Electricity Market Integration in ASEAN: Challenges and Opportunities for Thailand

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บูรณาการตลาดพลังงานไฟฟ้าอาเซียน ความท้าทายและโอกาสของประเทศไทย

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วัตถุประสงค์ของการศึกษา เพื่อศึกษาเปรียบเทียบการรวมตลาดไฟฟ้าในระดับภูมิภาคของตลาดไฟฟ้าอาเซียนกับกรณีศึกษาของตลาดนอร์ดิก ซึ่งเป็นหนึ่งในตลาดไฟฟ้าในสหภาพยุโรปที่ประสบความสำเร็จในการรวมตลาดไฟฟ้ามากที่สุด และแสดงความท้าทายและโอกาสในการรวมตลาดไฟฟ้าต่อตลาดไฟฟ้าประเทศไทย แบบจำลองที่ใช้ศึกษาประกอบด้วยการวิเคราะห์ปัจจัยทางการเมือง เศรษฐศาสตร์ สังคมและเทคโนโลยี ประกอบกับการสัมภาษณ์เชิงลึกจากผู้ที่เกี่ยวข้องในการรวมตลาดทั้งตัวแทนจากสถาบันทางวิชาการและภาคธุรกิจ

ผลการศึกษาพบว่า ตลาดนอร์ดิกประกอบด้วย 4 ประเทศเพื่อนบ้านที่มีศักยภาพและมีความสัมพันธ์ทางประวัติศาสตร์และการเมืองร่วมกันมายาวนาน ปัจจัยส่งเสริมความสำเร็จของการรวมตลาด คือการปรับโครงสร้างตลาดไฟฟ้า โดยการแยกส่วนของอุตสาหกรรมไฟฟ้า คือ แยกส่วนการผลิต และระบบส่งไฟฟ้าออกจากกัน เพื่อประสิทธิภาพทางการค้า การแบ่งออกเป็นตลาดขายส่งและขายปลีกของนอร์ดิก เปิดโอกาสให้ผู้ผลิตหลายรายและเกิดการแข่งขันสมบูรณ์ นอกจากนี้การวิเคราะห์ตลาดไฟฟ้าอาเซียนพบว่า ประเทศสมาชิกส่วนใหญ่ในอาเซียน มีโครงสร้างอุตสาหกรรมไฟฟ้าเป็นแบบรวมภาคการผลิต ระบบส่งและการจำหน่ายภายใต้การบริหารของบริษัทเดียว ซึ่งส่วนใหญ่บริหารและควบคุมโดยภาครัฐ การปรับโครงสร้างอุตสาหกรรมไฟฟ้าจึงเป็นความท้าทายของอาเซียนที่จะส่งเสริมการแข่งขันในตลาดมากยิ่งขึ้น ถึงแม้ว่าอาเซียนจะมีความหลากหลายในแหล่งต้นพลังงานในการผลิตไฟฟ้า แต่ความสามารถของระบบส่งภายในภูมิภาคยังคงเป็นข้อจำกัดในอาเซียน สำหรับประเทศไทย มีความได้เปรียบของภูมิศาสตร์และมีประสิทธิภาพของระบบส่ง สามารถเปรียบเสมือนกระดูกสันหลังหลักของระบบส่งไฟฟ้าของอาเซียนในอนาคต การซื้อขายไฟฟ้าของอาเซียนจึงเป็นความท้าทายสำคัญที่จะผลักดันให้ประเทศไทย พิจารณาการเปิดตลาดเสรีมากขึ้นและสามารถเป็นผู้นำของตลาดไฟฟ้าอาเซียนในอนาคต

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The main purpose of study is to investigate the factors regarding regional market integration by focusing on electricity market in ASEAN. The study aims to compare current situation to the best practice in the electricity market integration, electricity market of Nordic. The PEST model was applied to the study and in-depth interviews with participants in the business sector and academic institutions will show challenges and opportunities for the electricity market of Thailand.

