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Transition to an Electricity Market in Thailand: A Case for Asian Developing Countries

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ABSTRACT

Factors that drive reform of the electricity supply industry (ESI) in developing countries, especially in Asia are different in many important ways from those that do so in the West. Chief among these fundamental differences are (i) the maturity of the ESI structure, economic priority and the role of the state in development, (ii) the need for the consolidation of a national grid which is at a relatively early stage of evolution, (iii) the directive role of government policy in key sectors of the national economy and (iv) the way in which a power market should be designed. The inherited pre-reform organizational structures are also very different and this influences feasible post-reform options. This paper therefore proposes a transitional mechanism, criterion and synthesizes a model of reform that is sensitive to these realities. The case of Thailand's EGAT is used as the main reference point due to its medium size and orientation towards restructuring. Short sections on Sri Lanka, China and the ASEAN Power Grid Interconnection Project are included to broaden the relevance of the discussion. In addition, the impact of the proposed reform model on power system operation and the other relevant issues are also presented.

1. INTRODUCTION

1.1 Fundamental Background

There is a tendency in developing countries to adopt the structures implemented in the pioneering Western countries without a critical appraisal of their suitability in the local context [1]. These prescriptions are:

- dismantling key state-owned assets;
- decreasing national control over sectors of the national economy;
- preparing the ground for penetration by foreign capital.

The latter, furthermore, is expected to be on terms that are attractive to the investor. Lessons also need to be learnt from critical difficulties encountered elsewhere, for example the price and capacity problems in California in 2000-2001 and the stability/reliability problem in New York state and Canada in 2003.

1.2 National Grid Development

The transmission system is a natural monopoly in the economic, the geographical and the technical (control) sense, and therefore must continue to function as an integrated and regulated entity. However, to encourage competition in the generation and retail sides, it is necessary to unbundle these two sides from the transmission system and ensure that the latter offers open access on an equitable basis to all power suppliers and consumers. The transmission system thus becomes the focus of attention in organizing competition and must act as a "level playing field", and the rules for managing access by all participants must be transparent and non-discriminatory.

There is an important difference between the need to extend and reinforce a well developed and already mature grid and the need to develop a grid in the case where a national grid is non-existent. There is also a distinction in the structure of transmission systems in the Western countries and that in the developing nations, especially in Asia. In North America, for instance, many problems associated with transmission system use, transmission open access, and parallel path issues are the consequence of multiple-ownership of the transmission network which existed before deregulation. They are "structural problems", not physical problems [2]. It is envisaged that the transmission facilities of any one utility in a region are part of a larger, integrated transmission system which, from an electrical engineering perspective, operates as a single machine [3]. For this reason, the concept of a regional transmission organization (RTO) was introduced in the US in the year 2000. One of its functions is to remove impediments to achieving a fully competitive electricity market arising from the discriminatory practices of different transmission providers. In developing countries, on the other hand, the network topography will decide the fundamental structure of transmission systems historically. Multiple-ownership of the transmission system does not exist before reform. This single-ownership of the grid in developing countries could be used to advantage to prevent some of the problems which have occurred in developed countries.

1.3 Restructuring vs. Privatization

A national perspective on the deregulation of the power market should bear in mind the distinction between restructuring and privatization. The failure to appreciate this distinction has retarded restructuring as will be described in later sections of this paper. Privatization is indeed sometimes a consequence of restructuring, but this is not necessarily so, or at least not for all parts of the electricity supply industry (ESI). Privatization of the grid could also lead to the creation of multiple-ownership status of the transmission system and hence lead to the more complex problems encountered in the US before the creation of RTOs. Generally, in order to promote competition and market formation, privatization of portions of nationally owned generation and retail supply may be warranted. However, the transmission system is an unlikely candidate for privatization.

In the context of major transmission expansion needs in many countries of Asia, the role of government intervention and control is important [4-6]. In Thailand, Sri Lanka, China and other developing countries, transmission is a key part of the national infrastructure, and as such system expansion needs to be financed, regulated and implemented at a national planning level and hence should not be privatized.

1.4 A Proposal for Asia

This paper explores major factors that drive reform of ESI in developing countries in Asia. Three cases that can be useful guidelines for the transition to an electricity market in Asia are presented. The case of the Electricity Generating Authority of Thailand (EGAT) is used as the main reference point throughout these paper [4, 7-9] due to its medium size and orientation towards restructuring. We

first elaborate the notion of a "National Transmission Entity". Such an entity is required so as to maintain a flexible approach that encourages economic growth while protecting the long-term interests of the people in developing countries. Short sections focusing on Sri Lanka and China [10] are included to broaden the relevance of the discussion. The impact of the transmission model on power system operation and related power engineering issues is also discussed.

2. POWER MARKET MODELLING

2.1 Power Market Development in Asia

In most Asian developing countries, the conceptual structure of a conventional power system is given in Fig. 1 The Centralized Power System (CPS) [11], is normally a state owned enterprise, which not only owns its own plant but also buys electrical energy from independent power producers (IPPs), plants owned by Build-Operate-Transfer (BOT), Build-Operate-Own (BOO) consortiums and co-generators, and then resells to consumers. To some extent, this is similar to a former US utility buying from IPPs, where there were no direct commercial links between buyers and sellers, and all tariff formulation is mediated by the utility. The difference between a US IPP and an Asian BOT project is that the latter entails take-or-pay commitments and complex investment related guarantees.

In a competitive environment, the two major competitive elements in any power market are generation and retail supply. On the other hand some form of transmission entity (TE) illustrated in Fig. 2 which incorporates Transmission Ownership (TO), Dispatcher/ISO functions and Market Operator (Pool)/Power Exchange (PX) functions, constitutes the strategic core, the central nervous system, of the ESI. The competing entities will buy and sell power via the TE, which will provide wheeling transactions in both physical and administrative services.

The conceptual structure of the power market in developing countries is illustrated in Fig. 3. The complete model is illustrated in Fig. 6 and discussed later in Section 2.6, but many variations are possible.

The major components of the power market after unbundling of the conventional CPS are as follows:

2.1.1 Competitive Generators

Horizontal unbundling of generation will end the previous monopoly structure, giving way to several competing enterprises both private and public. Restructuring leads to a dramatic change in generation entities, from an arrogant tiger (monopoly) to many modest cats (competitive market). The number of generation participants is important in achieving the difference between an oligopoly and a competitive market, and the design of appropriate market rules and regulatory structures is essential. Moreover, policymakers need to decide whether only a small number of competing generators should be licensed in the first instance or whether free entry is to be encouraged. It is important to minimize market power abuse, which arises from barriers to entry limiting the number of participants or from exploitation of transmission constraints. On the other hand, in developing countries, economies of scale and quality of service are likely to be valid concerns, limiting the number of participants.

