

A DETAILED ANALYSIS OF CDM POTENTIAL IN THE THERMAL POWER GENERATION SECTOR OF SRI LANKA

A Research Project submitted to the Department of Mechanical Engineering, University of Moratuwa in partial fulfillment of the requirement for the Degree of Master of Engineering in Energy Technology

By

HETTIACHCHI MUDIYANSELAGE BUDDIKA HEMASHANTHA

2004 / 2005

LIBRARY
UNIVERSITY OF MORATUWA, SRI LANKA
MORATUWA

Supervised by:

Prf. R.A. Attalage

Prf. Priyantha D.C. Wijayathunga

Department of Mechanical Engineering
University of Moratuwa
Sri Lanka

621 "08"

620.9(003)

December 2008

107264

University of Moratuwa



107264

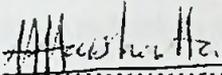
DEDICATION

This Research Report is dedicated to my loved mother, Sunethra, my beloved wife Anuradha and to my daughters Sasini and Isini

DECLARATION

I hereby declare this submission is my own work and that, to the best of my knowledge and behalf, it contains no material previously published or written by another person nor material, which to substantial extent, has been accepted for the award of any other academic qualification of a University or any other Institute of higher learning expect where acknowledgement is made in the text.

H.M. Buddika Hemashantha


.....

Name of the student

Signature

Date : ..28/12/2008.....

Prf. R.A. Attalage

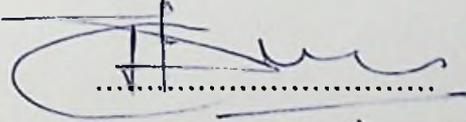

.....

Name of the supervisor

Signature

Date : ..28-12-2008.....

Prf. Priyantha D.C. Wijayathunga


.....

Name of the supervisor

Signature

Date : ..28/12/2008.....

INTRODUCTION

Global warming and climate change represent one of the greatest challenges for today's governments and organizations. The increased concentrations of greenhouse gases (GHGs) in the atmosphere, caused by the human activities in the modern industrialized world, are considered as the main causes. However, to tackle this problem needs the participations of both developed and developing countries.

The Clean Development Mechanism (CDM), created under the Kyoto Protocol, can act as the bridge to link the industrialized countries and developing countries. The CDM intends to assist developing countries achieve sustainable development by providing incentives for industrialized countries to invest cost-efficient GHGs reductions projects in these countries. The developed countries can receive some credits by investing and implementing GHGs emission reductions projects in the developing countries, then use these credits to fulfil their legally binding quantitative obligations laid down in the Kyoto Protocol. Although the Clean Development Mechanism (CDM) does not have an explicit technology transfer mandate, it may contribute to technology transfer by financing emission reduction projects using technologies currently not available in the host countries. Roughly 39% of all CDM projects accounting for 64% of the annual emission reductions claim to involve technology transfer. Technology transfer is more common for larger projects and projects with foreign participants. Technology transfer is very heterogeneous across project types. Technology transfer usually involves both knowledge and equipment with equipment imports accounting for most of the remaining transfer. The technology originates mostly from Japan, Germany, the USA, France, and Great Britain. The rate of technology transfer is significantly higher than average for projects in Ecuador, Honduras, Mexico, Sri Lanka, Thailand and Vietnam and significantly lower than average for projects in India.

ABSTRACT

The objective of this study is to analyse potential technology possibility under the CDM in power generation sector. This study is a theoretical study focused on the survey of the current state of the art of CDM and related issues. The climate and energy policy, the energy market and the status of energy technology in Sri Lanka. The results show that the potential of CDM opportunities in thermal power sector of Sri Lanka, and ten methodological areas are recommended as areas of potential CDM projects origins.

