered in the event of sudden fluctuations in the price of furnace oil.
- The capacity contribution of SPPs in comparison to the installed capacity of the system needs to be examined.

D) Present Method of Tariff calculation being followed by CEB

The present method estimates the avoided marginal cost as a result of small power projects added in the national grid. In this method, the variable costs of operation of CEB thermal plants and IPPs is calculated (after adjusting for losses at the 33 kV level). Thereafter, on the basis of projected load duration curve, the (monthly) fraction of time that a particular thermal plant operates in the margin is estimated. The fraction of time for which the particular power plant operates in the margin is then used as weighting factor to the respective variable costs of operation of each thermal plant in order to obtain the monthly 'weighted marginal energy cost', also called as 'the monthly avoided energy cost'. (The step-wise description of the present method of estimating avoided costs and determining tariffs is given in Annex 1). The avoided cost is then computed separately for the dry season (February to April) and the wet season (May to January). The seasonal tariff that is announced by CEB every year is a 3-year moving average of the last 3 years avoided energy costs. If the announced tariff for a particular year falls below 90% of the tariff during the year in which the SPPA was signed for a given SPP, the tariff applicable will be the tariff of the previous year, as per the standard *(5)*.

A committee, comprising CEB officials undertake the exercise of avoided cost estimation every year. This includes projection of demand, simulations for estimation of plant factors and estimation of fraction of time that a particular power plant would operate in the margin along with the estimation of variable costs of the thermal power plants. The tariff is then published along with all the assumptions and data.

The present method does not calculate separate capacity credits. Further the variable cost of the thermal plants is estimated on the basis of the fuel (diesel) prices (CIF basis) applicable at the time of calculation (typically the month of November for the tariff calculations of the subsequent year).

Advantages

- The main advantage of the existing method is that it is based on economic efficiency principles of marginal cost pricing
- There is no gain or loss to the utility, hence the consumer ultimately does not get affected in the process
- The avoided cost method is not dependant on the type of grid-connected RET i.e. it is technology neutral

Disadvantages

- The annual revenues are uncertain; however the floor price provides a minimum guarantee to developers. This floor price depends on the year in which the developer enters into a contract with the CEB and hence can be different for different years.
- The tariff calculation process is an annual exercise
- This method requires a detailed performance data of all thermal power plants, in terms of plant availability and energy generation, etc. This could be critical if a third party is to undertake the exercise of tariff estimation

Flat Tariff for renewable energy based power generation (as per Sri Lankan Government Budget for 2005)

In order to provide incentives for investments by mini hydropower developers (< 10 MW), the Government of Sri Lanka, in its Budget for 2005 has proposed a flat tariff of US$ 0.06 per unit for such projects. The Government has indicated that the treasury will share such expenditure with CEB.

Analysis of tariff methodologies and specific issues related to tariff setting

It emerges from the previous sections that there are two basic approaches of determining tariff: the cost based approach and the avoided cost approach. The different studies and proposed approaches discussed in the preceding section are variations of these basic approaches. The specific issues that emerged from the stakeholder consultations as well as based on the recommendations of the Working Group (given in Annex 2) are analysed below to arrive at specific recommendations for tariff setting. *Some of the issues are generic in nature whereas others are specific to either of the identified basic approaches of tariff setting methodologies.*

Generic Issues

The issues that are generic to both, the avoided cost and the cost based approach of tariff calculation, are discussed below:

Simplicity of tariff calculations

It is desirable to use a methodology, which is simple to understand, implement and has fewer requirements of data (especially the data that is not publicly available, e.g. the heat rates of different power plants).
space —> Another important issue is frequency of such calculation or theirvalidity.

The avoided cost method, as has been mentioned in the above section, requires performance data like (a) heat rate, (b) projected dispatches, and (c) fuel cost for all the existing thermal power plants. In addition, this exercise needs to be undertaken every year. Assuring transparency in the procedural aspects of estimating tariffs is also an issue, since at present the task is undertaken mainly by CEB.

The cost based method also have data requirement regarding the costs as well as performance of the proposed renewable energy power plant. Given that the costs are dependent on site conditions and the generation is dependent on resource availability, the cost as well as performance benchmarks need to be established. There are number of costs and performance parameters which need to benchmarked. Some of these parameters for which benchmarks are commonly established are: (a) capital cost, (b) annual generation, (c) O&M costs, (d) cost escalations, and (e) interest rate.

However, with experience of working with the technologies like mini hydro and biomass, it is possible to arrive at these benchmarks. Instead of using data provided by the developers, an independent study for benchmarking the cost and performance parameters may be undertaken for the major technologies like mini hydro, wind and biomass. This study can be commissioned by the Public Utility Commission of Sri Lanka (PUCSL), being the regulatory body and having a mandate of deciding the methodology of tariff determination.

In cost based approach, the major advantage is that the tariffs can be fixed for a longer period of time avoiding the annual tariff determining exercise.

Stable and predictable tariffs

Availability of long-term predictable and stable tariff reduces the project risk thereby making financing easier. This is critical especially for projects based on new technologies like wind and biomass, which are not yet commercialised. Presently, the avoided cost methodology depends on cost of oil since thermal generation in Sri Lanka is primarily oil based. Thus the tariff determined by the avoided cost method varies annually. Though the existing avoided cost method has some safeguards to incorporate sudden volatility in the form of three year moving average and the floor price, given the highly volatile nature of oil prices in the international market, the tariff is bound to fluctuate. However, the floor price clause and a possible cap can clearly define a range in which the tariff would vary, making it possible to have long term revenue projections along with providing comfort to the financing institutions.

The cost based method has an advantage over the avoided cost method since it provides a predetermined tariff for the entire duration of the agreement period.

Benefits of RETs to the consumer

The benefits of RETs are realised only in the long term, because of their high initial costs. The tariff methodology should be sensitive to this aspect and the benefits of using renewables must be transferred to the consumer, in the long run. The present method of estimating avoided cost does not transfer the direct benefits of using renewables, since the tariff given is not based on the cost of generation but on the 'avoided cost'. Thus, as far as the end consumer is concerned, there is no difference between the scenarios of with or without renewables. Given the fact that all of thermal generation in Sri Lanka is oil based, the benefit of using renewables in terms of partially stabilising the costs is not realised with avoided cost. This is crucial with the highly volatile nature of international oil prices. However, even with the avoided cost, the tariff methodology can de designed in such a manner that a sharing of benefits of using renewables in the generation mix, takes place between the project developer and the consumer. Alternatively, in order to avoid passing the oil price escalation directly, a cap on the tariff can be introduced and hence the cost of renewables can be controlled in the limited range. This would indirectly benefit the consumer. The main

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GHG emissions and thus offers possibilities for emission reductions and hence CDM projects. In case of the power sector, with the large hydro potential being already tapped to a large extent, the future growth would mainly be in the thermal and renewable sectors. Thus, with share of thermal power increasing, the renewable power projects as CDM projects would become more attractive.

However, with the CDM modalities and procedures still evolving internationally, there would be some time before the CDM projects result in actual revenue flow. Further, there are uncertainties regarding the CDM benefits. The emissions reductions from renewable energy projects like mini hydro or wind, would give additional revenue to the project. This revenue would not be uniform across all the projects, even within the same sector, as CDM is a project based activity and the baseline and emission reductions vary from project to project. Secondly, from the point of view of criteria of `additionality', all renewable energy projects may not qualify as CDM projects. Thus, while CDM projects offer an opportunity for additional revenue for the renewable energy projects; at the same time, at least presently, these can not be considered while deciding the tariffs for the renewable power projects. Further the CDM project development in Sri Lanka is just beginning, with three registered CDM projects as on December 2005. Thus, once there is some experience gained in developing and operating CDM projects, the CDM revenue can be shared between the developers and the government.

Issues related to the cost based approach

Some of the issues that are specific to the cost based method of tariff calculation are discussed below -

Two-tier tariff

The discussions with stakeholders had suggested two tier or three-tier tariff as possible options. This tariff methodology is employed in situations where technologies are still not fully commercialized and the cost of generation is higher than the other generation options (mainly conventional technologies). This tariff methodology provides a level playing field for renewable energy technologies, which are of national interest e.g. mini hydro (because of environmental and energy security reasons) and have long-term potential of cost reduction. In case of Sri Lanka, wind and biomass technologies (based on agro waste, captive plantation or municipal waste) are still evolving and can not be termed as commercialized, and this type of tariff methodology may be required if these technologies are to be encouraged.

The cost based tariff, based on actual costs would vary from year to year as the cash flows vary. One way to estimate flat tariff is based on discounted costs, which gives the flat levelized tariff as computed in Annex 3. However in this case there would be a cash flow problem since the revenues in the initial years (till the debt repayment period) would not be sufficient to cover all the costs. To overcome this tariffs may be given in two tier, (a) first covering the debt repayment period where tariff offered is higher and (b) the second period after debt repayment period where the tariff is lower.

Discount rate

Discount rate is one of the components that need to be fixed for estimation of tariff by cost based methodology. The options are to use the normative discount rate or to use the weighted average cost of capital (WACC). The present analysis is based on the normative discount rate (10%). However, similar analysis has also been done with the WACC15.2% and given in Annex 5.

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Issue of escalation

The issue of escalation arises in the cost based tariff calculation methodology, in order to incorporate the escalations in mainly the O&M costs and the fuel cost (if any), during the period for which the tariff is being fixed. In case of O&M costs, this issue can be addressed by incorporating the appropriate inflation rate. In Sri Lanka, the key inflation indicators are Colombo Consumer Price Index (CCPI), Sri Lanka Consumer Price Index (SCPI), and the Wholesale Price Index (WPI). The Consumer Price Indicator (CPI) is an imperfect indicator of cost escalations especially the O&M costs, because, basic consumer items (such as food, clothing, rent) account for 75 % of the CCPI. On the other hand, wholesale prices have the advantage of being based on producer costs. However, the WPI is very volatile in Sri Lanka (e.g. the WPI was3.1 % in 2003 and increased to 12.5% in 2004) *(6)*. The variations would give rise to practical difficulties in using it for tariff determination.

In case of biomass power projects, the issue of cost escalation in fuel price arises. In Sri Lanka, the present or the planned biomass power projects have either planned captive plantation or a contract in place for single point supply of biomass at prescribed rates. The fuel cost escalation can be based on the escalation built in the contract, (if any) or the aforementioned approach (for escalation for O&M costs) can be followed.

Present estimation of cost based tariff has been done with 3% escalation in O&M as per the recommendation of the Working Group. No escalation factor has been used for fuel costs in case of biomass projects.

The decision about the use of appropriate escalation factor that will be applied to different annual cost components may be taken by PUCSL.

An example of indicative flat and two-tier tariff is summarized in the table 1a and 1b below while detailed calculations ~~are given in Annex 4.~~ for flat tariff are given in annex 3 and calculation for two tier tariff are given in annex 4. In case of tariff estimation, the O&M component of the tariff has been estimated separately and termed as 'escalable' component.

Table 1a: Indicative flat tariffs

RETs	Escalable Component (O&M) (Rs/kWh)	Non escalable componentf (Rs./ kWh)
Mini Hydro	0.53	4.70
Wind	1.52	8.98
Biomass	0.80	8.53

Table 1b: Indicative two tier tariffs

RETs	Escalable Component (O&M) (Rs/kWh)	Non escalable component	
		Tier I (up to Debt repayment period) (Rs./ kWh)	Tier II (after repayment period) (Rs./ kWh)
Mini Hydro	0.53	6.48	2.30
Wind	1.52	12.39	4.40
Biomass	0.80	9.88	6.73

The escalable component shown in the table above has to be escalated at 3% and added to the non escalable component to arrive at the total tariff for a particular year.

, while offering the 2 tier tariff,

It is also imperative, to ensure that the power plants operate for full 15 years to realise benefits to the consumers (through CEB) and to the developer; especially since the consumer benefits in the latter part of the project when second tier tariff is applicable.

Tariffs after agreement period

The analysis carried out in this report is with 15 year PPA as per the present practise. The actual life of the projects is more than 15 years, in some cases. In such a scenario the tariffs for the subsequent agreement period should take in to consideration the fact that investments have been recovered while formulating tariffs. At the same time, there has to be an incentive for the developer to continue to operate the plant. The quantum of this incentive can be decided by PUCSL depending upon the power scenario at that time. In the present analysis, royalty has been imposed after the 15th year of the project (in case of mini hydro and wind projects) and the cash outflows include (a) the O&M cost, (b) additional outflow of royalty, (c) incentive to the promoter, if any, and the resultant tariff would be estimated accordingly. ~~In the present analysis royalty~~ equivalent to 10% of annual generation and an incentive of Rs 1.0/kWh has been assumed to estimate indicative tariffs after PPA period. The indicative tariffs are given table 2 below. Annexure 4, where two-tier tariff is estimated, also gives the estimation of tariffs after agreement period.

Table 2: Indicative tariffs for power purchase after PPA period

RETs	Escalable Component	Tariff after PPA period (Rs./ kWh)
Mini hydro	0.53	1.17
Wind	1.52	1.28
Biomass	0.80	6.00

The escalable component shown in the table above is O&M component of tariff in first year of project and has to escalated at 3% and added to the non escalable component to arrive at the total tariff.

Subsidy

In case cost based tariff methodology is adopted, and if the tariff computed by this methodology is higher than the avoided cost; the difference has to be subsidised. The first year tariffs, with the two tier tariff structure, for 1 MW grid connected mini hydro, wind and biomass based power plants, using the ~~cost based approach~~ have been computed as Rs. 7.02 per unit, Rs. 13.91 per unit and Rs. 10.68 per unit, respectively. It may be reiterated that these are indicative tariffs only and the actual tariff estimation based on costs and performance benchmarks will have to be carried out by PUCSL.

There can be two options to bridge the difference between the avoided cost and the cost based tariff given to these technologies. The first option would be the provision of capital subsidy by the government based on the cost of generation of such technologies. The second option would be to either recover the cost differential (between the cost based tariff rates and the avoided cost) from the consumers or provided by the government. Cost based tariff being linked to the performance of the plant would have a greater advantage over the one-time capital subsidy option. The exact mechanism of recovering the additional costs, as a result of paying higher tariff by CEB, may be decided by PUCSL along with CEB.