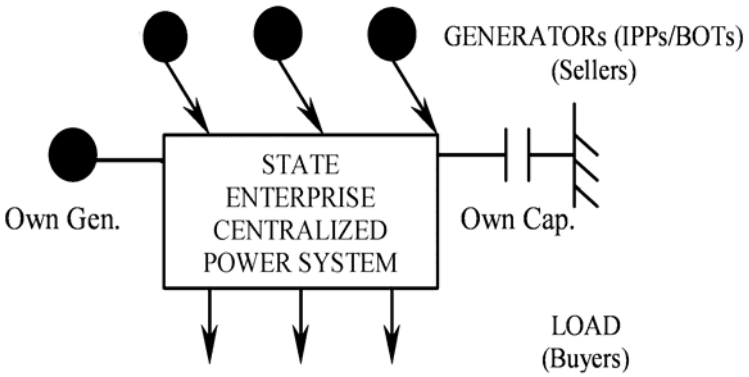

Fig. 1 Conventional power system structure in developing countries

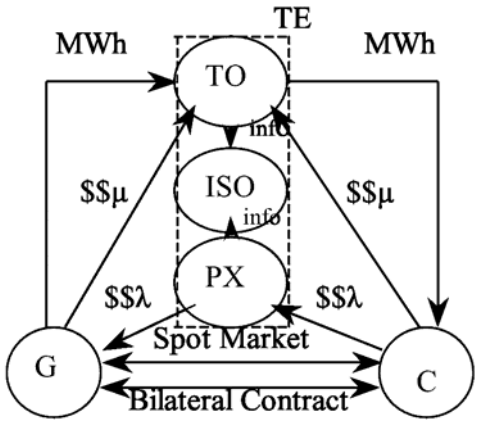

Fig. 2 Transmission entity as central nervous system of the ESI

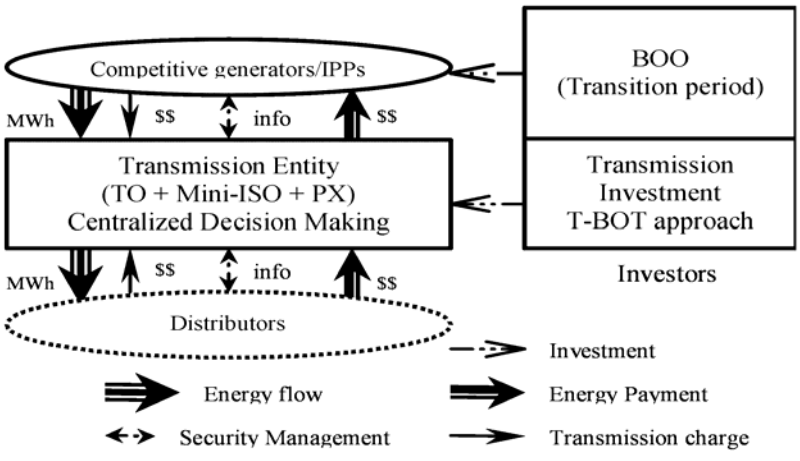

Fig. 3 Power market in developing countries

2.1.2 Transmission Entity

A crucial element in ESI restructuring is the configuration of the transmission entity. In a competitive electricity market, a transmission system performs like the network of public highways, which enjoys geographical natural monopoly status. It needs to be regulated to ensure impartial and efficient use of the assets by providing non-discriminatory access to promote fair competition among suppliers and consumers.

In Asia, the transmission system is growing rapidly and a unified national grid, connecting different provinces or regions, is being built. In large countries like China, India, and some APEC countries, there is an interest in developing and connecting regional power markets, for example the ongoing 14 across-border transmission projects among ASEAN member countries – ASEAN Power Grid Project. Transmission systems, because of their economic, technical and geographical natural monopoly features, play a key role in determining the overall technical and business configuration of the ESI. It will be argued below that unified decision making combining conventional system control and long-term grid investment is necessary in fast growing systems. Furthermore, government policy and state intervention are major factors affecting the success or failure of reform in developing countries.

2.1.3 Investors

Private investors play a crucial role in developing the power market. The BOT arrangement [12], [13] has been used extensively in some countries in Asia where the monopoly character of the national power utility remains intact. The BOO option may be used during the transition period since the BOO differs from the BOT in that ownership is retained by the private developer who then may hold the plant in perpetuity, or alternatively sell the plant to another entity. If there is partial unbundling, then a government-controlled authority, which can deal with BOT/BOO arrangements, will still exist. On the other hand, if there is complete unbundling of generation, then there will be no scope for BOO/BOT arrangements and all new private entrants will be IPPs, which are considered as competitive generators. Furthermore, a transmission-BOT (T-BOT) arrangement can be used for transmission investment in power markets in developing countries as discussed later in Section 2.6.2.

2.2 Ownership and Management Issues

S. Hunt and G. Shuttleworth [14] define owners as those "who are entitled to the profits of the industry". Owners can be individual persons, shareholders, or institutions[1]. A manager is appointed by the owner to run the enterprise, given authority to do so, and held accountable for the results. Ownership structures in power markets can be classified into three types: government, private and mixed ownership. A nationally owned grid has advantages from a policy perspective since it gives the government freedom in expansion planning and flexibility in designing the regulatory framework. The imposition of such policy objectives on a privately owned transmission grid, though not impossible, is more complicated. An example of the latter is California where vertically integrated, privately owned, utilities have been restructured, unifying their transmission assets (while retaining different transmission owners) and allowing operational access to third parties. Further, the types of ownership and management encouraged will depend on the economic, political and ideological drivers in each country.

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[1] Of course, corporate shareholders and institutions are themselves alternatively owned by individuals.

2.2.1 Government Ownership

The two common types of government ownership are:

a) Fully regulated government ownership

This is the case in many communist and socialist countries, the People's Republic of China for example. According to S. Hunt and G. Shuttleworth [14]:

> *"The government is entitled to all the profits of production, appoints the same managers and regulators to run and control industries, although sometimes, they have different nameplates in their different roles".*

b) State owned corporation

This form of ownership is derived from fully regulated government ownership but with arms length control. A committee or board is appointed to set the goals of the corporation as well as to implement other national polices such as promotion of the use of renewable energy or the pursuit of rural electrification. This is the case with the Electricity Generating Authority of Thailand (EGAT), Power Grid Corporation of India Ltd., and the Victorian Energy Network Corporation (VENCORP) in Australia and used to be the case with the Central Electricity Generating Board (CEGB) in the U.K.

2.2.2 Private Ownership

Private ownership can be classified as:

a) Publicly owned corporation

This is a form of private ownership "privatized" from the stage of state owned corporation, but the government may still hold enough shares, as in Singapore, to retain control. It seems difficult to transform ownership directly from a state enterprise to a completely private company due to political and ideological constraints. A possible solution to assist with the gradual privatization or as a permanent arrangement is to form a joint stock company with only a minority of shares held privately. Systems of this type are usually regulated by an independent regulator [15].

b) Privately owned company

This is completely owned by private capital, but the company is still heavily regulated because it is a natural monopoly, for example a conventional utility, or a new style ESI asset owner or operator. Usually these companies are listed on the stock market.

2.2.3 Mixed Ownership

In the Nordic group of countries in Europe, as well as in China, India, and elsewhere, state, private and cooperative property forms have, or are, being created to assume control of different sectors of a newly unbundled electricity supply industry. In many variations and combinations, transmission still remains a state owned asset, while competition is introduced into the power generation sector and the practices in respect of distribution services are variable. The Nordel experience is also

of interest in parts of Asia where regional (international) power markets exhibit variation in their existing structural arrangements.

