

DEVELOPMENT OF A METHODOLOGY TO DETERMINE THE OPTIMUM SOLAR PV AND WIND MIX FOR ELECTRICITY GENERATION IN SRI LANKA

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ABSTRACT

Adverse climate change impacts have created a global trend in moving towards ecologically sound development activities, especially in the power sector. Carving the path to this target, countries have made various pledges. Sri Lanka (SL) has committed itself to obtain 70% of its electricity requirement from Renewable Energy (RE) sources by 2030. The present RE trends indicate solar and wind (S&W) to be the key contributors in reaching this target. As investment in the power sector are significantly larger than in most other sectors, identifying the optimum mix of S&W is imperative for efficient use of the available financial capital.

Ceylon Electricity Board (CEB), develops the Long Term Generation Expansion Plan (LTGEP) to meet the forecast demand, under least cost criteria. In the planning process, mainly the financial costs are considered. As large-scale S&W plants will be newly added to the system, it becomes necessary to identify salient characteristics of these energy sources. By estimating the cost of certain measures that need to be incorporated to overcome their unfavorable impacts, more realistic cost of S&W can be obtained, in comparison to mere financial cost.

This research develops a model to quantify the economic cost of financial, technical, social and environmental aspects related to S&W, identifying plant factors with reference to candidate power plants in the pipeline. The Renewable Energy Development Master Action Plan (REDMAP) prepared by CEB as an extension to its LTGEP identifies the prospective renewable energy power plants that would fulfil the RE capacity addition envisaged in the plan. In addition to financial cost, (i.e. capital cost, operation and maintenance costs), cost of land, cost of carbon emission, cost of noise impact, cost of overcoming resource intermittency/variability/seasonality are evaluated in economic terms. Accordingly, the optimum mix of S&W for a particular year can be derived, which is well within the S&W total energy requirement specified by the LTGEP, for the 20-year planning horizon.

This research can be benchmarked to do a comprehensive analysis in preparation of the LTGEP in order to obtain the optimized S&W mix, where mixed objective optimization is adhered to, rather than the traditional financial cost minimization.

Keywords: Renewable energy, Electricity generation, Solar-wind optimization

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LIST OF ABBREVIATIONS

Abbreviation	Description
AC	Alternative Current
ADB	Asian Development Bank
BES	Battery Energy Storage
CEB	Ceylon Electricity Board
CoC	Cost of Capital
DC	Direct Current
GHG	Green House Gas
IDC	Interest During Construction
LTGEP	Long Term Generation Expansion Plan
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
O&M	Operational and Maintenance
PV	Photovoltaic
RE	Renewable Energy
REDMAP	Renewable Energy Development Master Action Plan
RERDP	Renewable Energy Resource Development Plan
SAM	System Advisor Model
SEA	Sustainable Energy Authority
SEG	Solar Energy Generation
SER	Solar Energy Requirement
SES	Solar Energy Storage
SL	Sri Lanka
S&W	Solar PV and Wind
WEG	Wind Energy Generation
WER	Wind Energy Requirement
WES	Wind Energy Storage



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