An analysis carried out for determining the impact of this cost differential on the overall consumer tariff shows that the when the contribution in total *generation* from mini hydro, biomass and wind power reaches 6%, 3% and 1% respectively, the overall impact on the consumer tariff would be about Rs.0.25/unit. Till the contribution of generation from these technologies is less than the above mentioned values, the overall impact on the consumers would be less than Rs.. 0.25/unit. For example if all the present mini hydro plants are given the tier I tariff, the impact in terms of average increase in consumer tariffs would be about Rs.0.026 /unit. The details of this calculation are given in Annex 6

Issues related to avoided cost estimation

The issues that are specific to the avoided cost based approach of tariff calculation are summarized below -

Capacity credits

The issue of capacity credits is specific to the avoided cost methodology. It has been argued that the small power renewable energy projects be given the capacity credits for the capacity displaced. The issue is twofold - firstly, are the capacity credits real i.e. do the small power plants really displace the capacity and secondly, which type of power plant is being displaced.

As of 15th April 2005, mini hydro projects with total capacity of 76 MW have been commissioned [in all 39 mini hydro power plants are connected to the local distribution grid (1)]. The total energy contribution by these power plants is approximately 2.4% in terms of energy (2). With already issued Letters of Intent (LoIs) and those that are under evaluation, (391 small power projects with a total capacity of 787 MW), this contribution could go up significantly. However, the average plant factors are in the range of 35-45% in case of mini hydro (which constitute majority share of the LoI), around 20% for wind; and 60-80% for biomass. It may be argued, therefore, that though the total installed capacity of SPPs is higher, the smaller individual power plants with low plant factors (except biomass) supplying non-dispatchable power in the grid, in the long term should not be considered for capacity credits.

as on 2003

The main problem with the SPPs (mini hydro and wind) is that these plants are non-dispatchable (not under control of CEB) and the nature of demand that these plants cater to (peak demand or a base-load demand) and the time during which these plants supply power to the grid is not known. As a result CEB cannot take the capacity availability from such plants into consideration and plan their operations accordingly. Hence, in this context capacity payments to such SPPs do not appear justified, except for biomass power plants.

The plants which can supply dispatchable power, may be given capacity credits. Presently only biomass power plants can supply dispatchable power and thus should be given capacity credit if the power plant has an installed capacity of 5MW or above.

Estimation of capacity credit

Looking at the trend of capacity additions in Sri Lanka, apart from the planned coal based 300 MW power plant, the proposed new capacity additions are mainly gas turbine based power plants in the range of 100-150MW *(Generation Expansion Plan 2005-2019)*. Further, based on the Generation Expansion Plan as well as past developments, it appears that the nature of capacity addition would be mainly gas turbine based peaking power plants. The capacity credits can thus be estimated based on the proposed gas turbine power plants. Based on the demand and capacity expansion data as given in CEB's latest generation expansion plan for 2005, it is estimated that the capacity credit for a gas turbine power plant of capacity 105 MW that is likely to come up in 2008 and which would most probably be displaced, would be around Rs. 0.84/ kWh (with a plant availability of 84%). Details of estimation of the capacity credits are given in Annex 7. However, this is an indicative number and needs to be confirmed by running simulations of the model presently being used for generation expansion planning.

3-year forward moving average

Since long term marginal cost principles dictate that the avoided energy cost is the value of one kWh displaced at the margin, when a power purchase is made in the *future*, it is necessary that the avoided energy cost calculations be based on forward moving averages of the avoided cost in the future years. However, in Sri Lanka, the avoided generation is predominantly oil based, which is unpredictable. On analyzing forecasted prices in international crude oil markets, it is seen that these projections do not provide realistic estimates. For instance, long term World Oil price projections ($/ bbl) as per the International Energy Association (IEA) and the Energy Information Administration (EIA) of US would have been declining till 2025. Also, based on 2003 constant prices, the world oil price forecasts for 2005 according to EIA was $33.99/ bbl, when in reality the price of crude oil in June 2005 was close to $58/ bbl.

Hence, taking into account the extremely volatile nature of international oil markets, long-term price projections for oil do not give a very realistic estimate of actual market behavior. Thus the next alternative for calculating avoided energy costs is the backward average of past three years avoided cost, which is presently being used.

Floor price and cap

Floor Price

The floor price is part of the present SPPA as minimum tariff:
'The tariff in any given year shall not be less than 90% of the First Year Tariff. If during the term of agreement the tariff forecast for any year becomes less than 90% of the Tariff on the date of execution of this agreement (First Year Tariff), the tariff applicable for that year will be equal to the Tariff applicable for the ***previous year***'.

In economic terms if the avoided cost is the basis for tariff then there should not be any floor or cap. However, the floor price has been given to provide assurance of minimum returns and reduces risk, which is useful for attracting investment. In the initial period the floor price was useful to build the confidence of financing institutions in small power projects. In new technologies which are not yet fully commercialised, floor price would be required, in case the tariff is determined based on avoided cost.

Cap Price

The present avoided cost method does not have a 'cap' on tariff.

In the recent years the avoided cost based SPP tariffs have shown an increasing trend.

It is also clear that, with increasing oil prices internationally, the avoided costs would increase. In order to safeguard interests of all the stakeholders including the CEB and the customers, a cap may be introduced while deciding tariff by using the avoided cost methodology.

Selection of Tariff Methodology

Based on the above discussion on specific advantages and disadvantages as well as different issues related to tariff methodologies it emerges that both the cost based approach and the avoided cost based tariff setting methodologies have (a) specific advantages and (b) can be adopted/modified to address specific issue(s).

In Sri Lanka, presently, generation tariffs are being computed both on the principles of the cost based approach and the avoided cost methodology. While conventional thermal IPPs, which have about 42.7% share of generation, are offered tariffs that are computed on a cost based approach, tariffs that are offered to SPPs are computed on the basis of the 'energy only' avoided cost. Under the current methodology, CEB pays tariffs to SPPs, which is calculated as the short term marginal energy cost due to power generation by thermal plants.

The tariff calculation methodology that is currently being followed by CEB is based on the World Bank study that was conducted in 1995. The study had suggested that to begin with, generation tariffs for small power should be based on 'energy only' avoided costs. As discussed earlier in the report, although the present method is based on these recommendations, there are certain deviations, such as (a) tariffs that are published are based on the backward average of three-years' avoided cost, (b) the present method does not have a capacity credit component and (c) the tariffs are seasonal but do not include different rating periods of peak and off-peak. Thus, the present method is not an exact estimation of avoided cost but is an approximation with some assumptions.

The generation tariff setting methodology for renewable energy resources based electricity generation in many countries is based on the cost based approach (with a rate of return regulation). Though the avoided cost methodology is the most economically sound method of calculating generation tariffs, this method is more appropriate for technologies, which are mature and operate in fully commercial/ market based environment. The use of avoided cost methodology gives clear market signals for use of lower cost options to meet the demand and makes the renewable energy technologies compete with other cheaper sources of generation. This methodology, though appropriate, has not been adopted in many countries because of various reasons like (a) availability of data and (b) the cost of most RETs is more than the tariff offered by this methodology.

Further, it is important to note that in situations of market imperfection, necessary changes may have to be incorporated in the avoided cost based tariff determination process. For instance, in Sri Lanka where the thermal power generation is predominantly oil based, (with imported fuel and highly volatile international oil prices); the use of alternative fuels may not necessarily reflect the true economic value of the unit power that they would be displacing in the margin.

Even with the avoided cost estimated based on high international oil prices, power generation from renewable energy technologies other than mini hydro would not be economical. Even the levelised cost of generation from biomass as well as wind projects is higher than the present avoided cost. Thus, in the initial stages till these technologies are developed to a stage where they can compete with other sources, the avoided cost based tariff would not be adequate.

Based on these factors, it is suggested to use a combined approach for tariffs for grid connected SPPs. This approach suggests that the developer gets the two tier tariff, which is as per the cost based methodology, and the difference / benefit of buying power by CEB from SPPs is to be shared between CEB and government. The specific recommendations for estimation of tariff and the sharing arrangement are given in the next section. The mechanism of sharing of benefits will be determined by the PUCSL.

Recommendations

Keeping into view the aforementioned issues it is recommended that, tariffs for all grid-connected RETs [including mini-hydro, wind and biomass (which includes grown firewood, agro wastes, or municipal wastes)]will be calculated as 'technology specific cost based two tier tariffs'. Thus the developers would be offered two tiers with a specific requirement to operate the power plant for full 15 years. Further, it is suggested that the benefits / cost difference would be shared with government. The specific recommendations for estimation of technology specific cost based tariff are given below.

Transparency

The PUCSL would have a central role while deciding tariffs using the cost based approach. The cost and performance parameters will have to be benchmarked along with detailed financial analysis. The parameters to be benchmarked would include: capital cost, O&M cost, fuel cost (in case of biomass), interest rate, discount rate, capacity factor, and fuel consumption (in case of biomass based plants). It is suggested to carry out this exercise with the involvement of all the concerned stakeholders. The PUCSL may commission an independent study in order to assess the realistic cost and performance parameters, which will be used in estimation of tariffs for the three major renewable energy technologies viz. mini hydro, biomass and wind.

Royalty

It is suggested to impose royalty on wind and hydro resources and not on biomass. The quantum and timing of imposing the royalty would be decided by PUCSL. It is suggested that the royalty to be introduced after 15th year (i.e. from 16th year onwards) and the payments so received transferred to the Government or specific fund established by it.

Two tier tariff

The cost based method has flexibility to design tariffs to suit the requirements. In case of renewable energy technologies, as a result of high capital cost, in the initial years the cash outflows are higher. Thus a multi-tier tariff, with different tariffs for different periods is essential to overcome the cash flow problem. The recommended approach to estimate two-tier tariff is explained below.

1. The first tier of the tariff would correspond to the debt repayment period (, typically 6 years). The cost components in this period that would be considered for setting the tariff, are: (a) principal repayment; (b) interest repayment; (c) return on equity; (d) O&M costs (and fuel cost, in case of biomass power plants).
2. The tariff would be lower in the second tier. The second tier of the tariff would be calculated for the subsequent period i.e. after the debt repayment period is over, till the introduction of royalty. In the second tier, the cost components considered for tariff setting would be (a) return on equity, (b) O&M costs (c) fuel cost and (d) royalty.

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It is essential that the power plant operates for full 15 years so that the long term benefits are realised.

Tariff after PPA period

The plants that are operational after the PPA term is over would have recovered the investment. Thus the tariff offered to SPPs after the agreement period would cover the O&M costs. However, in addition to the O&M costs, there needs to be an incentive for the developers to operate the plant. Therefore an incentive for generation may be given for such power plants over and above the O&M costs. The quantum of this incentive would be decided by PUCSL. Besides the O&M costs and incentive payment, tariff after the PPA period will also include the royalty payment.

For those projects, which have completed the agreement period, and are entering in to for new agreement, the applicable tariff will not be same as that for a new power plant.

Sharing of benefits / costs

Renewable energy resources such as mini hydro and wind are national resources and thus the benefits of using this resource need to be shared. The tariff can be adjusted to share this benefit. The cost of generation from mini hydro is expected to become lower than the avoided cost, in near future considering the increasing trend of oil prices. While as for RETs such as wind and biomass, where with present costs, the cost based tariff would be higher than the avoided cost, CEB would have to recover this additional cost either from consumers or from the government. In such a scenario, it is suggested that the benefit as well as the additional cost will be borne by the government. The suggested arrangement is to share the difference between the avoided cost and cost based tariff. Thus if tariff provided for a particular technology is higher than the avoided cost, the additional costs will come from government. Similarly in case of technologies with tariffs lower than the avoided cost the benefit will go the government account. It is also possible that at the end of the year a net revenue, of benefits as well as additional costs, is estimated which either can come from government or can go to government depending upon whether the benefits are more or less than the additional cost

The estimation of avoided cost may be required to determine the benefits. This exercise of estimation of avoided cost will be undertaken jointly by the PUCSL and CEB. While estimating the avoided cost, capacity credit may be given to power plants with capacity more than 5MW, which can supply firm power.

Duration of tariff

The tariff regulations may be announced by the PUCSL with a provision to review it after a time period of 3 (three) years.

Off grid RETs

The off grid renewable energy systems for providing energy services in the village have higher generation costs, mainly as a result of smaller size, smaller load and remote locations. The technology options for off grid, considered for the analysis are village hydro, biomass gasification and solar photovoltaic (although this analysis can also be extended to other forms of off-grid renewable energy technologies). These three technologies have different cost structure and hence the generation costs are different, as shown in the table below. Details of the estimation of generation costs are given in Annex 8.

Table 3 Cost of generation of off-grid RETs

Technology	Indicative generation cost Rs/kWh
Biomass gasification	13.26
Solar photovoltaic	54.36
Village hydro	6.02

The capital cost of off grid renewable energy technology based systems is also higher. It is also a known fact that the paying capacity in the remote areas would be limited. Further, provision of *electricity for all* is a social obligation for the government and Government of Sri Lanka (GOSL) has a policy mandate (as per the Rural Electrification Policy, November 2002) of electrifying all households by 2010. Hence, there is a need for provision of subsidy to the off grid renewable energy systems, to achieve the target of 100% electrification of the nation.

Subsidy for off-grid RETs

The subsidy amount for different renewable energy technologies can be estimated on the basis of generation costs for a typical size of the system and load. The difference between the cost of generation from such RETs and the domestic tariff for consumers served by the national grid may be given as subsidy.

In Sri Lanka, the category of domestic tariffs has 5 different slabs. Depending upon the consumption levels, an appropriate slab can be considered for the purpose of estimation of the subsidy amount. In the present analysis, tariff for slab 1 (Rs. 3.0/kWh) along with the fixed charges (Rs 30 /month) has been used for estimation of subsidy.

Before computing the quantum of capital subsidy for different RETs, the per unit cost differential between the cost of generation of each RET and the tariff for block 1, domestic consumers is estimated. The government's subsidy component can be estimated based on per unit cost difference between generation cost and the domestic consumer tariff. The total annual cost difference is estimated by multiplying the annual generation by per unit cost difference. The estimation of total capital subsidy is estimated with 20 years life time for solar PV and 15 years lifetime for the village hydro and biomass gasifier based systems. The discount rate used for this analysis is 10%. The total capital subsidy is equal to the net present value of all the annual total cost difference between the cost of generation and the block 1 domestic tariff.