The study showed that the Nordic region consists of 4 powerful neighbors, which have strong relationships based on political similarity and a long history of cooperation. The key success factor has been electricity reform and restructuring, which vertically separated the generation and supply function from distribution and transmission networks. The wholesale and retail markets support the competitiveness in electricity trading of Nordic. Furthermore, the analysis showed that most ASEAN countries are vertically-integrated model which market structure was operated by political authority. These caused difficulties in achieving cross-border integration in the electricity market structure in ASEAN. The increasing demand for electricity has led to challenges for ASEAN countries to develop cross border interconnections and to consider the alternative of nuclear power as an energy source for the future. Thailand has geographical advantages that can be hub of ASEAN electricity market. The transmission system of Thailand can be the Back Bone of ASEAN electricity market. The goal to establish a regional power exchange presents a challenge for Thailand to reconsider market reform to create a competitive market in the future.

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ABBREVIATION

ACE	**ASEAN Centre for Energy**
AEC	**ASEAN Economic Community**
AEE	**ASEAN Electricity Exchange**
AERN	**ASEAN Energy Regulatory Network**
AFOC	**ASEAN Forum on Coal**
AGTP	**APG Generation & Transmission Planning institutions**
AIMS	**ASEAN Interconnection Master Plan Study**
AMEM	**The ASEAN Ministers of Energy Meeting**
APAEC	**ASEAN Plan of Action for Energy Cooperation**
APG	**ASEAN Power Grid**
APGCC	**ASEAN Power Grid Consultative Committee**
ASCOPE	**ASEAN Council on Petroleum**
ASCOPE	**ASEAN Council on Petroleum**
ATSO	**APG Transmission System Operator**
COD	**Commercial Operation Date**
CU	**Customs Union**
DSO	**Distribution system operators**
ECC	**European Economic Community**
ECSC	**European Coal and Steel Community**
EE&C-SSN	**Energy Efficiency and Conservation Sub-sector Network**
EEX	**European Energy Exchange**
EGAT	**Electricity Generating Authority of Thailand**
EGCO	**Electricity Generating PCL**
ENTSO-E	**European Network of Transmission System Operators**
EPPO	**Energy Policy and Planning Office**
ERC	**Energy Regulatory Commission**
ESB	**Enhanced Single Buyer Scheme**
EU	**European Union**
FTA	**Free Trade Area**
GMS	**Greater Mekong Subregion**
GW	**Gigawatt**
HAPUA	**Heads of ASEAN Power Utilities/Authorities**
HVAC	**High Voltage Alternating Current**
HVDC	**High Voltage Direct Current**
HWG	**HAPUA Working Group**
IEA	**International Energy Agency**
IPP	**Independent Power Producer**
LTMS-PIP	**Laos, Thailand, Malaysia and Singapore Power Integration Project**

MEA	**Metropolitan Electricity Authority**
MER	**Central American Power Pool**
MOU	**Memorandum of Understanding**
MW	**Megawatt**
NCM	**Nordic Council of Ministers**
NEC-SSN	**Nuclear Energy Cooperation Sub-sector Network**
PEA	**Provincial Electricity Authority**
PPA	**power purchase agreements**
RATCH	**Ratchaburi Electricity Generating Holding PCL**
REPP-SSN	**Regional Energy Policy and Planning Sub-sector Network**
RE-SSN	**Renewable Energy Sub-sector Network**
SAPP	**South African Power Pool**
SOME	**The Senior Officials Meeting on Energy**
SPP	**Small Power Producer**
TAGP	**Trans -ASEAN Gas pipeline**
TPA	**Third Party Access**
TSO	**Transmission system operators**
Twh	**Terawatt-hours**
UCPTE	**The Union for the Co-ordination of Production and Transmission of Electricity**
VSPP	**Very Small Power Producer**
WAPP	**West African Power Pool**

