

C

LB/DON/12/09

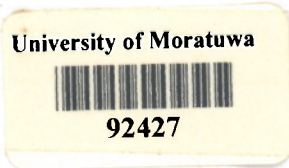
**TECHNICAL PRE-FEASIBILITY FOR
 DEVELOPING A TRANSMISSION SYSTEM
 INTERCONNECTION BETWEEN INDIA AND SRI
 LANKA – A CASE STUDY FOR MADURAI –
 VEYANGODA INTERCONNECTION**

**A dissertation submitted to the Department of Electrical Engineering,
 University of Moratuwa in partial fulfillment of the requirements for
 the degree of Master of Science**



S. W. A. D. N. WICKRAMASINGHE

Supervised by: Prof. J. R. Lucas



**Department of Electrical Engineering
 University of Moratuwa, Sri Lanka**

February 2009

32427

92427
 621.3 "09"
 621.3(043)
 TH

Declaration

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

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

UOM Verified Signature

S.W.A.D.N. Wickramasinghe

Date:13-02-2009.....



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

We/I endorse the declaration by the candidate.

UOM Verified Signature

Prof. J.R. Lucas

Contents

Declaration.....	i
Contents	ii
Abstract.....	iv
Acknowledgement	v
List of Figures.....	vi
List of Tables	vii
List of Tables	vii
List of Annexes.....	viii
1.0 Background and Scope	1
1.1 Introduction.....	1
1.2 Background.....	1
1.3 Objective.....	2
1.4 Methodology.....	2
2.0 Analyzing of the present power systems	3
2.1 Present Indian power system	3
2.2 Present Sri Lankan power system.....	7
2.3 India - Sri Lanka Interconnection	13
3.0 Selecting the most suitable power transmission method	15
3.1 Capacity of the connection	15
3.2 Connection across the Sea	16
3.3 Transmission Technologies	17
3.4 Voltage of the connection.....	25

4.0	Selecting the most suitable location based on load forecast.....	27
4.1	Suitable locations in Sri Lanka.....	27
5.0	Transmission system analysis for the interconnection.....	31
5.1	Assumptions for the analysis.....	32
5.2	Transmission system analysis for the interconnection of 500MW to Veyangoda grid substation.....	33
5.2.1	Normal operating conditions.....	33
5.2.2	Single contingency operating conditions.....	34
5.2.3	Transmission Losses.....	35
5.3	Transmission system analysis for the interconnection of 500MW to New Anuradhapura grid substation.....	35
5.3.1	Normal operating conditions.....	35
5.3.2	Single contingency operating conditions.....	36
5.3.3	Transmission Losses.....	37
5.4	Evaluation of the Results.....	37
5.5	Interconnection Routes.....	39
6.0	Conclusion and Recommendations.....	41
6.1	Conclusion.....	41
6.2	Recommendations.....	43
	References.....	44
	Annexes.....	45

Abstract

To cater to the growing demand of power in Sri Lanka, establishing a power transmission interconnection between India and Sri Lanka has become very important at present. The objective of this study is to do a technically pre-feasibility analysis of such an interconnection with the power system in 2008 and to propose a new interconnection option for the transmission of power.

Capability of the power transmission and the capacity of the link are decided by analyzing the present and future generation capacity in both countries. The locations for the potential terminus points for the interconnection are decided by examining the transmission systems. The most suitable power transmission method is selected by considering the technical and economic aspects. Finally the power transmission system of Sri Lanka is modeled with the selected interconnections and the power flow studies are carried out to analyze the performance of the system and to find the most suitable interconnection.

According to the present and future generation and transmission capacity in both countries there is enough opportunity to justify a transmission interconnection between India and Sri Lanka. The capacity of the link has been decided for 500MW in short term and for 1000MW in medium term. Since there are many advantages of using HVDC over HVAC, HVDC technology has been chosen and for the reliability the bipolar configuration was selected. And the selected voltage was HVDC 400kV. As for the forecasted loads of the grid substations and the locations (nearness to the major load centers) of them Veyangoda grid substation was taken as the terminus point for the power interconnection in Sri Lanka. The decided route for the interconnection is via Mannar.