Table 4 Cost of generation of different off grid RETs

RETs	Capacity (kW)	Cost of generation (Rs./ kWh)	Domestic tariff for block 1 consumers (Rs./ kWh)	Per unit cost difference (Rs./ kWh)	Annual generation (kWh)	Total annual cost difference (million Rs)	Total capital subsidy (million Rs)	Capital subsidy (Rs/kW)
Solar PV	35	54.36	4.0	50.36	55188	2.78	23.66	676,100
Biomass gasifier	25	13.26	4.0	5.26 [a]	59130	3.11	2.36	94,661
Village Hydro	25	6.02	4.0	2.02	59130	0.12	0.91	36,396

[a] – This excludes the per unit fuel cost

In case of biomass, the generation cost (for estimation of subsidy purpose) dose not include the fuel costs since the inclusion of fuel cost would result in subsidy amount being higher than the capital cost.

It is important to highlight that off grid projects along with the provisions for capital subsidy, would also need financing for the difference between the capital cost and the subsidy. The revenues through sale of energy, with tariffs equivalent to the domestic users served by national grid, would cover the financing cost and running costs.

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Annexure

1. Avoided Cost Estimation Methodology presently used by CEB
2. Recommendations from the Meeting of Stakeholders
3. Estimation of levelised tariff
4. Three tier tariff estimation: Mini Hydro
5. Tariff calculations with 10% Discount Rate
6. Estimation of impact of higher tariff on per unit consumer tariff
7. Capacity Credit Calculations
8. Computation of cost of generation of off-grid systems

Annexure 1

Avoided Cost Estimation Methodology presently used by CEB

Annex 1: Avoided Cost Estimation Methodology presently used by CEB

The avoided cost methodology which is presently being used by the Ceylon Electricity Board (CEB) is based on estimation of *marginal energy cost* due to power generation by small power producers. The method followed for estimation of avoided cost is as explained below.

Step 1 –

The average fuel cost of each thermal plant (CEB owned and IPPs) is calculated based on the fuel prices, heat content and heat rate data. The fuel prices are projections for the next year, for the 2005 estimations the crude costs were provided by the Ceylon Petroleum Corporation (CPC) on *CIF* basis. These fuel costs are then adjusted for station losses and transmission losses (all thermal plants connected at 132 kV and above). This gives the variable costs at 33 kV level (in Rs./ kWh) for each plant. As an illustrative example, the data used by CEB in the calculation of 2005 small power tariffs, is given below[2]:

Table 1.1: Average Fuel Cost by Plant Type

Thermal Plants	GTR	GTNW	KPS-JBIC	DLTL	APPL	BARGE	DSP	DSPX	Matara	Horana	Heladhanavi	AES CCP	Embilipitiya
Fuel Used	Auto Diesel	Auto Diesel	Naphtha				Residual Oil	Residual Oil					
Fuel Price (Rs./ Litre)	39.32	39.32	31.98				19.13	19.13					
Heat Content (kCal./ Litre)	8,862	8,862	7,657				9,682	9,682					
Heat Rate (kCal./ kWh)	3,911	2,868	1,793				2,246	2,068					
Fuel Usage (Litres/ kWh)	0.44	0.32	0.23				0.23	0.21					
Fuel Cost (Rs./ kWh)	17.35	12.73	7.49		4.94	4.79	4.44	4.09			5.4	5.21	5.76
Variable O&M Cost													
US Cents/ kWh	0.198	0.291	0.143				1.43	0.8603					
Rs./ kWh	0.21	0.31	0.15				1.53	0.92					
Station Losses (%)	3%	3%	3%				3%	3%					
Rs./ kWh	0.53	0.32	0.21				0.18	0.15					
Transmission Losses (%)	3.20%	3.20%	3.20%		3.20%	3.20%	3.20%	3.20%			3.20%	3.20%	3.20%
Rs./ kWh	0.58	0.35	0.23		0.18	0.18	0.2	0.17			0.17	0.17	0.18
Avoided Cost at 33kV level (Rs./ kWh)	18.67	11.22	7.47	6.12	5.66	5.75	6.32	5.40	5.73	5.67	5.57	5.38	5.94

[2] GTR, GTNW, KPS-JBIC, DSP, DSPX and AES-CCP are CEB owned Thermal plants while, DLTL, APPL, Barge, Matara, Horana are IPP Thermal Plants

Step 2 –

The Systems Control Dispatch Centre of CEB uses the short term planning model (takes into account a 3-year planning horizon), called the METRO model, which provides estimates of energy expected to be delivered from each power plant during each month of the particular year.

While estimating the energy expected to be delivered by a particular plant, the model optimizes various power plants based on the generation cost along with other constraints and inputs in the model.

As per the avoided cost estimation by CEB for 2005, the estimated energy delivery by different thermal power plants for the year 2005 is as shown in table 2 below.

Table 1.2: System Control Dispatch Schedule (GWh), 2005

Thermal Plants	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
GTR	2	1	1	0	0	0	0	0	0	0	0	0	4
GTNW	6	1	5	1	0	1	0	0	0	0	0	1	15
KPS-JBIC	59	62	44	11	6	3	1	1	6	1	5	42	241
DSP	25	23	25	24	25	24	37	37	36	37	34	37	364
DLTL	16	14	15	14	11	7	5	8	8	6	11	14	129
Embilipitiya	0	0	0	67	62	55	51	56	57	66	63	68	545
BARGE	42	38	42	39	35	26	17	31	30	37	36	29	402
Matara	17	15	17	15	13	8	6	10	9	10	14	15	149
Horana	14	13	14	13	11	8	5	9	9	9	12	12	129
APPL	35	31	35	33	32	32	29	30	30	33	32	35	387
Heladhanavi	71	64	71	68	69	67	63	66	65	70	65	71	810
DSPX	42	38	42	40	42	41	42	42	41	42	39	42	493
AES CCP	99	88	80	58	28	19	9	17	27	8	28	84	545
Total Thermal	428	388	391	383	334	291	265	307	318	319	339	450	

Step 3 –

Using monthly (plant-wise) energy delivered, plant capacity, the plant factor (or capacity factor) is calculated for each month. The table below gives the calculated plant factors for the year 2005.

Table 1.3: Calculated Plant Factors

Plant Factors	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total	Capacity
No. of days in the month	31	28	31	30	31	30	31	31	30	31	30	31		(MW)
GTR	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	120
GTNW	0.07	0.01	0.06	0.01	0	0.01	0	0	0	0	0	0.01	0.01	115
KPS-JBIC	0.48	0.56	0.36	0.09	0.05	0.03	0.01	0.01	0.05	0.01	0.04	0.34	0.17	165
DSP	0.47	0.48	0.47	0.46	0.47	0.46	0.69	0.69	0.69	0.69	0.66	0.69	0.58	72
DLTL	0.96	0.93	0.9	0.86	0.66	0.43	0.3	0.48	0.49	0.36	0.68	0.84	0.65	22.5
Embilipitiya	0	0	0	0.93	0.83	0.76	0.69	0.75	0.79	0.89	0.88	0.91	0.62	100
BARGE	0.94	0.94	0.94	0.9	0.78	0.6	0.38	0.69	0.69	0.83	0.83	0.65	0.76	60
Matara	1	1	1	1	0.87	0.56	0.4	0.67	0.63	0.67	0.97	1	0.85	20
Horana	0.94	0.97	0.94	0.9	0.74	0.56	0.34	0.6	0.63	0.6	0.83	0.81	0.74	20
APPL	1	1	1	1	0.96	0.99	0.87	0.9	0.93	0.99	0.99	1	0.98	45

Heladhanavi	0.95	0.95	0.95	0.94	0.93	0.93	0.85	0.89	0.9	0.94	0.9	0.95	0.92	100
DSPX	0.71	0.71	0.71	0.69	0.71	0.71	0.71	0.71	0.71	0.71	0.68	0.71	0.7	80

Step 4 –

The time for which a particular plant operates at margin is estimated by stacking the power plants with increasing order of variable costs, as shown below in figure 1. The plant facts are taken from the published small power purchase tariff for 2005, published by CEB. The plant factors for the month of January are used in the figre to explain the methodology. The power plant GTNW would operate for 0.07 fraction of time out of which it would operate in the margin for 0.05 fraction of total time.

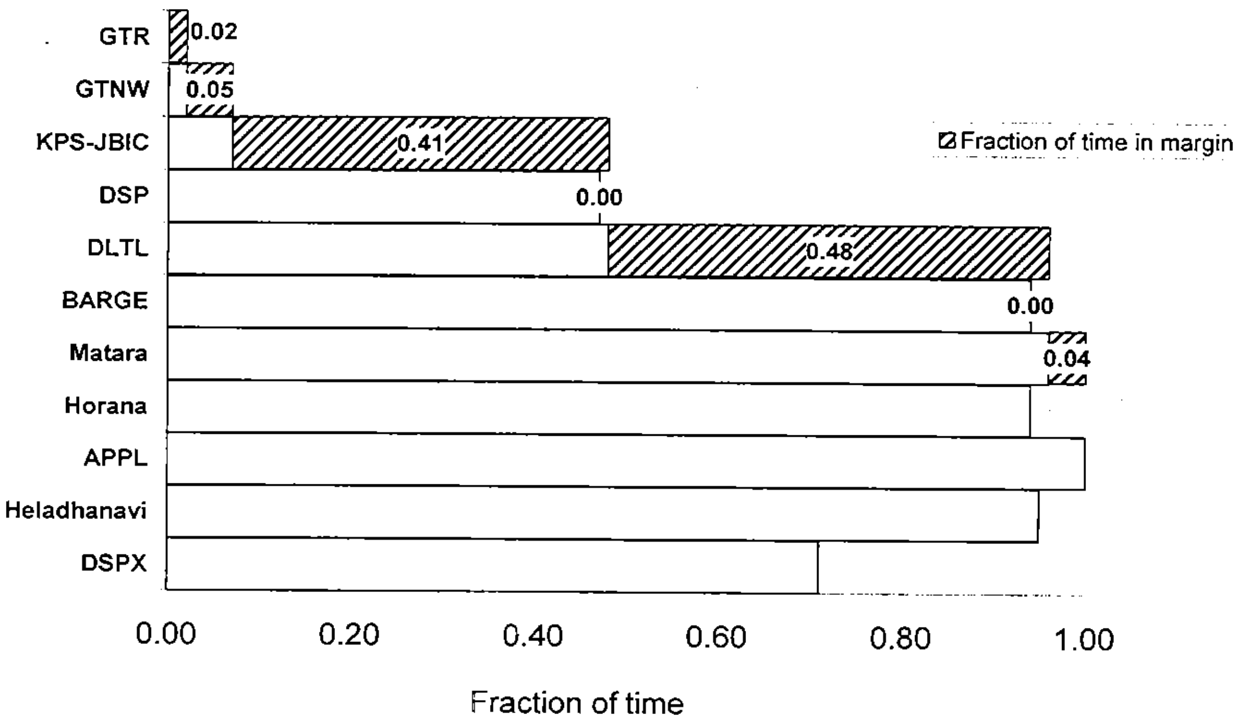

Figure 1: Estimation of fraction of time a power plant operates in the margin (based on plant factors in January 2005, as given in table 1.3)

This figure is an illustrative description of the way in which thermal plants are operated in the margin and the mechanism by which fraction of time that these plants operate in the margin is determined. This has been verified by the CEB. The thermal plants are stacked in an increasing order of variable costs such that those plants which are most expensive, are run for the shortest margin of time followed by the next most costly plant and so on. However, it should be noted that only those plants that are technologically suited to be dispatched at the margin (i.e. having low ramp-up and ramp-down times and costs) are stacked in the manner that has been depicted. This would mean that if the variable cost of Plant A is lower than that of Plant B, but it is technologically suited to run Plant B at

Annexure 2

Recommendations from the Meeting of Stakeholders

Annex 2: Recommendations from the Meeting of Stakeholders

The recommendations from the meeting of stakeholders held on 18th February 2005 regarding the report on tariff methodology and legal and regulatory framework

PART I : Grid Connected Systems

1. Renewable Energy is a national asset. An independent party should calculate the tariff. Tariff calculated by the independent party should be based on economical and commercial benefits received by the country as a nation from the renewable energy. Also it is better for the tariff technology specific.

   Geographical differentiation of tariff to recognise regional issues including costs and Govt. Policy, can be implemented through direct subsidies via Provincial Councils.

   Calculated tariff should be a uniform tariff for whole country, without annual fluctuations. The consultant should address practical difficulties of calculating a regional tariff.

   It is better to identify the independent organization to calculate the tariff. We recommend the Public Utility Commission for this purpose.

   When calculating the tariff, all types of power plants should be considered, since it reflects the consumer tariff. Once the independent party calculates the tariff, only the cost that could be paid by the CEB is passed to the CEB, while the balance should be paid by some other mechanism. The consultant should evaluate options for this mechanism.

2. Since a large number of factors is involved in the calculation method of avoided cost it is very complicated. It is recommended to study a flat power purchase tariff due to simplicity. The tariff calculated by this methodology would be paid by the utility to the developer. (CEB pay what they can pay. The balance part will be collected from the government.) The government would pay other part of the tariff, which calculated on the basis of economic and social benefits.

   Tariff needs to take into account both the capacity and energy displacement. If there is any capacity credit could be paid, then it is required to analyze them for each technology. It is also required to provide a methodology of calculating the capacity credit for different technologies for which capacity credit payment is recommended.

   Recommended to study "Preferential Tariff" for new technologies as a "Development Tariff".

   Recommended to study a fixed tariff in Sri Lanka Rupees and adjusted for the inflation. Recommended inflation factors also should be made available with justification. These should consider the facts that (a) loan repayment and interest rates are mostly fixed for the entire duration of the project (b) O & M spares are mostly imported (c) staff and local overheads are spent in LKR.

   Three- (3) tier tariff is recommended for the technologies such as wind and hydro. The first two component of the tariff should be based on the cash flow of the developer. Third tariff is by considering the national interest.

   Tier-I
   Cost recovery, upto the end of loan repayment period, typically 8 years + O & M

Tier-II

Equity return period + O & M, typically upto 12-15 years

Third-III

12 - 15^{+} - resource cost + O & M

3. Study the economic efficiency of the investment.

4. Study the subsidy mechanism required for implementing the renewable energy technologies. This is to finance preferential tariffs or development tariffs, over and above what the electric utilities can pay by way of avoided costs.
    - Green funds
    - Cross subsidy
    - Carbon funds

5. Streamlining of approval process for project is important.

PART II : Policy & Regulation

1. Level playing field for off-grid system and the grid-connected system should be studied. It is also required to address the regulation of the distribution system of off-grid system. Subsidy given to grid extension (rural electrification presently by CEB) needs to be addressed with development of off-grid systems.

2. Need to address the development of the off-grid system after the completion of the RERED Project. What step should be taken, what mechanism should be implemented to ensure the Govt. meets the off-grid electrification targets.