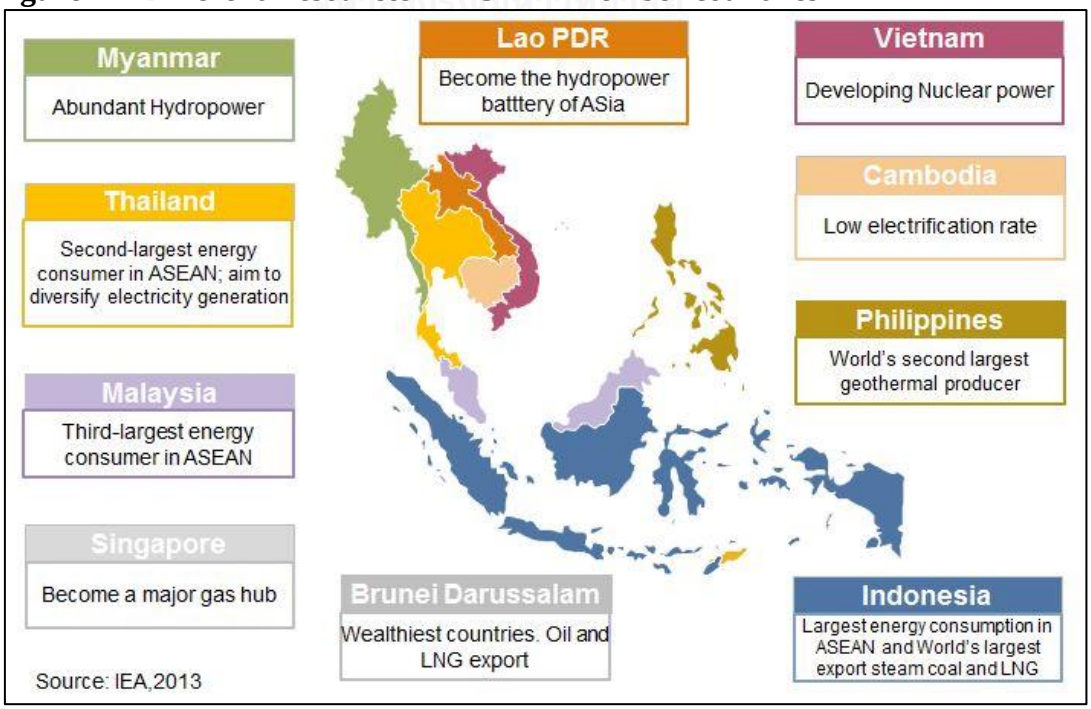
CHAPTER 1
INTRODUCTION

1.1 Background

ASEAN is one of the fastest growing economic regions in the world with rising energy demand driven by economic and population growth. This growth has led to significant increases in energy consumption, which ASEAN member countries have to be concerned about in order to secure a supply of energy for the future. Furthermore, The International Energy Agency (IEA) forecasted that economic and social growth of ASEAN would result in an increase of 4.4% per year in the average rate of final energy consumption in the region until the year 2030 which was 1.4% higher than the predicted global average rate. EGAT (2012) Therefore, preparation of energy resources for the upcoming ASEAN Economic Community (AEC) in 2015 is a great challenge for all ASEAN members, as electricity is an important basis for economic and social development.

In order to ensure electricity supply and share the different resources among member countries, ASEAN electricity cooperation is the way to share the different resources among ASEAN member's countries as Figure 1-1.

