Interconnection of India-Sri Lanka Electricity Grids

Cross Border Electricity Transmission with HVDC

Executive Exchange

18th- 20th September 2011 Dhaka, Bangladesh

Ceylon Electricity Board
Sri Lanka
SAARC Region
Overview of Energy Sector

- Hydro, Wind, Biomass, Solar - only indigenous resources
- No proven oil, gas or coal resources
- Large hydro resources developed to a great extent
## Electricity Sector of Sri Lanka

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed capacity</td>
<td>2820 MW</td>
</tr>
<tr>
<td>Peak Demand</td>
<td>1963 MW</td>
</tr>
<tr>
<td>Energy Generated</td>
<td>10714 GWh</td>
</tr>
<tr>
<td>Energy Mix</td>
<td>Hydro 42% Thermal 58%</td>
</tr>
<tr>
<td>Demand growth</td>
<td>7-8%</td>
</tr>
<tr>
<td>System losses</td>
<td>13.5%</td>
</tr>
<tr>
<td>Load Factor</td>
<td>62%</td>
</tr>
<tr>
<td>Access to Electricity</td>
<td>88%</td>
</tr>
<tr>
<td>Per Capita Elec. Consumption</td>
<td>450 kWh</td>
</tr>
</tbody>
</table>

Reference year 2010
Capacity of the System

- Hydro: 1185 MW
- Thermal: 1635 MW
  (CEB: 809, IPP: 826)
- Non Conventional Renewable Energy: 220 MW
  (approx Mini hydro 180MW, Bio mass 10MW, wind 30MW)
Hydro Thermal Share

[Graph showing the generation in GWh from 1990 to 2009. The graph compares Self Generation, Thermal Generation, and Hydro Generation.]
Supplying this load curve with the sharp peak is challenging and costly
Structure of the Sri Lankan Power Sector

Government

Ministry of Power & Energy

Ceylon Electricity Board (CEB)
Lanka Electricity Company (LECO)
Lanka Transformers Ltd.
Atomic Energy Authority
Sustainable Energy Authority (SLSEA)

Public Utilities Commission of Sri Lanka (PUCSL)
## Generation Expansion Plan

<table>
<thead>
<tr>
<th>YEAR</th>
<th>RENEWABLE ADDITIONS</th>
<th>THERMAL ADDITIONS</th>
<th>THERMAL RETIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>-</td>
<td>1x315 MW Puttalam Coal (Stage I)</td>
<td>-</td>
</tr>
<tr>
<td>2012</td>
<td>150 MW Upper Kotmale</td>
<td>75 MW Gas Turbine</td>
<td>20 MW ACE Power Matara</td>
</tr>
<tr>
<td>2013</td>
<td>-</td>
<td>24MW Northern Power 35 MW Gas Turbine</td>
<td>20 MW ACE Power Horana 22.5 MW Lakdanavi</td>
</tr>
<tr>
<td>2014</td>
<td>-</td>
<td>2x315 MW Puttalam Coal (Stage II)</td>
<td>85 MW Kelanitissa Gas Turbines</td>
</tr>
<tr>
<td>2015</td>
<td>35 MW Broadlands 120 MW Uma Oya 49 MW Gin Ganga</td>
<td>-</td>
<td>100MW ACE Power Embilipitiya 100 MW Heladanavi 60 MW Colombo Power</td>
</tr>
<tr>
<td>2016</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2017</td>
<td>-</td>
<td>2x250 MW Trinco Coal Power</td>
<td>-</td>
</tr>
<tr>
<td>2018</td>
<td>-</td>
<td>-</td>
<td>51MW Asia Power 20 MW Northern Power</td>
</tr>
<tr>
<td>2019</td>
<td>-</td>
<td>1x250 MW Trinco Coal Power</td>
<td>72 MW Sapugaskanda Diesel</td>
</tr>
<tr>
<td>2020</td>
<td>-</td>
<td>1x250 MW Trinco Coal Power</td>
<td>-</td>
</tr>
</tbody>
</table>
Percentage Share of the Energy Balance

Draft

[Graph showing the percentage share of energy from various sources (Coal, Petroleum, NCRE, Major Hydro) over the years 2011 to 2025.]
Present Transmission Network

- Transmission voltage levels
  - 220kV
  - 132kV

- Transmission Lines
  - 220kV 350 km
  - 132kV 1765 km

- Grid Substations
  - 132/33 kV 43 2793
  - 220/132/33 kV 5 2100
  - 220/132 kV 1 105
  - 132/11kV 4 306
Present Transmission System

The Map of Sri Lanka Transmission System in Year 2011
Sri Lanka needs new generation to meet increasing demand

Power exchange with India be a candidate for meeting future power demand
Benefits and Opportunities

- Meeting growing power demand with imported power
- Improved load profile - valley filling
- Improved system reliability and security
- Access to electricity from cheaper sources of power generation in the South Asia Region
Benefits and Opportunities

• Opportunity to enter into India Power Exchange for energy trading
• Reduction in operational cost through better resource management
• Avoiding hiring of emergency generation
Background

- Under consideration since mid 1970’s
- Pre-feasibility study conducted with the assistance of USAID in 2002 by Nexant Inc.
- Review of the Pre-feasibility study with assistance of USAID in 2006 by Nexant/Power Grid Corporation of India
- Considered under SAARC and BIMSTEC Regional Grid
Background

• Bilateral discussions by Secretary, Ministry of Power and Energy Sri Lanka and Secretary Ministry of Power, India in Dec 2006.