2.3 Restructuring Procedure

2.3.1 Commercialization/Corporatization

'Commercialization' and 'corporatization' are the processes of transforming a direct government ownership to a state owned corporation. Commercialization places emphasis on a change in behavior rather than ownership by adopting commercial business practices and separating the core business from other functions. S. Hunt and G. Shuttleworth [14] note that Corporatization is "the formal and legal move from direct government control to a legal corporation with separate management".

2.3.2 Privatization

Dinavo [16] defines privatization as a process of transferring assets and service functions from the government to private sector. The impact of privatization is not only on the national economy and on social welfare, but it is also very sensitive to employment and trade union issues. This is especially the case in developing countries where potential buyers within a country are limited and foreign investors are wary of these concerns.

2.4 Modelling Structure

The pre-reform organizational structure has a significant effect on the shape of the post-reform structure [17]. Different pre-reform arrangements appear to give rise to different post-organizational structures. Using G: Generation, T: Transmission, and D: Distribution. The known or reasonably feasible organizational structures of the ESI can be formulated and categorized as described below:

$$\sum_{i}\{GTD\}+\sum_{j}\{GT\}+\sum_{k}\{TD\}+\sum_{l}\{G\}+\sum_{m}\{T\}+\sum_{n}\{T(G)\}+\sum_{p}\{D\} = \text{Structure Type } \lambda \qquad (1)$$

where, λ = one of the following organizational structures which can be described as follows:

Type{a}: 1GTD: One fully integrated national utility; i =1; j, k, l, m, n, p = 0;

Type{b}: 1GT+∑D: one integrated national generation/ transmission utility and several distributors; j = 1; p > 1; i, k, l, m, n = 0;

Type{c}: ∑G+1GTD: One integrated-national generation / transmission/ distribution utility, and several generators (e.g. IPPs); i = 1; l >1; j, k, m, n, p = 0;

Type{d}: ∑G + 1GTD + ∑D: one integrated national generation/transmission/ distribution utility, and several generators, and distributors; i = 1; l, p > 1; j, k, m, n = 0;

Type{e}: ∑G + 1TD: Several generators and one integrated national transmission /distribution utility; k = 1; l > 1; i, j, m, n, p = 0;

Type{f}: ∑G + 1T + ∑D: one national transmission facility and several generators and distributors; m = 1; l, p > 1; i, j, k, n = 0;

Type{g}: ∑{GT} +∑D: Several regional integrated generation/transmission utilities and several distributors; j, p > 1; i, k, l, m, n = 0;

Type{h}: $\sum G + \sum T(G)$ (unified) $+\sum D$: one unified transmission facility with several transmission owners owning generators[2] and several producers and distributors; l, p > 1; i, j, k, n = 0;
Type{i}: $\sum\{GTD\}$: several regional fully integrated utilities; I > 1; j, k, l, m, n, p = 0;
Type{j}: $\sum G + 1T(G) + \sum D$: one national transmission facility own generators with several producers and distributors; n =1; l, p > 1; i, j, k, m = 0.

The organizational structure and ownership status between pre-reform and post-reform situations seen around the world can be illustrated in Table 1. The vertical regulated utilities–organizational structure type a, b, c, d and g – were implemented before the reform while the structure type e, f, h and j are deregulated systems. The suitable post-reform organizational structures in each country depend on their inherited structures. In most developing countries, the inherited structure of the electric utilities was state or local government owned. These countries can learn to devise efficient structures in the context of the prevailing local conditions of the utility industry, rather than follow a single model of restructuring [18].

Table 1 Pre-reform and post-reform situation worldwide

Country	Pre-reform		Post-reform	
	Type	Ownership	Type	Ownership
Australia	NSW VIC QLD SA b a b a	Government	f	Private (VIC)
England & Wales	b	Government	f	Private
Northern Ireland	a	Government	e	Private
Norway	d	Municipalities	f	Municipalities
New Zealand	b	Government	f	Mixed ownership
United States	g	Mostly private, Some G federal	h	Mostly private, Some G federal
Argentina	d	Government	f	Private
Chile	d	Government	f	Mostly private
Japan	i	Private	i	Private
Thailand	c	Government	f or j ?	Mostly private Some G government

Sources: Yajima (1997), NEPO (2000)

2.5 Integration or Separation?

The question behind the objective of restructuring is what type of transmission system structure should be applied in developing countries – an integrated TO/ISO or a separated TO/ISO. Two distinct examples are the former UK system – National Grid Company (NGC) [19], and the now defunct California ISO/PX.

In general, the transmission company structures seen around the world are a result of the starting point of the reform. If there were multiple grid owners before introducing a competitive market, there are likely to be multiple owners later on (invariably the same). This has been the case in California where there were three investor owned utilities (IOUs) [15]. Since they continue as power suppliers after restructuring, their transmission assets have to be placed under an ISO for unified open access operation of the three sets of transmission facilities as shown in Fig. 4.

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[2] This is the case in California where most transmission owners still continue to own their generators.

In contrast, if all transmission assets were under the control of a single entity before the reforms, they usually continue to be owned by a single company afterwards (see Fig. 5). This was the case in England and Wales, New Zealand and all the Nordic group of countries. In Thailand, like most countries in Asia, all transmission assets have a single owner, usually a state-owned enterprise. In this case, there is no need to separate transmission facilities from the control function and also no valid reason to privatize the grid and hand it over to profit seeking investors.

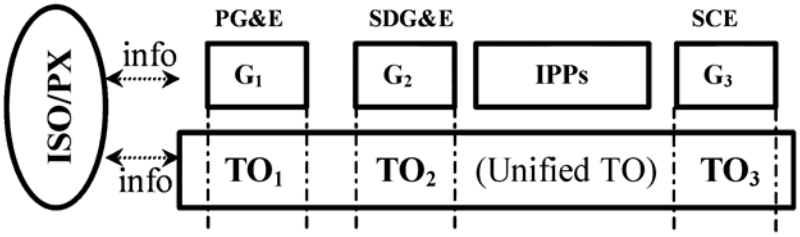

Fig. 4 System with private multiple transmission owners in California

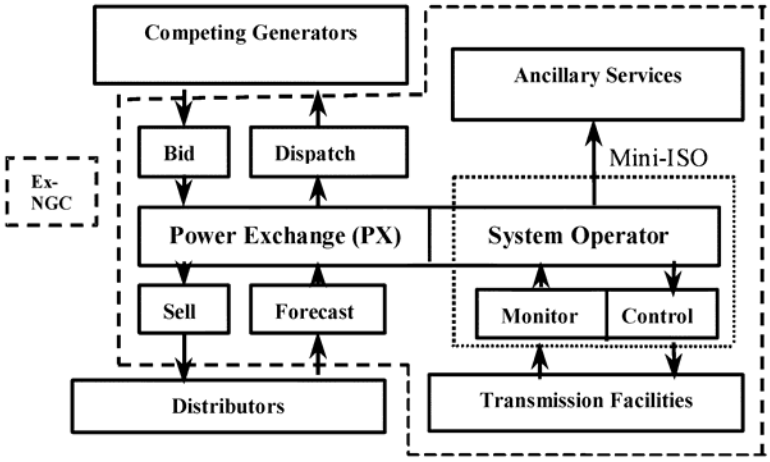

Fig. 5 Integrated system (former UK type)

2.6 A National Transmission Authority: An Option for Asian Developing Countries

2.6.1 Organizational Structure

The term National Transmission Authority (NTA) is introduced here to represent the case where transmission ownership (TO), dispatch (ISO) and market operation (Pool/PX) remain within a single body or holding organization and its ownership is separated from all other ESI participants including EGAT (G). This is different from the former U.K. pool, NGC of England & Wales, only in the sense that the NGC is a listed private company [19] in the UK while the NTA is envisaged to be in the hands of the government.