In order to further investigate the opportunities for implementation of CDM in thermal power sector in Sri Lanka and to identify the potential problems, two case studies were conducted. First case study is the construction and operation of 600 MW super critical coal fired grid power plant (CoP: 0.065 USD/kWh). Electricity generated by the project activity will supply to Sri Lanka national grid replacing sub-critical coal power plant what would have been implemented in the absence of the project activity since sub-critical coal power plant (CoP: 0.063 USD/kWh) is more economically attractive than the project activity. The emission reduction of the first case study is 160,000 tCO₂/annum. There are some barriers associated with installation of super-critical coal power plants such as investment barriers (high investment compared to the investment what would have been made to a sub-critical coal power plant), prevailing practice barriers (the project activity is the first super-critical coal power plant in Sri Lanka, there are no super-critical coal power plants implemented at the time of the investment decision) and technological barriers (there are no super-critical coal power plants in Sri Lanka which leads to have lack of skilled labour). Second case study is the construction and operation of new natural gas fired power plant (CoP: 0.263 USD/kWh). Electricity generated by the project activity will supply to Sri Lanka national grid replacing sub-critical coal power plant what would have been implemented in the absence of the project activity since sub-critical coal power plant (CoP: 0.063 USD/kWh) is more economically attractive than the project activity. The emission reduction of the first case study is 82,200 tCO₂/annum. There are some barriers associated with installation of natural gas based power plants such as investment barriers (high investment compared to the investment what would have been made to a sub-critical coal power plant), prevailing practice barriers (the project activity is only one natural gas project in Sri Lanka, which has been developed by the government) and technological barriers (natural gas based power plants are not common in Sri Lanka, which leads to have lack of skilled labour, further there is no proper natural gas pipe line constructed in the country to distribute the natural gas). However there are some barriers to be resolved in order to achieve the CDM status.

It is concluded that Sri Lanka not only can achieve credits to earn some extra revenue, but also can maintain its leading position in international cooperation and competence on the climate change issues, moreover, Sri Lankan expert can involve in international climate change process. Further, the CDM projects can help Sri Lanka to realize sustainable development, while reducing its GHGs emissions, which could be a great contribution in addressing climate change.

Acknowledgments

First of all, I would like to express my gratitude to my supervisors Professor R.A. Attalage and Professor Priyantha D.C. Wijayathunga for useful ideas, guidance and other help during the work with this thesis.

I am very happy to make some friends during my study here. Thank you for all the chats, lunch break, discussions, trips and other activities we shared together.

Last, but not least, I would like to express my heartfelt thanks to Sunethra, my loved mother, Anuradha, my wonderful wife, love and best friend, for your tremendous support, useful suggestion, care, patience and love. I am very proud that I have you with me in my life. Thank you very much for what you have done for me and for our dear daughters, Sasini and Isini.

Table of Contents

Introduction	III
Abstract	IV
Acknowledgement	VI
Annexes	VIII
List of figures	IX
List of table	X
List of Abbreviations, unit conversions	XI
CHAPTER 1: INTRODUCTION	2
1.1 Background	2
1.2 Significance of this work	4
1.3 Scope of this work	5
CHAPTER 2: THE STATUS QUO	7
2.1 Basic data on population of Sri Lanka	7
2.2 Economic development in Sri Lanka	7
2.3 Energy	9
2.3.1 <i>Energy Sources and Supply Situation</i>	9
2.3.2 <i>Indigenous Primary Sources of Energy</i>	9
2.3.3 <i>Electricity Generation</i>	11
2.3.4 <i>Power Generation in the National Grid</i>	12
2.4 CDM Initiative in thermal power plants in the world	
2.4.1 <i>Success stories</i>	16
2.5 CDM initiative in the thermal power plants in Sri Lanka	18
2.5.1 <i>Existing CDM projects from Sri Lanka</i>	19
2.5.2 <i>Sri Lanka Carbon Fund Ltd</i>	20
2.6 Existing CDM methodologies for thermal power plants	17
CHAPTER 3: EXISTING CDM METHODOLOGIES FOR THERMAL POWER PLANTS	
3.1 AMS II B Supply side energy efficiency improvements – generation	23
3.2 AMS III B Switching fossil fuels	24
3.3 AMS III Q Waste Energy Recovery (gas/heat/pressure) Projects	24
3.4 AM0029 Methodology for Grid Connected Electricity Generation Plants using Natural Gas --- Version 3	26
3.5 AM0061 Methodology for rehabilitation and/or energy efficiency improvement in existing power plants --- Version 2	26
3.6 AM0062 Energy efficiency improvements of a power plant through retrofitting turbines --- Version 1.1	27
3.7 ACM0007 Methodology for conversion from single cycle to combined cycle power generation --- Version 3	28
3.8 ACM0011 Consolidated baseline methodology for fuel switching from coal and/or petroleum fuels to natural gas in existing power plants for electricity generation --- Version 2.2	29
3.9 ACM00012 Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects --- Version 3.1	30
3.10 ACM0013 Consolidated baseline and monitoring methodology for new grid connected fossil fuel fired power plants using a less GHG intensive technology --- Version 2	30

