

**DEVELOPMENT TRANSMISSION USE OF SYSTEM CHARGES SCHEME
FOR MALAYSIA TRANSMISSION NETWORK**

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To my dearest mother, father and family for their encouragement and blessing
To my beloved classmate for their support and caring

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ABSTRACT

Presently, the trend of electricity industry is towards restructuring of electricity supply industry, as a means to increase operation efficiency and lower energy costs. Restructuring environment is referring to unbundling of electricity utilities into its basic component such as generation, transmission and distribution. One of the outstanding issues in unbundling of electricity supply industry is transmission service pricing. This project is focus on the development transmission use of system charges scheme for Malaysia transmission network in restructuring environment. This project required to identify the costs of transmission services provided by the transmission utility and evaluating the transmission assets. The several alternatives of the allocation methods that can be used to evaluate the usage of transmission services have been studied. From this study, a suitable usage allocation method is identified. This project also involved study the transmission pricing methodologies. As the result, the transmission access pricing for Malaysia transmission will classify. The transmission access pricing must be non discrimination, transparent, economically, efficiency and allow full recovery of costs. Finally, the transmission service charge percentage is allocated between customers and generators. The developed scheme is tested on the bus systems and the TNB system to evaluate its effectiveness providing a fair transmission charges to the users.

ABSTRAK

Pada masa kini, corak pembekalan elektrik sedang menuju kearah proses penstrukturan semula, iaitu sebagai satu cara meningkatkan kecekapan operasi dan merendahkan kos tenaga. Penstrukturan semula merujuk kepada pembahagian perkhidmatan kepada penjanaan, penghantaran dan pengagihan. Salah satu isu utama di dalam penstrukturan semula industri pembekalan elektrik ialah caj perkhidmatan penghantaran. Projek ini memfokuskan kepada pembangunan skim caj penggunaan sistem penghantaran elektrik di dalam persekitaran penstrukturan semula. Projek ini memerlukan pengenalpastian kos-kos yang berkaitan dalam sistem penghantaran dan juga dikehendaki menilai aset sistem penghantaran elektrik. Beberapa kaedah penetapan penggunaan dikaji bagi mengenalpasti kaedah yang paling sesuai digunakan untuk skim ini. Beberapa kaedah penentuan harga dikaji bagi mengenalpasti kaedah yang paling adil, tulus, efektif dan dapat merangkumi sepenuhnya kos-kos di dalam sistem penghantaran. Di peringkat akhir, peratusan caj yang dibayar oleh pihak penjanaan dan pihak pengagihan akan ditentukan. Skim yang dibangunkan diuji di dalam beberapa sistem bus dan juga sistem bus TNB bagi menilai keberkesanannya didalam menyediakan caj perkhidmatan yang adil kepada pengguna.

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LIST OF SYMBOLS

SYMBOL	DESCRIPTION
$\alpha_i^{(u)}$	- Set of buses supplying directly bus i
$A(i-j, b)$	- A factor for line i-j with respect to bus injection b
A_u	- (n x n) distribution matrix
B	- Susceptance matrix
C_{ij}	- Contribution of generator I to common j
F_{ik}	- Flow on the link between commons j
F_{i-j}	- Base case power flow on line i-j
F_{ijk}	- Flow between common j and k due to generator i
G_g	- Base generation at bus g
I_k	- Inflow of common k
L_g	- Total load at bus g
L_i	- Length of circuit i
N	- Total number of circuits in the system
P_{Gi}	- Generation in bus i
P_i	- Capacity rating of circuit i
P_i^k	- Power flow imposed on the circuit i by the user k
P_{Li}	- Total load at each bus
X_{ij}	- Reactance at line i-j

LIST OF ABBREVIATIONS

AC	-	Alternating Current
AIV	-	Annuity Investment Value
CAPEX	-	Capital Expenditure
DC	-	Direct Current
DCLF	-	Direct Current Load Flow
ESBNG	-	ESB National Grid
GSDF	-	Generalized Displacement Distribution Factors
GGDF	-	Generalized Generation Distribution Factors
GLDF	-	Generalized Load Distribution Factors
ICRP	-	Investment Cost Related Pricing
IEEE	-	Institute of Electrical and Electronic Engineering
LRIC	-	Long Run Incremental Costs
LRMC	-	Long Run Marginal Costs
MW	-	Mega Watt
MWkm	-	Mega Watt Kilometer
NGC	-	National Grid Company
ROI	-	Rate of Investment
ROR	-	Rate of Return
SRIC	-	Short Run Incremental Costs
SRMC	-	Short Run Marginal Costs
TNB	-	Tenaga Nasional Berhad
TuoS	-	Transmission Use of System
UK	-	United Kingdom
OPEX	-	Operating Expenditure

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CHAPTER 1

PROJECT OVERVIEW

1.1 Introduction

The current scenario in Worldwide Electrical Supplies Industry is towards unbundling and deregulation of the services. The new scheme established free access to the transmission lines and boosting competition among generator and customer. In this environment, the transmission network is considered to be key factor of the electricity markets. Transmission plays a vital role as separate business of transmitting energy from generator to the load. In addition, it maintaining the system integrity with all transaction treated in an equal and non discrimination. The problem is how to allocate the total cost of all the users in an equitable way. One of the outstanding issues in unbundling of electricity supply industry is transmission service pricing. This project focuses on charging the use of transmission system. It is a scheme that determines who “uses” a given line and identifies how to charge among to charge the user based on the usage of the transmission line.

1.2 Objective and scope

The thesis work is mainly to develop the transmission use charge scheme for Malaysia transmission network under deregulated environment.

It involves the following tasks:

- Evaluate and estimate the asset of transmission networks for costing the transmission services.
- Identify the suitable usage allocation method for evaluating the contributions of individual transmission user to the line flows.
- Determine the suitable pricing methodology which can generate an appropriate amount of transmission revenue and provides efficient economic signal to the user.
- Establish the transmission allocation charge percentage among the users.

1.3 Research Methodology

The research work is undertaken in the following five developmental stages:

- 1) Identifying of costs of transmission services provided by the transmission utility and evaluating the transmissions assets.
- 2) Study several alternatives of the allocation methods that can be used to evaluate the usage of transmission services. The comparison between allocation methods is made for identified the most suitable methods that can be used in proposed scheme.
- 3) Study the transmission methodologies that can recover the transmission utility costs, transparent, provides efficient economic signal to the user and non discrimination.
- 4) Identified the suitable percentage between generators and customers for allocating the transmission service charges in the context of Malaysian electricity supply structure.
- 5) The developed scheme is tested on bus systems which are 6 bus system, IEEE bus system and TNB bus system for analyzing the effectiveness and drawback of the scheme. The MATLAB programming is used for this analysis to compute the entire calculation base on the method used.

1.4 Thesis Outline

This thesis has been divided into nine chapters. This chapter briefs the overview of this thesis. Then, the chapter two discusses the background of deregulated power system in detail. Chapter three reviews the existing Transmission Use of System Charge in National Grid, Republic Ireland and Chile Transmission System. Meanwhile, chapter four describes the asset of transmission network. Transmission Usage Allocation method was discussed in chapter five and the Pricing Methodology was discussed in chapter six. Chapter seven explains the transmission allocation charge percentage among the generation companies and customer loads. Chapter eight discusses the implementing MATLAB programming in this project. Chapter nine analyses the simulation result of the proposed scheme. Chapter ten gives the conclusion of the project and suggestion for future work. Finally, the references and appendices are attached in the end of the thesis.