

The Methodology for Feed-In-Tariffs - NCRE

**The basis for deciding purchase tariff for energy supplied by Non-
Conventional Renewable Energy based Electricity Generation**

October 04, 2011

This document defines the basic principles and the methodology for calculating feed-in-tariffs for non conventional renewable energy based electricity generation and such methodology is applicable for purchasing non-conventional renewable energy based electricity from plants having capacities below 10 MW and operating under Standard Power Purchase Agreements (SPPA) with the transmission licensee of Ceylon Electricity Board.

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1. Application of the Methodology

This Methodology for Non Conventional Renewable Energy (NCRE) purchase tariff is approved by the Public Utilities Commission of Sri Lanka in terms of Section 43 of Sri Lanka Electricity Act, No 20 of 2009. This document may be cited as the Methodology for determining feed in tariffs for Non-Conventional Renewable Energy based electricity generation and shall come into effect on the date on which this document is issued.

The Methodology applies for purchasing Non-Conventional Renewable Energy based electricity from plants having capacities below 10 MW and operating under Standard Power Purchase Agreements (SPPA) with the Ceylon Electricity Board.

2. Applicable NCRE technologies / Fuels

- a) Mini-hydro
- b) Mini-hydro- Local; mini-hydro plants that, at least, use locally manufactured turbines
- c) Wind
- d) Wind – Local; wind plants that, at least, use locally manufactured turbine blades
- e) Biomass –Dendro; biomass fired plants that use grown fuel wood
- f) Biomass- Agricultural/ Industrial Waste; biomass fired plants that use byproducts like paddy husk, saw dust, sugar cane bagasse, etc
- g) Municipal Solid Waste
- h) Waste Heat Recovery

3. Tariff Options

The NCRE based electricity purchase tariffs (Tariffs) will be calculated based on projected cash flow of a generic 1 MW plant over 20 years, including the Return on Equity (ROE) for 15 years. There will be two options; (1) tiered (three tier tariff) and (2) flat tariff, options.

3.1. Tiered option

- a) Tier 1 (first 8 years):Cash outflow will include, loan repayment for 6 years, annual O &M cost, Return on Equity and Fuel cost
- b) Tier 2 (next 7 years):Cash outflow will include, annual O &M cost, Return on Equity and Fuel cost
- c) Tier 3 (next 5 years):Cash outflow will include, annual O &M cost, Fuel cost and an Incentive Payment

In all three tiers, escalations will be applicable for O & M cost, Fuel cost and the Incentive payment

3.2. Flat option

This option is a constant tariff over 20 years, where the same cash outflows are taken with the year 1 estimated escalation applied to total SPPA period, and a single all inclusive tariff is determined for each technology.

4. Parameters

All costs are to be estimated at the current year terms. The estimation of cash flows, parameters for each technology shall be done as shown below; Parameters developed for year 2010 is shown in annex 01 as an example.

4.1. Capital Cost

The total investment for a typical 1 MW power plant of each technology is to be established. The average size of a typical plant constructed in Sri Lanka has to be taken into consideration when arriving at per MW investment cost. The cost components of a typical plant would be; project development cost, infrastructure development cost, cost of civil works, cost of logistics, cost of electromechanical equipment, fuel handling system cost, interconnection cost, working capital and contingencies. Local ICTAD indices and international equipment cost indices could be used to update the capital cost on yearly basis. In case of Mini-hydro – Local and Wind-local technologies, an additional 10% of the electromechanical equipment cost allocation in the investment cost could be allowed as an assistance to encourage locally manufactured components.

4.2. Operation and Maintenance (O&M) Cost

Plant Operation and Maintenance cost shall be estimated as a percentage (%) of the investment cost per annum, and this percentage could be varied during the SPPA period taking into account the age of the plant. This cost shall cover all costs (yearly) other than initial working capital, loan repayment and fuel costs of a typical plant of each technology.

4.3. Plant Factor

Plant factor shall be set for each technology to estimate annual electricity generated from each technology. Following Factors, among others, shall be considered when setting the plant factor;

- a) Optimal design of a typical power plant
- b) Existing resource potential in the country (consideration shall be given for tapping best sites in case of emerging technologies)
- c) Typical plant size and technology used in Sri Lanka

- d) Typical maintenance hours/ days per annum
- e) Historical plant factors of existing power plants of the same technology

4.4. Fuel Cost

Fuel cost (Rs. / kWh) is applicable for Biomass (Dendro and Agro/ industrial Waste technologies) and Municipal Solid Waste technologies only. Following factors, among others, shall be considered.

- a) Prevailing/ projected market price of the fuel (in real terms)
- b) Cost of production, in case of grown fuel wood
- c) Transport cost/ tipping fees of the fuel
- d) Moisture content and plant efficiency (typically assumed as 1.4 kg/kWh in case of biomass)

4.5. Construction Period

Plant construction period is to be assumed as 2 years, while equal percentage of investment made in those two years (50% each) and the total equity investment is done during first year of construction. Interest During Construction (IDC) shall be capitalized for estimation of loan repayments and Return on Equity calculations.