In Asia, in the context of major transmission expansion needs, the role of government intervention and control is important. In Thailand, Sri Lanka, China and other developing countries, transmission is a key part of the national economy and as such system expansion needs to be financed,

regulated and implemented at a national planning level and hence should not be privatized. In general, a National Transmission Authority will include several different divisions as follows.

- Mini-ISO to perform control actions focusing on network switching security and reliability including re-configurations, transactions, curtailments, re-dispatch of generations and congestion management.
- High voltage wire provider (TO) to represent legal ownership and take the responsibility for maintaining physical operation and maintenance (O&M).
- Expansion and planning division (E&P) which has two major functions:
  - Responsibility for future planning and investment needs as indicated by generation market growth trends and transmission expansion to consolidate a national grid;
  - Responsibility for determining and designing of proper tariff for the use of the transmission network. The tariff must encourage the efficient use of the existing transmission system and also send correct signals for future transmission expansion and investment.
- Power Exchange division (PX) to provide the commercial market place, manage the power market and carry out the settlement of accounts.

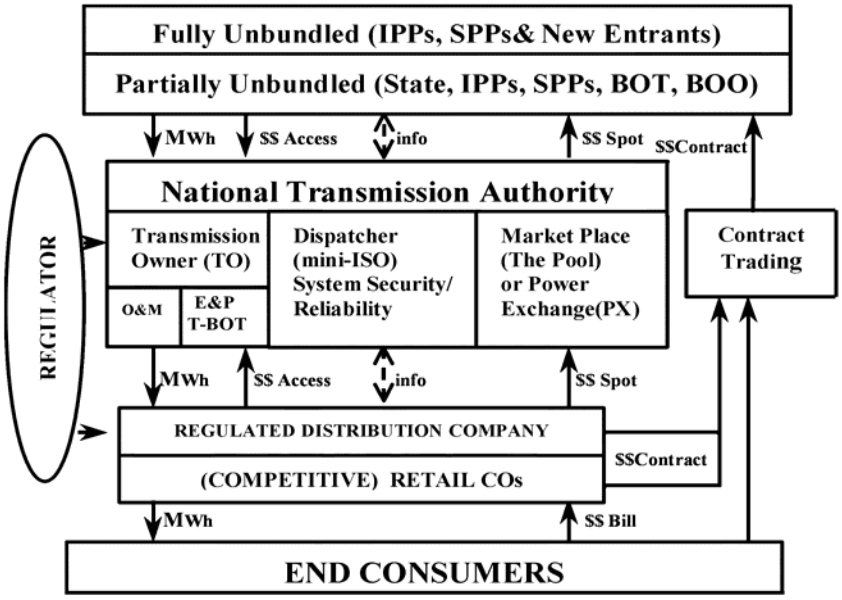

Fig. 6 Power market structure with national transmission entity

The NTA is envisaged as a public domain entity at arms-length from government, rather than a government department. This model is suited to countries where the transmission grid is developing rapidly and the decision making for transmission expansion is a critical issue of national policy. Fig. 6 illustrates an example of a power market structure incorporating an NTA model.

Some characteristics of the NTA model are:

- Owner and operator of the grid;
- Responsibility for providing transmission services;
- Determining, procuring and funding grid investment in collaboration with the national government;
- Operating the day-ahead and real-time market;
- Completely independent of generation ownership;
- Regulated by an independent regulator.

In the context of rapid system expansion as in Asia, keeping transmission ownership and operation functions together will be beneficial as this will minimize organizational, policy and political complications and ensure smoother implementation of strategic growth plans in the long run.

The sine qua non for a successful NTA refers to a stable and supporting political environment in each particular nation with a sound legal and administrative framework. Hence, the specific relationships between different divisions or subsidiaries within some form of holding organization or business structure in the NTA need to be worked out case by case and country by country.

2.6.2 Transmission Investment under NTA Framework

The experiences of China, India, Indonesia and indeed almost all Asian developing economies indicate that the foreign and local investor sector have not been able to make any significant contributions to transmission expansion. This is because commercial profitability and essential infrastructure building are not congruent tasks. While foreign and local investors have a useful role to play in the generation sector, and to a certain degree in the distribution sector, they will most likely make no significant contribution to the transmission sector. Transmission expansion planning and investment are natural candidates for national planning.

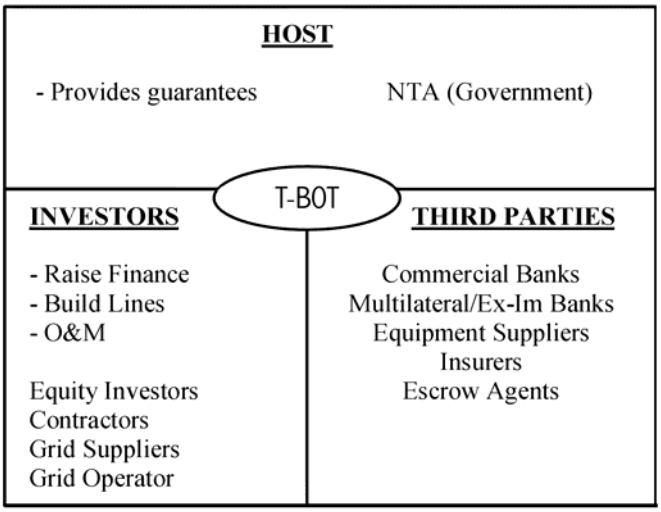

Fig. 7 Transmission investment structure under NTA framework

However, since total capital investment for transmission expansion may be too large to meet entirely from government and multilateral financial institutions, it is useful to explore the possibility of securing a portion from private investors. One way to attract private investment while retaining strategic control of grid development in the hands of the state is the Transmission-Built-Operate-Transfer (T-BOT) option. In a T-BOT arrangement, investors (consortium partners) are the owners of the lines until the agreed time for ownership transfer to the host utility. The following are the main parties to a T-BOT arrangement and can be depicted in Fig. 7.

- NTA as the host, backed by the government, which provides final guarantees to investors.
- Investors or consortium partners who raise finance, build lines and carry out O&M duties.
- Third parties such as commercial banks and insurers.

The detailed description of the BOT arrangement lies outside the scope of this thesis but some publications as in [12] and [13] may be useful.

