

**Comments on the Draft  
Long Term Generation Expansion Plan (2018-2037) of  
the Ceylon Electricity Board**

submitted by

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to the Public Utilities Commission of Sri Lanka

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# CEB Methodology

- Generation cost depends critically on the capital cost and fuel cost
- The capital costs adopted are based on costs estimated during pre-feasibility studies carried out several years ago (p. 4-2).
- Fuel prices are also based on past data; Coal prices from past purchases and LNG prices from a 2014 report based on prices for Japanese imports.

<b>Plant</b>	<b>Plant price USD/kW</b>	<b>Coal price USD/t</b>	<b>LNG Price USD/MBtu</b>	<b>PF %</b>	<b>Unit cost Uscts/kWh</b>
Coal supercritical	1,917	70		80	6.77
NG fired CCGT	1,115		10	80	9.37

# Proposed methodology

- The Plan assumes this price differential to be valid throughout the entire planning period, which is an incorrect assumption.
- Both the capital cost and fuel price are subject to fluctuations, due to various market forces including changes in supply and demand for fuel.
- No one can say exactly what the fuel prices will be in 10 or 20 years' time, or how the coal plant price will change relative to that of LNG plant price.
- The planned schedule of adding coal plants and LNG plants up to 2037 based on just one set of prices determined several years ago, is therefore **highly flawed**.
- When the future generation capacity addition has been identified, quotations should be called separately for plants operating on coal and NG, giving detailed specifications on performance, emissions and environmental requirements.
- The selection of a power plant - whether coal or gas – is best made after comparing prevailing prices, specific generation costs and performance against specifications.

# Legal validity

- In the Amended Electricity Act 31 of 2013, the CEB's Least Cost Generation Expansion Plan has been granted legal status by saying that no person shall procure or operate a new generation plant unless such plant is included in the Licensee's LTGE Plan.
- In Section 43 (8) of the Act, the term "Least Cost Long Term Generation Expansion Plan" has been defined as "a plan .....indicating the future electricity generating capacity determined on the basis of **least economic cost**"
- Economic cost would mean externality costs including damage to health of people, ecology and climate system.
- The CEB Plan, however, **has not included** the cost of externalities saying that "unless country and locations specific study is carried out, it is difficult to estimate the (external) damage cost with **reasonable accuracy**" (p. 7-25).
- Lack of accuracy applies to other parameters including plant cost and fuel cost as well.
- As such, the LTGE Plan has no legal validity as it does not conform to the provisions in the Amended Electricity Act, and hence should be **rejected outright**.

# Cost of externalities

- The damage caused to health of people, ecology and climate system caused by excessive emission of polluting gases into air from thermal power plants is given in a paper “Quantifying the Costs of Air Pollution: the ExternE Project of the EC, R. Friedrich, A. Rabl and J. V. Spadaro”
- [http://www.academia.edu/17480668/Quantifying\\_the\\_Costs\\_of\\_Air\\_Pollution\\_the\\_ExternE\\_Project\\_of\\_the\\_EC](http://www.academia.edu/17480668/Quantifying_the_Costs_of_Air_Pollution_the_ExternE_Project_of_the_EC)
- Costs of damage is expressed in Euros per kg of pollutant gases.
- These costs are valid in all countries within EU irrespective of their GDP per capita which varies by a factor of 2 between countries in the North and South

Pollutant	SO <sub>2</sub>	NO <sub>x</sub>	PM	CO <sub>2</sub>
Damage cost Euro/kg	6.3	9.9	8.9	0.0024

# Cost of damage due to Supercritical Coal Plant

- Emissions from supercritical coal plant (LTGE Plan)

<b>Pollutant</b>	<b>SO<sub>2</sub></b>	<b>NOx</b>	<b>PM</b>	<b>CO<sub>2</sub></b>	<b>Total</b>
Emissions g/kWh	0.34	0.31	0.06	831	
<b>Damage cost Ects/g</b>	<b>0.63</b>	<b>0.99</b>	<b>0.89</b>	<b>0.00024</b>	
<b>Damage cost Ects/kWh</b>	<b>0.21</b>	<b>0.30</b>	<b>0.05</b>	<b>0.21</b>	<b>0.77</b>

- Damage cost converted to UScts by multiplying by 1.11 and adjusted for population density by multiplying by 3.25, ratio of population densities in Europe (100) and Sri Lanka (325).
- The external damage cost for supercritical coal plant for Sri Lanka is UScts/kWh 2.8.

