

# **Least-Cost Generation Expansion Planning Code**

**Version 1.0**

**25<sup>th</sup> April 2011**

# TABLE OF CONTENTS

<b>1. BACKGROUND</b> .....	<b>1</b>
<b>2. GENERATION EXPANSION PLANNING</b> .....	<b>1</b>
2.1. <i>Objective of Generation Planning</i> .....	1
2.2. <i>The Planning Period, Frequency of Updates and Date of Submission</i> .....	1
2.3. <i>Plan Boundaries</i> .....	1
2.4. <i>Demand Forecast</i> .....	2
2.5. <i>Planning Criteria</i> .....	2
2.5.1. <i>Peaking availability</i> .....	2
2.5.2. <i>Power Supply Security Standards</i> .....	2
2.6. <i>Economic Parameters</i> .....	2
2.6.1. <i>Reference Year for Costs</i> .....	2
2.6.2. <i>Cost Database</i> .....	2
2.6.3. <i>Reference year for Present Value Analysis</i> .....	2
2.6.4. <i>Plant Economic Life</i> .....	3
2.6.5. <i>Cost of Unserved Energy</i> .....	3
2.7. <i>Planning Models</i> .....	3
2.8. <i>Development of the Reference (Base) Case</i> .....	3
2.8.1. <i>Consideration of non-dispatchable power plants</i> .....	3
2.8.2. <i>Sensitivity Studies</i> .....	4
2.9. <i>Policy Analysis and Scenario Analysis</i> .....	4
2.9.1. <i>Policy Analysis</i> .....	4
2.9.2. <i>Scenario Analysis</i> .....	4
2.10. <i>The Recommended Generation Expansion Plan</i> .....	4
2.11. <i>The Planning Report</i> .....	5

---

## 1. BACKGROUND

The Transmission and Bulk Supply Licensee (Transmission Licensees or TL) is engaged in two principal businesses, as stated in the license:

- (i) Transmission Business (planning, construction, operation and maintenance of the Transmission network)
- (ii) Bulk Supply and Operation Business, which consists of
  - the single buyer of electricity generated by generation licensees;
  - the supplier of electricity in bulk to Distribution Licensees for re-sale and to Bulk Supply Consumers; and
  - the system operator in respect of the Transmission System

Section 24 of the Sri Lanka Electricity Act (SLEA) states that,

A transmission licensee shall (a) develop and maintain an efficient, coordinated, reliable and economical transmission system; (b) procure and sell electricity in bulk to distribution licensees so as to ensure a secure, reliable and economical supply of electricity to consumers; and (c) ensure that there is sufficient capacity from generation plant to meet reasonable forecast demand for electricity.

TL is presently developing a least-cost generation expansion plan updated every year. This consultation document sets out the timing, key parameters and features of the least cost generation plan to be prepared by the TL from year 2011 onwards.

## 2. GENERATION EXPANSION PLANNING

### 2.1. OBJECTIVE OF GENERATION PLANNING

The objective of generation expansion planning is to aim at serving the demand at a specified level of reliability, at the lowest possible cost. Generation expansion planning shall be distinctly different from economic dispatch, which relates to existing and committed power plants.

### 2.2. THE PLANNING PERIOD, FREQUENCY OF UPDATES AND DATE OF SUBMISSION

The planning period shall be twenty (20) years, commencing from the first year after the year the plan is published. The Transmission Licensee may conduct studies covering more than twenty years, to smoothen out the "end effects", and to enable the development of robust recommendations for new generating plants, replacements, or upgrades to existing plants.

The Transmission Licensee shall update the generation expansion plan at least once in two years. The plan shall be documented in the form of a report titled "Least-cost Generation Expansion Plan *start year – ending year*" (hereinafter referred to as the "the Plan").

The Plan shall be submitted for review and approval by the Public Utilities Commission of Sri Lanka (the Commission) not later than 30<sup>th</sup> day of April, of the year in which an update to the Plan is due. However, the first such submission of the Plan will be due on 30<sup>th</sup> May 2011. The Commission shall review the Plan for compliance with the guidelines provided herein, request for clarifications and amendments, and approve the Plan. The Transmission Licensee shall publish the Plan on the Licensee's web site immediately after the Plan is approved by the Commission.

### 2.3. PLAN BOUNDARIES

The Plan shall cover the boundaries of the Bulk Supply and Operations Business of the Transmission Licensee, namely:

Off-take from Generating Plant at the high voltage terminals, and delivery to Distribution Licensees and other Transmission Customers.

