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Key Policies in the Thai Power Sector: Integration and Competition

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Abstract

This paper discusses the issues of horizontal integration, vertical integration and competition in the Thai power sector. Given the integration structure of the Thai power sector, competition that results in some unbundling of the assets in the power sector raises an interesting question of whether the anticipated gains from competition outweighs the losses in cost savings from the integration structure. This paper argues that competition in the Thai power sector resulted in increases in costs of the power supply due to the nature of the power purchase agreement and suggests alternative policy options to reduce the costs of the power supply.

Keywords: Horizontal and vertical integration; power sector; competition; independent power producers; system operator; purchase power agreement.

JEL Classification: L94, L98

1. Introduction

Electricity was introduced to the city of Bangkok in 1884 when two power generators were purchased to light up the Chakrimahaprasart Hall (EGAT, 2013). Since then, the power sector has expanded steadily to provide a sufficient and continuous supply of electricity for the country. The reserve margin of the generation system ranges from 18 percent to 32 percent with an average of approximately 25 percent during the period 2002 through 2015 (NEPO, 2015).

This paper aims to evaluate the key policies behind the development of the power sector in Thailand and to suggest future options for this sector. The key policies addressed in this paper are limited to the policies that affect the organization structure and the nature of competition in the power sector. The paper is organized into 6 sections. The next section reviews the development history of the power sector in Thailand. Section 3 identifies the key issues that affect the development patterns of the power sector. The theoretical framework required to evaluate the relevant policies in the power sector is developed in Section 4 and the policy evaluations are presented in Section 5. The summary, conclusions, and recommendations are then presented in Section 6.

2. Development of the Electricity Sector

Following the introduction of electricity in 1884, a market for electricity began to emerge and expanded steadily into one of the largest energy sector in Thailand. This section reviews the development patterns of the power sector since 1884. The review focuses on the evolutions of the roles of the private sector and the government as the providers of electricity, and the organization structure of the power sector.

2.1 Early Roles of Electricity Providers

The first market supply of electricity was provided by the private sector when a concession to generate and sell electricity to the Bangkok residents was awarded in 1887 to the Bangkok Light Syndicate (EGAT, 2013). The Bangkok Light Syndicate generated and distributed power from its power plant, known as the Watlieb power plant, for the power customers in the southern areas of Bangkok. The Bangkok Light Syndicate later sold its concession in 1898 to the Siam Electricity Company Ltd., another private company, which continued to generate and distribute electricity for the Bangkok residents until 1950 when the concession ended.

The government's role as a provider of electricity began to emerge in 1912 when the Ministry of Interior was assigned the task of providing electricity for the northern areas of Bangkok. The Royal Samsen Electric Authority was established under the jurisdiction of the Ministry of Interior for this purpose and provided electricity for the northern areas of Bangkok from its Samsen power plant. The responsibility of providing electricity for the Bangkok areas up to 1950 was thus divided between the government and the private sector.

Electricity was not provided for the provinces until 1909 when King Rama V issued a royal command that electricity be provided for the provinces of Thailand. In spite of the royal command, it was not until 1927 when electricity was first provided for the provinces. The Electricity Section was established under the Ministry of Interior to oversee the provision of electricity for the Ratchaburi province. The Electricity Section was later upgraded to a division status in 1934 and was responsible for providing electricity to the other provinces by awarding concessions to the private power producers.

2.2 Emergence of Policy Oriented Institutions in the Early Years

The increase in electricity demand and the needs to manage the provision of electricity led the government to establish the Power Plant Construction Committee, a policy oriented body, in 1951 under the Prime Minister Office to oversee the construction of power plants in Thailand (EGAT, 2013). The Power Plant Construction Committee was renamed Thailand Electricity and Energy Committee in 1952, and renamed again in 1953 as the National Energy Authority and its responsibility was extended to oversee the development of the other forms of energy in Thailand.

After the establishment of the policy oriented institution the patterns of development in the power sector began to change as the responsibility to provide electricity shifted from the private sector to the government. The first shift in policy is observed when the concession of the Siam Electricity Company Ltd. that ended in 1950 was not extended. Instead, the Bangkok Electric Works Section was established under the Ministry of Interior to take over the operations of the WatLieb power plant and to provide electricity for the southern areas of Bangkok. This essentially ended the role of the private sector as an electricity provider for the Bangkok areas.

Other organizations were also established under the guidance of the National Energy Authority to strengthen the provision of electricity for the country. The Lignite Electrical Power was established in 1954 to provide electricity for the southern areas of Thailand (EGAT, 2013). It was later upgraded to the Lignite Authority (LA) in 1960. The Provincial Electricity Organization was established in 1954 to oversee the provision of electricity for all the provinces of Thailand. It was later upgraded to the Provincial Electricity Authority (PEA) under the Ministry of Interior in 1960.

The Yanhee Electricity Authority (YEA) was established in 1957 to provide electricity for the central and the northern provinces of Thailand. The Bangkok Electric Works and the Royal Samsen Electric Authority were merged on August 1, 1958 to establish the Metropolitan Electricity Authority (MEA) which strengthens the role of the government as a provider of electricity in the Bangkok metropolitan areas. After its establishment, the MEA was assigned only the responsibility of distributing electricity so its generating capacity was transferred to the Yanhee Electricity Authority (YEA). The Northeast Electricity Authority (NEEA) was established in 1962 to provide electricity for the northeastern provinces of Thailand.

The Electricity Generating Authority of Thailand (EGAT) was established in 1969 by merging the LA with the YEA and the NEEA to provide electricity for the whole country. An important change after the establishment of the EGAT is that the private producers are no longer allowed to produce and distribute power to the power customers. This essentially ended all the concessions to the private power producers as the EGAT took over the task of power generation. The EGAT was also assigned the responsibility of dispatching the power plants and overseeing the interconnected transmission system through which its power is sold to the MEA and the PEA. The MEA and the PEA then distribute the purchased power to the power customers in the Bangkok metropolitan areas and in the provinces respectively.

