

MAINSTREAMING RENEWABLE ENERGY DEVELOPMENTS INTO TRADITIONAL PLANNING

J.H.K. Kanchana Chathuranga

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Degree of Master of Science in Electrical Engineering

Department of Electrical Engineering

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Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Electrical Engineering

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the Masters Dissertation under my supervision



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ABSTRACT

Electricity is one of the key driving forces of the economy of a country and generation of electricity in an optimal way to meet the increasing demand has become a national priority in the recent years. Due to serious concerns with regard to energy security, global warming, rising costs and depleting reserves of fossil fuels, many countries are now actively seeking to mainstream NCRE power generation in to their generation portfolios as a future energy solution. Since generation planning plays a major role in a country's efforts to mainstream NCRE developments, the Sri Lankan generation planning practices were examined and several methodological changes and models were proposed to successfully integrate and evaluate NCRE resources in the present planning approaches.

The CEB generation planning process was reviewed and associated issues concerning NCRE planning were identified. These issues were first addressed conceptually and the proposed solutions were subsequently applied to the Sri Lankan system to assess their applicability. This thesis provides a new insight into the capacity contribution of NCRE plants and also discusses the constraints to mainstream adoption of NCRE technologies in Sri Lanka along with the present policy and regulatory interventions relating to NCRE developments. The use of peak period capacity factor method was suggested to calculate the capacity credit of NCRE generation and since the associated risks are not explicitly evaluated in the present approaches, the Mean Variance Portfolio Theory is proposed to assess the risks of generation portfolios. Two models were developed to calculate the wind power output from wind measurement data and to evaluate the portfolio risks of generation mixes which can be readily used in the present practices. In addition, methodologies were presented to model a wind power plant in WASP IV and to evaluate the benefits of modeled NCRE plants.

Keywords:

Non-Conventional Renewable Energy

Long Term Generation Planning

Wien Automatic System Planning Package

Capacity Credit

Mean Variance Portfolio Theory

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LIST OF ABBREVIATIONS

AIC	Average Incremental Cost
BOI	Board of Investments
CCGT	Combined Cycle Gas Turbine
CEB	Ceylon Electricity Board
EF	Efficient Frontier
EGEAS	Electric Generation Expansion Analysis System
ELCC	Effective Load Carrying Capability
EMCAS	Electricity Market Complex Adaptive System
ENS	Energy-Not-Served
EPRI	Electric Power Research Institute
EU	European Union
FOR	Forced Outage Rate
IEA	International Energy Agency
LNG	Liquefied Natural Gas
LOI	Letter of Intent
LOLE	Loss of Load Expectation
LOLP	Loss of Load Probability
MIT	Massachusetts Institute of Technology
MVPT	Mean Variance Portfolio Theory
NCRE	Non-Conventional Renewable Energy
NREL	National Renewable Energy Laboratory
O&M	Operation and Maintenance
OECD	Organization for Economic Cooperation and Development
ORNL	Oak Ridge National Laboratory
PUCSL	Public Utilities Commission of Sri Lanka
PV	Present Value
ROR	Run-of-River
RPS	Renewable Portfolio Standard
SLSEA	Sri Lanka Sustainable Energy Authority
SPPA	Standardized Power Purchase Agreements
SYSIM	System SIMulation
TVA	Tennessee Valley Authority
WASP	Wien Automatic System Planning



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