3. LESSON LEARNT FROM THAILAND'S EGAT

EGAT was established in 1969 by merging three regional utilities to form a centralized state-owned enterprise. EGAT has responsibility of providing electric power for the whole country by generating, transmitting and selling bulk power to two distribution agencies – the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA). EGAT's mission has been also to expand generation and transmission capacities and accelerate electrical supply to rural areas.

3.1 System Structure

EGAT, owned solely by the government which guarantees all of the outstanding debt obligations, has over 18,000 MW of installed generation capacity. The EGAT Act. obliges the government to provide state appropriations to the company if funds to cover revenue deficiencies cannot be obtained from other sources.

3.1.1 Generation

At the time of this writing, about 65% of the total installed capacity is from EGAT built plant while about 32% is from power purchase agreements (PPA) with the private sector and Laos PDR. EGAT built plants include about 2,886 MW (13%) hydropower, 6255 MW (28.5%) thermal power, 5,318 MW (24%) combined cycle plant, and 540 MW (2.5%) gas turbine and diesel oil power plant. Other generation participants are mainly private sector plants under contract to EGAT such as the Electric Generating Public Company of Thailand (EGCO), independent power producers (IPPs) and small power producers (SPPs). EGAT's power development plan indicates that EGAT and these private participants will add 21,000 MW of capacity to come on line between 1999 and 2011 from several projects. Projects include new EGAT-built plants, 7 selected IPP projects (5,900 MW), 53 selected SPP projects (2,000 MW) and power purchase from foreign generators. This additional capacity will boost total capacity to 39,400 MW compared with an expected peak demand of 22,000–31,000 MW, assuming average growth of 4% through 2001, 6.5% through 2006 and 6.65% through 2011.

3.1.2 Transmission

The whole EGAT transmission system is interconnected and divided into 5 regional service grids - the Metropolitan Area Grid, the Central Grid, Northern Region Grid, North-eastern Region Grid, and Southern Region Grid. Some Grids are interconnected to neighboring Laos PDR and Malaysia. The transmission system voltages in use are 500, 230, 132, 115 and 69 kV.

3.2 Privatization Master Plan

Privatization in the energy sector had been planned and implemented gradually for several years in Thailand but the 1997 economic crisis led the government to accelerate privatization and encourage competition in the hope of reducing the debt burden and enhancing private investment flows. The proposals also included reforms of the electricity supply industry and the establishment of a power market.

In September 1998, after a lengthy examination of economic, political and ideological issues, the government of Thailand approved a Privatization Master Plan (PMP) for all parts of the national infrastructure including communication, transportation, water supply and energy supply [8].

The restructuring of the power industry in the PMP is divided into three stages. The first stage began in 1999 and the last stage will reach completion in the year 2003 at which stage, a wholesale spot market would have been established with generation entities and retail suppliers. The PMP envisages that all of the EGAT's generation facilities will be privatized and broken into different business units which would compete against each other and against new private entrants into the generation market. The last stage also envisages that the transmission system will be privatized, and "EGAT-T", a separate transmission company will be established as a subsidiary of the EGAT holding company. This holding company functions as "publicly owned corporation" which allows it financial and managerial autonomy compared to old style state enterprises, but the government will still hold enough shares to retain ultimate control. It seems difficult to transform ownership directly from a state enterprise to a completely private company in Thailand or other similar developing countries due to political and ideological constraints. A possible solution to assist with the gradual privatization or as a permanent arrangement is to form a joint stock company with only a minority of shares held privately [14]. Moreover, the "ISO option" (separation of system control from grid ownership) has also been included in the PMP, imitating similar arrangements in some Western countries.

3.3 Progress to Date

At the time of writing this paper, there is a significant change in the direction of the restructuring of the ESI due to the reform of the political sector under Shinawatra's administration. This includes the change in the regulatory body in the energy sector from the National Energy Policy Office (NEPO) to the Energy Policy and Planning Office (EPPO) whose organizational control body was turned over from the office of the Prime Minister to the brand-new 'Ministry of Energy'. Under these changes, the establishment of an electricity market has been shifted out of the PMP including the plan for the completion of horizontal unbundling of EGAT's generation assets. However, the new focus of government policy is on the promotion of local products and services and therefore there is some hope that this administration would embrace the concept that is similar to the NTA discussed in Section 2.6.

3.4 The Case of Ratchaburi Power Plant

This was the case when the privatization of Ratchaburi power plant, the largest installation in the country, was strongly opposed by EGAT's labor unions in 1999. This critical situation led to a reversal of privatization plans and created uncertainty in introducing competition and creating a power market. Moreover, risk and financial uncertainty are also of concern in privatization because the stock market in Thailand has still not fully recovered from the Asian crisis. The weak market will have difficulty absorbing large sales of generation assets. Hence, it is possible, if sales prices are low (lower than book value), the government will back off, and consequently the entire plan to create a power market will falter.

3.5 Concerns

The consortium of international consultants mentioned previously proposed that EGAT should retain a significant stake in both the generation and transmission business, but that all non-hydro generation facilities should be privatized. In reality, however, EGAT may not be able to divest its generation utilities completely by the time of power pool commencement envisaged in the PMP. Many

factors are involved, and in particular a combination of political and social pressures make it difficult to privatize generation facilities whose investment burden has been borne by the state out of public funds. Other concerns are on the 'structural problem' like multi-ownership of the transmission network that may lead to the physical undesirability like a 'loop flow' problem if government, under new administrative policy, opens the door for EGAT to turn over the ownership of the transmission system into a listed privately owned corporation and separates the control function from the transmission facilities. In Thailand, like most developing countries in Asia, the national grid is the fundamental structure of transmission systems historically under Thailand's network topology which is advantageous to the national security and economy in preventing some of the complex problems which have been occurring in the developed world.

3.6 Cross Ownership Problems

Two issues arise about the transmission structure to be employed in Thailand – an integrated TO/ISO or separating the TO and ISO functions, and secondly, combining or separating the TO from EGAT (Generation). This pair of issues, mutatis mutandis, is relevant to almost every developing country in Asia (see Fig. 8).

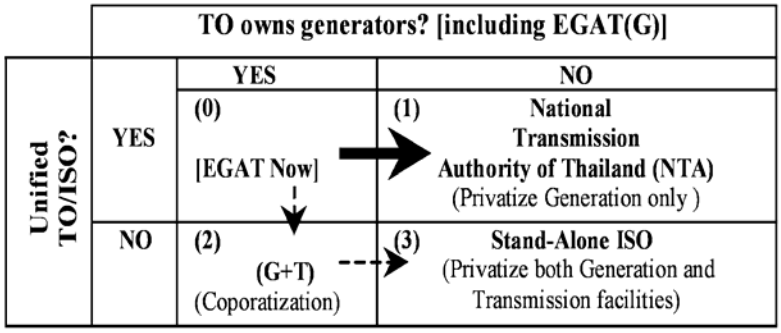

Fig. 8 Progression matrix for transition to a competitive market

EGAT now owns both generation and transmission facilities and also integrates grid ownership with control. Box **(0)** in Fig. 8 illustrates the starting point for change of transmission ownership and reorganization of system control. There are two alternative paths that the Thai government can choose - path **(0) →(2) →(3)** or path **(0) →(1)**. The former is the case when the government is moving EGAT's status from **(0)**, or "EGAT Now", to a stand-alone ISO arrangement. Following this path, the government will first corporatize EGAT's utilities into several business units and then privatize both EGAT's generation and transmission facilities (PMP). This is the approach proposed by the international consultants; the final arrangement is analogous to the system illustrated in Fig. 9. However, if the government splits both grid ownership and control functions from EGAT (G) and keeps transmission and system control within a single entity as illustrated in Fig. 6, it would be taking the path **(0) →(1)** of Fig. 8. The alternatives, therefore, can be summarized as follows:

Alternative (a): The ownership of the transmission grid will be retained with EGAT (G) or grid ownership will be (partly/fully) separated from EGAT (G) by privatizing the transmission grid; path **(0) →(2) →(3)**. A stand-alone ISO option is essential in this approach to achieve open access.

