

**UNIVERSITI TEKNOLOGI MARA**

**DEVELOPMENT OF UPSTREAM  
MARKET MODELS FOR MALAYSIA  
ELECTRICITY SUPPLY INDUSTRY  
USING SYSTEM DYNAMICS APPROACH**

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## ABSTRACT

The Malaysia Electricity Supply Industry (MESI) has become increasingly dynamic and sophisticated after the privatisation of Tenaga Nasional Berhad (TNB). In light of the government's efforts to reform MESI, a comprehensive model of the Malaysian generation market is necessary to evaluate the cause and effect of the reformation of the base electricity tariff in Malaysia. A generation market model – also called as upstream market model; can provide an overview of the industry and assist the government and power utilities in planning the future of the MESI. Three research objectives are being pursued in conjunction with this study. First, using the System Dynamics approach to develop an upstream market model of MESI as an evaluation tool for MESI. In general, energy market modelling is recognised as a dynamic and complex system; thus, System Dynamics is extensively used in this work as a planning and evaluation tool for the electricity market model. The first model, often known as the base case model, is an evaluation tool developed utilising Malaysia's current market model – the Single Buyer (SB) market framework. In this approach, a government-backed central body is in responsible of purchasing electricity from TNB Generation and independent power producers (IPPs), typically via term contracts. The second objective is to formulate two new models, the hybrid market model and the open market model, which incorporate wholesale market trading. These models are created with the goal of analysing market models that may be suitable for MESI as part of their market reformation planning. The hybrid market model incorporates two market frameworks – the SB market and the wholesale trading market – making it a model of a somewhat competitive market because it includes merchant generators who participate in the trading market as well as existing generators who are bound by the Power Purchase Agreement (PPA). Meanwhile, the open market, the model is built around the concept of a completely competitive market. In this market model, the participating generators will compete to sell their electricity based on their net present value (NPV). The study is then followed by the third objective, which is to build market models that incorporate the policy and incentives provided to RE generators, in line with Malaysia's spectacular expansion of renewable energy (RE), particularly after MESI began to gradually integrate RE into its system. The expansion of RE generation has been thoroughly evaluated in their most recent report on generating development plans in order to address coal supply challenges and fuel price hikes. To examine the impact of the RE policy and incentive deployment on the MESI base electricity pricing, the carbon tax (CT) and the investment tax allowance (ITA) have been adopted. The findings show that the three market models react differently to change. Because the base electricity rate is the main outcome examined in this study, the hybrid market model delivers the highest tariff of the three models. Nonetheless, despite its origins as a fully wholesale market, the open market model offers a lower base tariff than the hybrid market. Meanwhile, the incorporation of CT and ITA into MESI models demonstrates that it has an impact not just on the base tariff, but also on the system's generating mix.

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# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of Research

In the worldwide electricity supply industry, it is crucial to provide power in a dependable and economical manner. Generation, transmission, and distribution were viewed as natural monopolies for more than a century. It is also vertically integrated within a utility and may be investor-owned and state-regulated or government-owned. In the early 1980s, several economists contended that due to the monopoly structure of electric utilities, the incentive to run effectively and to avoid unnecessary spending had been eliminated [1]. In addition, the disagreement continues with the issue of the expense passed on to customers as a result of the error made by private utilities. Due to the numerous problems of the monopoly market, practically every energy supply business in the world is now expanding and reorganising its market into a competitive environment. The shift toward competition in the electricity industry has pushed researchers to develop decision and analysis support models that are adaptable to a fluctuating market environment. Countries have reformed their utility industries in recent years in an effort to foster private ownership and competition. Privatisation and regulatory reform have been acknowledged as solutions to the problem of poor performance by formerly state-owned incumbents, as well as a means of attaining improved services and lower rates [2].

The history of the power supply industry in Malaysia was reflective of the situation of the electricity industry at the time. The first private business to generate power at its own expense was established in 1984. Historically, the Central Electricity Board (CEB) was founded in 1949 and renamed the Lembaga Letrik Nasional (LLN) in 1965. LLN has been corporatized in an effort to improve efficiency and reduce the financial load on the government. In September 1990, however, LLN was privatised under its new name, Tenaga Nasional Berhad (TNB). Government now owns TNB in its entirety as a private corporation. TNB's key operations include of energy generation, transmission, and distribution. tw, the government conducted an immediate assessment of the nation's power generation industry, introducing Independent Power Producers (IPPs) to all private companies that intended to participate in the generation