• Cabinet of Ministers approved in principle in Dec 2006, to study the feasibility of power interconnection and to appoint a Steering Committee Co-chaired by Secretaries of Power Ministries and to appoint a Task Force for technical, commercial, regulatory and legal aspects.
Background

• A MOU on Feasibility Study for India- Sri Lanka Electricity Grid Interconnection was signed among GOSL, GOI, CEB and Power Grid Corporation of India Limited (PGCIL) on 9th June 2010.

• Executing Agencies; CEB and PGCIL are jointly carrying out the feasibility study
  1. Portion in the Indian territory - PGCIL
  2. Undersea cable route - PGCIL
  3. Portion in the Sri Lankan territory - CEB
Power Transmission Interconnection options
Interconnection Alternatives proposed in 2002 study

1. Madurai-Anuradhapura Interconnection using HVDC
2. Tuticorin-Puttalam Interconnection using HVDC
3. Madurai-Puttalam Interconnection using HVDC
4. Madurai-Anuradhapura Interconnection using overhead HVAC line with back-to-back DC conversion
Proposed Electricity Grid Interconnection

- Madurai
- Pannaikulam
- Mannar
- New Anuradhapura

Distance:
- Madurai to Pannaikulam: 150 km
- Pannaikulam to Mannar: 127 km
- New Anuradhapura to Mannar: 110 km
Proposed Interconnection Option

± 400kV HVDC line from Madurai to Anuradhapura

• Part-I (Land Route - Indian Territory)
  ➢ Madurai to Indian Sea Coast Pannaikulam HVDC overhead line 150km
  ➢ HVDC Terminal at Madurai

• Part-II (Sea Route)
  ➢ India Sea Coast Pannaikulam to Sri Lankan Sea coast Thirukketiswaram, Mannar HVDC Submarine Cable 127km

• Part-III (Land Route - Sri Lankan Territory)
  ➢ Sri Lankan Sea Coast Mannar to Anuradhapura HVDC overhead line 110km
  ➢ HVDC Terminal at Anuradhapura
Scope of Work

1. System studies for the Interconnection
2. Design Studies and equipment Parameter Finalization
4. Preparation of Bill of Quantities and Cost Estimates
5. Economic and Financial Analysis - Least Cost Planning
6. Funding and Recovery of Investment
7. Legal and Institutional Issues
8. Report Preparation
Detailed Scope of Work

1. System studies
   - Power system studies for the Sri Lankan grid for exchange of 500 MW and 1000 MW power
   - Study alternatives with respect to the configuration of HVDC modules, termination points in both sides of the interconnection
   - Assessing adequacy of the transmission system on Sri Lankan side of the connection
   - Recommend the network configuration and establish the parameters of the Interconnection

In progress - jointly with PGCIL
Detailed Scope of Work

2. Design Studies and equipment Parameter Finalization
   - Substation/terminal station layout - being carried out

   - Survey of transmission line route
   - Selection of site for HVDC station
   - Environment Impact Assessment Studies

Sites for HVDC substations identified near Madurai and Anuradhapura. Landing points identified at Pannaikulam and Mannar. Line routes have been finalized. Both marine environmental survey and oceanographic surveys assigned to National Institute of Oceanography, Goa, India.

CEB and PGCIL have commenced the environmental approval process.

4. Preparation of Bill of Quantities and Cost Estimates – being prepared
5. **Economic and Financial Analysis - Least Cost Planning**
   - Evaluation of economic and financial viability of the interconnection over short term and long term basis, with assessment of economic benefit to India and Sri Lanka.

6. **Funding and Recovery of Investment**
   - Assessment of phased funding requirement as per the implementation cycle
   - Analyze and recommend a suitable tariff mechanism for recovery of the investment as well as payment security mechanism

7. **Legal and Institutional Issues**
   - Identifying legal and institutional issues in respect of exchange of electricity

8. **Report Preparation**
   - Preparation of Feasibility Report are being carried out
Proposed HVDC Interconnection
Options

1. 500MW Mono pole – stage I
   500MW – stage II
2. 2x500MW – Stage I
3. 2x250MW Bi-pole – Stage I
   2x250MW – Stage II

Conventional and VSC
Proposed Interconnection Option

Transmission System in Submarine Cable
Interconnection option
Thank You