Alternative (b): The ownership of the grid will be legally split from EGAT (G) with the creation of a national transmission authority which could include both transmission ownership and ISO activities; path **(0) →(1)**.

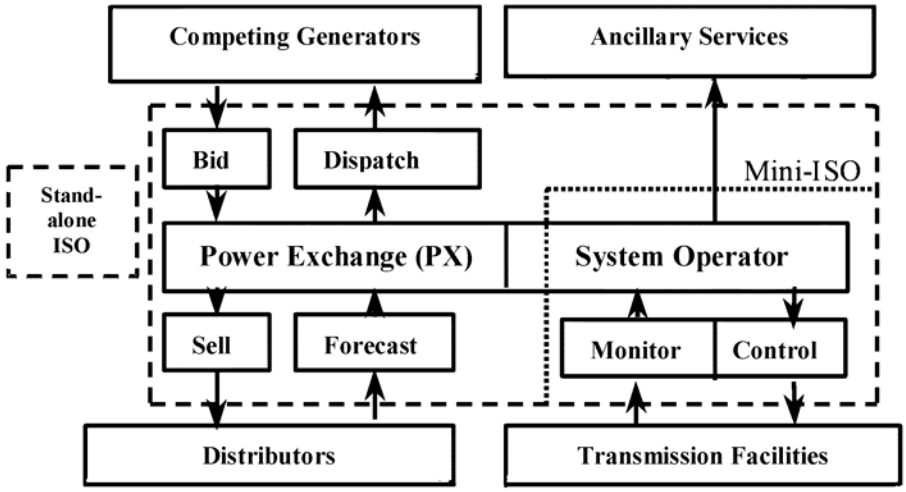

Fig. 9 Stand-alone ISO incorporating the power exchange (PJM type)

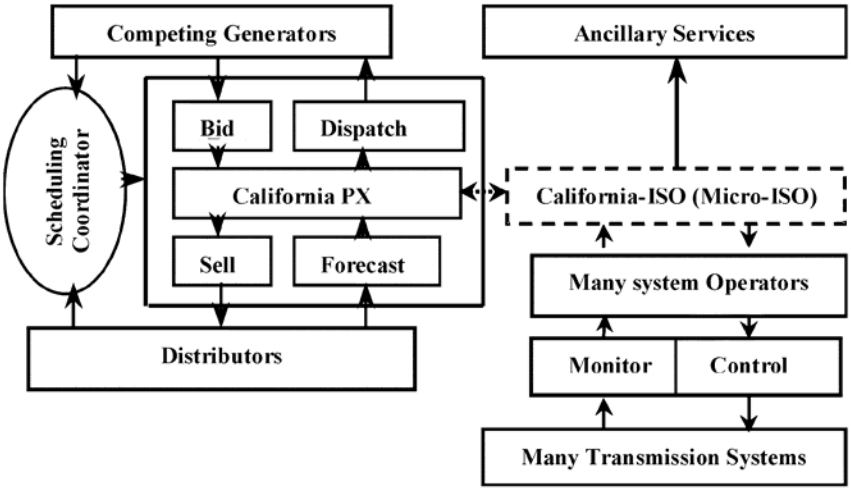

Fig. 10 Micro-ISO with a separate power exchange (California type)

In the case where alternative (a) is specified, the system operation can be a stand-alone entity (Mini-ISO+PX) [20], as illustrated in Fig. 9, which has responsibility for managing the use of transmission and ancillary services and also for coordinating the power market as in the case of the National Electricity Market Management Company (NEMMCO) in Victoria and the PJM Interconnection in the United States.

Alternatively, the system operation can be separated into a transmission operation and a power exchange (Micro-ISO+Separate PX) [20] as illustrated in Fig. 10. This type of system operation was implemented in California [18] [21]. In the NTA, discussed in section 2.6, these different activities may belong to different divisions of one holding organization.

3.7 Proposed Changes

It would be much wiser for the government of Thailand to reconsider the privatization of transmission assets envisaged in the PMP, remove grid ownership from EGAT (Generation), create a "National Transmission Authority", discussed in section 2.6, and turn entities like Ratchamburi into public corporations that are required to compete in an electricity market. The private sector will, in this scenario, enter the market through new plant investments, instead of attempting to gain control of existing state assets. That is to say, following Alternative (b); option **(0)→(1)** is encouraged.

4. THE CASE OF SRI LANKA

The Ceylon Electricity Board (CEB), a monopoly national utility, owns a relatively small system of less than 1000 MW capacity dominated by several multipurpose (irrigation, power and flood control) hydro schemes. A sparse grid covers the whole island but penetration of supplies into rural areas, where a large portion of the population lives, is inadequate. The distribution network in most cities is overstretched resulting in poor reliability and poor quality of supply. The system, like most in Asia, faces investment capital shortfall concerns.

4.1 The Principal Issues

The need for extensive restructuring of the Sri Lanka ESI is palpably obvious but has not been addressed because the design of a proper alternative structure for the system has not been thought through. The overall generation expansion program is not established and in recent years has proceeded by ad hoc decision making. One problem is that at the national policy level, the role of private investment has not been formulated unambiguously and consensus achieved, nor has the distinction between privatization and private sector participation been appreciated and clarified in government pronouncements.

Privatization of the existing state owned generation assets is neither possible nor desirable, especially in the case of hydro plants where down stream flows need to be regulated to service short term and seasonal agricultural needs. There is also no reason to privatize the remaining relatively much smaller CEB owned thermal plant and encounter employee and political hostility. It is better to require this plant to generate competitively against potential new investor owned plant and some recently added BOT plant.

Corporate management is not strong or purposeful, high professional standards in decision making run up against indecisive decision structures, accountability is poor, graft is widespread and employee productivity is low. Hence a range of objectives, not simply a concern with creating an artificial power market, should motivate a thorough reform of the electricity supply industry in Sri Lanka as in many other Asian countries.