3. Off-grid systems distribution operation is likely to be licensed while generation is exempted from licensing. These networks need to be based on acceptable standards so that they can be absorbed in-to the main grid at a later date when grid is extended to these locations.

4. Viability of addressing off-grid tariff issues to be left with the communities themselves.

5. The concept of mini-grids and private sector participation of mini-grids.

6. Development of the specific site to its maximum power potential. Presently, developers may under-size a power plant owing to investment fund limitations or to limit development to 10 MW.

7. Consider the need for a renewable energy act.

Annexure 3
Estimation of levelised tariff

~~Levelized~~ Tariff estimation: Mini hydro power plant

Assumptions

All costs are in million Rs								
Capital Cost	100	Million Rupees/MW						
Equity	40%	Debt	60%	Plant load factor	43%	Depreciation rate	10.0%
Return on equity	20%	Interest rate	12%	O&M	2% of Capital cost	Tax rate	10% for 2 years after tax holiday period and 20% thereafter
		Loan Repayment period	6.0 Years	Escalation in O&M	0.0%	Tax holiday considered	5 years
				Fuel consumption	0		
		Life	15 Years	Fuel cost	0	Discount rate	10.00%
		Construction Period	2 Years	Escalation in O&M	0		

Capacity	1 MW	Allowance of Funds used during construction				Capitalized Cost of Project	108.40
Capital cost	100	Interest During Construction (IDC)	Year 1	Year 2	Total IDC	Debt	65.04
Debt	60	Project Disbursement	50%	50%	1.00	Equity	43.36
Equity	40	Laon Disbursement	10%	50%			
		Interest Payment	1.2	7.2	8.4		

Flat

~~Levelized~~ Tariff Estimation																	
Year	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ROE			8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67
Project Investment	50	50															
Equity Investment	41.2	2.16															
Debt	10	55.04	65.04	54.20	43.36	32.52	21.68	10.84	0.00	0.00							
Principle Repayment			10.84	10.84	10.84	10.84	10.84	10.84									
Interest Payment	1.2	7.80	7.80	6.50	5.20	3.90	2.60	1.30	0.00	0.00							
Fuel cost			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
O&M Expenses			2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Total Expenses		0.60	29.32	28.02	26.72	25.41	24.11	22.81	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67
Sales			3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77
Tariff			7.78	7.44	7.09	6.75	6.40	6.06	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83
~~Levelized~~ Tariff			5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23
Discounted ROE			65.96														
Discounted Principle Repayment			47.21														
Discounted Interest payments			21.39														
Discounted O&M			15.21														
Discounted. Expenses			149.78														
Discounted Sales			28.65														
~~Levelized~~ Tariff (Rs/kWh)			5.23														

Flat

CASH FLOWS			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Income Tax																	
Revenue			19.69	19.69	19.69	19.69	19.69	19.69	19.69	19.69	19.69	19.69	19.69	19.69	19.69	19.69	19.69
O&M			2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Depreciation			10.84	10.84	10.84	10.84	10.84	10.84	10.84	10.84	10.84	10.84	0.00	0.00	0.00	0.00	0.00
Interest			7.80	6.50	5.20	3.90	2.60	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE			8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67
Earnigs Before Tax			-0.95	0.35	1.65	2.95	4.25	5.55	6.85	6.85	6.85	6.85	17.69	17.69	17.69	17.69	17.69
Tax			0.00	0.00	0.00	0.00	0.00	0.56	0.69	1.37	1.37	1.37	3.54	3.54	3.54	3.54	3.54
Earnigs After Tax			-0.95	0.35	1.65	2.95	4.25	5.00	6.17	5.48	5.48	5.48	14.15	14.15	14.15	14.15	14.15
Debt Service Coverage Ratio			0.95	1.02	1.10	1.20	1.32	1.41									
Outflow																	
Equity Invested	41.2	2.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Principle Repayment			10.84	10.84	10.84	10.84	10.84	10.84	0.00	0.00	0.00	0.00	0.00				
Interest			7.80	6.50	5.20	3.90	2.60	1.30	0.00	0.00	0.00	0.00	0.00				
O&M			2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Tax			0.00	0.00	0.00	0.00	0.00	0.56	0.69	1.37	1.37	1.37	3.54	3.54	3.54	3.54	3.54
Total Outflow	41.2	2.76	20.64	19.34	18.04	16.74	15.44	14.70	2.69	3.37	3.37	3.37	5.54	5.54	5.54	5.54	5.54
Net Cash Flow	-41.20	-2.76	-0.95	0.35	1.65	2.95	4.25	5.00	17.01	16.32	16.32	16.32	14.15	14.15	14.15	14.15	14.15

Internal Rate of Return 12%

Flat
~~Levelized~~ Tariff estimation: Wind power plant

Assumptions

All costs are in million Rs								
Capital Cost	120	Million Rupees/MW						
Equity	40%	Debt	60%	Plant load factor	27%		Depreciation rate	12.5%
Return on equity	20%	Interest rate	12%	O&M	3%	of Capital cost	Tax rate	10% for 2 years after tax holiday period and 20% thereafter
		Loan Repayment period	6.0 Years	Escalation in O&M	0.0%		Tax holiday considered	5 years
				Fuel consumption	0			
		Life	15 Years	Fuel cost	0		Discount rate	10.00%
		Construction Period	2 Years	Escalation in O&M	0			

Capacity	1	MW
Capital cost	120	
Debt	72	
Equity	48	

Allowance of Funds used during construction			
Interest During Construction (IDC)	Year 1	Year 2	Total IDC
Project Disbursement	50%	50%	1.00
Laon Disbursement	10%	50%	
Interest Payment	1.44	8.64	10.08

Capitalized Cost of Project	130.08
Debt	78.05
Equity	52.03

Flat

~~Levelized~~ Tariff Estimation																	
Year	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ROE			10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41
Project Investment	60	60															
Equity Investment	49.44	2.59															
Debt	12	66.05	78.05	65.04	52.03	39.02	26.02	13.01									
Principle Repayment			13.01	13.01	13.01	13.01	13.01	13.01									
Cumulative Prinicpal repayment			0.00	13.01	26.02	39.02	52.03	65.04									
Interest Payment	1.44	9.37	9.37	7.80	6.24	4.68	3.12	1.56									
Loan Repayment			22.37	20.81	19.25	17.69	16.13	14.57	0.00	0.00							
Fuel cost			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M Expenses			3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
Depreciation			7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20
Cumulative Depreciation			7.20	14.40	21.60	28.80	36.00	43.20	50.40	57.60	64.80	72.00					
Advance Against Depreciation (AAD)					5.81	5.81	5.81	5.81	0.00	0.00	0.00	0.00					
Total Expenses		0.73	36.38	34.82	33.26	31.70	30.14	28.58	14.01	14.01	14.01	14.01	14.01	14.01	14.01	14.01	14.01
Sales			2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
Tariff			15.38	14.72	14.06	13.40	12.74	12.08	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92
Levelized Tariff			10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50
Discounted ROE			79.15														
Discounted Principle Repayment			56.65														
Discounted Interest payments			25.67														

Discounted O&M			27.38
Discounted Expenses			188.86
Discounted Sales			17.99
~~Levelized~~ Tariff (Rs/kWh)			10.50

Flat

CASH FLOWS			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Income Tax																	
Revenue			24.83	24.83	24.83	24.83	24.83	24.83	24.83	24.83	24.83	24.83	24.83	24.83	24.83	24.83	24.83
O&M			3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
Depreciation			16.26	16.26	16.26	16.26	16.26	16.26	16.26	16.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AAD			0.00	0.00	5.81	5.81	5.81	5.81	0.00	0.00	0.00	0.00	0.00				
Interest			9.37	7.80	6.24	4.68	3.12	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE			10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41
Earnigs Before Tax			-4.40	-2.83	-1.27	0.29	1.85	3.41	4.97	4.97	21.23	21.23	21.23	21.23	21.23	21.23	21.23
Tax			0.00	0.00	0.00	0.00	0.00	0.34	0.50	0.99	4.25	4.25	4.25	4.25	4.25	4.25	4.25
Earnigs After Tax			-4.40	-2.83	-1.27	0.29	1.85	3.07	4.47	3.98	16.98	16.98	16.98	16.98	16.98	16.98	16.98
Debt Service Coverage Ratio			0.95	1.02	1.10	1.20	1.32	1.43									
Outflow																	
Equity Invested	49.44	3.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Principle Repayment			13.01	13.01	13.01	13.01	13.01	13.01	0.00	0.00	0.00	0.00	0.00				
Interest			9.37	7.80	6.24	4.68	3.12	1.56	0.00	0.00	0.00	0.00	0.00				
O&M			3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
Tax			0.00	0.00	0.00	0.00	0.00	0.34	0.50	0.99	4.25	4.25	4.25	4.25	4.25	4.25	4.25
Total Outflow	49.44	3.32	25.97	24.41	22.85	21.29	19.73	18.51	4.10	4.59	7.85	7.85	7.85	7.85	7.85	7.85	7.85
Net Cash Flow	-49.44	-3.32	-1.14	0.42	1.98	3.54	5.10	6.32	20.73	20.24	16.98	16.98	16.98	16.98	16.98	16.98	16.98
Internal Rate of Return			**12%**														

Flat ~~Levelized~~ Tariff estimation: biomass based power plant

Assumptions

All costs are in million Rs

Capital Cost	140	Million Rupees/MW					
Equity	40%	Debt	60%	Plant load factor	80%	Depreciation rate	12.5%
Return on equity	20%	Interest rate	12%	O&M	4% of Capital cost	Tax rate	10% for 2 years after tax holiday period and 20% thereafter
		Loan Repayment period	6.0 Years	Escalation in O&M	0.0%	Tax holiday considered	5 years
				Fuel consumption	2		
		Life	15 Years	Fuel cost	2.5	Discount rate	10.00%
		Construction Period	2 Years	Escalation in O&M	0		

Capacity	1 MW	**Allowance of Funds used during construction**				
Capital cost	140	Interest During Construction (IDC)	Year 1	Year 2	Total IDC	
Debt	84	Project Disbursement	50%	50%	1.00	
Equity	56	Laon Disbursement	10%	50%		
		Interest Payment	1.68	10.08	11.76	

Capitalized Cost of Project	151.76
Debt	91.06
Equity	60.70

Levelized Tariff Estimation																
Year	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ROE			12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14
Project Investment	70	70															
Equity Investment	57.68	3.02															
Debt	14	77.06	91.06	75.88	60.70	45.53	30.35	15.18	0.00	0.00							
Principle Repayment			15.18	15.18	15.18	15.18	15.18	15.18									
Interest Payment	1.68	10.93	10.93	9.11	7.28	5.46	3.64	1.82	0.00	0.00							
Fuel cost			35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04
O&M Expenses			5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60
Total Expenses		0.85	78.88	77.06	75.24	73.42	71.60	69.78	52.78	52.78	52.78	52.78	52.78	52.78	52.78	52.78	52.78
Sales			7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01
Tariff			11.26	11.00	10.74	10.48	10.22	9.96	7.53	7.53	7.53	7.53	7.53	7.53	7.53	7.53	7.53
Levelized Tariff			9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33
Discounted ROE			92.34														
Discounted Principle Repayment			66.10														
Discounted Interest payments			29.95														
Discounted Fuel Cost			266.52														
Discounted O&M			42.59														
Discounted. Expenses			497.50														
Discounted Sales			53.30														
Levelized Tariff (Rs/kWh)			9.33														

Flat

CASH FLOWS			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Income Tax																	
Revenue			65.41	65.41	65.41	65.41	65.41	65.41	65.41	65.41	65.41	65.41	65.41	65.41	65.41	65.41	65.41
Fuel			35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04
O&M			5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60
Depreciation			18.97	18.97	18.97	18.97	18.97	18.97	18.97	18.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest			10.93	9.11	7.28	5.46	3.64	1.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE			12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14
Earnigs Before Tax			-5.13	-3.31	-1.49	0.34	2.16	3.98	5.80	5.80	24.77	24.77	24.77	24.77	24.77	24.77	24.77
Tax			0.00	0.00	0.00	0.00	0.00	0.40	0.58	1.16	4.95	4.95	4.95	4.95	4.95	4.95	4.95
Earnigs After Tax			-5.13	-3.31	-1.49	0.34	2.16	3.58	5.22	4.64	19.81	19.81	19.81	19.81	19.81	19.81	19.81
Debt Service Coverage Ratio			0.95	1.02	1.10	1.20	1.32	1.43									
Outflow																	
Equity Invested	57.68	3.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Principle Repayment			15.18	15.18	15.18	15.18	15.18	15.18	0.00	0.00	0.00	0.00	0.00				
Interest			10.93	9.11	7.28	5.46	3.64	1.82	0.00	0.00	0.00	0.00	0.00				
Fuel			35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04
O&M			5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60
Tax			0.00	0.00	0.00	0.00	0.00	0.40	0.58	1.16	4.95	4.95	4.95	4.95	4.95	4.95	4.95
Total Outflow	57.68	3.87	66.74	64.92	63.10	61.28	59.46	58.03	41.22	41.80	45.59	45.59	45.59	45.59	45.59	45.59	45.59
Net Cash Flow	-57.68	-3.87	-1.33	0.49	2.31	4.13	5.95	7.37	24.19	23.61	19.81	19.81	19.81	19.81	19.81	19.81	19.81
Internal Rate of Return			12%														

Annexure 4
Two tier tariff estimation

Assumptions

All costs are in million Rs									
Capital Cost	100	Million Rupees/MW		Plant factor	43%		Depreciation rate	10.0%
Equity	40%	Debt	60%	O&M	2%	of Capital cost	Tax rate	10% for 2 years after tax holiday period and 20% thereafter
Return on equity	20%	Interest rate	12%	Escalation in O&M	0.0%		Tax holiday considered	5 years
		Loan Repayment period	6.0 Years	Fuel consumption	0			
				Fuel cost	0		Discount rate	10.00%
		Life	15 Years	Escalation in O&M	0			
		Construction Period	2 Years	Incentive after 15th year	1	Rs/kWh		
				Royalty	10%	annual generation		

Capacity	1	MW
Capital cost	100	
Debt	60	
Equity	40	

Allowance of Funds used during construction				
Interest During Construction (IDC)	Year 1	Year 2	Total IDC	
Project Disbursement	50%	50%		
Loan Disbursement	10%	50%		
Interest payment	1.20	7.20	8.40	