2.3 Development of Policy Institutions

There was a change in the patterns of the policy oriented institutions when the National Energy Authority was renamed the National Energy Administration in 1971 and was transferred to be under the jurisdiction of the Ministry of Science, Technology and Energy in 1979 (Ministry of Energy, 2013). In 1992, the National Energy Policy Committee (NEPC), chaired by the Prime Minister, was established by the National Energy Policy Committee Act, B.E. 2535. Initially, the National Energy Administration acted as a secretariat to the NEPC and was assigned the task of formulating the energy policies for the countries.

After the establishment of the NEPC, the National Energy Policy Office (NEPO) was established in 1993 and acts as a formal secretariat to the NEPC (NEPO, 2013). Its main responsibility is to assist the NEPC on energy policy issues which includes policy formulation for the power sector. It is reasonable to interpret that the NEPO acted as an 'informal policy formulator and regulator' for the power sector at that time. After the establishment of the NEPO, the NEA was restructured as the Department of Energy Development and Promotion (DEDP) under the Ministry of Science, Technology and Energy which was later renamed the Ministry of Science, Technology and Environment. The responsibility of the DEDP is to oversee and implement the actual operations in accordance with the given policy. Another important shift in the roles of the electricity providers occurred in the nineties when the private producers were, again, allowed to participate in the generation of electricity.

There was a significant change in the structure of the energy sector in 2001 when the government at that time decided to integrate the energy organizations in the country. The concept of the Energy Bureau was considered in 2001 and this concept was later expanded to establish the Ministry of Energy in 2002. After its establishment, the EGAT and the DEDP were transferred from the Prime Minister Office to the Ministry of Energy while the MEA and the PEA remained under the jurisdiction of the Ministry of Interior. There was an attempt to privatize the EGAT in 2004 as a listed company in the security exchange market. However, the plan to privatize the EGAT was not successful and the EGAT's status remains a state enterprise.

A regulating body was established for the first time in Thailand when the Electricity Regulatory Commission was appointed by the cabinet in 2003 and was assigned the task of regulating the power sector in a transparent manner. The Electricity Regulatory Commission became the Energy Regulatory Commission in 2007 when its regulating responsibility was extended to cover all the energy issues (Energy Regulatory Commission of Thailand, 2015).

3. Key Policy Issues in the Power Sector

The review of the power sector development in the previous section provides a background to identify key policy issues that are relevant to the development of the power sector in Thailand. The increasing role of the state in providing electricity for the country since the mid fifties led to the issues of selecting the 'best option' to finance and to manage the development of the power sector. The rapid increases in the capital required to finance the expansion of the power sector led to increases in the international debt for the country. Eventually, the international debt related to the power sector expansion constituted about half of the total international debt during the 1967-1971 period (Wisuttisak, 2012). The rising international debt related to the power sector expansion captured the attention of the World Bank, a major financier of the power sector expansion in Thailand.

The World Bank was concerned with the financing methodology of the power sector. It raised the issue of the needs to reform the power tariff structure and the needs to address the issues of liberalization and privatization in the power sector to facilitate the development of the power sector in the 'appropriate' direction. The issue of the tariff reform was initially considered by the NEA in 1986 and the average cost tariff was replaced by the marginal cost tariff (Lorchirachoonkul and Vikitset, 1986). When the National Energy Policy Council (NEPC) was established, the NEPO took over the task of restructuring the power tariff from the NEA.

The issues of liberalization and privatization of the power sector were also considered by the NEPO which led to the change in the structure of the generation system in the early nineties. The EGAT Act was amended in 1992 to allow the private power producers to participate in power generation. After the amendments of the EGAT Act, the proposals from the small power producers (SPP) were accepted in 1992 and the first round of independent power producer (IPP) solicitation was issued in 1994 (NEPO, 1999). The amended Act also specifies the EGAT as the only buyer of electricity from the SPPs and the IPPs into its generation system and is obligated to purchase all the available electricity generated by the firmed SPPs and by the IPPs. The government also formulated the policy in 2002 to promote the use of renewable energy in electricity generation. The renewable energy promotion policy allows the MEA and the PEA to purchase power from the very small power producers (VSPP) that generate their electricity from the renewable energy sources.

There are differences between the patterns of participation from the private power producers at the beginning of the electricity era and their participation following the amendments of the EGAT Act in 1992. The private power producers at the beginning of the electricity era were given concessions to produce and distribute electricity to their customers, whereas the SPP and the IPP in the nineties were contracted to generate electricity for the EGAT via the power purchase agreement but were not allowed to distribute power directly to the retail customers.

Following the participation of the SPPs and the IPPs in power generation, the NEPO devised a plan to promote more ‘competition’ in the power sector. The plan was proposed by the NEPO and approved by the cabinet in 1998. Essentially, the plan is to expand the share of generation from the IPPs in the generation system while the EGAT remains the only organization to oversee the transmission system (NEPO, 1999). Up to the time of this writing, there is, as yet, no competition at the distribution level as the MEA and the PEA remain the two distributors of electricity for the whole country.

The structure of the power sector as approved by the NEPC in 2003 may be summarized as follows:

a) The EGAT is responsible for the management of generation and transmission of electricity. It is also designated as the single buyer of electricity from the private domestic power producers, the SPPs and the IPPs, and also from the foreign power producers, and then sells its electricity to the MEA and the PEA.

b) The EGAT is the system operator of the power system in Thailand.

c) The MEA and the PEA purchase most of their electricity from the EGAT and a small amount from the VSPPs for distribution to the retail customers in their own jurisdictions.

d) The Energy Regulatory Commission is assigned the responsibility of regulating the power sector and the other energy operations. In addition, it is responsible for the regulation of the power generation bidding process of the private power producers to ensure a free and transparent competition.

The key issues that affected the development patterns of the power sector and will have bearings on its future development may be identified as the organization structure of the power sector and the nature of competition in the sector; the tariff structure; and the feed in tariff for power generation from the renewable energy sources. This paper focuses only on the organization structure, the tariff structure, and the nature of competition in the power sector[1].