Transmission system analyses were done for two cases as 500MW connected to Veyangoda and to New Anuradhapura. The observed low voltages at 220kV AC busses in both cases highlighted the requirement of reactive power addition to the system. The results of the studies confirmed that the transmission system around New Anuradhapura is fairly weak compared to the transmission system around Veyangoda. Also the losses of the system were high in New Anuradhapura case. Therefore Veyangoda grid substation was selected as the terminus point of the India – Sri Lanka power interconnection.

Acknowledgement

First and foremost I offer my sincerest gratitude to my supervisor, Professor Rohan Lucas, who has supported me by stimulating suggestions and encouraging throughout my thesis with his patience and knowledge. Also my thanks should go to Dr. J. P. Karunadasa, Head of the Department of Electrical Engineering, and the other members of the academic staff of the Department of Electrical Engineering, for their valuable suggestions and comments.

In addition I would like to thank the officers in Post Graduate Office of the Faculty of Engineering of University of Moratuwa for helping in various ways to clarify the things related to my academic works in time with excellent cooperation and guidance. Sincere gratitude is also extended to the people who serve in the Department of Electrical Engineering office.

Especially I must be thankful very much to my colleagues in the Transmission Planning branch of Ceylon Electricity Board for providing assistance in numerous ways to carry out the studies of the project.

I express my thanks and appreciation to my family for their understanding, motivation and patience. Lastly, but in no sense the least, I am thankful to all colleagues and friends for giving their fullest co-operation throughout the time of research and writing of this thesis.



List of Figures

Figure 3. 1: Cost breakdown for HVAC & HVDC	22
Figure 4. 1: Transmission system of Sri Lanka by 2011	28
Figure 5. 2: Line routes for the Madurai – Veyangoda interconnection	40



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

List of Tables

Table 2. 1: Region-wise installed capacity for different fuel based generation in India..	4
Table 2. 2: Region-wise peak demand in India	4
Table 2. 3: Inter-regional capacity of the transmission lines in India	5
Table 2. 4: The power situation of India from April 2007 to March 2008.....	5
Table 2. 5: Future power supply scenario of India for 2001-12 condition	6
Table 2. 6: Future capacity of interregional links by 2011-12	6
Table 2. 7: The distribution of generation capacity.....	7
Table 2. 8: List of future power plants up to 2015	8
Table 2. 9: Power demand at generation end from 2006 to 2026.....	10
Table 4. 1: Grid Substation Peak Demand Forecast from 2006 to 2015	29
Table 5. 1: Allowable voltage variations.....	31
Table 5. 2: Voltage criteria violations at 132kV & 220kV level for Veyangoda interconnection	33
Table 5. 3: Voltage criteria violations in single contingency for Veyangoda interconnection	34
Table 5. 4: Voltage criteria violations at 132kV & 220kV level for New Anuradhapura interconnection	35
Table 5. 5: Voltage criteria violations in single contingency for New Anuradhapura interconnection	36

List of Annexes

Annex A - 1: Single line diagram of the Sri Lankan transmission system in year 2011 with 500 MW additions to Veyangoda grid substation.	46
Annex A - 2: Load flow diagram for night peak thermal maximum condition – Veyangoda	47
Annex A - 3: Load flow diagram for night peak hydro maximum condition – Veyangoda	48
Annex A - 4: The load flow diagrams for night peak thermal maximum condition with the addition of capacitor banks to the system – Veyangoda.....	49
Annex A - 5: The load flow diagrams for night peak hydro maximum condition with the addition of capacitor banks to the system – Veyangoda.....	50
Annex A - 6: Single line diagram of the Sri Lankan transmission system in year 2011 with 500 MW additions to New Anuradhapura grid substation.....	51
Annex A - 7: Load flow diagram for night peak thermal maximum condition - New Anuradhapura	52
Annex A - 8: Load flow diagram for night peak hydro maximum condition - New Anuradhapura	53
Annex A - 9: The load flow diagrams for night peak thermal maximum condition with the addition of capacitor banks to the system - New Anuradhapura	54
Annex A - 10: The load flow diagrams for night peak hydro maximum condition with the addition of capacitor banks to the system - New Anuradhapura	55