Capitalized Cost of Project	108.40
Debt	65.04
Equity	43.36

Levelized Tariff Estimation																						
Year	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
ROE			8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67					
Project Investment	50.00	50.00																				
Equity investment	41.20	2.16																				
Debt	10.00	55.04	65.04	54.20	43.36	32.52	21.68	10.84	0.00													
Principle Repayment			10.84	10.84	10.84	10.84	10.84	10.84														
Cumulative Prinicpal repayment			10.84	21.68	32.52	43.36	54.20	65.04														
Interest Payment	1.20	7.80	7.80	6.50	5.20	3.90	2.60	1.30														
Loan Repayment			18.64	17.34	16.04	14.74	13.44	12.14														
Fuel cost			0.00	0.00	0.00	0.00	0.00	0.00														
O&M Expenses			2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Depreciation			6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00					
Cumulative Depreciation			6.00	12.00	18.00	24.00	30.00	36.00	42.00	48.00	54.00	60.00										
Advance Against Depreciation (AAD)					4.84	4.84	4.84	4.84	0.00	0.00	0.00	0.00										
Royalty (10% of generation)																						
Incentive (Rs. 1/kWh of generation)																		3.77	3.77	3.77	3.77	3.77
Total Expenses	-	0.60	29.32	28.02	26.72	25.41	24.11	22.81	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	2.00	2.00	2.00	2.00	2.00
Sales			3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77
Tariff			7.78	7.44	7.09	6.75	6.40	6.06	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	0.53	0.53	0.53	0.53	0.53

Levelized Tariff			5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23
								Estimation of two tier tariff				Tariff after PPA period										
								Year 1-6	Year 7-15			Year 15-20										
Discounted ROE			65.96					37.77	49.94			0.00										
Discounted Interest payments			21.39					21.39	0.00			0.00										
Discounted O&M			15.21					8.71	11.52			7.58										
Discounted Principle Repayment			47.21					47.21	0.00			0.00										
Discounted Royalty												0.00										
Discounted Incentive Payment												14.28										
Discounted. Expenses			149.78					115.09	61.46			21.86										
Discounted Sales			28.65					16.41	21.69			14.28										
Levelized Tariff (Rs/kWh)			5.23					7.02	2.83			1.53										
Tariff including Royalty												1.70										
O&M Portion included in tariff (Rs/kWh)			0.53					0.53	0.53			0.53										
Escalatiojn in o&M			0.03																			
Fixed component			6.48	6.48	6.48	6.48	6.48	6.48	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	1.17	1.17	1.17	1.17	1.17
escalable component			0.53	0.55	0.56	0.58	0.60	0.62	0.63	0.65	0.67	0.69	0.71	0.73	0.76	0.78	0.80	0.83	0.85	0.88	0.90	0.93
Tariff			7.02	7.03	7.05	7.06	7.08	7.10	2.94	2.96	2.97	2.99	3.02	3.04	3.06	3.08	3.11	2.00	2.02	2.05	2.07	2.10
CASH FLOWS			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Income Tax																						
Revenue			26.42	26.48	26.55	26.61	26.68	26.74	11.06	11.13	11.21	11.28	11.36	11.44	11.52	11.61	11.70	7.52	7.62	7.71	7.81	7.91
O&M			2.00	2.06	2.12	2.19	2.25	2.32	2.39	2.46	2.53	2.61	2.69	2.77	2.85	2.94	3.03	3.12	3.21	3.31	3.40	3.51
Depreciation			10.84	10.84	10.84	10.84	10.84	10.84	10.84	10.84	10.84	10.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest			7.80	6.50	5.20	3.90	2.60	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE			8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	0.00	0.00	0.00	0.00	0.00
Royalty																		0.75	0.76	0.77	0.78	0.79
Earnigs Before Tax			5.78	7.08	8.38	9.68	10.98	12.28	-2.17	-2.17	-2.17	-2.17	8.67	8.67	8.67	8.67	8.67	3.66	3.65	3.64	3.63	3.62
Tax			0.00	0.00	0.00	0.00	0.00	1.23	0.00	0.00	0.00	0.00	1.73	1.73	1.73	1.73	1.73	0.73	0.73	0.73	0.73	0.72
Earnigs After Tax			5.78	7.08	8.38	9.68	10.98	11.06	-2.17	-2.17	-2.17	-2.17	6.94	6.94	6.94	6.94	6.94	2.92	2.92	2.91	2.90	2.89
Debt Service Coverage Ratio			1.31	1.41	1.52	1.66	1.82	1.91														
Outflow under tiered tariff																						
Equity Invested	41.20	2.76																				
Principle Repayment			10.84	10.84	10.84	10.84	10.84	10.84	0.00													
Interest			7.80	6.50	5.20	3.90	2.60	1.30	0.00													
O&M			2.00	2.06	2.12	2.19	2.25	2.32	2.39	2.46	2.53	2.61	2.69	2.77	2.85	2.94	3.03	3.12	3.21	3.31	3.40	3.51
Tax			0.00	0.00	0.00	0.00	0.00	1.23	0.00	0.00	0.00	0.00	1.73	1.73	1.73	1.73	1.73	0.73	0.73	0.73	0.73	0.72
Royalty																		0.75	0.76	0.77	0.78	0.79
Total Outflow	41.20	2.76	20.64	19.40	18.17	16.93	15.69	15.69	2.39	2.46	2.53	2.61	4.42	4.50	4.59	4.67	4.76	4.60	4.70	4.80	4.91	5.02
Net Cash Flow	-41.20	-2.76	5.78	7.08	8.38	9.68	10.98	11.06	8.67	8.67	8.67	8.67	6.94	6.94	6.94	6.94	6.94	2.92	2.92	2.91	2.90	2.89
Equity Internal Rate of Return for 15-years				14.3%																		

Two tier tariff estimation: Wind

Assumptions

All costs are in million Rs

Capital Cost	120	Million Rupees/MW		Plant factor	27%		Depreciation rate	12.5%
Equity	40%	Debt	60%	O&M	3%	of Capital cost	Tax rate	10% for 2 years after tax holiday period and 20% thereafter
Return on equity	20%	Interest rate	12%	Escalation in O&M	0.0%		Tax holiday considered	5 years
		Loan Repayment period	6.0 Years	Fuel consumption	0			
				Fuel cost	0		Discount rate	10.00%
		Life	15 Years	Escalation in O&M	0			
		Construction Period	2 Years	Incentive after 15th year	1	Rs/kWh		
				Royalty	10%	annual generation		

Capacity	1	MW
Capital cost	120	
Debt	72	
Equity	48	

Allowance of Funds used during construction

Interest During Construction (IDC)	Year 1	Year 2	Total IDC
Project Disbursement	50%	50%	
Loan Disbursement	10%	50%	
Interest payment	1.44	8.64	10.08

Capitalized Cost of Project	130.08
Debt	78.05
Equity	52.03

Levelized Tariff Estimation

Year	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
ROE			10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41					
Project Investment	60.00	60.00																				
Equity Investment	49.44	2.59																				
Debt	12.00	66.05	78.05	65.04	52.03	39.02	26.02	13.01														
Principle Repayment			13.01	13.01	13.01	13.01	13.01	13.01														
Cumulative Prinicpal repayment			13.01	26.02	39.02	52.03	65.04	78.05														
Interest Payment	1.44	9.37	9.37	7.80	6.24	4.68	3.12	1.56														
Loan Repayment			22.37	20.81	19.25	17.69	16.13	14.57														
Fuel cost			0.00	0.00	0.00	0.00	0.00	0.00														
O&M Expenses			3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
Royalty (10% of generation)																						
Incentive (Rs. 1/kWh of generation)																		2.37	2.37	2.37	2.37	2.37
Total Expenses	-	0.73	36.38	34.82	33.26	31.70	30.14	28.58	14.01	14.01	14.01	14.01	14.01	14.01	14.01	14.01	14.01	3.60	3.60	3.60	3.60	3.60

Sales			2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
Tariff			15.38	14.72	14.06	13.40	12.74	12.08	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92	1.52	1.52	1.52	1.52	1.52
Levelized Tariff			10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50
								Estimation of two tier tariff				**Tariff after PPA period**										
								Year 1-6	**Year 7-15**			**Year 15-20**										
Discounted ROE			79.15					45.32	59.93			0.00										
Discounted Interest payments			25.67					25.67	0.00			0.00										
Discounted O&M			27.38					15.68	20.73			13.65										
Discounted Principle Repayment			56.65					56.65	0.00			0.00										
Discounted Royalty												0.00										
Discounted Incentive Payment												8.97										
Discounted. Expenses			188.86					143.33	80.66			22.61										
Discounted Sales			17.99					10.30	13.62			8.97										
Levelized Tariff (Rs/kWh)			**10.50**					**13.91**	**5.92**			**2.52**										
Tariff including Royalty												[illegible]										
O&M Portion in tariff (Rs/kWh)			**1.52**					**1.52**	**1.52**			**1.52**										
Escalation in O&M			**0.03**																			
Fixed component			12.39	12.39	12.39	12.39	12.39	12.39	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	1.28	1.28	1.28	1.28	1.28
Escalable componenet			1.52	1.57	1.61	1.66	1.71	1.76	1.82	1.87	1.93	1.99	2.05	2.11	2.17	2.24	2.30	2.37	2.44	2.52	2.59	2.67
Tariff			**13.91**	**13.96**	**14.01**	**14.06**	**14.10**	**14.16**	**6.22**	**6.27**	**6.33**	**6.39**	**6.45**	**6.51**	**6.57**	**6.64**	**6.70**	**3.65**	**3.72**	**3.80**	**3.87**	**3.95**
CASH FLOWS			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Income Tax																						
Revenue			32.91	33.02	33.13	33.24	33.36	33.48	14.70	14.83	14.97	15.10	15.24	15.39	15.54	15.69	15.85	8.64	8.80	8.98	9.16	9.34
O&M			3.60	3.71	3.82	3.93	4.05	4.17	4.30	4.43	4.56	4.70	4.84	4.98	5.13	5.29	5.45	5.61	5.78	5.95	6.13	6.31
Depreciation			16.26	16.26	16.26	16.26	16.26	16.26	16.26	16.26												
Interest			9.37	7.80	6.24	4.68	3.12	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE			10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	0.00	0.00	0.00	0.00	0.00
Royalty																		0.86	0.88	0.90	0.92	0.93
Earnigs Before Tax			3.68	5.24	6.81	8.37	9.93	11.49	-5.85	-5.85	10.41	10.41	10.41	10.41	10.41	10.41	10.41	2.16	2.15	2.13	2.11	2.09
Tax			0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.00	2.08	2.08	2.08	2.08	2.08	2.08	2.08	0.43	0.43	0.43	0.42	0.42
Earnigs After Tax			3.68	5.24	6.81	8.37	9.93	10.34	-5.85	-5.85	8.33	8.33	8.33	8.33	8.33	8.33	8.33	1.73	1.72	1.70	1.69	1.68
Debt Service Coverage Ratio			1.31	1.41	1.52	1.66	1.82	1.93														
Outflow under tiered tariff																						
Equity Invested	49.44	3.32																				
Principle Repayment			13.01	13.01	13.01	13.01	13.01	13.01	0.00	0.00	0.00	0.00	0.00									
Interest			9.37	7.80	6.24	4.68	3.12	1.56	0.00	0.00	0.00	0.00	0.00									
O&M			3.60	3.71	3.82	3.93	4.05	4.17	4.30	4.43	4.56	4.70	4.84	4.98	5.13	5.29	5.45	5.61	5.78	5.95	6.13	6.31
Tax			0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.00	2.08	2.08	2.08	2.08	2.08	2.08	2.08	0.43	0.43	0.43	0.42	0.42
Royalty																		0.86	0.88	0.90	0.92	0.93
Total Outflow	49.44	3.32	25.97	24.52	23.07	21.62	20.18	19.89	4.30	4.43	6.64	6.78	6.92	7.06	7.21	7.37	7.53	6.91	7.09	7.27	7.47	7.67
Net Cash Flow	-49.44	-3.32	6.94	8.50	10.06	11.62	13.18	13.59	10.41	10.41	8.33	8.33	8.33	8.33	8.33	8.33	8.33	1.73	1.72	1.70	1.69	1.68

Equity Internal Rate of Return for 15-years **14.0%**

Two-tier tariff estimation: Biomass

Assumptions

All costs are in million Rs

Capital Cost	140 Million Rupees/MW			Plant factor	80%	Depreciation rate	12.5%
Equity	40%	Debt	60%	O&M	4% of Capital cost	Tax rate	10% for 2 years after tax holiday period and 20% thereafter
Return on equity	20%	Interest rate	12%	Escalation in O&M	0.0%	Tax holiday considered	5 years
		Repayment period (inclusive of moratorium)	6.0 Years	Fuel consumption	2		
		Moratorium after construction	0.0 Years	Fuel cost	2.5	Discount rate	10.00%
		Life	15 Years	Escalation in O&M	0		
		Construction Period	2 Years	Incentive after 15th year	1 Rs/kWh		
				Royalty	10% annual generation		

Capacity	1 MW
Capital cost	140
Debt	84
Equity	56

Allowance of Funds used during construction

Interest During Construction (IDC)	Year 1	Year 2	Total IDC
Project Disbursement	50%	50%	
Loan Disbursement	10%	50%	
Interest payment	1.68	10.08	11.76

Capitalized Cost of Project	151.76
Debt	91.06
Equity	60.70

Levelized Tariff Estimation																						
Year	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
ROE			12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14					
Project Investment	70.00	70.00																				
Equity investment	57.68	3.02																				
Debt	14.00	77.06	91.06	75.88	60.70	45.53	30.35	15.18														
Principle Repayment			15.18	15.18	15.18	15.18	15.18	15.18														
Cumulative Prinicpal repayment			15.18	30.35	45.53	60.70	75.88	91.06														
Interest Payment	1.68	10.93	10.93	9.11	7.28	5.46	3.64	1.82														
Loan Repayment			26.10	24.28	22.46	20.64	18.82	17.00														
Fuel cost			35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04
O&M Expenses			5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60
Depreciation			8.40	8.40	8.40	8.40	'8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40					
Cumulative Depreciation			8.40	16.80	25.20	33.60	42.00	50.40	58.80	67.20	75.60	84.00										
Advance Against Depreciation (AAD)					6.78	6.78	6.78	6.78	0.00	0.00	0.00	0.00										
Royalty (nil)																						
Incentive (Rs. 1/kWh of generation)																		7.01	7.01	7.01	7.01	7.01
Total Expenses	-	0.85	78.88	77.06	75.24	73.42	71.60	69.78	52.78	52.78	52.78	52.78	52.78	52.78	52.78	52.78	52.78	40.64	40.64	40.64	40.64	40.64