4.2 An Approach to Restructuring

Private investment in new generation, which certainly would involve foreign participation, is required. There is also a need for additional investment in the distribution sector to improve reliability

and technical performance and to extend supply to new customers. There is potential for commercial success in city distribution business while rural electrification will continue as a subsidized national infrastructure development activity. Hence the structure of reform in Sri Lanka must incorporate the following major elements:

(i) Incorporating state owned hydro-generation, which will be superimposed on the system according to weather patterns and irrigation needs, in power dispatch.
(ii) Divesting state owned thermal-generating plant into competitive public sector commercial corporations.
(iii) Developing a methodology for (i) that is acceptable to competing commercial generators including (ii).
(iv) Unbundling distribution and vesting those that require large additional investment in private companies.
(v) Creating a framework to ensure that rural electrification continues to progress.
(vi) Establishing an NTA as described in Section 2.6.

The expansion of generation capacity and including in this framework a large thermal, preferably coal fired, component is the major investment needed at this time. However, for reasons, too many to summarize here, there is a measure of uncertainty in respect to both technical and geographical decisions in this matter. This spills over directly as complexity and uncertainty in long term national transmission grid structuring. This provides additional justification for establishing a transmission authority which is empowered with authority in policy matters.

5. DEVELOPMENTS IN CHINA

China's electricity supply industry is divided into 15 regional power grids, some covering a single province or region, while others combine two-to-four provincial power companies. The largest is the East China grid serving Shanghai and the surrounding region, which has an installed capacity of about 48,000 MW. The other large ones are the North China, Northeast China and Central China Power Networks, and the Guangdong, Northwest and the Shandong Provincial Grids. Other networks are much smaller particularly in the less developed regions.

5.1 Reform Plan

The most important new development is the State Power Corporation (SPC) reforms comprising several stages. The first, implemented in 1997 was the SPC taking over of the role of the Ministry. The second, now current, stage aims to turn provincial power bureaus into electric power companies and establish a core group of IPPs; create one utility in every county, and restructure financial mechanisms. Further stages, beyond 2003 assumes that a national power market will be available so that a competitive national power generation market can begin to take shape.

The SPC's role could be very important in achieving long term national goals as a matter of priority. The reforms could, however, restrict foreign businesses entering the market as government subsidies allow Chinese power generators to produce electricity at cheaper prices. For example, National Power, UK, may have to delay its $1.8 billion investment in Zhejiang province. Nevertheless, it is essential that the reforms be developed systematically, taking the country's long term needs as fundamental, while the pace of power-market innovation has to be seen not as an end in itself but as a tool for this purpose.

5.2 Progress of Reforms

The claims sometimes made of power pool implementation are premature. Some operators in the Shanghai pool have indicated that the ground rules for pool operations are not at all clear and

officials in Shandong have stated that their planned pool is not ready for implementation. In some areas, it is possible that the power pool will be little more than an alternative method for allocating off-peak output which has traditionally been priced at a discount, but on a negotiated, not spot market, basis. Advice from international expertise is not always appropriate, there is a delay between policy announcement and implementation and there are reversals of policy, as China climbs a difficult learning curve.

By far the greatest change for China's power industry in recent years has been the creation of the SPC, as a replacement for the Ministry of Electric Power. The SPC is a government entity, but the Chinese Government's decision to establish it points the way towards a greater use of market mechanisms. Hierarchically below the SPC are increasingly independent regional, provincial and district level entities running generation, transmission and distribution activities. Though government owned in the formal legal sense, these entities, which also operate privately financed plant, are of great importance. Devolution of greater autonomy and authority to this level will be a crucial requisite in invigorating ESI development in China.

The ownership of generation and transmission is likely to be unbundled and will pave the way for more power market operations and motivate some changes in power pricing. It is unlikely, however, that even on the more advanced Eastern seaboard this process will be completed for another decade.

Generators will bid for access to the grid and the transmission company will purchase from the lowest bidders for sale to consumers. The provincial subsidiaries are likely to sign five-year contracts with the power generators and undertake to purchase 80% of the output. From the perspectives of this thesis, the important point is that the proposed provincial state owned transmission companies will have to extract part of the funding needed for China's huge future transmission and distribution expansion from surpluses or taxes in power-market operations.

5.3 Future Growth

Development of the transmission and distribution systems is a major challenge for the future and is often lost sight of in discussions that focus on the more profitable generation sector. It is anticipated that $15.2 billion will be required for T&D investment in the country, one-third in urban areas and two-thirds in rural areas.

The Three Gorges project, which will be completed by 2009, is centered on the north-south and east-west portions of an emerging national grid. The grid developments will include several major HVDC lines, thousands of kilometers of 500 kV AC lines and incorporate FACTS, SVC and series compensation equipment.

The Chinese government is planning a proposal for a Xinjiang-to-Shanghai natural gas pipeline with massive generation facilities en-route, additional hydropower projects and expansion in pumped storage.

The regional power markets being experimented with at this time must, therefore, be compatible with the needs and opportunities of the future. Great care has to be taken not to set in stone, at this time, impediments to long-range national priorities. This prioritization is not difficult to achieve since the central and provincial governments are the big spenders, key players and driving force behind the grid development as China's installed capacity approaches 300,000 MW, second in size only to the United States.

5.4 An Approach to Restructuring

In the long term, it is certain that private investment in new generation involving foreign participation will grow. There is also a need for additional investment in the distribution sector to improve reliability and technical performance and to extend supply to new customers. Hence the structure of reform in China will include the following major elements:

- Incorporating state owned hydro-generation, which will be superimposed on the system according to weather patterns and irrigation needs.
- Developing a methodology that is acceptable to diverse commercial generators.
- Unbundling distribution and vesting some that require large additional investment in private companies.
- Establishing an NTA as described in Section 2.6.

As the Chinese economy continues to grow rapidly, after WTO entry, long term growth in the power industry is unlikely to slow down. Whether deregulation of utilities happens as quickly and as smoothly as some authorities and of course investors, hope, remains to be seen. If the proposed west-east, Xinjiang-to-Shanghai, natural gas pipeline goes ahead, the Chinese energy market could change significantly. If gargantuan projects like Three Gorges are successful, we may see more large-scale projects in the future. Two things remains certain; China is still the largest potential market for electricity in the world; NTA-type structures, perhaps more than one such structure because of the large scale and complexity of development, are essential for China.

6. THE CASE OF ASEAN POWER GRID

ASEAN Power Grid is a regional collaboration program under the ASEAN Vision 2020 protocol[3], detailed in the Hanoi Plan of Action[4] and further detailed in the ASEAN Plan of Action for Energy Cooperation 1999-2004. This is an infrastructure project involving integration of the electrical transmission networks of the member countries. There are 14 cross-border grid interconnection projects (see Fig. 1) which aim to provide economic generation and transmission of electricity, greater security of power systems and facilitate energy trading among ASEAN countries.

ASEAN Power Grid Project will lead to a larger scale of regional electricity trading in Southeast Asia and hence increase the potential market for electricity in the region. The policy and the implementation of the project are of course retained at the ASEAN state planning level. Under this circumstance, the NTA-Type structure is essential for each member countries in order to gain benefit of security and control function of the system. Internationally, it can be extended to the larger scale of transmission authority introduced here as 'the International Transmission Authority – ITA'. The ITA will empower control of the transactions and planning policy so that the utilization of the unified grid will be fair for all member countries.