CHAPTER 4: ANALYSIS OF CDM POTENTIAL IN THERMAL POWER GENERATION SECTOR IN SRI LANKA	33
4.1 CDM opportunities for thermal power plants and applicable methodologies	33
4.2 Potential barriers in implementing identified opportunities	34
CHAPTER 5: ANALYSIS OF POLICY STATUS ON POWER SECTOR AND CDM	40
5.1 Policy on power generation sector	40
5.2 Policy related to climate change	41
CHAPTER 6: ECONOMIC ANALYSIS FOR IMPLEMENTING CDM PROJECTS IN THERMAL POWER SECTOR	45
6.1 Case Study 1	45
6.2 Case Study 2	
CHAPTER 7: CONCLUSION	52
7.1 Viable CDM projects	52
7.2 Policy for energy and CDM in context of enhancing the CDM opportunities	53
List of references	54

Annexes

List of Annexes

- Annex 1 Input values to the levelized cost comparison of subcritical and supercritical
- Annex 2 Levelised cost of the 600 MW subcritical coal power plant
- Annex 3 Levelised cost of the 600 MW supercritical coal power plant without CER revenue
- Annex 4. Levelised cost of the 600 MW supercritical coal power plant with CER revenue
- Annex 5 Levelised cost of the 600 MW LNG power plant without CER revenue
- Annex 6 Levelised cost of the 600 MW LNG power plant with CER revenue

List of figures

Figure 1 : Marginal Abatement Costs and additional efficiency	4
Figure 2 : Hydro-thermal Share of Electrical Energy in the National Grid	12
Figure 3 : Fuel used for electricity generation	13
Figure 4 : Electricity generation by IPP power plants	14
Figure 5 : Gross electricity generation by CEB power plants	14
Figure 6 : Importance of thermal power in future	15

List of tables

Table 1: Grid connected thermal power plants in Sri Lanka	12
Table 2: Thermal power plants to be connected to the national grid	15
Table 3: Projects at validation stage as of December 2008	16
Table 4: Registered projects	17
Table 5: Existing CDM projects from Sri Lanka as of January 2009	19
Table 6: CDM opportunities for thermal power plants and applicable methodologies	33
Table 7: Specification of the power plants for case study I	45
Table 8: Investment comparison analysis between the project activity and the baseline Scenario	46
Table 9: Sensitivity analysis for case I	46
Table 10: Specification of the power plants for case study 2.	47
Table 11: Investment comparison analysis between the project activity and the baseline scenario.	49
Table 12: Sensitivity analysis for case 2	49
Table 13: Viable CDM projects in Sri Lanka	52

List of abbreviations, unit conversions

Abbreviations

ADB	Asian Development Bank
CDM	Clean Development Mechanism
CEA	Central Environmental Authority
CEB	Ceylon Electricity Board
CER	Certified Emission Reductions
CHP	Combined Heat and Power
COP	Conference of the Parties
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IEA	International Energy Agency
IISD	International Institute for Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
L.A.D.	Lanka Auto Gas
LNG	Liquefied Natural Gas
MACs	Marginal Abatement Costs
OECD	Organization for Economic Co-operation and Development
SAR	Second Assessment Report
SLEMA	Sri Lanka Energy Managers Association
SME	Small and medium enterprise
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WHO	World Health Organization
WTO	World Trade Organization