4. Theoretical Framework and their Applications to the Thai Power Sector

The nature of the technical relationship between generation, transmission, and distribution of the non-storable electricity is well understood. The technical relationship requires precise co-ordinations between its generation, transmission, and distribution networks at the planning stage and at the operation stage (Michaels, 2004, 2006). The planning stage involves forecasting of the electricity demand which is an important input for the design of the interconnected systems of generation, transmission, and distribution to serve the power customers. Once the systems of generation, transmission, and distribution are commissioned, a precise balance of demand and supply of the non-storable electricity must be managed by the dispatching center or the system operator in order to minimize the costs of the electricity supply.

This section sets out the theoretical framework to evaluate the government's power sector policies discussed in the previous section. The evaluation of the power sector policies are based on their effects on social welfare. Conceptually, social welfare is maximized when there are efficiencies on the supply side and on the demand side. Efficiency on the supply side is

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[1] This paper is based on Vikitset, T., and Lorchirachoonkul, V., 2015. "Electricity Sector Policy: Analysis and Recommendations" Research funded by the Research Committee, National Institute of Development Administration, Bangkok, Thailand. The discussions on the feed in tariff policy for power generation from the renewable energy sources can be found in this paper.

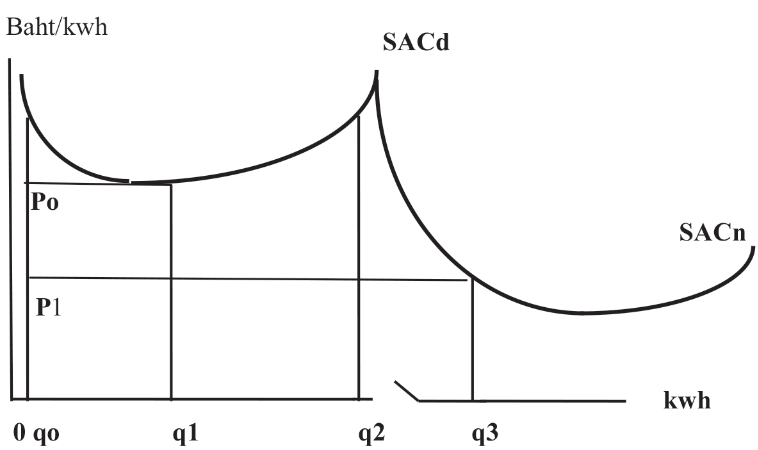
achieved when power can be supplied at their minimum costs while efficiency on the demand side is achieved when power is priced at its long run marginal costs (Monasinghe and Warford, 1982).

Given this framework, the following sections sets out the theoretical concepts that explain how economies of scale and horizontal/integration in the power sector affect the costs of the power supply. The determination of the power tariff, the nature of competition and their effects on social welfare on the demand side are then reviewed.

4.1 Economies of Scale and Horizontal/Vertical Integration in the Power Sector

The existence of economies of scale in the power sector affects the costs of the power supply. A power transmission/distribution network is a well understood natural monopoly that exhibits the existence of economies of scale. Any attempt to disaggregate a given interconnected transmission/distribution network into independent transmission/distribution lines will create unneeded duplications that lead to increases in the power supply costs. On the other hand, the existence of economies of scale in power generation is less obvious and depends on the types and capacities of power plants that are available in the generation system.

Figure 1. Economies of Scale in Power Generation



The concept of economies of scale in power generation and its effects on the generation costs is illustrated graphically in figure 1. For illustration purpose assume that a diesel power plant with a short run average cost of SACd is the only available power plant for power generation. If the power output of q1 kwh is required it can be generated by this diesel power plant at the cost of Po baht/kwh. If the generation output of nq1 kwh is required it must be generated by number of n diesel power plants at the same cost of Po baht/kwh so there are no economies of scale in this example.

Economies of scale are possible when a range of options of generating capacities and types of power plants becomes available. Suppose that a relatively larger nuclear power plant with the short run average cost of SACn becomes available for power generation, the costs of power generation can be lowered by adopting the nuclear power plant. For illustration purpose, let q3 equals nq1 so that the generation of q3 kwh can now be generated by one nuclear power plant at the lower cost of P1 baht/kwh.

The interdependency between power generation, power transmission, and power distribution, implies that there are potential benefits to be realized from their integration that may take the forms of the horizontal integration or/and the vertical integration. A horizontal integration is a situation where similar units supplying output at the same stage of production are merged into a single unit. Vertical integration is the process where firms at different stages of production are integrated into a single firm. It is expected that the costs of power supply from the integrated units are lower than the costs of power supply from the independent units.

A reduction in the excess capacity and the cost complementary are identified as the two major factors that lower the power supply costs in the integrated power sector. Cost savings from the reduction in excess capacity from the integration are made possible by the sharing of resources such as skills and equipments. Cost savings from the cost complementarity are realized when an expansion of output in one unit reduces the marginal costs of the related unit.

A mathematical model may be used to explain conceptually the benefits from integration in the power sector. As an illustration consider the horizontal integration of the Royal Samsen Electric Authority and the Bangkok Electric Works to establish the Metropolitan Electricity. Following the methodology of Pulley and Humphrey (1991) that utilizes a quadratic cost function to estimate the benefits from integration and assuming, for the simplicity of illustration, that the function is strongly separable in the input prices.