# Cost of damage due to NG fired CCGT plant

- Emissions from NG fired CCGT plant (LTGE Plan)

Pollutant	SO <sub>2</sub>	NOx	PM	CO <sub>2</sub>	Total
Emissions g/kWh	0	0.20	0	367	
Damage cost Ects/g	0.63	0.99	0.89	0.00024	
Damage cost Ects/kWh	0	0.20	0	0.09	0.29

- Damage cost converted to UScts by multiplying by 1.11 and adjusted for population density by multiplying by 3.25, ratio of population densities in Europe (100) and Sri Lanka (325).
- The external damage cost for NG fired CCGT plant for Sri Lanka is UScts/kWh 1.0.

# Data for generation cost estimate

- Levelized Cost of Electricity (LCE) depends on the amortized annual cost of the capital expenditure, fixed and variable operational and maintenance (O&M) expenditure and the fuel cost.
- The O&M expenditure was taken from the CEB LTGE Plan.
- The capital expenditure was based on data collected from the internet on latest contracts awarded for building power plants in Asia.
- For coal price, a range from USD/t 60 to 110 was assumed
- For LNG price, a range from USD/MBtu 6 to 11, based on spot market prices was assumed

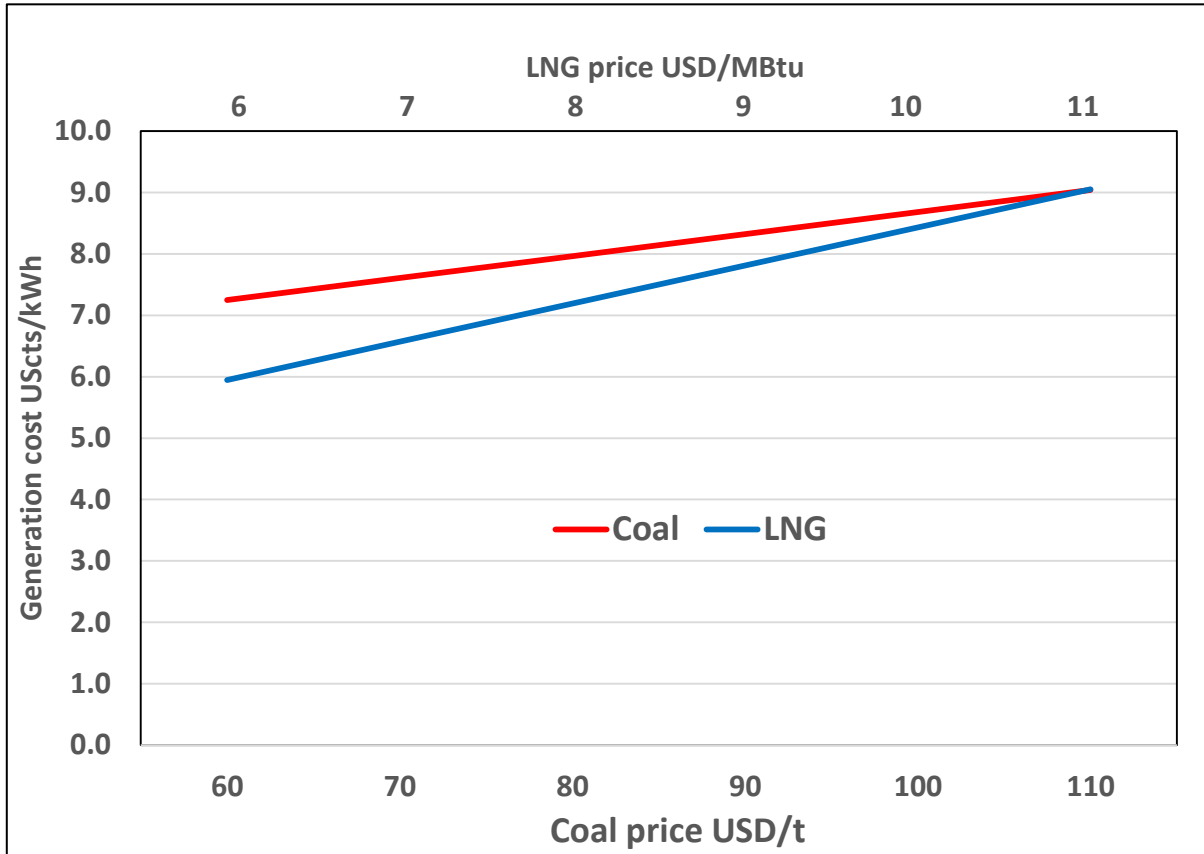


# Levelized cost of electricity

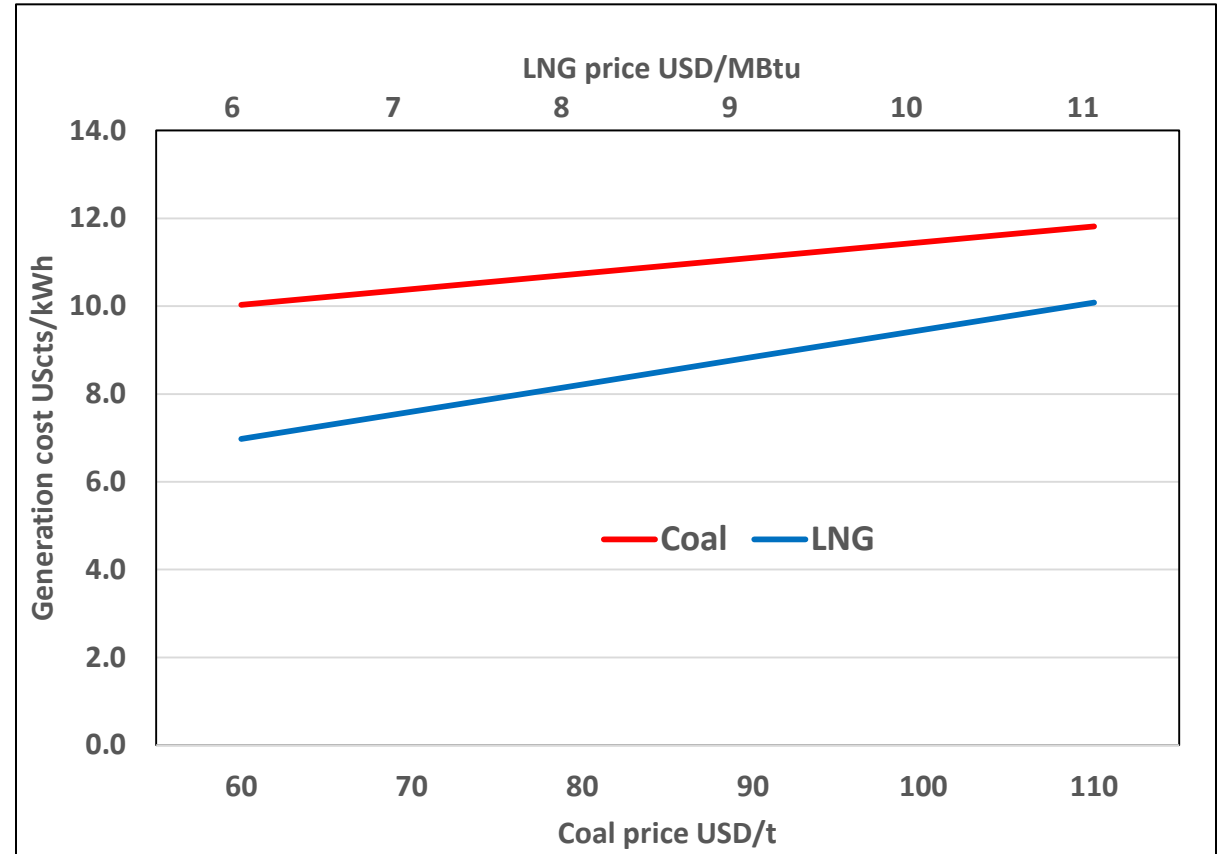
Plant	Capital cost USD/kW	Fuel cost USD/t or USD/MBtu	Fixed & Var. O&M UScts/kWh	Generation cost UScts/kWh	External cost UScts/kWh	Total cost UScts/kWh
Coal-fired Supercritical	2,250 <sup>1</sup>	60 - 110	1.06	7.2 – 9.0	2.8	10.0 – 11.8
NG-fired CCGT	1,000 <sup>2</sup>	6 - 11	0.51	5.9 – 9.1	1.0	7.0 - 10.1

- Reference 1: <http://energy.economictimes.indiatimes.com/news/coal/vietnam-set-to-approve-coal-fired-power-plants-worth-7-5-bln/58850785>
- Reference 2: <https://www.gastopowerjournal.com/item/6559-bangladesh-advances-first-414-mw-power-plant-ppp>