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Sales			7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01
Tariff			11.26	11.00	10.74	10.48	10.22	9.96	7.53	7.53	7.53	7.53	7.53	7.53	7.53	7.53	7.53	5.80	5.80	5.80	5.80	5.80
Levelized Tariff			9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33
								Estimation of two tier tariff				Tariff after PPA period										
								Year 1-6	Year 7-15			Year 15-20										
Discounted ROE			92.34					52.88	69.92			0.00										
Discounted Interest payments			29.95					29.95	0.00			0.00										
Discounted Fuel Costs			266.52					152.61	201.80			132.83										
Discounted O&M			42.59					24.39	32.25			21.23										
Discounted Principle Repayment			66.10					66.10	0.00			0.00										
Discounted Royalty												0.00										
Discounted Incentive Payment												26.57										
Discounted Expenses			497.50					325.92	303.97			180.62										
Discounted Sales			53.30					30.52	40.36			26.57										
Levelized Tariff (Rs/kWh)			9.33					10.68	7.53			[redacted]										
O&M Portion in tariff (Rs/kWh)			0.80					0.80	0.80			0.80										
Fuel Cost Portion in tariff			5.00					5.00														
escalation			0.03																			
Fixed component			9.88	9.88	9.88	9.88	9.88	9.88	6.73	6.73	6.73	6.73	6.73	6.73	6.73	6.73	6.73	6.00	6.00	6.00	6.00	6.00
escalable component			0.80	0.82	0.85	0.87	0.90	0.93	0.95	0.98	1.01	1.04	1.07	1.11	1.14	1.17	1.21	1.24	1.28	1.32	1.36	1.40
Tariff			10.68	10.70	10.73	10.75	10.78	10.81	7.69	7.72	7.74	7.78	7.81	7.84	7.87	7.91	7.94	7.24	7.28	7.32	7.36	7.40
CASH FLOWS			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Income Tax																						
Revenue			74.83	75.00	75.18	75.35	75.54	75.73	53.87	54.07	54.27	54.49	54.71	54.93	55.17	55.40	55.65	50.77	51.03	51.30	51.58	51.87
Fuel			35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04
O&M			5.60	5.77	5.94	6.12	6.30	6.49	6.69	6.89	7.09	7.31	7.53	7.75	7.98	8.22	8.47	8.72	8.99	9.26	9.53	9.82
Depreciation			18.97	18.97	18.97	18.97	18.97	18.97	18.97	18.97			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest			10.93	9.11	7.28	5.46	3.64	1.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE			12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	0.00	0.00	0.00	0.00	0.00
Earnigs Before Tax			4.30	6.12	7.94	9.76	11.58	13.40	-6.83	-6.83	12.14	12.14	12.14	12.14	12.14	12.14	12.14	7.01	7.01	7.01	7.01	7.01
Tax			0.00	0.00	0.00	0.00	0.00	1.34	0.00	0.00	2.43	2.43	2.43	2.43	2.43	2.43	2.43	1.40	1.40	1.40	1.40	1.40
Earnigs After Tax			4.30	6.12	7.94	9.76	11.58	12.06	-6.83	-6.83	9.71	9.71	9.71	9.71	9.71	9.71	9.71	5.61	5.61	5.61	5.61	5.61
Debt Service Coverage Ratio			1.31	1.41	1.52	1.66	1.82	1.93														
Outflow under tiered tariff																						
Equity Invested	57.68	3.87																				
Principle Repayment			15.18	15.18	15.18	15.18	15.18	15.18	0.00													
Interest			10.93	9.11	7.28	5.46	3.64	1.82	0.00													
Fuel			35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04
O&M			5.60	5.77	5.94	6.12	6.30	6.49	6.69	6.89	7.09	7.31	7.53	7.75	7.98	8.22	8.47	8.72	8.99	9.26	9.53	9.82
Tax			0.00	0.00	0.00	0.00	0.00	1.34	0.00	0.00	2.43	2.43	2.43	2.43	2.43	2.43	2.43	1.40	1.40	1.40	1.40	1.40
Total Outflow	57.68	3.87	66.74	65.09	63.44	61.80	60.16	59.87	41.73	41.93	44.56	44.77	44.99	45.22	45.45	45.69	45.94	45.17	45.43	45.70	45.98	46.26
Net Cash Flow	-57.68	-3.87	8.09	9.91	11.73	13.55	15.38	15.86	12.14	12.14	9.71	9.71	9.71	9.71	9.71	9.71	9.71	5.61	5.61	5.61	5.61	5.61
Equity Internal Rate of Return for 15-years				14.0%																		

Annexure 5

Tariff calculations with ~~10%~~ Discount Rate

WACC ??

Flat

~~Tariff calculations with 10% discount rate~~

Levelised tariff estimation: Mini hydro

Assumptions

All costs are in million Rs

Capital Cost	100 Million Rupees/MW						
Equity	40%	Debt	60%	Plant load factor	43%	Depreciation rate	10.0%
Return on equity	20%	Interest rate	12%	O&M	2% of Capital cost	Tax rate	10% for 2 years after tax holiday period and 20% thereafter
		Loan Repayment period	6.0 Years	Escalation in O&M	0.0%	Tax holiday considered	5 years
				Fuel consumption	0		
		Life	15 Years	Fuel cost	0	Discount rate	15.20%
		Construction Period	2 Years	Escalation in O&M	0		
Capacity	1 MW						
Capital cost	100						
Debt	60						
Equity	40						

Allowance of Funds used during construction			
Interest During Construction (IDC)	Year 1	Year 2	Total IDC
Project Disbursement	50%	50%	1.00
Laon Disbursement	10%	50%	
Interest Payment	1.2	7.2	8.4

Capitalized Cost of Project	108.40
Debt	65.04
Equity	43.36

Levelized Tariff Estimation																	
Year	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ROE			8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67
Project Investment	50	50															
Equity Investment	41.2	2.16															
Debt	10	55.04	65.04	54.20	43.36	32.52	21.68	10.84	0.00	0.00							
Principle Repayment			10.84	10.84	10.84	10.84	10.84	10.84									
Interest Payment	1.2	7.80	7.80	6.50	5.20	3.90	2.60	1.30	0.00	0.00							
Fuel cost			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
O&M Expenses			2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Total Expenses		0.60	29.32	28.02	26.72	25.41	24.11	22.81	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67
Sales			3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77
Tariff			7.78	7.44	7.09	6.75	6.40	6.06	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83
Levelized Tariff			5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58
Discounted ROE			50.22														
Discounted Principle Repayment			40.80														
Discounted Interest payments			19.13														
Discounted O&M			11.58														
Discounted. Expenses			121.74														
Discounted Sales			21.81														

Levelized Tariff (Rs/kWh)			5.58														
CASH FLOWS			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Income Tax																	
Revenue			21.02	21.02	21.02	21.02	21.02	21.02	21.02	21.02	21.02	21.02	21.02	21.02	21.02	21.02	21.02
O&M			2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Depreciation			10.84	10.84	10.84	10.84	10.84	10.84	10.84	10.84	10.84	10.84	0.00	0.00	0.00	0.00	0.00
Interest			7.80	6.50	5.20	3.90	2.60	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE			8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67
Earnigs Before Tax			0.38	1.68	2.98	4.28	5.58	6.88	8.18	8.18	8.18	8.18	19.02	19.02	19.02	19.02	19.02
Tax			0.00	0.00	0.00	0.00	0.00	0.69	0.82	1.64	1.64	1.64	3.80	3.80	3.80	3.80	3.80
Earnigs After Tax			0.38	1.68	2.98	4.28	5.58	6.19	7.36	6.55	6.55	6.55	15.22	15.22	15.22	15.22	15.22
Debt Service Coverage Ratio			1.02	1.10	1.19	1.29	1.42	1.51									
Outflow																	
Equity Invested	41.2	2.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Principle Repayment			10.84	10.84	10.84	10.84	10.84	10.84	0.00	0.00	0.00	0.00	0.00				
Interest			7.80	6.50	5.20	3.90	2.60	1.30	0.00	0.00	0.00	0.00	0.00				
O&M			2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Tax			0.00	0.00	0.00	0.00	0.00	0.69	0.82	1.64	1.64	1.64	3.80	3.80	3.80	3.80	3.80
Total Outflow	41.2	2.76	20.64	19.34	18.04	16.74	15.44	14.83	2.82	3.64	3.64	3.64	5.80	5.80	5.80	5.80	5.80
Net Cash Flow	-41.20	-2.76	0.38	1.68	2.98	4.28	5.58	6.19	18.20	17.39	17.39	17.39	15.22	15.22	15.22	15.22	15.22
Internal Rate of Return			14%														

Flat

Levelized Tariff estimation: wind

Assumptions

All costs are in million Rs							
Capital Cost	120	Million Rupees/MW					
Equity	40%	Debt	60%	Plant load factor	27%	Depreciation rate	12.5%
Return on equity	20%	Interest rate	12%	O&M	3% of Capital cost	Tax rate	10% for 2 years after tax holiday period and 20% thereafter
		Loan Repayment period	6.0 Years	Escalation in O&M	0.0%	Tax holiday considered	5 years
				Fuel consumption	0		
		Life	15 Years	Fuel cost	0	Discount rate	15.20%
		Construction Period	2 Years	Escalation in O&M	0		
Capacity	1	MW					
Capital cost	120						
Debt	72						
Equity	48						

Allowance of Funds used during construction			
Interest During Construction (IDC)	Year 1	Year 2	Total IDC
Project Disbursement	50%	50%	1.00
Laon Disbursement	10%	50%	
Interest Payment	1.44	8.64	10.08

Capitalized Cost of Project	130.08
Debt	78.05
Equity	52.03

Levelized Tariff Estimation																
Year	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ROE			10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41
Project Investment	60	60															
Equity Investment	49.44	2.59															
Debt	12	66.05	78.05	65.04	52.03	39.02	26.02	13.01									
Principle Repayment			13.01	13.01	13.01	13.01	13.01	13.01									
Interest Payment	1.44	9.37	9.37	7.80	6.24	4.68	3.12	1.56									
Fuel cost			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M Expenses			3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
Total Expenses		0.73	36.38	34.82	33.26	31.70	30.14	28.58	14.01	14.01	14.01	14.01	14.01	14.01	14.01	14.01	14.01
Sales			2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
Tariff			15.38	14.72	14.06	13.40	12.74	12.08	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92
Levelized Tariff			11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17
Discounted ROE			60.27														
Discounted Principle Repayment			48.96														
Discounted Interest payments			22.96														
Discounted O&M			20.85														
Discounted. Expenses			153.04														
Discounted Sales			13.70														
Levelized Tariff (Rs/kWh)			**11.17**														
CASH FLOWS			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Income Tax																	
Revenue			26.43	26.43	26.43	26.43	26.43	26.43	26.43	26.43	26.43	26.43	26.43	26.43	26.43	26.43	26.43
O&M			3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
Depreciation			16.26	16.26	16.26	16.26	16.26	16.26	16.26	16.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest			9.37	7.80	6.24	4.68	3.12	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE			10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41
Earnigs Before Tax			-2.80	-1.24	0.32	1.88	3.44	5.01	6.57	6.57	22.83	22.83	22.83	22.83	22.83	22.83	22.83
Tax			0.00	0.00	0.00	0.00	0.00	0.50	0.66	1.31	4.57	4.57	4.57	4.57	4.57	4.57	4.57
Earnigs After Tax			-2.80	-1.24	0.32	1.88	3.44	4.50	5.91	5.25	18.26	18.26	18.26	18.26	18.26	18.26	18.26
Debt Service Coverage Ratio			1.02	1.10	1.19	1.29	1.42	1.53									
Outflow																	
Equity Invested	49.44	3.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Principle Repayment			13.01	13.01	13.01	13.01	13.01	13.01	0.00	0.00	0.00	0.00	0.00				
Interest			9.37	7.80	6.24	4.68	3.12	1.56	0.00	0.00	0.00	0.00	0.00				
O&M			3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
Tax			0.00	0.00	0.00	0.00	0.00	0.50	0.66	1.31	4.57	4.57	4.57	4.57	4.57	4.57	4.57
Total Outflow	49.44	3.32	25.97	24.41	22.85	21.29	19.73	18.67	4.26	4.91	8.17	8.17	8.17	8.17	8.17	8.17	8.17
Net Cash Flow	-49.44	-3.32	0.45	2.01	3.57	5.14	6.70	7.76	22.17	21.51	18.26	18.26	18.26	18.26	18.26	18.26	18.26

Internal Rate of Return 14%

Levelized Tariff estimation: biomass

Assumptions

All costs are in million Rs

Capital Cost	140	Million Rupees/MW						
Equity	40%	Debt	60%	Plant load factor	80%		Depreciation rate	12.5%
Return on equity	20%	Interest rate	12%	O&M	4%	of Capital cost	Tax rate	10% for 2 years after tax holiday period and 20% thereafter
		Loan Repayment period	6.0 Years	Escalation in O&M	0.0%		Tax holiday considered	5 years
				Fuel consumption	2			
		Life	15 Years	Fuel cost	2.5		Discount rate	15.20%
		Construction Period	2 Years	Escalation in O&M	0			

Capacity	1	MW	
Capital cost	140		
Debt	84		
Equity	56		

Allowance of Funds used during construction			
Interest During Construction (IDC)	Year 1	Year 2	Total IDC
Project Disbursement	50%	50%	1.00
Laon Disbursement	10%	50%	
Interest Payment	1.68	10.08	11.76

Capitalized Cost of Project	151.76
Debt	91.06
Equity	60.70

Levelized Tariff Estimation																	
Year	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ROE			12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14
Project Investment	70	70															
Equity Investment	57.68	3.02															
Debt	14	77.06	91.06	75.88	60.70	45.53	30.35	15.18	0.00	0.00							
Principle Repayment			15.18	15.18	15.18	15.18	15.18	15.18									
Interest Payment	1.68	10.93	10.93	9.11	7.28	5.46	3.64	1.82	0.00	0.00							
Fuel cost			35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04
O&M Expenses			5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60
Total Expenses		0.85	78.88	77.06	75.24	73.42	71.60	69.78	52.78	52.78	52.78	52.78	52.78	52.78	52.78	52.78	52.78
Sales			7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01
Tariff			11.26	11.00	10.74	10.48	10.22	9.96	7.53	7.53	7.53	7.53	7.53	7.53	7.53	7.53	7.53
Levelized Tariff			9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60
Discounted ROE			70.31														
Discounted Principle Repayment			57.13														
Discounted Interest payments			26.79														
Discounted Fuel Cost			202.92														
Discounted O&M			32.43														
Discounted. Expenses			389.58														
Discounted Sales			40.58														