E.g.If investment per MW is C and debt is 60%, following estimation shall be done for simplicity,

Construction Year	1	2
Equity	40%	-
Debt	10%	50%
IDC	$C \times 10\% \times r\%$	$C \times (10\% + 50\%) \times r\%$

r = loan interest rate

and the capitalized total investment cost is $\{C + IDC_{\text{year 1}} + IDC_{\text{year 2}}\}$

4.6. Cost of Debt (interest rate)

Debt is assumed as a fraction of the capitalized total investment cost (typically taken as 60%), cost of debt shall be estimated based on 12 month Average of Weighted Deposit Rates (AWDR) published by the Central bank of Sri Lanka;

Post tax cost of debt = $\{(12 \text{ month average AWDR} + 12 \text{ month Average AWFDR})/2 + 5\% - 1.5\%$,

and the adjustments shown above are typical values of, bank premium (5%) and tax benefit (1.5%) as interest is tax deductible.

The loan repayment period shall be taken as 6 years (typical loan period). The principal repayment is on equal installments and the interest is calculated for the outstanding balance. Annual loan repayment simulation could be used for simplicity.

4.7. Return on Equity

A fixed Return on Equity (ROE) as a percentage of capitalized total investment cost is to be allowed for 15 years of the SPPA, for equity taken as a fraction of capitalized total investment cost (typically taken as 40%). The percentage (%) return on Equity (ROE) shall be set such that the investor receives at least the Cost of Equity (COE); k_e , estimated using the Capital Asset Pricing Model (CAPM), over the 20 year SPPA period.

4.7.1. Capital Asset Pricing Model(CAPM);

$$k_e = k_{RF} + (k_M - k_{RF}) \beta$$

k_{RF} = risk-free rate (use long-term (6/ 10-yr) Treasury bond interest rate- 5 year average)

$(k_M - k_{RF})$ = equity risk premium (ERP) – typical risk of a investment in the country compared to risk free investment, typically taken as 10% for Sri Lanka

β = Beta, which measures a project’s risk (technology, energy forecast, revenue, etc). It represents a project’s volatility relative to the overall market. Typically taken as 0.9 for electricity sector investments in Sri Lanka

The ROE % shall be estimated through an iterative process where the ROE % is adjusted until the Equity Internal Rate of Return (EIRR) over the 20 year SPPA is equal to COE. Since, the ROE figure may vary depending on the technology based on cashflows, an estimated rounded ROE figure shall be used.

4.8. Discount Rate

The discount rate for the cashflows shall be estimated using the Weighted Average Cost of Capital (WACC) as shown below.

$$WACC = \frac{\text{debt \%} \times \text{interest rate\%} + \text{equity\%} \times \text{COE\%}}{100}$$

4.9. Methods of Cost Escalations

4.9.1. O&M cost

O & M cost is to be escalated over 20 year’s period as average of USD exchange rate and CCPI escalation rates over the past five years. Hence, this escalation rate has to be calculated and published every year.

In case of 3 tier option, no escalations are assumed in the tariff calculation and the annual escalation is done over and above the published tariffs. In case of flat option, the year 1 escalation is assumed over the 20 year period to arrive at the flat tariff for each technology.

4.9.2. Fuel Cost

Shall be taken as 2/3 rd of the O & M escalation rate, and its application is similar to that of O & M escalation rate for the two tariff options.

5. Incentive for third tier

Tier 3 does not contain a ROE; hence it is unlikely that the investor would continue the operation only with the O & M cost allowed through the tariff, hence an incentive that would be sufficient to continue the operation shall be provided. This incentive is to be escalated at 2/3 of the O & M escalation rate, and its application is similar to that of O & M escalation rate for the two tariff options.

6. Tariff Calculation

6.1. Tiered Option

Tier 1 (first 8 years): NPV of total cash outflow/ NPV of energy generated;
Tier 2(next 7 years): NPV of total cash outflow/ NPV of energy generated;
Tier 3(next 5 years): {NPV of total cash outflow/ NPV of energy generated} + incentive payment

Cash outflow contain loan repayment, Return on Equity, O & M, fuel cost as applicable and the escalations are applied outside the calculation

6.2. Flat Option

Tariff: NPV of total cash outflow over 20 years/ NPV of energy generated

Cash outflow include escalations (at year 1 rates) over 20 years and incentive payments in addition to loan repayment, Return on Equity, O & M and fuel cost as applicable.

7. Royalty

A royalty payment may be imposed by the Sri Lanka Sustainable Energy Authority.

Annex 01:

Parameters used for 2010 NCRE tariff revision

	Capital Cost (LKR Mn./ MW)	O & M, % (Year 1-15)	O & M, % (Year 16-20)	Plant Factor, %	Fuel Cost (LKR/ kWh)
Mini-hydro	179	3.00	3.00	38.00	None
Mini-hydro-local	183	3.00	3.00	38.00	None
Wind	212	4.00	4.00	32.00	None
Wind-local	218	4.00	4.00	32.00	None
Biomass*	226	4.00	5.00	80.00	9.10
Agro & Indus	226	4.00	5.00	80.00	4.55
Municipal Waste	339	7.00	7.00	60.00	1.75
Waste Heat	189	1.33	1.33	67.00	None

Interest rate: 13%

 k_{rf} : 9.87% $k_m - k_{rf}$: 10% β : 0.9

COE: 18.87%

ROE: 22%

WACC: 15.35%

Incentive after Yr. 15: Rs. 1.68/ kWh