# Levelized cost of electricity with and without externalities



Levelized cost without cost of externalities



Levelized cost with cost of externalities

# Least economic cost option

- With no externalities cost included, cost of generation from natural gas is lower than that from coal depending on the relative prices of the two fuels.
- With the externalities cost included, cost of generation from natural gas is lower than that from coal for all prices of LNG and coal.
- When least **economic** cost is taken into consideration, the least cost option is always natural gas power plants rather than even supercritical coal power plants.
- The scheduling of power plants to meet the future electricity demand should be based on generation costs, plant costs and fuel costs prevailing at the time of calling proposals for the plant and supply of fuel.

# Hydropower development – Upper Kothmale

- It is proposed to divert Pundalu Oya and Pundal Falls tributary and link it with the existing Upper Kothmale system increasing the annual energy generation by 39 GWh (Section 5.3, p. 5.7)
- This option was rejected by the people after extended public hearings when it was included in the original Upper Kothmale Hydropower (UKHP) Project, and hence not prudent to revive it again.
- The present UKHP plant has only a small pond (0.8 Mm<sup>3</sup>) operating only for peaking during evening hours, while water is spilling over St. Clair's water falls during the major part of the day, being one of the conditions for approval of the project.
- A reservoir with high capacity could be built below St. Clair's water falls to collect water falling down St. Clair's and Devon waterfalls without displacing any people.
- Water from this reservoir could be taken to the main shaft of the UKHP to generate electricity during rest of the day which has the potential to add about 500 GWh (according to the CECB proposal submitted during hearings).

# Hydropower development – Uma Oya

- Under the Uma Oya Project, water will be diverted to the Kirindi Oya driving a 122 MW power plant expecting to generate 290 GWh annually (Table 2.1).
- Currently, Uma Oya joins the Rantembe Reservoir, water from which feeds a 49 MW power plant generating 239 GWh annually (Table 2.1).
- In addition, water collected in the Rantembe reservoir after generating power is taken in an open canal for irrigating land to the East of the Mahaweli River.
- When Uma Oya water is diverted to the South, there will be a depletion in both the energy generation of Rantember plant and the amount of water sent for irrigation to the Mahaweli system.
- However, no reference has been made for this depletion in the Plan.
- It may be noted that this project has already caused several adverse social, physical and environmental impacts including damages to many houses, which have not been addressed in the EIA Report.