Levelized Tariff (Rs/kWh)			9.60														
CASH FLOWS			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Income Tax																	
Revenue			67.27	67.27	67.27	67.27	67.27	67.27	67.27	67.27	67.27	67.27	67.27	67.27	67.27	67.27	67.27
Fuel			35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04
O&M			5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60
Depreciation			18.97	18.97	18.97	18.97	18.97	18.97	18.97	18.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest			10.93	9.11	7.28	5.46	3.64	1.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE			12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14
Earnigs Before Tax			-3.27	-1.45	0.38	2.20	4.02	5.84	7.66	7.66	26.63	26.63	26.63	26.63	26.63	26.63	26.63
Tax			0.00	0.00	0.00	0.00	0.00	0.58	0.77	1.53	5.33	5.33	5.33	5.33	5.33	5.33	5.33
Earnigs After Tax			-3.27	-1.45	0.38	2.20	4.02	5.26	6.89	6.13	21.30	21.30	21.30	21.30	21.30	21.30	21.30
Debt Service Coverage Ratio			1.02	1.10	1.19	1.29	1.42	1.53									
Outflow																	
Equity Invested	57.68	3.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Principle Repayment			15.18	15.18	15.18	15.18	15.18	15.18	0.00	0.00	0.00	0.00	0.00				
Interest			10.93	9.11	7.28	5.46	3.64	1.82	0.00	0.00	0.00	0.00	0.00				
Fuel			35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04
O&M			5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60
Tax			0.00	0.00	0.00	0.00	0.00	0.58	0.77	1.53	5.33	5.33	5.33	5.33	5.33	5.33	5.33
Total Outflow	57.68	3.87	66.74	64.92	63.10	61.28	59.46	58.22	41.41	42.17	45.97	45.97	45.97	45.97	45.97	45.97	45.97
Net Cash Flow	-57.68	-3.87	0.53	2.35	4.17	5.99	7.81	9.05	25.86	25.10	21.30	21.30	21.30	21.30	21.30	21.30	21.30
Internal Rate of Return			14%														

Two-tier tariff estimation: Mini Hydro

Assumptions

All costs are in million Rs

Capital Cost	100	Million Rupees/MW		Plant factor	43%		Depreciation rate	10.0%
Equity	40%	Debt	60%	O&M	2%	of Capital cost	Tax rate	10% for 2 years after tax holiday period and 20% thereafter
Return on equity	20%	Interest rate	12%	Escalation in O&M	0.0%		Tax holiday considered	5 years
		Loan Repayment period	6.0 Years	Fuel consumption	0			
				Fuel cost	0		Discount rate	15.20%
		Life	15 Years	Escalation in O&M	0			
		Construction Period	2 Years	Incentive after 15th year	1	Rs/kWh		
				Royalty	10%	annual generation		

Capacity	1 MW
Capital cost	100
Debt	60
Equity	40

Allowance of Funds used during construction			
Interest During Construction (IDC)	Year 1	Year 2	Total IDC
Project Disbursement	50%	50%	
Loan Disbursement	10%	50%	
Interest payment	1.20	7.20	8.40

Capitalized Cost of Project	**108.40**
Debt	65.04
Equity	**43.36**

Levelized Tariff Estimation																						
Year	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
ROE			8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67					
Project Investment	50.00	50.00																				
Equity Investment	41.20	2.16																				
Debt	10.00	55.04	65.04	54.20	43.36	32.52	21.68	10.84	0.00													
Principle Repayment			10.84	10.84	10.84	10.84	10.84	10.84														
Cumulative Prinicpal repayment			10.84	21.68	32.52	43.36	54.20	65.04														
Interest Payment	1.20	7.80	7.80	6.50	5.20	3.90	2.60	1.30														
Loan Repayment			18.64	17.34	16.04	14.74	13.44	12.14														
Fuel cost			0.00	0.00	0.00	0.00	0.00	0.00														
O&M Expenses			2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Depreciation			6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00					
Cumulative Depreciation			6.00	12.00	18.00	24.00	30.00	36.00	42.00	48.00	54.00	60.00										
Advance Against Depreciation (AAD)					4.84	4.84	4.84	4.84	0.00	0.00	0.00	0.00										
Royalty (10% of generation)																						
Incentive (Rs. 1/kWh of generation)																		3.77	3.77	3.77	3.77	3.77

Total Expenses	-	0.60	29.32	28.02	26.72	25.41	24.11	22.81	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	10.67	2.00	2.00	2.00	2.00	2.00
Sales			3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77	3.77
Tariff			7.78	7.44	7.09	6.75	6.40	6.06	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	0.53	0.53	0.53	0.53	0.53
Levelized Tariff			5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58
								Estimation of two tier tariff				**Tariff after PPA period**										
								Year 1-6	**Year 7-15**			**Year 15-20**										
Discounted ROE			50.22					32.64	41.09			0.00										
Discounted Interest payments			19.13					19.13	0.00			0.00										
Discounted O&M			11.58					7.53	9.48			6.67										
Discounted Principle Repayment			40.80					40.80	0.00			0.00										
Discounted Royalty												0.00										
Discounted Incentive Payment												12.57										
Discounted. Expenses			121.74					100.11	50.56			19.24										
Discounted Sales			21.81					14.18	17.85			12.57										
Levelized Tariff (Rs/kWh)			5.58					7.06	2.83			1.53										
Tariff including Royalty												[illegible]										
O&M Portion included in tariff (Rs/kWh)			0.53					0.53	0.53			0.53										
Escalatiojn in o&M			0.03																			
Fixed component			6.53	6.53	6.53	6.53	6.53	6.53	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	1.17	1.17	1.17	1.17	1.17
escalable component			0.53	0.55	0.56	0.58	0.60	0.62	0.63	0.65	0.67	0.69	0.71	0.73	0.76	0.78	0.80	0.83	0.85	0.88	0.90	0.93
Tariff			7.06	7.08	7.09	7.11	7.13	7.14	2.94	2.96	2.97	2.99	3.02	3.04	3.06	3.08	3.11	2.00	2.02	2.05	2.07	2.10
CASH FLOWS			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Income Tax																						
Revenue			26.60	26.66	26.72	26.78	26.85	26.91	11.06	11.13	11.21	11.28	11.36	11.44	11.52	11.61	11.70	7.52	7.62	7.71	7.81	7.91
O&M			2.00	2.06	2.12	2.19	2.25	2.32	2.39	2.46	2.53	2.61	2.69	2.77	2.85	2.94	3.03	3.12	3.21	3.31	3.40	3.51
Depreciation			10.84	10.84	10.84	10.84	10.84	10.84	10.84	10.84	10.84	10.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest			7.80	6.50	5.20	3.90	2.60	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE			8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	8.67	0.00	0.00	0.00	0.00	0.00
Royalty																		0.75	0.76	0.77	0.78	0.79
Earnigs Before Tax			5.95	7.25	8.55	9.85	11.15	12.45	-2.17	-2.17	-2.17	-2.17	8.67	8.67	8.67	8.67	8.67	3.66	3.65	3.64	3.63	3.62
Tax			0.00	0.00	0.00	0.00	0.00	1.25	0.00	0.00	0.00	0.00	1.73	1.73	1.73	1.73	1.73	0.73	0.73	0.73	0.73	0.72
Earnigs After Tax			5.95	7.25	8.55	9.85	11.15	11.21	-2.17	-2.17	-2.17	-2.17	6.94	6.94	6.94	6.94	6.94	2.92	2.92	2.91	2.90	2.89
Debt Service Coverage Ratio			1.32	1.42	1.53	1.67	1.83	1.92														
Outflow under tiered tariff																						
Equity Invested	41.20	2.76																				
Principle Repayment			10.84	10.84	10.84	10.84	10.84	10.84	0.00													
Interest			7.80	6.50	5.20	3.90	2.60	1.30	0.00													
O&M			2.00	2.06	2.12	2.19	2.25	2.32	2.39	2.46	2.53	2.61	2.69	2.77	2.85	2.94	3.03	3.12	3.21	3.31	3.40	3.51
Tax			0.00	0.00	0.00	0.00	0.00	1.25	0.00	0.00	0.00	0.00	1.73	1.73	1.73	1.73	1.73	0.73	0.73	0.73	0.73	0.72
Royalty																		0.75	0.76	0.77	0.78	0.79
Total Outflow	41.20	2.76	20.64	19.40	18.17	16.93	15.69	15.70	2.39	2.46	2.53	2.61	4.42	4.50	4.59	4.67	4.76	4.60	4.70	4.80	4.91	5.02
Net Cash Flow	-41.20	-2.76	5.95	7.25	8.55	9.85	11.15	11.21	8.67	8.67	8.67	8.67	6.94	6.94	6.94	6.94	6.94	2.92	2.92	2.91	2.90	2.89
Equity Internal Rate of Return for 15-years				14.5%																		

Two-tariff tariff estimation: Wind

Assumptions

All costs are in million Rs

Capital Cost	120 Million Rupees/MW		
Equity	40%	Debt	60%
Return on equity	20%	Interest rate	12%
		Loan Repayment period	6.0 Years
		Life	15 Years
		Construction Period	2 Years

Plant factor	27%	
O&M	3%	of Capital cost
Escalation in O&M	0.0%	
Fuel consumption	0	
Fuel cost	0	
Escalation in O&M	0	
Incentive after 15th year	1	Rs/kWh
Royalty	10%	annual generation

Depreciation rate	12.5%
Tax rate	10% for 2 years after tax holiday period and 20% thereafter
Tax holiday considered	5 years
Discount rate	15.20%

Capacity	1 MW
Capital cost	120
Debt	72
Equity	48

Allowance of Funds used during construction				
Interest During Construction (IDC)	Year 1	Year 2	Total IDC	
Project Disbursement	50%	50%		
Loan Disbursement	10%	50%		
Interest payment	1.44	8.64	10.08	

Capitalized Cost of Project	130.08
Debt	78.05
Equity	52.03

Levelized Tariff Estimation																					
Year	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
ROE			10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41					
Project Investment	60.00	60.00																				
Equity Investment	49.44	2.59																				
Debt	12.00	66.05	78.05	65.04	52.03	39.02	26.02	13.01														
Principle Repayment			13.01	13.01	13.01	13.01	13.01	13.01														
Cumulative Prinicpal repayment			13.01	26.02	39.02	52.03	65.04	78.05														
Interest Payment	1.44	9.37	9.37	7.80	6.24	4.68	3.12	1.56														
Loan Repayment			22.37	20.81	19.25	17.69	16.13	14.57														
Fuel cost			0.00	0.00	0.00	0.00	0.00	0.00														
O&M Expenses			3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
Royalty (10% of generation)																						
Incentive (Rs. 1/kWh of generation)																		2.37	2.37	2.37	2.37	2.37
Total Expenses	-	0.73	36.38	34.82	33.26	31.70	30.14	28.58	14.01	14.01	14.01	14.01	14.01	14.01	14.01	14.01	14.01	3.60	3.60	3.60	3.60	3.60

Sales			2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
Tariff			15.38	14.72	14.06	13.40	12.74	12.08	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92	1.52	1.52	1.52	1.52	1.52
Levelized Tariff			**11.17**	**11.17**	**11.17**	**11.17**	**11.17**	**11.17**	**11.17**	**11.17**	**11.17**	**11.17**	**11.17**	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17
								Estimation of two tier tariff				**Tariff after PPA period**										
								Year 1-6	**Year 7-15**			**Year 15-20**										
Discounted ROE			60.27					39.17	49.30			0.00										
Discounted Interest payments			22.96					22.96	0.00			0.00										
Discounted O&M			20.85					13.55	17.06			12.01										
Discounted Principle Repayment			48.96					48.96	0.00			0.00										
Discounted Royalty												0.00										
Discounted Incentive Payment												7.89										
Discounted. Expenses			153.04					124.65	66.36			19.90										
Discounted Sales			13.70					8.90	11.21			7.89										
Levelized Tariff (Rs/kWh)			**11.17**					**14.00**	**5.92**			**2.52**										
Tariff including Royalty												2.80										
O&M Portion in tariff (Rs/kWh)			**1.52**					**1.52**	**1.52**			**1.52**										
Escalation in O&M			**0.03**																			
Fixed component			12.48	12.48	12.48	12.48	12.48	12.48	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	1.28	1.28	1.28	1.28	1.28
Escalable componenet			1.52	1.57	1.61	1.66	1.71	1.76	1.82	1.87	1.93	1.99	2.05	2.11	2.17	2.24	2.30	2.37	2.44	2.52	2.59	2.67
Tariff			**14.00**	**14.05**	**14.09**	**14.14**	**14.19**	**14.24**	**6.22**	**6.27**	**6.33**	**6.39**	**6.45**	**6.51**	**6.57**	**6.64**	**6.70**	**3.65**	**3.72**	**3.80**	**3.87**	**3.95**
CASH FLOWS			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Income Tax																						
Revenue			33.11	33.22	33.33	33.45	33.57	33.69	14.70	14.83	14.97	15.10	15.24	15.39	15.54	15.69	15.85	8.64	8.80	8.98	9.16	9.34
O&M			3.60	3.71	3.82	3.93	4.05	4.17	4.30	4.43	4.56	4.70	4.84	4.98	5.13	5.29	5.45	5.61	5.78	5.95	6.13	6.31
Depreciation			16.26	16.26	16.26	16.26	16.26	16.26	16.26	16.26												
Interest			9.37	7.80	6.24	4.68	3.12	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE			10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	10.41	0.00	0.00	0.00	0.00	0.00
Royalty																		0.86	0.88	0.90	0.92	0.93
Earnigs Before Tax			3.89	5.45	7.01	8.57	10.13	11.69	-5.85	-5.85	10.41	10.41	10.41	10.41	10.41	10.41	10.41	2.16	2.15	2.13	2.11	2.09
Tax			0.00	0.00	0.00	0.00	0.00	1.17	0.00	0.00	2.08	2.08	2.08	2.08	2.08	2.08	2.08	0.43	0.43	0.43	0.42	0.42
Earnigs After Tax			3.89	5.45	7.01	8.57	10.13	10.52	-5.85	-5.85	8.33	8.33	8.33	8.33	8.33	8.33	8.33	1.73	1.72	1.70	1.69	1.68
Debt Service Coverage Ratio			1.32	1.42	1.53	1.67	1.83	1.95														
Outflow under tiered tariff																						
Equity Invested	49.44	3.32																				
Principle Repayment			13.01	13.01	13.01	13.01	13.01	13.01	0.00	0.00	0.00	0.00	0.00									
Interest			9.37	7.80	6.24	4.68	3.12	1.56	0.00	0.00	0.00	0.00	0.00									
O&M			3.60	3.71	3.82	3.93	4.05	4.17	4.30	4.43	4.56	4.70	4.84	4.98	5.13	5.29	5.45	5.61	5.78	5.95	6.13	6.31
Tax			0.00	0.00	0.00	0.00	0.00	1.17	0.00	0.00	2.08	2.08	2.08	2.08	2.08	2.08	2.08	0.43	0.43	0.43	0.42	0.42
Royalty																		0.86	0.88	0.90	0.92	0.93
Total Outflow	49.44	3.32	25.97	24.52	23.07	21.62	20.18	19.91	4.30	4.43	6.64	6.78	6.92	7.06	7.21	7.37	7.53	6.91	7.09	7.27	7.47	7.67
Net Cash Flow	-49.44	-3.32	7.14	8.70	10.26	11.82	13.38	13.78	10.41	10.41	8.33	8.33	8.33	8.33	8.33	8.33	8.33	1.73	1.72	1.70	1.69	1.68
Equity Internal Rate of Return for 15-years				**14.2%**																		