In order to achieve the large scale of investment and expansion of transmission system across the border under ASEAN Power Grid project, the T-BOT approach discussed in section 2.6.2 is therefore encouraged. In the longer term, the progression of the project may be extended to other neighboring countries like India and China. Although there is an uncertainty for such scenario, the

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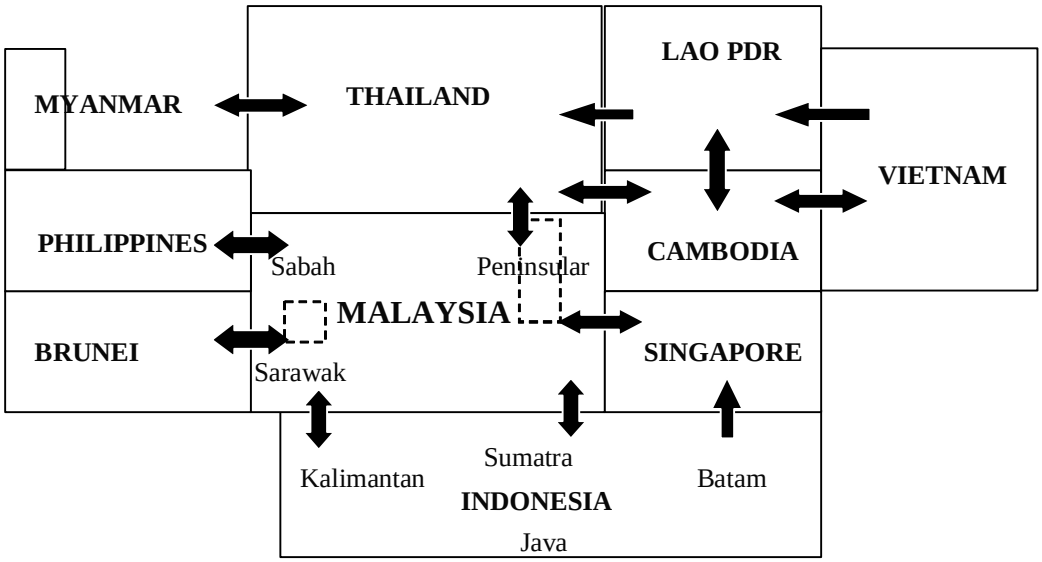
[3] This is to establish interconnecting arrangements in the field of energy utilities for electricity, natural gas and water within ASEAN through the ASEAN Power Grid and Trans-ASEAN Gas Pipeline, and promote cooperation in energy efficiency and conservation, as well as the development of new and renewable energy resources.

[4] This is to ensure security and sustainability of energy supply, efficient utilization of natural energy resource in the region and the rational management of energy demand, with due consideration of the environment. This plan was adopted by the ASEAN Heads of State at the 6thASEAN Summit, Hanoi, Vietnam, December 15-16, 1998

creation of transmission authority like NTA/ITA could be a solid ground for the long term planning which is essential for Asian power infrastructure.



Source: The ASEAN Center for Energy (ACE)

Fig. 11 The future ASEAN electricity trading

7. IMPACT ON SYSTEM OPERATION AND OTHER RELEVANT ISSUES

The impact of NTA-type structures on the power system operation is considered below:

7.1 National/Regional Control Center(s)

Control center or the mini-ISO function in the NTA, is the most important part, which has responsibility for maintaining reliability/security at an acceptable level. Although the unified national grid is needed under the NTA's framework, there are generally several regional control centers that need to be coordinated closely. In Thailand, for example, there are five regional control centers spread throughout the country. Similar conditions exist in India and China where regional markets are making more general competitive markets possible until a fully integrated national grid is achieved. This has led to a major concern - how regional control centers can be linked to the national control center in a reliable fashion? Hence, there is a need for steady stage-by-stage development of a new national control center and linkages to regional control centers using the latest technology available.

7.2 Security Management

A lesson can be learnt from a critical difficulty encountered in California in 2000-2001 and in the New York blackout of 2003. The focus should be on the prevention of extensive outage rather than on restoration after the occurrence of such outages. This was the case, for example, when Pacific Gas & Electric Co. spent $8.3 million to resolve 98 percent of some 6,600 outage-related claims in the summer of 2000 [22]. Under the NTA's framework, particularly on the management of security, all

market participants need to communicate promptly to NTA accurate and adequate information before and after an unexpected event. This will have an impact on the cost of system operation of the participants in order to maintain the NTA's standard of such system security.

7.3 Relevant Issues

Other important issues also arise in fast growing developing countries when competition in the electricity supply industry is introduced. Chief among these issues are (i) the utilization of the transmission network by market participants that need to be priced to cover both short-run operating cost and long-term system expansion and investment, (ii) the partitioning of market share among suppliers to ensure appropriate competition and minimize the potential for market power to be exercised by a dominant firm or groups of firms such as cartel arrangements, and (iii) the prevention of physical strategy to be exerted by a generator such as the inducing of transmission congestion to lockout competitors and create a local monopolistic market. These issues should be considered and worked out case-by-case and country-by-country.

8. OBSERVATIONS

8.1 Observations and Recommendations on The NTA Framework

When the NTA approach is adopted, then the ownership of competing generators can include state-owned, municipal owned or privately owned generators. This is the case in the Nordic group of countries in Europe, as well as in China, India, and elsewhere, where state, private and cooperative property forms have been, or are being, created to assume control of different sectors of a newly unbundled ESI. Thus, the question of whether generation is a state-owned or privatized generation company does not matter. "The NTA" will be a separate national transmission authority, which will own the grid and provide open access to all, including new private participants such as IPPs, SPPs or new private entrants who may enter the future market. The main problems for competition will occur, in Thailand for example, if EGAT's stake in generation is so large that it will have a dominant market position. This will inhibit competition until a reasonable number of larger generation providers enter the market.

8.2 Observations on the Transmission Development

It is observed that there is a need to pursue the projects on the development of transmission expansion in Thailand, as is similar to that of many developing countries in Asia. The question to be answered is who should invest for the required new transmission lines? Does the government have enough funds for these transmission projects since the downturn of the Asian economies? It is argued here that the transmission-BOT approach, as proposed in section 2.6.2 is a suitable option for transmission investment and this will help the government to relieve the burden while still achieving the commitment of providing a sufficient and reliable transmission service to the transmission users.

9. CONCLUSIONS

This paper proposes the development of a national transmission entity during the period of transition to an electricity market in developing countries in Asia. Thailand, since it is of medium size and is reform oriented, has been used as the main case study, but short sections on Sri Lanka, China

and ASEAN Power Grid program have been included to broaden the relevance of the discussion. The core issue is the approach to the transmission system including the relation between the organizational structure and its ownership status. This issue, mutatis mutandis, is relevant to almost every developing country in Asia. Moreover, some related issues associated with the impact on power system operation under such NTA frameworks have also been presented. It is noted that the author does not propose a model, which is the best for all developing countries. However, it is emphasized that the model proposed is suitable for developing Asian countries where major transmission expansion and investment is a matter of key national policy and the role of government policy intervention is a matter of necessity.

10. ACKNOWLEDGEMENTS

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