

**DEVELOPMENT OF A SOLAR PV CAPACITY  
ADDITION PLAN FOR SRI LANKA TO MAXIMIZE  
ECONOMIC BENEFITS**

R.M.M.R Rathnayake

168530T

Degree of Master of Science

Department of Electrical Engineering

University of Moratuwa

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Dissertation submitted in partial fulfilment of the requirements  
for the degree Master of Science in Electrical Engineering

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## **DECLARATION**

I declare that this is my own work and this thesis 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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R.M.M.R Rathnayake

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

Signature of the supervisor:

Date:

Dr. Upuli Jayatunga

Signature of the supervisor:

Date:

Dr. Tilak Siyambalapitiya

## **DEDICATION**

I dedicate this M.Sc research thesis to my beloved parents for their guidance given throughout my life.

## **ACKNOWLEDGEMENT**

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## **ABSTRACT**

Sri Lanka has set various targets to integrate renewable energy-based power plants into the main grid while keeping a stronger focus on solar photovoltaic (PV) and wind power plants. A proper economic justification is not available, specially for targets set on increasing the capacity of solar PV systems.

This research addresses this drawback by quantifying the economic costs and benefits related to electricity generated by solar PV systems under penetration of different solar PV capacities. An optimum capacity which maximizes the net economic benefits was derived as the final output of the research.

Sri Lankan power system at generation level was modelled using a dispatch modelling software (PLEXOS) to obtain displaced fossil fuel and variable operation and maintenance (O&M) costs, by electricity generated by solar PV systems. A spreadsheet-based economic benefits evaluation model was used to calculate the present value of net benefits of the analysed solar PV penetration levels.

*Key words: economic analysis, dispatch modelling, solar electricity, PLEXOS*

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## **LIST OF ABBREVIATIONS**

<b>Abbreviation</b>	<b>Description</b>
\$	United States Dollars
<sup>0</sup> C	degree Celsius
AC	Alternating Current
ADB	Asian Development Bank
bbl	barrel
BCR	Benefits to Costs Ratio
BoS	Balance of System
CEB	Ceylon Electricity Board
EBEM	Economic Benefits Evaluation Model
FiT	Feed in Tariff
GML	Ground Mounted Large
GWh	gigawatt hour
IAEA	International Atomic Energy Agency
IPP	Independent Power Producers
EIRR	Economic Internal Rate of Return
IRR	Internal Rate of Return
kcal	kilo calories
LDC	Load Duration Curve
LECO	Lanka Electricity Company (Private) Limited
LOLP	Loss of Load Probability
LTGEP	Long Term Generation Expansion Plan
m <sup>2</sup>	square meter
MMBtu	Million British Thermal Units
MoPEBD	Ministry of Power, Energy and Business Development
MoPRE	Ministry of Power and Renewable Energy
MT	Metric Ton
MW	megawatt
NCRE	Non Conventional Renewable Energy
NPV	Net Present Value

<b>Abbreviation</b>	<b>Description</b>
NREL	National Renewable Energy Laboratory
O&M	Operation and Maintenance
ORE	Other Renewable Energy
PUCSL	Public Utilities Commission of Sri Lanka
PV	Photovoltaic
RE	Renewable Energy
SAM	System Advisory Model
SCF	Standard Conversion Factor
SERF	Shadow Exchange Rate Factor
SLSEA	Sri Lanka Sustainable Energy Authority
SPP	Small Power Producers
ST	Short Term
STC	Standard Test Condition
SWRF	Shadow Wage Rate Factor
UNDP	United Nations Development Programme
W	watt
WASP	Wien Automatic System Planning package