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A proposal for annual power fee in Thailand based on electricity tracing methodology

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Abstract

It is envisaged that by 2003 electrical energy in Thailand will be freely traded under the new electricity supply industry (ESI) structure. The transmission use of system charge will be based on the short run marginal cost (SRMC). The well-known issue with the SRMC is its inability to recover the embedded cost of the transmission system. To recover such cost, the Electricity Generating Authority of Thailand (EGAT) proposed an annual power fee based on the proportion of generation and demand in each zone. As such fee gives a crude signal towards investment in a particular zone, in this paper application of the electricity tracing methodology has been investigated. Tracing-based fee can be seen as a refinement of the crude fee based on the proportion of zonal generation and demand as it takes into account how the zonal imbalance of generation and demand loads up transmission facilities in other zones. In addition, the paper provides an alternative combined zonal and nodal annual power fee where the nodal component of the annual power fee provides an additional signal towards a balanced location of generation and demand within a zone. Analysis of the results for Thai system has confirmed that the proposed methodology provides intended signals.

Keywords: Thailand; Electricity tracing methodology; Short run marginal cost

1. Introduction

At present, the Thai Electricity Supply Industry (ESI) structure is vertically integrated. The Electricity Generating Authority of Thailand (EGAT) owns and operates transmission facilities and most of the generation. The Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA) are accountable for distribution. EGAT, MEA, and PEA are government owned. This type of structure lacks the competition, which eventually may result in over-investments and inefficiencies in operation. To create a competitive environment in Thai ESI, the National Energy Policy Office (NEPO) of Thailand has decided to restructure the ESI following a commonly adopted scheme of separating generation, transmission, and distribution sectors. The competition in generation sector should eventually improve the efficiency in procuring electricity to meet the demand with better services, fair price, and acceptable reliability. The transmission system, run by a monopolistic transmission company subjected to regulation, will be treated as a common carrier that ensures fair competition in generation. The distribution companies are to be free to look for economically efficient contracts with generators [1].

Once the power pool is fully operational, nodal energy prices will be based on locational marginal pricing (LMP) [2]. The merchandise surplus left over after charging all the consumers, and paying all the generators, at nodal marginal prices will be passed on to the transmission company to pay for the cost of transmission. The well-known problem with the short run marginal pricing is its inability to recover the embedded cost of the transmission system [3]. To solve this problem, EGAT is expected to implement a

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supplementary charge, the annual power fee, that will be used to recover the embedded cost and which will be imposed on both generators and consumers. As currently proposed, the fee will be simply based on the proportion of generation and demand in each zone. As a result, the annual power fee will be high for generators, and low for consumers, in a zone where generation exceeds demand. And conversely, the fee will be low for generators, and high for consumers, in a zone where demand exceeds generation. Although such fee would provide a locational signal signaling investment opportunity in a given zone, the simple proportional rule is quite crude and it may not send sufficient signals. In particular, the rule does not reflect the effect the generation/demand imbalance in a particular zone has on other zones in the system.

In this paper, application of the electricity tracing method [4,5], which allows to evaluate the usage of the system by a user, is investigated. Tracing-based fee can be seen as a refinement of the crude fee based on the proportion of zonal generation and demand as it takes into account how the zonal imbalance of generation and demand loads up transmission facilities in other zones. The paper describes implementation of the zonal annual power fee as originally envisaged by EGAT, and compares it with the tracing-based fee. The paper also provides an alternative combined zonal and nodal annual power fee for consumers based on electricity tracing. The aim of that fee is to refine the zonal signal by providing an additional pricing signal for optimal consumer location within a zone.

2. Overview of EGAT system

As of early 2001, EGAT system had total generating capacity of approximately 22 000 MW, out of which about 77% was owned by EGAT whereas another 23% were owned by independent power producers (IPP), small power producers (SPP), and imports. EGAT's generating capacities consist of 16.5% hydropower, 45.5% thermal power, 34.3% combine cycle, 3.7% gas turbine, and 0.03% diesel. The EGAT system is geographically divided into five zones, MCC, R1, R2, R3, and R4, shown in Fig. 1. MCC covers the capital city, Bangkok, and its vicinity. R1, R2, R3, and R4 cover central, northeastern, southern, and northern part of Thailand, respectively. The EGAT system is composed of 255 buses that are crisscrossed with a network of 1920 circuit-km of 500 kV transmission lines (in MCC, R1, and R4 only), 10 430 circuit-km of 230 kV, 13 360 circuit-km of 115 kV, 50 circuit-km of 69 kV (in R1 only), and 10 circuit-km of 132 kV (in R3 only). The total transformer capacities in each zone are 16 700 MVA (MCC), 17 600 MVA (R1), 6500 MVA (R2), 4400 MVA (R3), and 8200 MVA (R4). Fig. 1 shows the interzonal connections and the number of substations in the zones. The arrows indicate the tie-lines and the direction of the flows during the on-peak periods.

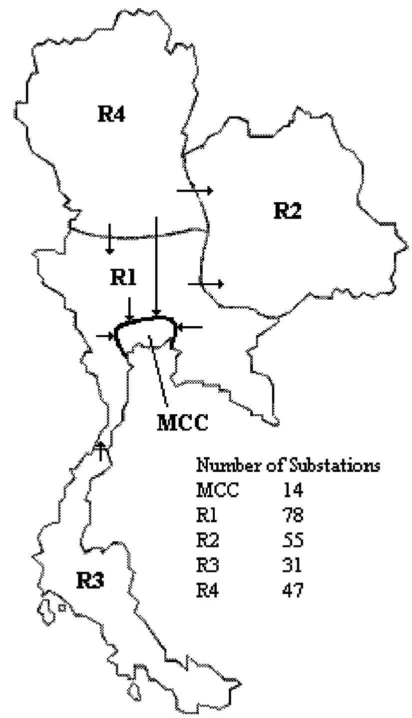

Fig. 1. Regional division of EGAT system.

3. Transmission pricing under nodal pricing framework

According to the Thai market rule after the power pool has been fully introduced [6], LMP will be used to determine nodal energy prices. Power pool will calculate the nodal prices for a trading interval in the day-ahead market and for a dispatch time interval in the real-time market at a given node i using the following formula:

$$\gamma_i = \lambda^{\mathrm{R}} + \gamma_i^{\mathrm{L}} + \gamma_i^{\mathrm{C}}, \tag{1}$$

where γ_i (Baht/MW h) is the nodal price at node i, λ^{R} (Baht/MW h) is the marginal generation cost based on valid demand bids and supply offers, γ_i^{L} (Baht/MW h) is the marginal loss component of the nodal price at node i, and γ_i^{C} (Baht/MW h) is the congestion component of the nodal price at node i. The marginal loss component, γ_i^{L}, of the nodal price at any node i is defined as:

$$\gamma_i^{\mathrm{L}} = (\mathrm{WF}_i - 1)\lambda^{\mathrm{R}}, \tag{2}$$

where WF_i, is the net injection factor at node i that is:

$$WF_i = 1 - \frac{\partial L}{\partial P_i}, \tag{3}$$

where L is the total transmission loss, P_i is the net amount of energy injected at node i and balanced by the