The costs of the Royal Samsen Electric Authority, the costs of the Bangkok Electric Works, and the costs of the MEA are represented, respectively, by the quadratic cost functions

$$C_s = (a_0 + a_{10}Q_s + 0.5a_{11}{Q_s}^2).f(p) \quad (4.1)$$

$$C_B = (a_0 + a_{20}Q_B + 0.5a_{21}{Q_B}^2).f(p) \quad (4.2)$$

$$C_{MEA} = (a_0 + a_{20}Q_B + a_{10}Q_s + 0.5a_{11}{Q_s}^2 + 0.5a_{21}{Q_B}^2 + a_{12}Q_sQ_B).f(p) \quad (4.3)$$

where C_s = costs of the Royal Samsen Electric Authority; C_B = costs of the Bangkok Electric Works; C_{MEA} = costs of the MEA; Q_s = output of the Royal Samsen Electric Authority; Q_B = output of the Bangkok Electric Works; f(p) = function of the relevant input prices

Cost savings from the horizontal integration are realized if the costs of the MEA are less than the sum of the costs of the Royal Samsen Electric Authority and the costs of the Bangkok Electric Works. The condition of costs savings is then

$$(C_s + C_B - C_{MEA}) = (a_0 - a_{12}Q_sQ_Bf).f(p) > 0 \quad (4.4)$$

and the cost function can be said to exhibit the sub-additivity property. The extent of the cost savings from the horizontal integration is indicated by the economies of scope (ES) which is given by the ratio

$$ES = \frac{(C_s + C_B - C_{MEA})}{(C_s + C_B)} \quad (4.5)$$

The cost savings from the reduction in excess capacity from the integration are reflected by the coefficient a_o and the cost savings from cost complementarity are reflected by a negative a_{12} in equation (4.4). Benefits from the vertical integration of relevant units in the power sector can be similarly estimated by the cost function.

There are several empirical studies of economies of scale and benefits of integration in the power sector. The existence of economies of scale in power generation is supported by several empirical studies. An example of these studies is the empirical findings by Christensen and Greene (1976). They utilize the translog cost function and the cross section data in 1955 and in 1970 to show the existence of economies of scale in power generation for the United State power utilities. The power plants in the data set are the steam, hydroelectric, internal combustion, and nuclear power plants. Another example is the study by Retancourt and Edwards (1987) that shows the existence of economies of scale in power generation with allowances for differences in the load factors among 36 power plants in the United States. This study shows that economies of scale in power generation can be realized in spite of the differences in the load factor. These studies imply that there must be flexibility in the selection of capacities and types of power plants to realize the economies of scale.

Since the mid eighties, several empirical studies were undertaken in an attempt to 'confirm' the expected costs savings from the horizontal integration and the vertical integration of the power utilities in the power sector. Michaels (2006) and Bruno (2011) provided a survey of 18 studies that cover the power utilities in the United States, Japan, Switzerland, Italy, and Spain. There are 15 studies that utilize various specifications of the cost function to study the nature of cost savings from integration of the relevant power utilities. The cost functions used in these studies are the translog cost function, the quadratic cost function, the symmetric generalized McFadden cost function, and the composite cost function.

The estimated cost functions in these studies are tested for separability, sub-additivity, and cost complementarity. Some studies also provide the measurement of the economies of scope. The purpose of the separability test is to test for the dependency between the related units. The hypothesis of separability is rejected if cost savings from integration are significant. There are 2 studies that use the data envelopment analysis technique and one study that uses the input distance function technique to study the cost savings from the integration.

It is not surprising, given the technical nature of electricity, to find that most of these empirical studies reported significant cost savings from the horizontal/vertical integration of the power utilities in a given power sector. For example, a study by Jara-Diaz et al. (2004) investigates the presence of cost savings from the vertical integration and the horizontal integration of the Spanish electricity firms. By using a quadratic cost function, the authors found the existence of cost savings from the horizontal integration of generation from coal, fuel, hydro, and nuclear power plants. In addition, the authors also found evidence of cost savings from a vertical integration between the generation and the transmission/distribution units.

A similar study of the Spanish electricity firms by Arocena et al. (2009) using the data envelopment technique found similar results. This study reported the existence of cost savings from the horizontal integration at the generation level between thermal and hydro generation. As in the case of Jara-Diaz et. al, the study also found the evidence of cost savings from the vertical integration of these firms.

Growitsch, et al. (2009) investigates the nature of cost savings from the horizontal integration of the European distribution companies by using the input distance function technique. The authors found evidence of cost savings from the horizontal integration of these firms. The cost savings may be traced to the larger number of customers facing the integrated firms that tends to flatten the total demand facing the integrated firms.

A study of the US utilities by Hayashi et al. (1997) on the vertical integration of the generation and transmission/distribution using the translog cost functions also found evidence of cost savings from the vertical integration. The authors also estimated the extent of the cost savings in the range from 9.2 percent to 24.2 percent.

4.2 Competition in the Power Sector: Theory and Evidence

Economies of scale and benefits from integration tend to justify the monopolistic structure of the power sector. However, an important but controversial policy to reform the power sectors of many countries began to emerge in the eighties. The basic concept behind the reform is the liberalization and the privatization of the state own power utilities to encourage competition in the power sector. Several characteristics of the state own utilities in many developing countries at the time may have contributed to the reform pressure for more competition in the power sector. A survey of 360 utilities from 57 developing countries (Kessides, 2004) found the power tariffs to be underpriced such that they created financial burdens for the government to finance the expansion of the power sector.

The underpriced tariff rates induces excess demand for electricity that is used to justify the investment required to expand the power sector that are inadequately supported by the revenue generated by the low power tariffs. In addition to the poor financial performance of the state own power utilities, their poor service to the power customers, the low rate of electrification for the rural areas, and the needs to raise revenue for power sector expansion contributed to the pressure for the power sector reform.

