CLEAN ENERGY & REGULATORY INTERVENTIONS FOR GREENHOUSE GAS EMISSION MITIGATION IN THE SRI LANKAN POWER SECTOR

A thesis submitted to the
Department of Electrical Engineering, University of Moratuwa
in partial fulfillment of the requirements for the
Degree of Master of Philosophy

by

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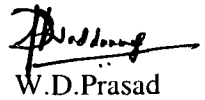
DECLARATION

The work submitted in this thesis is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.



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I endorse the declaration by the candidate.

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Executive Summary

Renewable Portfolio Standard (RPS) is rapidly emerging as a popular mechanism among policy makers to increase the penetration of renewable in the electricity markets, requiring the electricity supply industry to include a minimum level of electricity generation from renewable energy sources. Sri Lankan energy policy has set a target of 10% of grid electricity by 2015 to come from non-conventional energy sources (NCRE). Mini-hydro, biomass including dendro power and wind energy, which have been identified as the three leading, sustainable, non-conventional forms of renewable energy promoted in Sri Lanka for electricity generation to feed into the national grid.

The present installed capacity of grid-connected non-conventional renewable energy based electricity generation in Sri Lanka is around 100 MW and these plants are mainly connected to the primary distribution system. All these plants contribute to the nation's energy requirement generating only a small fraction of total generation amounting to approximately 2.5%. The long-term least-cost power generation expansion plan has given rise to the installation of oil-fired and coal-fired thermal plants to meet the increasing demand. This process does not give adequate consideration to the alternate supply-side options such as those based on NCRE.

The study presented in this thesis first investigates the impact of alternate generation options like NCRE based technologies, clean fuel options and reciprocating diesel engines with small capacities in the Sri Lankan power system considering Traditional Resource Planning based on minimizing total economic cost.

The main intention of this study is to investigate technological and regulatory interventions especially the impact of the RPS of 10% on the least-cost power generation expansion plan of Sri Lanka considering available renewable technologies as supply-side options together with their technical potential and economic feasibility. The study also examines the impact of these interventions on overall power sector emissions and the greenhouse gas emissions (GHG) in particular. The sensitivity of the outcomes of the 10% RPS to different supply side interventions are also presented in the thesis. It has been found that the 10% RPS target by 2015 can be achieved with an additional cost burden of US$ 57.25 million on the government. The results also show that mini-hydropower is the best NCRE based technology which needs minimum financial incentives when achieving the target. Wind power and dendro power require substantial government incentives if they are to play a role in RPS.

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Lastly, the author expresses his deep appreciation towards his family for their encouragement and support. This work is dedicated to his beloved mother.

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ACRONYMS

AIT	-	Asian Institute of Technology
CDM	-	Clean Development Mechanism
CEB	-	Ceylon Electricity Board
CEI	-	Chief Electrical Inspector
ECF	-	Energy Conservation Fund
EIA	-	Energy Information Administration
GHG	-	Greenhouse Gas
GoSL	-	Government of Sri Lanka
IGCC	-	Integrated Gasified Combined Cycle
IPP	-	Independent Power Producer
IRP	-	Integrated Resource Planning
LECO	-	Lanka Electricity Company
LNG	-	Liquefied Natural Gas
LOLP	-	Loss of Load Probability
LoI	-	Letter of Intent
LRAC	-	Long Run Average Cost
LTGEP	-	Long Term Generation Expansion Plan
MoPE	-	Ministry of Power and Energy
NCRE	-	Non Conventional Renewable Energy
NREL	-	National Renewable Energy Laboratory
OTEC	-	Ocean Thermal Energy Conversion
PFBC	-	Pressurized Fluidized Bed Combustion
PUCSL	-	Public Utilities Commission of Sri Lanka
RET	-	Renewable Energy Technologies
RERED	-	Renewable Energy for Rural Economic Development
RPS	-	Renewable Portfolio Standard
R&D	-	Research and Development
TGC	-	Tradable Green Certificate
TRP	-	Traditional Resource Planning
UKHP	-	Upper Kothmale Hydro Power
WASP	-	Wien Automatic System Planning