Accordingly, all information about the demand forecast, existing generating plant and new generating plant shall be presented as measured at the high voltage terminals. Capacity and energy

---

required to meeting the auxiliary requirements in generating plant and in step-up transformers at generating plant shall be included in the respective Power Purchase Agreements (PPAs).

## **2.4. DEMAND FORECAST**

The Plan shall be prepared based on a demand forecast prepared by the Transmission Licensee in accordance with the forecasting guidelines provided in the Grid Code.

## **2.5. PLANNING CRITERIA**

### **2.5.1. PEAKING AVAILABILITY**

The peaking availability of hydroelectric plants and thermal plants shall be in accordance with the data furnished by the respective Generation Licensees, in accordance with the respective PPAs. For new power plants considered as candidates, prudent information shall be used.

### **2.5.2. POWER SUPPLY SECURITY STANDARDS**

To ensure that the generation reserve is sufficient to meet the demand, even if one or more units are out of service for scheduled maintenance or in the event of non-availability of adequate hydroelectric generation capacity during the dry period, adequate reserve capacity shall be built into the system for both capacity and energy. The key criteria for generating system security shall be the following:

<b>Criterion</b>	<b>Value</b>
Loss of Load probability (LOLP)	Minimum: 0.5% Maximum: 1.5% Typical: 0.8%
Reserve Margin	Minimum: 10% Maximum: 35% Typical: 15%

## **2.6. ECONOMIC PARAMETERS**

### **2.6.1. REFERENCE YEAR FOR COSTS**

All cost estimates shall reflect economic conditions as on 1<sup>st</sup> January of the first year of the Plan. The cost shall exclude taxes and duties.

### **2.6.2. COST DATABASE**

Capital and operating cost estimates of existing power plants and new generating units planned for system addition shall be developed by the Transmission Licensee.

The Transmission Licensee shall ensure that the costs of existing power plants are updated prior to commencing studies, in accordance with the PPAs and SPPAs with all Generation Licensees. The PPAs and SPPAs should have been previously approved by the Commission.

In the case of candidate power plants, the Transmission Licensee shall ensure that the most up to date information from feasibility studies, pre-feasibility studies and other studies will be used. The required studies shall be commissioned periodically by the Transmission Licensee, to ensure that the cost database is updated prior to commencing the studies.

### **2.6.3. REFERENCE YEAR FOR PRESENT VALUE ANALYSIS**

An economic discount rate of 10% shall be used as a base rate for discounted cash flow analysis related to all analyses, and for calculating the net present value of all alternatives to the Base Case. At least two sensitivity studies shall be provided for (i) the Base Case Plan and (ii) the Recommended Plan (if different from the Base Case Plan), conducted at discount rates of 5% and 15%.

---

#### **2.6.4. PLANT ECONOMIC LIFE**

For planning studies, the economic life of generating plants shall be assumed as follows.

<b>Plant Type</b>	<b>Economic Life (Years)</b>
Hydroelectric	50
Steam	30
Open Cycle Gas Turbine	20
Combined Cycle Gas Turbine	30

#### **2.6.5. COST OF UNSERVED ENERGY**

The value of unserved energy shall be considered in the economic analysis to develop the Plan, and for each sensitivity study. For the first submission of the Plan (in 2011), the value of unserved energy shall be 0.50 USD/kWh.

The Transmission Licensee shall conduct a review of the value of unserved energy at least once in four years, and update such value through economic analyses and customer surveys. The first review and update should be prepared in time for the Plan to be submitted in year 2015.

To meet the requirements of Distribution Licensees in assessing the economic value of power interruptions, studies by the Transmission Licensee shall study and report results for the Authorised Areas of each Distribution Licensee or for each Province of Sri Lanka. Until the first review and the update is published by the Transmission Licensee in year 2015, the Distribution Licensees shall use a common value of 0.50 USD/kWh.

### **2.7. PLANNING MODELS**

The Transmission Licensee shall select a suitable software package to model the demand and the generating system, and to generate and analyse the alternative combinations of power plants, and to conduct scenario studies.

### **2.8. DEVELOPMENT OF THE REFERENCE (BASE) CASE**

The Plan will develop and present a reference case (ie the base case) generation expansion plan, under the following criteria:

- All capital costs expressed in constant currency terms, expressed in currency at the reference date, in economic terms (border prices)
- All fuel prices assumed to remain constant as of the reference date, and expressed in economic terms (border prices)
- An economic discount rate of 10% per year.
- All other economic parameters remaining constant over the planning period
- Any policy guidelines, technology options, and forced/natural operating patterns that would cause new investments or power purchase agreements that would not contribute to the least-cost objectives, would not be considered in developing the reference case
- All existing and candidate power plant costs shall include the cost of meeting the Sri Lanka Environmental standards, as applicable.