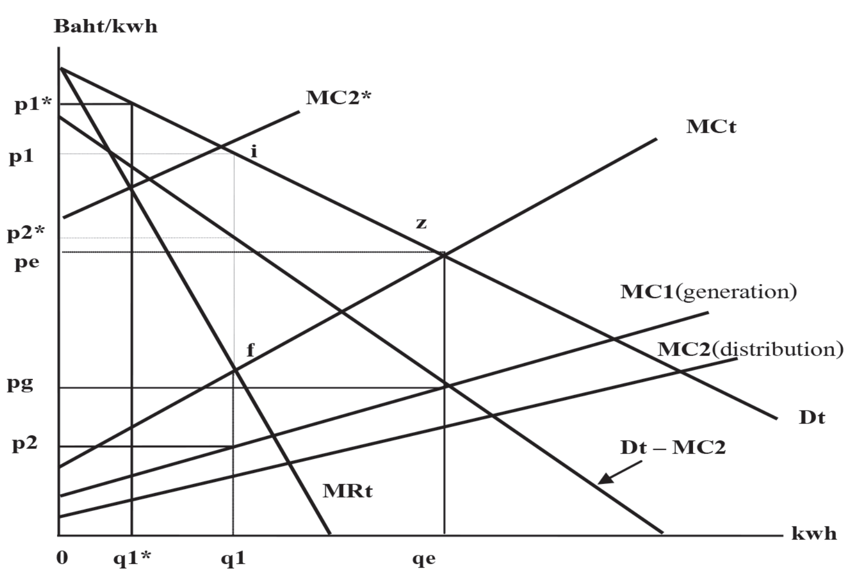
Another factor that contributes to the reform pressure is the development of technology in the power sector that tends to lessen the benefits of costs savings from the integrated power utility. Before the eighties, economies of scale in power generation are realized from the large fossil fuel power plants situated far away from the cities (Kessides, 2004). The development of the gas turbine and the high efficiency combined cycle gas turbine with relatively smaller capacity and faster commission time, and the timely development of the gas fields and gas pipelines in Western Europe and the United States made power generation from the combined cycle power plants relatively more attractive than the existing technologies at the time. In addition, the increasing load density and the increasing number of power stations open up the opportunity for competition at the generation level.

Chile was one of the first countries to address the issue of competition in its power generation in the eighties (Kessides, 2004). Following the Chile example, more than 70 countries have elected to reform their power sectors by introducing more competition in their power generation (Bacon and Basant-Jones, 2001). The reform towards competition in the power sector inevitably led to the unbundling of some monopoly assets in the power sector.

Given the benefits from the economies of scale and horizontal/vertical integration from the supply side of the power sector, the direction of the reform towards competition raises an issue of whether the competition policy negates the benefits from the supply side by removing benefits from economies of scale and from integration. A theoretical discussion begins with the comparison between the power tariff in the unintegrated power sector with the power tariff in the integrated power sector. The introduction of competition into the power sector is then discussed as to their effects on social welfare.

The comparison of the power tariff is presented graphically in Figure 2. For the simplicity of illustration, it is assumed that there are two power authorities, the generation authority and the transmission/distribution authority that provide power supply to the power customers. The generation authority and the transmission/distribution authority can be two independent organizations or they can be vertically integrated into one organization.

Figure 2. Power Tariff Under Integrated and Independent Power Authorities



In Figure 2, D_t is the power customers' demand for the electricity of the transmission/distribution authority with MR_t as its marginal revenue; MC_1 is the marginal costs of the generation authority; MC_2 is the marginal costs of the transmission authority; and MC_t is the vertical summation of MC_1 and MC_2[2]. The difference between D_t and MC_2 reflects the price that the transmission authority is willing to pay for the electricity of the generation authority which is essentially the transmission authority's demand for electricity of the generation authority.

If the generation authority and the transmission authority are vertically integrated, the integrated authority can maximize its profit by setting the power tariff for its power customers at p_1 where its marginal revenue equals the combined marginal costs which results in the purchase of q_1 units of electricity by the power customers. In order to achieve this objective, the internal transfer price of the generation authority must be set at p_2 which becomes its induced marginal revenue. The internal transfer price leads to the generating authority's induced profit maximizing output of q_1 which is consistent with the profit maximizing output of the integrated utility. The setting of the transfer price can be managed internally by the authorized administrators of the vertically integrated authority.

If the generation authority and the transmission authority are two independent power authorities the generation authority will not accept the transfer price of p_2 for the distribution authority's purchase of q_1 units. Instead, the generating authority will use the distribution authority's demand for its electricity D_t-MC_2 to price q_1 units of electricity at p_2^* which is higher than the induced transfer price p_2 when the two power authorities are vertically integrated.

When the transmission authority includes the cost of purchased power p_2^* to its marginal transmission costs its total marginal costs MC_2^* becomes the marginal costs of the power supply to the power customers. The profit maximizing units of the transmission authority is now equal to q_1^*,

[2] For simplicity it is assumed that marginal costs of the integrated and unintegrated units are equal which essentially ignores the benefits of integration. This assumption that has no effect on the conclusion of the analysis.

which is less than q_1, and the power tariff for the power customers is set at p_1^* which is higher than p_1 under the integrated power authority. A bilateral monopoly pricing situation then emerges and the final agreed power tariff at the generation level is indeterminate and the final tariff depends on the negotiations between the two authorities. Nevertheless, the negotiated power tariff at the generation level must be between p_2 and p_2^* and the agreed units between q_1 and q_1^*.

The above analysis shows that the power customers and the power authorities both gain from the unregulated power tariff under the structure of a vertically integrated power authority. The tariff for the power customers is relatively lower under the vertically integrated power authorities while the vertically integrated power authority earns relatively higher profit than the combined profits of the two independent power authorities.

Even though the power consumers and the power authority benefit from a vertically integrated power authority, the unregulated power tariff p_1 is still greater than the marginal costs of power supply. The efficient power tariff must be set at p_e which equals its marginal costs of supply and induces the efficient consumption of q_e units of power. Given the profit maximizing objective of the integrated power authority, it has no incentive to set the power tariff at p_e so a regulating body is required to regulate the power tariff at its efficient level. The power regulator can also set the tariff for generated power, or the bulk tariff, at p_g, which equals the marginal costs of generation. The two regulated power tariffs will induce an efficient electricity consumption of q_e and increase social welfare by the area of the triangle Δifz compared to the unregulated tariff of p_1 under the integrated but unregulated power authority. This concept of power tariff determination can be extended to cover the power distribution authority. When the distribution authority purchased power from the transmission authority at the price p_e, the efficient retail tariff can then be set equal to p_e plus the marginal costs of power distribution.