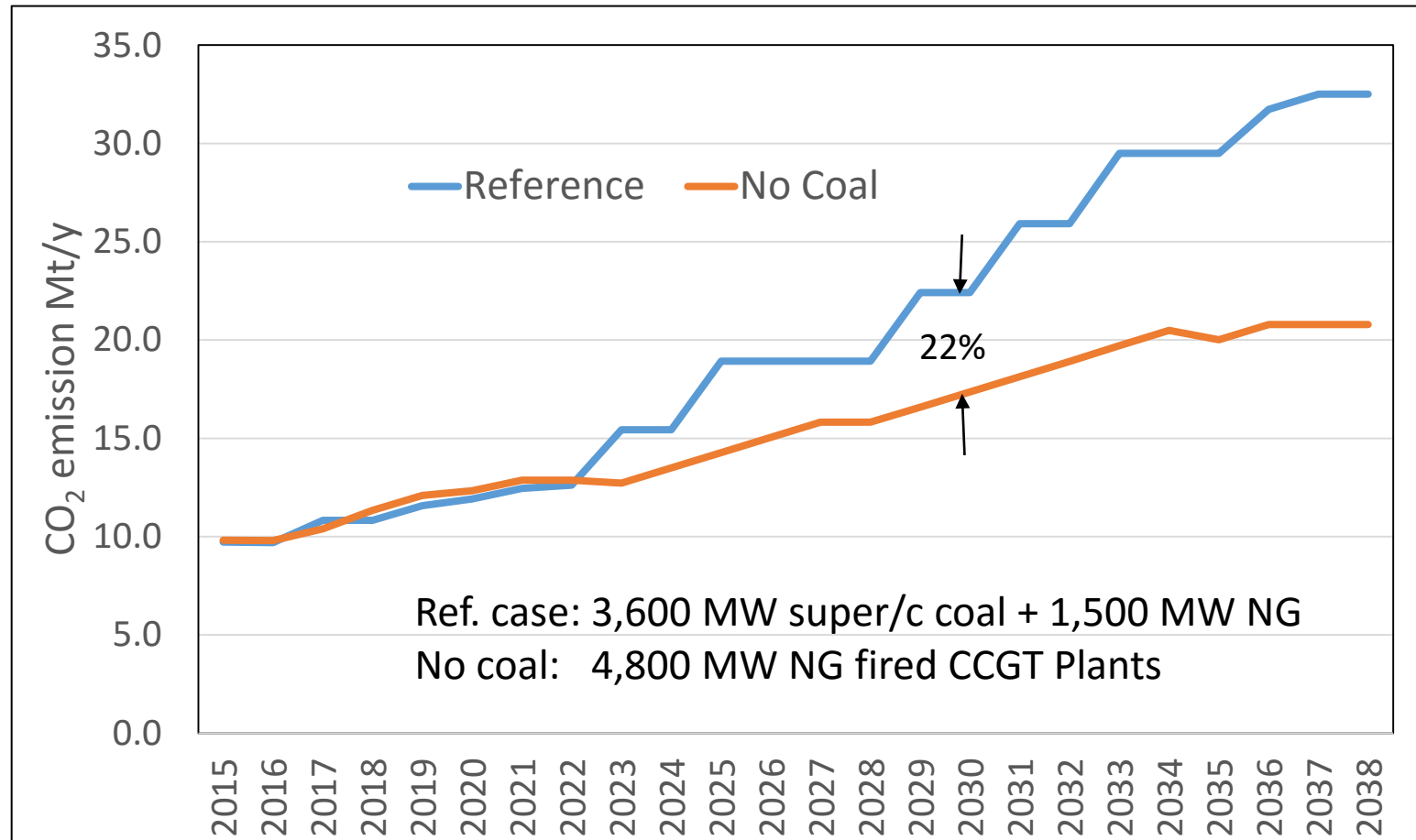
# Nuclear Power development

- In Section on Fuels (Section 4.2, p. 4.7), a 600 MW nuclear power plant has been included in the LTGE Plan as a candidate plant from year 2030 onwards.
- The Ministry of P&RE is initiating a feasibility study assisted by the International Atomic Energy Agency (IAEA) to prepare a feasibility report by the end of 2020.
- According to the LTGE Plan the current generation cost of nuclear plant is estimated to be UScts/kWh 12.94 at 80% plant factor, which is almost double that of coal power plant which is UScts/kWh 6.77 (Table 4.6), and this will not conform to least cost criterion.
- Sri Lanka being a small country with a high population density, a nuclear plant will not be socially acceptable as it involves many risks and with issues relating to disposing of spent fuel, nuclear power has no place in the country's energy mix.

# Nationally determined contributions under Paris Agreement on Climate Change

- Under the Paris Agreement on Climate Change, all Parties to the Agreement are required to declare the extent of greenhouse gases (GHG) emissions each Party will reduce in a specified time frame, both with their own resources (unconditional) and with external funding (conditional).
- Sri Lanka has undertaken 4% unconditional and 16% conditional reduction of GHG emissions by 2030 compared to business-as-usual (reference) scenario.
- Sri Lanka currently plans to achieve the above unconditional target of 4% by introducing several renewable sources into the energy mix.
- If the no-coal scenario given in Annex 7.6 is adopted, it will be possible to reduce carbon dioxide, the principal GHG, by 22% by 2030.
- Sri Lanka will then be eligible to receive funding to achieve this target under the Paris Agreement, which is a win-win situation for Sri Lanka.

# Mitigation of Carbon Dioxide





# Summary

- Present methodology used to determine future generation options based on past prices of plants and fuels showing coal as the least cost option is highly flawed
- When economic costs are considered after adding cost of externalities, generation from LNG is lower than that from coal for all prices of LNG and coal
- Since the LTGE Plan has not considered economic costs which is required under the Electricity (Amendment) Act 31 of 2013, the LTGE Plan has no legal validity
- Instead of proposed Pundal Oya diversion, a better option is to build a reservoir below St. Clair's water falls and divert that water to the main shaft of UKHP project
- No reference has been made for depletion of energy generation from Rantembe and its water accumulation capacity when Uma Oya is diverted to the South
- With high generation costs and risks, studying nuclear option is a futile exercise
- Adopting no-coal option will reduce CO<sub>2</sub> emissions by 22% by 2030, and Sri Lanka could claim funding under the PA to meet any additional incremental costs.

That's all

Thank you