Two-tier tariff estimation: Biomass

Assumptions

All costs are in million Rs

Capital Cost	140	Million Rupees/MW		Plant factor	80%		Depreciation rate	12.5%
Equity	40%	Debt	60%	O&M	4%	of Capital cost	Tax rate	10% for 2 years after tax holiday period and 20% thereafter
Return on equity	20%	Interest rate	12%	Escalation in O&M	0.0%		Tax holiday considered	5 years
		Repayment period (inclusive of moratorium)	6.0 Years	Fuel consumption	2			
		Moratorium after construction	0.0 Years	Fuel cost	2.5		Discount rate	15.20%
		Life	15 Years	Escalation in O&M	0			
		Construction Period	2 Years	Incentive after 15th year	1	Rs/kWh		
				Royalty	10%	annual generation		

Capacity	1	MW
Capital cost	140	
Debt	84	
Equity	56	

Allowance of Funds used during construction

Interest During Construction (IDC)	Year 1	Year 2	Total IDC
Project Disbursement	50%	50%	
Loan Disbursement	10%	50%	
Interest payment	1.68	10.08	11.76

Capitalized Cost of Project	151.76
Debt	91.06
Equity	60.70

Levelized Tariff Estimation

Year	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ROE			12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14
Project Investment	70.00	70.00															
Equity Investment	57.68	3.02															
Debt	14.00	77.06	91.06	75.88	60.70	45.53	30.35	15.18									
Principle Repayment			15.18	15.18	15.18	15.18	15.18	15.18									
Cumulative Prinicpal repayment			15.18	30.35	45.53	60.70	75.88	91.06									
Interest Payment	1.68	10.93	10.93	9.11	7.28	5.46	3.64	1.82									
Loan Repayment			26.10	24.28	22.46	20.64	18.82	17.00									
Fuel cost			35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04
O&M Expenses			5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60
Royalty (nil)																	
Incentive (Rs. 1/kWh of generation)																	
Total Expenses	-	0.85	78.88	77.06	75.24	73.42	71.60	69.78	52.78	52.78	52.78	52.78	52.78	52.78	52.78	52.78	52.78
Sales			7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01	7.01

Tariff			11.26	11.00	10.74	10.48	10.22	9.96	7.53	7.53	7.53	7.53	7.53	7.53	7.53	7.53	7.53
Levelized Tariff			9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60
								Estimation of two tier tariff				**Tariff after PPA period**					
								Year 1-6	**Year 7-15**			**Year 15-20**					
Discounted ROE			70.31					45.70	57.52			0.00					
Discounted Interest payments			26.79					26.79	0.00			0.00					
Discounted Fuel Costs			202.92					131.90	166.01			116.91					
Discounted O&M			32.43					21.08	26.53			18.68					
Discounted Principle Repayment			57.13					57.13	0.00			0.00					
Discounted Royalty												0.00					
Discounted Incentive Payment												23.38					
Discounted. Expenses			389.58					282.59	250.07			158.97					
Discounted Sales			40.58					26.38	33.20			23.38					
Levelized Tariff (Rs/kWh)			**9.60**					**10.71**	**7.53**			**6.80**					
O&M Portion in tariff (Rs/kWh)			**0.80**					**0.80**	**0.80**			**0.80**					
Fuel Cost Portion in tariff			**5.00**					**5.00**									
escalation			**0.03**														
Fixed component			9.91	9.91	9.91	9.91	9.91	9.91	6.73	6.73	6.73	6.73	6.73	6.73	6.73	6.73	6.73
escalable component			0.80	0.82	0.85	0.87	0.90	0.93	0.95	0.98	1.01	1.04	1.07	1.11	1.14	1.17	1.21
Tariff			**10.71**	**10.74**	**10.76**	**10.79**	**10.81**	**10.84**	**7.69**	**7.72**	**7.74**	**7.78**	**7.81**	**7.84**	**7.87**	**7.91**	**7.94**
CASH FLOWS			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Income Tax																	
Revenue			75.07	75.24	75.41	75.59	75.78	75.97	53.87	54.07	54.27	54.49	54.71	54.93	55.17	55.40	55.65
Fuel			35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04
O&M			5.60	5.77	5.94	6.12	6.30	6.49	6.69	6.89	7.09	7.31	7.53	7.75	7.98	8.22	8.47
Depreciation			18.97	18.97	18.97	18.97	18.97	18.97	18.97	18.97			0.00	0.00	0.00	0.00	0.00
Interest			10.93	9.11	7.28	5.46	3.64	1.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROE			12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14
Earnigs Before Tax			4.54	6.36	8.18	10.00	11.82	13.64	-6.83	-6.83	12.14	12.14	12.14	12.14	12.14	12.14	12.14
Tax			0.00	0.00	0.00	0.00	0.00	1.36	0.00	0.00	2.43	2.43	2.43	2.43	2.43	2.43	2.43
Earnigs After Tax			4.54	6.36	8.18	10.00	11.82	12.28	-6.83	-6.83	9.71	9.71	9.71	9.71	9.71	9.71	9.71
Debt Service Coverage Ratio			1.32	1.42	1.53	1.67	1.83	1.95									
Outflow under tiered tariff																	
Equity Invested	57.68	3.87															
Principle Repayment			15.18	15.18	15.18	15.18	15.18	15.18	0.00								
Interest			10.93	9.11	7.28	5.46	3.64	1.82	0.00								
Fuel			35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04	35.04
O&M			5.60	5.77	5.94	6.12	6.30	6.49	6.69	6.89	7.09	7.31	7.53	7.75	7.98	8.22	8.47
Tax			0.00	0.00	0.00	0.00	0.00	1.36	0.00	0.00	2.43	2.43	2.43	2.43	2.43	2.43	2.43
Total Outflow	57.68	3.87	66.74	65.09	63.44	61.80	60.16	59.89	41.73	41.93	44.56	44.77	44.99	45.22	45.45	45.69	45.94
Net Cash Flow	-57.68	-3.87	8.33	10.15	11.97	13.79	15.61	16.07	12.14	12.14	9.71	9.71	9.71	9.71	9.71	9.71	9.71

Equity Internal Rate of Return for 15-years **14.2%**

Annexure 6

Estimation of impact of higher tariff on per unit consumer tariff

Annex 6: Estimation of impact of higher tariff on per unit consumer tariff

The two tier tariffs would be higher than the avoided costs in case of technologies like wind and biomass. One of the suggested option to recover this additional cost is to pass it on to consumers. An indicative estimation of impact on consumer tariffs is carried out here with certain assumptions of installed capacity of wind and biomass plants.

Table 6.1 Key assumptions

Assumptions	Units
Total annual generation (GWh); source- CEB Statistical Digest, 2003	7612
Total installed capacity (MW) source- CEB Statistical Digest, 2003	2450
Avoided cost (SLR/kWh) Average of wet and dry season, 2006	6. 27

The impact of renewable based power generation with installed capacities mentioned in table 6.2 below, on total generation of 2003 has been estimated as shown below. The table below shows impact of contribution (column C) from different renewable energy technologies in total generation on overall consumer tariff (column G). In case of biomass when the contribution reaches 3% of total generation, the impact, as aresult of highet tarifft o biomass projects, will be about 0.13 SLR/Unit.

The first year tariff, as estimated in the annex 4, has been used to estimate the impact.

Table 6.2 Calculation of per unit cost differential between levelised cost and avoided cost

RETs	Installed capacity (MW) **(B)**	Annual generation (million kWh) **(A)**	Contribution to total generation (C)	First tier tariff (Rs/ kWh)[a] **(D)**	Difference between **(D)** and avoided costs, **(E)**	Total cost Differential million Rs. **(F)**[b]	Per unit cost differential (Rs/ kWh)[c] **(G)**
Biomass	32.5	228	3%	10.68	4.41	1007	0.13
Wind	32.1	76	1%	13.91	7.64	581	0.07
Mini Hydro	121	456	6%	7.02	0.75	342	0.04
Total			10				0.25

Notes

a – First year tariff as calculated in Annex 4

b – Total cost differential (SLR) = E * A * Total annual generation (in GWh) * 10^6

c – Per unit cost differential (SLR / kWh) = Total cost differential/ Total annual generation

Annexure 7
Capacity Credit Calculations

Annex 7: Capacity Credit Calculations

The calculation of capacity credits has been done based on the concept of 'peaker method', whereby the value (opportunity cost) ofmini hydro generation is determined by the economic cost of the alternative resource that is planned to meet the expected load growth. In this case, a Gas Turbine of capacity 105 MW, planned for development in 2008. The indicative capital cost of gas turbine plant is taken from Long term generation expansion plan 2005-2019, published in 2004.

Table 7.1: Capacity Credit calculations using the peaker method

Cost of Gas Turbine Capacity Support	
Avoided Unit	GT
Installed Capacity (MW)	105
Capital Cost ($/ kW)	424.9
Foreign ($/ kW)	374
Local ($/ kW)	50.9
Year Required	2008
Life (years)	20
Station Use (% of Gross Generation)	0.03
Discount Rate (%)	0.12
Fixed O&M (% of capital cost), $/ kW -month	0.396
CRF	0.13
Avoided Cost ($/ kW/ yr)	61.64
Exchange Rate (SLR/ USD)	100
Avoided Cost (Rs/ kW/yr)	6163.7
Plant Availability (%)	84.4
Total no. of hours (/year)	8760
Capacity Charge (Rs./ kWh)	**0.84**

Notes:

$$\text{Capacity Charge (Rs./ kWh)} = \frac{\text{Avoided Capacity Cost (Rs./ kW/year)}}{\text{Plant availability * total no. of hours in a year}}$$

Annexure 8
Computation of cost of generation of off-grid systems

Annex 8: Computation of cost of generation of off-grid systems

For the analysis of off grid systems, a typical village that is situated at a distance of 5kms from the nearest grid point has been assumed having an annual load of 25 kW and an annual energy consumption of 54.75MWh of energy consumption. Based on these assumptions, the off grid systems of a stand-alone PV system, biomass gasifier based system and a village hydro scheme of capacities 35 kW, 25 kW and 25 kW respectively have been assumed to be designed to meet the load and energy requirements of the village. The cost details of each of the off grid systems is given below.

(A) Solar PV system

A Solar PV system of capacity 35 kW with a capacity utilization factor of 18% has been assumed for computation of the cost of generation.

Cost estimation basis

Capital costs are based on existing capital cost in India. The capacity of this plant has been assumed as 35 kW. A discount rate of 10% has been assumed for calculations.

Capital cost

The table below gives the assumptions that have been used while computation of cost of generation:

Table 8.1 Assumptions

Component	Units
Capital Cost (Rs/ kW)	700,000
Capacity (kW)	35
CUF (%)	18
Life (years)	20

Generating cost

Based on the assumed discount rate and the life of the plant, the capital cost is annualized and the total cost of generation has been estimated using the O&M costs. The O&M costs have been assumed as 0.5%of the capital cost in case of solar PV.

The cost of generation of the SPV system has been computed as 54.36 Rs/ kWh.

(B) Biomass gasifer based power plant

A biomass gasifier based power plant of capacity 25 kW with a capacity utilization factor of 27% has been assumed for computation of the cost of generation.

Cost estimation basis

Capital costs have been assumed as Rs 140,000/ kW for a 25 kW plant. A discount rate of 10% has been assumed for calculations.

Capital cost

The table below gives the assumptions that have been used for computation of cost of generation of a biomass gasifier based power plant:

Table 8.2 Assumptions

Component	Units
Capital Cost (Rs/ kW)	140,000
Capacity (kW)	25
CUF (%)	27
Life (years)	15

Fuel cost

The table below gives the fuel cost assumptions:

Table 8.3 Fuel Cost assumptions

Component	Units
Fuel consumption (kg/kWh)	1.6
Cost of fuel (Rs/kg)	2.5

Generating Cost

Based on the assumed discount rate and the life of the plant, the capital cost is annualized and the total cost of generation has been estimated using the O&M costs. The O&M costs have been assumed as 4%of the capital cost in case of biomass based projects.

The cost of generation of the biomass-based power plant has been computed as 13.26 Rs/kWh.

(C) Village hydro scheme

A grid-village hydro scheme of capacity 25 kW with a capacity utilization factor of 27% has been assumed for computation of the cost of generation.

Cost estimation basis

Capital costs have been assumed as Rs 100,000/ kW for a 25 kW plant. A discount rate of 10% has been assumed for calculations.

Capital cost

The table below gives the assumptions that have been used for computation of cost generation of the VHS:

Table 8.4 Assumptions

Component	Units
Capital Cost (Rs/ kW)	100,000
Capacity (kW)	25
CUF (%)	27
Life (years)	20

Generating cost
Based on the assumed discount rate and the life of the plant, the capital cost is annualized and the total cost of generation has been estimated using the O&M costs. Variable O&M costs have been assumed as 2.5%of the capital cost.

The cost of generation of the biomass-based power plant has been computed as 6.02 Rs/ kWh.