The above analysis implies that the regulated power tariff for an integrated power sector can generate maximum social welfare for the country. The introduction of competition into the integrated power sector then raises an issue of its effects on social welfare. Given the technical characteristics of the power sector it is apparent that competition must not negate the benefits from the economies of scale and the benefits from integration.

The logical option for competition in the power sector is thus in power generation. Conceptually, it is possible that the marginal costs of power generation can be lower than MC1 in figure 2 through competition which will lead to increases in social welfare. With competition at the power generation level, the competitive power generators must distribute power to their customers through the transmission/distribution facilities by paying rental fees known as the wheeling charges. It is important that the transmission operator must retain the role of power dispatcher to ensure that power is supply at their minimum costs. The introduction of competition in power generation has implications on the tariff policy which will be discussed later.

The effects of competition on the power supply costs and hence on social welfare depend on the characteristics of competition. In general, if competition occurs without negating the benefits from economies of scale and integration it is possible for society to benefit from competition. On the other hand, if competition does negate the benefits of economies of scale and from integration, society may have to bear the burden of competition in the form of increases in the power tariff.

Nagayama (2009) investigated the effects of the liberation, privatization and competition in the power sectors of 20 Latin American countries, 26 countries from the former Soviet Union and Eastern Europe, 11 Asian developing countries that includes Thailand, and 26 developed countries on their electricity prices. Econometric models were constructed to estimate the effects of liberation, privatization and competition in the power sectors on the electricity prices from the panel data of these 83 countries during the period 1985 through 2002.

The electricity price is defined as the ratio of the industrial tariff to the residential tariff and is the dependent variable in this study. The independent variables consist of the 0/1 dummy variables with interaction terms to account for the effects of the reform variables on electricity prices that are the introduction of the foreign IPPs; privatization; unbundling; establishment of a regulatory institution; introduction of the wholesale spot market/power exchange; and introduction of the retail competition. The equation also includes other controlling variables that are the per capita GDP; the losses in transmission and distribution; the political democratic degree index;

the imported energy impact variable; share of hydropower; and share of nuclear power.

The estimation results from this study seem to be consistent with earlier studies by Steiner (2001), Hattori and Tsutsui (2004), and Zhang et al. (2002). The estimation results show that the introduction of the foreign IPPs lowers the electricity prices in the developed countries. Interestingly, the study found that the introduction of the IPPs results in higher electricity prices in the developing countries. The author expresses his suspicion that these unexpected and unwanted results may be attributable to the payment 'obligations' to the IPPs that cause the electricity prices to rise in the developing countries. The establishment of a regulatory institution tends to lower the electricity prices in the developed countries but, as in the case of the IPP introduction, tends to increase the electricity prices for the Latin American countries and the developing countries.

The empirical studies provide a general view of the effects that the IPPs and the establishment of regulatory institution have on electricity prices. The reasons behind these effects may vary between countries and specific country studies are required to explain the origins of these effects.

5. Evaluation of the Power Sector Policy

This section evaluates the effects that the key power sector policies identified in section 3 have on social welfare. Their evaluations are based on the theoretical concepts and empirical findings presented in the previous section.

5.1 Organization Structure of the Power Sector

The technical relationships between the generation units, the transmission units, and the distribution units in the power sector are well defined and may be considered to be universally applicable to a given power sector. Given the universal technical relationships, the empirical findings of the existence of economies of scale and benefits of the horizontal/vertical integration for the power sectors in other countries considered to be compatible to the Thai power sector will be used as references to evaluate the policies that affect the organization structure of the Thai power sector.

It will be argued that the policy that establishes the EGAT, the MEA, and the PEA enhances efficiency of the power sector on the supply side. The establishment of the EGAT allows it to realize the benefits from economies of scale, the horizontal integration of power plants, and from the vertical integration of its generation and transmission units. The monopoly in power generation allows the EGAT the flexibility to realize the benefits from economies of scale from selections of a wide range of different power plant types and capacities which is compatible to the empirical findings of Christensen and Greene, and the findings of Retancourt and Edwards.

The empirical studies by Jara-Diaz et al. (2004) and by Arocena et al. (2009) that found evidence of cost savings from the horizontal/vertical integration of generation and transmission units for the Spanish power sector are also compatible to the case of the EGAT. The horizontal integration of the generation units and the vertical integration of the generation and the transmission units allow the EGAT to save costs through the reduction of excess capacity and the cost complementarity.

The horizontal integration of the power generation units allows a centrally planned generation output that can lower the generation costs by sharing certain costs. An example of cost savings from the reduction of the excess capacity is the joint purchase of inputs such as natural gas or lignite for the integrated power plants which lower the transaction costs. The horizontal integration also lead to cost savings from cost complementarity through power dispatching of the integrated power plants.

The EGAT can also realize costs savings from vertical integration through the reduction of excess capacity and the cost complementarity. An example of the cost savings through the reduction of excess capacity is the sharing of the central building that is used to manage the generation units and the transmission units which lower the transaction costs through the reduction of excess capacity.

Cost savings from the vertical integration through the cost complementarity can also be expected since the integration allows the EGAT to plan and coordinate the interconnected network of the generation system with the transmission system. An expansion in the output of the power plant in one area with relatively lower marginal cost of power generation can reduce the marginal costs of transmission since an extra power plant can lower the requirement to construct the transmission lines and, hence, its marginal costs. Vice versa, an expansion in the transmission system can lower the requirements to build an extra power plant, and, hence, its marginal costs, since the interconnected system allows more sharing of the generation output of a large power plant.

The establishments of the MEA and the PEA allow the two organizations to realize the economies of scale, cost savings from the horizontal integration through the reduction of excess capacity and the cost complementarity of their distribution net works. The empirical study by Growitsch, et al. (2009) that finds evidence of cost savings in the horizontal integration of the European distribution companies is compatible with the establishment of the MEA and the PEA.

