

A Market Framework for Energy Bidding Decision-Making Strategy to provide a Competitive Mechanism in the Context of Deregulated Electricity Market

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Abstract—In the modern power grid operation, the regulatory goal of the market is to provide continuous electricity supply to the customers with reasonable energy prices. The current structure of energy market in Malaysia follows the single buyer market model, where the generation is procured solely by a single utility with a limited competition, which is not effective in lowering the electricity prices. This paper proposes a market framework for competitive strategies to achieve maximum benefits of the power grid in Sarawak, Malaysia while the optimal bidding in the day-ahead market is assessed. Game theory with the non-cooperative scheme is applied for the electricity market comprising various participants. The performance of the proposed approach is evaluated using a practical power grid with data of the electricity market obtained from available sources. The feasibility of electricity market deregulation in Sarawak is proven to be effective, as the proposed framework can provide insight into the generated revenue of energy producers in a fair and competitive market environment.

Keywords—*electricity market, bidding optimization, energy monopolies, restructuring of power industry*

I. INTRODUCTION

The electricity industry in many countries has shifted from a monopolized market to a deregulated market. Chile is regarded as the first country to introduce major restructuring in the country's electricity market in 1982. In the late 1980s, England and Wales followed suit with a massive privatization scheme, and some power plants started to be privatized from 1990 to 1991. The electricity market was based on the idea of energy as a commodity, and thus as stated by some economists, the monopoly of any electric utility or power generation company removed the initiative of efficient operation that resulted in higher electricity prices. The advantage of a deregulated electricity market is that the market becomes more competitive, abuse of market power will be reduced, lower and more stable electricity prices will be established as it would be closer to the marginal cost [1], [2], [3]. A typical electricity market consists of generation, transmission and distribution, and wholesale. The wholesale market usually exists as electricity pools or bilateral transactions. In a deregulated electricity market, the day-ahead market is operated by considering hourly bids and the amount of generation by individual generation companies (GC). The hourly generation and dispatch schedules are obtained from the GC bids.

Customers submit offers to buy electricity, specifying the quantity and price. The market clearing price (MCP) is obtained from the point of intersection between the supply and demand curves. GC receive payment based on MCP for each MW and customers bidding to buy power and pay according to the MCP, irrespective of the bids and offers submitted. No matter what the structure of electricity market is, the ultimate goal for GC is to maximize profit and minimize risk; and for customers, it is to minimize electricity costs and achieve maximum savings [3], [4]. In the deregulated power grid, the dynamic pricing structures should realize the actual value of demand flexibility which has to be a part of electricity market integration [5].

Malaysia's electricity consumption per capita is showing a declining trend. Hence, it is crucial to create an affordable electricity market and decrease the number of people without access to electricity [6]. In Malaysia, consumers are only served by a single utility which is Tenaga Nasional Berhad (TNB) in Peninsular Malaysia, Sarawak Energy Berhad in Sarawak, and Sabah Electricity Sdn. Bhd. in Sabah. Other than the implementation of a single buyer model which introduces some competition in the generating sector, the rest of the electricity supply structure remains monopolized. The demand for electricity in Peninsular Malaysia is expected to increase by 1.62% each year from 2016 to 2035 [7]. Accordingly, the cost of generation increases as demand increases because generators with higher operating costs are still utilized to fulfil the energy demand. Hence, it is unlikely for electricity prices to decrease unless power suppliers operate efficiently with the help of government to support the deregulation of electricity market. After the major blackout occurred in Peninsular Malaysia in 1992, the government introduced independent power producers (IPP) to the generation sector. In 1993, five companies were contracted to supply 30% of the electricity demand. A Single buyer or monopsony is a situation where there is only one buyer. Here, the single buyer is responsible for energy procurement and scheduling generation dispatch while the system operator is responsible for grid system operation and real-time dispatch. The ring-fencing of single buyer involves maintaining a separate account as well as separate operation to avoid conflict of interest or favoritism since it is still a part of TNB. The purpose of ring-fenced single buyer is to ensure transparency. The first phase of the new enhanced dispatch arrangement (NEDA) was implemented on 1st