

SUSTAINABLE AND OPTIMUM GENERATION MIX POSSIBILITIES
FOR MALAYSIA POWER SECTOR

AHMAD AMIRUDDIN BIN MOHAMMAD ARTIS

FACULTY OF ELECTRICAL ENGINEERING
UNIVERSITY TEKNOLOGI MARA
MALAYSIA

ACKNOWLEDGEMENT

In the name of Allah S.W.T, the Creator of all mankind and the Most Gracious Most Merciful. Firstly, I would like to express my heartily thankfulness to my final year project supervisor, Dr. Nofri Yenita Dahlan for her guidance and consent in completing this project.

My gratitude goes to my family, especially my mother, my father and not to forget my siblings for their trustiness and supportive action in doing this thesis. My gratitude for their spirit and always support me to achieve the goal of my project. Thank you very much for supporting me from the start till the end of this report.

Last but not least, my great appreciation dedicated to my fellow friends that always give me an endless moral support in completing this report. May Allah bless you all.

ABSTRACT

Malaysia generation mix has been long time dependence on a single fuel. This over-dependency is not a good option for long-term energy sustainability and security. This has led Malaysia to find other alternative resources to generate electricity. Some possible options are firstly using coal, however this leads to the dependency on imported coal and increase CO₂ emission. Secondly by using Nuclear power plant, however the recent Fukushima incident and the public acceptance are the major consideration. Lastly using renewable energy (RE), however the resources are interruptible and expensive. This report proposes a study to determine optimal long-term generation mix for Malaysia using DP-based model at least cost. The model takes into account characteristics associated with different technologies, such as the investment cost, the operation and maintenance (O&M) cost, the lifetime, the construction period, the fuel cost, the carbon emission tax and the nuclear waste fee. The 5-fold key points that will shape Malaysia generation mix i.e. availability and price of natural gas, cost and availability of nuclear, environment policy and energy security are also considered in the model. The proposed model has been tested on a generation portfolio based on Malaysia power system. Result shows that optimal generation mix for Malaysia in 2030 will be 40% is from coal, 38% from gas, 11% from RE, 5% from hydro, 5% from nuclear and 1% from oil. Sensitivity analysis shows that increasing the RE target capacity and introducing carbon tax affect the development of coal in the generation mix. On the other hand, increasing the gas price reduce the percentage of gas power plant and encourage the development of nuclear plant.

Table of Contents

DECLARATION	ii
ACKNOWLEDGEMENT	iv
ABSTRACT.....	v
List of Figures.....	viii
List of Tables	ix
List of Abbreviation.....	x
CHAPTER 1 INTRODUCTION	1
1.1 Introduction.....	1
1.2 Background of Study	2
1.3 Problem Statement.....	3
1.4 Objective of Study	3
1.5 Scope of Study	4
1.6 Thesis Outline	5
CHAPTER 2 LITERITURE REVIEW.....	6
2.1 Introduction.....	6
2.2 History of Generation Mix in Malaysia.....	7
2.3 Fuels Management Policies.	9
2.2.1 National Energy Policy	10
2.2.2 National Depletion Policy.....	11
2.2.3 Four Fuel Diversification Policy.....	11
2.2.4 Fifth Fuel Diversification Policy.....	11
2.4 International Bidding Process by EC	12
2.5 Fuel option for generation in Malaysia.....	13
2.6 Determines the Optimum Generation Mix.....	15
2.7 Dynamic Programming (DP) Least cost model.	16
2.8 Two-phase K-best DP trade off method	17
2.9 General Algebraic Modeling system (GAMS)	18
CHAPTER 3 METHODOLOGY	19
3.1 Introduction.....	19

3.2	DP-Based Generation Mix Model.....	20
3.3	DP-Based Least Cost Generation Mix Model formulation.....	22
3.4	Economic dispatch.....	24
3.5	Test Data.....	26
CHAPTER 4 RESULT		30
4.1	Introduction.....	30
4.2	Base Case.....	30
4.3	Sensitivity to the Development of RE.....	32
4.4	Sensitivity to CO ₂ tax.....	34
4.5	Sensitivity to Gas Price.....	34
CHAPTER 5 CONCLUSION AND RECOMMENDATION.....		36
REFERENCES		37