Several examples of the cost savings from the reduction of excess capacity in the establishment of the MEA can be pointed out. One example is the transaction costs such as billings for the power customers that can be decreased by sharing the resources such as personnel and the computer system. An example of cost savings from the cost complementarity is a joint design of the interconnected distribution network for given areas where an expansion of the interconnected distribution network in one area can lower the marginal costs in the other area. Without integration, independent designs of distribution systems in different areas cannot benefit from the cost complementary and lead to higher distribution costs.

5.2 The Power Tariff and Competition

Unlike many developing countries that were faced with the underpriced tariff rates which was identified as one of the major factors that led to the power sector reforms, Thailand has adopted the marginal costs based tariff structure since 1987 that can generate revenue to satisfy the revenue requirements criterion of the World Bank[3] (Lorchirachoonkul and Vikitset, 1987). Even

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[3] The revenue requirements criterion for the 1987 power tariff was a minimum rate of returns of 8 percent on revalued assets of the power sector. Later, the revenue requirements criterion was based on the sufficiency of the revenue generated from the power tariff to partially fund the expansion of the power sector without adverse effects on the fiscal position of the country. Ibid.

though there was no formal regulatory body to regulate the power tariff at that time the authority to design and set the power tariff rests with the sub-committee of energy policy formulation chaired by a deputy prime minister. The sub-committee decides to adopt the power tariff that is based on the long run marginal costs of the power supply and could thus be argued that the tariff policy is an economically efficient tariff.[4] The marginal costs based tariff was designed as a uniform tariff where a given category of power consumers face the same tariff regardless of their geographical locations.[5]

The uniform tariff policy necessitates the estimations of the marginal costs of power supply as if the generation units, the transmission units and the distribution units are fully integrated as one power utility. The estimated marginal costs of generation, transmission, and distribution of the power supply are used to design the power tariff structure. The wholesale power tariff which is the tariff that the EGAT sells its power to the MEA and the PEA is based on the marginal costs of its generation and transmission and compatible to Pg in figure 2.

The retail tariff is then determined by the wholesale tariff and the marginal costs of the whole distribution system which is compatible to Pe in figure 2. Even though the tariff structure adopted in 1987 is an efficient tariff, the fact that the MEA and the PEA are not horizontally integrated raises a financial management issue that will be discussed in the next section.

The government decided to introduce competition into the generation system when the IPP policy was implemented in the nineties. The IPP policy seems to follow the trend of liberalizing and privatizing the power sector in other countries. The IPP policy was kick started by the unbundling of the Rayong power plant which was formerly one of the power plants in the EGAT generation system. The Rayong power plant was sold to a successful bidder so there was a transfer of ownership from the EGAT to the successful bidder.

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[4] In its actual implementation, the efficiency of marginal costs based tariff was modified to satisfy the socio-political policy of subsidizing the residential power consumers, a policy that exists before 1987. See Lorchirachoonkul and Vikitset (1987).

[5] For the reasons behind the uniform power tariff policy see Lorchirachoonkul and Vikitset (1987).

The new owner of the Rayong power plant, now an IPP, then sold power back into the EGAT generation system as stipulated by the power purchase agreement (PPA).

Following the Rayong example, other power plants in the EGAT generation system were unbundled from the EGAT's generation system and offered to the private power producers through the bidding process. In addition to the unbundling of the EGAT's power plants, the private power producers were also invited to submit their proposals to sell power to the EGAT, the only power authority authorized to purchase power from the IPP through the power purchase agreement (PPA).

When the PPAs have been signed with the successful IPPs the EGAT also becomes a major shareholder in some IPPs. For example, the EGAT holds 25.41% of shares in the Electricity Generating Public Company Ltd. (EGCO), 48% in the Ratchaburi Electricity Generating Holding PCL. (RATCH)[6]. Internationally, the EGAT has a PPA to purchase electricity from the Nam Theun 2 project in which EGCO holds 35% of the total shares.

Some issues may be raised from the patterns of 'competition' inherent in the IPP policy. The structure of the shareholders in the IPPs raises an issue of acceptable governance. The EGAT's status as a major shareholder in the IPPs that sell power to the EGAT under the PPA inevitably suggests a conflict of interest which cannot be considered good governance in the development of the power sector. Moreover, the relatively high returns of the EGAT from its investment in the IPPs are not included in the EGAT financial statement. This practice tends to distort the financial status of the EGAT since its consolidated financial position is superior to the financial position presented in its official financial statement.

The second issue concerns the characteristics of competition in the IPP policy. It is reasonable to expect that the IPP policy will lower the costs of the power supply through competition when the total capacity proposed by all the IPPs to the EGAT exceeded the required capacity announced in the procurement announcement. Upon closer scrutiny, it will be argued that

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[6] These two power plants were in the EGAT's generation system before their unbundling.

the expected lower the costs of power supply from the IPP policy did not materialize due to the nature of the power purchase agreement between the EGAT and the IPPs.

Even though the PPA of a given IPP is confidential, several salient points in the PPAs are 'unofficially' known. The first point concerns the rate of return on investments of the IPPs which is one of the key variables that determine the costs of the IPP's power supply. In order to provide 'incentive' for the IPPs, a rate of return of more than 18 percent was allowed for the first batch of the IPPs compared to the average rate of 12 percent offered by the commercial banks at the time. The allowed rate of return decreased to 15 percent for the second and third batches of the IPPs but the average rate offered by the commercial banks also decreased to less than 8%.

The third issue concerns the adjustments of the power purchase prices when there are deviations of the fuel costs and the exchange rates from the agreed reference values. In addition, the EGAT is obliged to purchase all electricity generated from the IPPs' power plants. In the event that the EGAT fails to purchase electricity from the IPPs when it is available it is obligated to pay the availability payment to the IPPs. The nature of these agreements eliminates essentially the major risks of the IPPs and the only risks remaining are the construction costs of the power plant and their operations. The purchase agreement also poses a problem in load dispatching for the EGAT as it is obligated to purchase power from the IPPs which may go against the load dispatching order.