The reference case will be the least cost plan, and this plan and a complete analysis of the plan in terms of year-by-year investment requirements, fuel requirements and costs, capacity and energy balance, shall be provided.

Investment requirements for the reference case shall be provided both in economic terms and in financial terms.

#### **2.8.1. CONSIDERATION OF NON-DISPATCHABLE POWER PLANTS**

Existing non-dispatchable power plants of any description already in operation as of 1<sup>st</sup> January of the first year of the Plan, shall be included in developing the reference case, if such plants operate

---

on a PPA/SPPA approved by the Commission. The payments for energy under such PPAs shall be externally calculated, clearly shown and included in the calculation of costs of the reference case.

Candidate non-dispatchable power plants required to be included owing to policy guidelines issued by the Commission or any of the Transmission Licensee's own policies, shall not be included in the reference case, unless the Transmission Licensee can demonstrate that such power purchase costs shall not violate the least-cost objective of developing the reference case. If such power plants are to be included, the Transmission Licensee requires to develop a plan and a sequence of such power plant additions, and demonstrate that the reference case will continue to be least cost even after addition of such non-dispatchable power plants.

### **2.8.2. SENSITIVITY STUDIES**

The Plan requires to develop and present a number of sensitivity studies to examine the sensitivity of the reference case plan to variations in key input parameters. The variations to be modelled shall include variations in

- discount rate
- demand forecast
- fuel prices fluctuations

The Plan should present the inputs and results of the sensitivity studies, and compare the key variations against the reference case.

## **2.9. POLICY ANALYSIS AND SCENARIO ANALYSIS**

Prior to commencing policy and scenario analyses, the Transmission Licensee shall communicate with the Commission, the list of such scenarios to be analysed, such that the Commission may comment on such analyses planned.

### **2.9.1. POLICY ANALYSIS**

The Plan shall include analysis of policies required as a consequence of (i) policy guidelines issued by the Commission, or (ii) general policies and strategies required to fulfil the requirements given in the Sri Lanka Electricity Act, the License, or the National Energy Policy, or (iii) specific interventions by which the Transmission Licensee can demonstrate that the resulting plan may be of lower cost than the least-cost reference case.

Examples for policies to be analysed are (a) meeting a specified strategic fuel mix in generation by a given milestone year, (b) meeting a target ratio of non-conventional renewable energy included in the generation mix, (c) interventions to modify the load profiles by such strategies as demand-side management, and (d) interconnections with other countries.

Each policy analysis shall result in a revised generation expansion plan, evaluated using the same economic parameters as those used in developing the reference case.

### **2.9.2. SCENARIO ANALYSIS**

The Plan shall also include analysis of other scenarios, that the Transmission Licensee considers prudent and realistic. Examples of scenarios to be analysed are (a) differential changes in fuel prices, (b) changes in emission standards and other applicable environmental guidelines, and (c) development of pumped storage power plants.

## **2.10. THE RECOMMENDED GENERATION EXPANSION PLAN**

Considering the reference case, the sensitivity analyses, policy analyses and scenario analyses, the Transmission Licensee shall develop a recommended Generation Expansion Plan.

If the recommended generation expansion plan deviates from the least-cost plan developed under conditions stated in section 2.8, the Transmission Licensee shall provide justification on the reasons for the deviation, quantify the economic cost of the deviation, and include proposals on how the Licensee proposes to meet such additional costs.

---

## **2.11. THE PLANNING REPORT**

The Transmission Licensee shall submit to the Commission, a report titled "Least-cost Generation Expansion Plan xxxx to xxxx", which would consist of the following sections:

- (1) Development of the demand forecast
- (2) Performance of the existing generating system
  - including a review of at least the past five years
- (3) Analysis of the hydroelectric generating system
  - including a review of at least the past five years
- (4) Fuel costs and other economic parameters
- (5) Costs and characteristics of candidate power plants
- (6) Development of the reference case (base case expansion plan)
  - analysis of the results
  - investment plan, energy/capacity balance, dispatches
- (7) Sensitivity Studies
- (8) Policy analysis and scenario analysis
- (9) The Recommended Expansion Plan