In the event that there are increases in the costs of generation from the IPPs they can be passed on to the power customers through the increases in the power tariff. Moreover, the overhaul costs of the generators in the IPP power the PPA period are also allowed to be passed on to the power customers through the increases in the retail power tariff. In the event that there are improvements in the generation efficiency of the IPPs the benefits of these improvements are not shared with the power customers and remain entirely with the IPPs in the form of higher profits.

From the characteristics of the PPA it is not surprising to find that the rate of returns of the IPPs from the first three batches of power purchases are considerably greater than the rate of return of the EGAT. In conclusion, the 'competition' from the IPP policy tends to increase the prices of electricity which is consistent with the general findings for the developing countries and the observation that the electricity prices increase due to the 'obligation payments' to the IPPs (Nagayama, 2009).

6. Summary, Conclusions and Recommendations

The power sector in Thailand has expanded continuously since electricity was introduced to the country over a century ago. An important policy that proved to be the solid foundation of the power sector on the supply side are the establishments of the EGAT, the MEA, and the PEA that allow the horizontal/vertical integration in the Thai power sector. Benefits from the horizontal/vertical integration in the power sector are borne out by many empirical studies. The marginal costs based tariff adopted in 1987 is a major tariff policy on the demand side that is based on the criterion of economic efficiency. Unfortunately, the competition policy that introduced the IPP into the generation system of the EGAT does nothing to lower the generation costs. On the contrary, it can be argued that the IPP policy leads to increases in the costs of power generation as is the case for many developing countries. Some recommendations may be made on the organization structure and the competition policy may be offered for the Thai power sector.

The vertically integrated structure of the EGAT and the horizontal integrated structure of the MEA and the PEA should remain to preserve the benefits derived from such as structure. The empirical evidences seem to suggest that further cost savings may be possible from the horizontal integration of the MEA and the PEA into a single distribution authority, and, ultimately, the vertical integration of the single distribution authority and the EGAT. It is premature to suggest that there should be more integration in the Thai power sector. However, it is useful to consider issues relevant to the consideration of further integration in the Thai power sector.

The first issue concerns the financial imbalances between the MEA and the PEA caused by the uniform tariff policy implemented since 1987. Due to the geographical differences, the marginal costs of distribution in the PEA area are relatively higher than the marginal costs of distribution in the MEA area. Thus, the marginal costs of distribution for the integrated distribution system are higher that the MEA marginal costs and lower than the PEA marginal costs. The uniform tariff that is based on the marginal costs of the fully integrated power sector inevitably leads to financial windfalls for the MEA and financial deficits for the PEA.

In 1987 the financial imbalances between the two distribution authorities were redressed through the wholesale tariff of the EGAT. The wholesale tariff is designed such that the wholesale tariff for the MEA is higher than the wholesale tariff for the PEA but the weighted average of the two wholesale tariff equals the marginal costs of the integrated system. The method of redressing the financial imbalance has been adjusted several times and presently the financial imbalances were redressed through the power development fund where the MEA deposit a given amount of fund to be withdrawn by the PEA.

If the MEA and the PEA are horizontally integrated, the financial imbalances between the two authorities will no longer be an issue under the uniform tariff policy. Furthermore, it is conceivable that the horizontal integration of these two authorities may lead to further cost savings through the reduction of excess capacity and the cost complementarity. However, it is premature to suggest a horizontal integration of the MEA and the PEA. Other non-economic factors that are relevant to the integration policy must receive carefully consideration. An example of the relevant non-economic factors is the organization culture that exists within the power authorities. The analysis of the non-economic factors lies outside the scope of this report.

Competition in the power sector should be justified only if it leads to lower costs of the power supply relative to the existing integrated structure of the EGAT, the MEA, and the PEA. More important, competition should not negate the benefits of economies of scale and cost savings from integration. It appears that the IPP policy initiated in the nineties did not lower the costs of the power supply. On the contrary, the policy tends to increase the costs of the power supply through the PPAs. Even though the past patterns of participation of the IPPs in the generation system cannot be undone it is crucial to review and modify the IPP policy to lower the future costs of the power supply. Some guidelines may be discussed for the competition policy modifications.

The first guideline concerns the flexibility of the EGAT as the system operator to manage the load dispatching. Whatever the level of the participation of the IPPs in power generation it is essential that the EGAT must manage the load dispatching as if the generation and the transmission systems are one integrated power utility. In order to achieve this objective the obligation of the EGAT to purchase power from the IPPs whenever it becomes available must be removed from the PPA.

The second guideline is directed towards the bidding stage of the IPPs. Before the IPP policy was launched the constructions of power plants in the PDP were solely the responsibility of the EGAT and the contractors were negotiated to construct these power plants which are under the ownership of the EGAT. It was proposed before the launching of the IPP policy in the nineties that this procedure is extended to the bidding process of the IPPs (Vikitset, 1991).

In order to ensure that the costs of the power supply from the power plants of the IPPs are at least equal to the costs of power plants constructed by the EGAT, the potential IPPs are invited to participate in the bid to construct the power plants as a contractor. The successful bidder has then the option of purchasing the power plant from the EGAT. The cost parameters that are used to design the power tariff such as the discount rate must be compatible to the cost parameters used to design the PPA between the EGAT and the IPPs. The potential IPPs should also be allowed to submit a proposal of an alternative power plant to a given power plant in the PDP. In the event that there are no successful IPPs in this competitive environment, there will be, at least, no increases in the costs of the power supply as evident from the past IPP policy.

The modified competition at the generation level may be extended to competition at the distribution level. The structure of competition at the distribution level must be such that it does not compromise the benefits of integration inherent in the organization structure of the MEA and the PEA. Following this guideline, the private utility companies must be allowed to distribute their power through the transmission/distribution networks of the EGAT, the MEA and the PEA. The right of the private utility companies to distribute power through transmission/distribution networks require further researches in two major issues.

The first issue concerns the determination of the rental or the wheeling charges of the transmission/distribution networks which is a pre-requisite before the launching of competition by the private utility companies. The second issue concerns the modifications of the uniform tariff policy to allow differences in the power tariffs in different areas according to the market mechanism.

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