Figure 1-1 Different Resources in ASEAN member countries



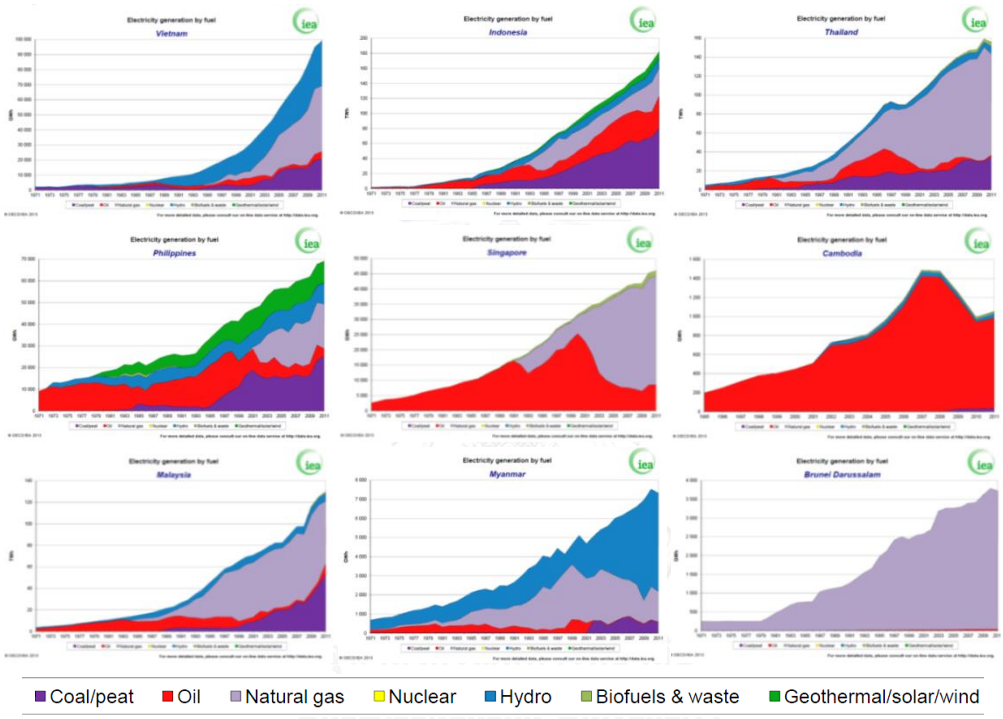
Nicolas (2009) as of 1997, ASEAN heads of state launched energy cooperation with the declaration for ASEAN Vision 2020, which sought to establish an arrangement for interconnections for electricity, natural gas and water within ASEAN through the ASEAN Power Grid and the Trans -ASEAN Gas pipeline and promote cooperation in energy efficiency and conservation, as well as development of new and renewable resources. In 2009, ASEAN ministers repeated their support for enhancing energy security, accessibility and sustainability, and agreed on 26 strategies and 91 actions towards these objectives through APAEC 2010-2015. This plan, the third in a series of action plans to cover the energy component of the AEC blueprint, serves as a blueprint for ASEAN cooperation in the field of energy, to ensure regional energy security while promoting efficient use and sharing of energy resources. Moreover, APAEC 2010-2015 directs ASEAN to enhance energy security and sustainability through accelerated implementation of seven components: the ASEAN Power Grid, the Trans-ASEAN Gas Pipeline, coal and clean coal technology, renewable energy, energy efficiency and conservation, regional energy policy and planning, and civilian nuclear energy**.**

Therefore, electricity plays an important role in ASEAN economic integration. Also the electricity generation mix including oil, natural gas, coal, hydropower and geothermal power (illustrated in Figure 1-2) is an important issue to consider in planning for the future. Atchatavivan (2012) the growing demand for electricity, which is driven by economic and demographic growth, has created a challenging task for ASEAN in the 21th century to achieve the goals of energy security and environmental protection simultaneously.

For Thailand and its neighboring countries, the transmission interconnections have been completed between Thailand and Laos and between Thailand and Malaysia. Today, through the power grid, Thailand is importing electricity of 2,104.60 megawatts (MW) per year from Lao PDR and has planned to increase electricity purchase to 5,420 MW per year by the year 2019. For the transmission within Malaysia, an electricity exchange and purchase of 300 MW is on-going while the Power Grid is being constructed for the import of 100 MW more from Malaysia. In addition, the natural gas in the Gulf of Thailand is decreasing; the price of imported LNG is twice as high as that of indigenous natural gas, which might have an impact

on the energy security and electricity price in the future. EGAT (2012), to deal with these matters, the National Power Development Plan (third revision) of 2013-2030 has reduced the proportion of power plants using natural gas as fuel, while power plants using clean coal technology and power purchase from neighboring countries are substituted to maintain power stability and a reasonable electricity price.

Figure 1-2 Mix of Fuels Produced in ASEAN Countries



Source: IEA

However, ASEAN electricity market integration still has made slow progress. There are many factors that are still obstacles to ASEAN collaboration. This study is concerned about factors affecting ASEAN cooperation in electricity market integration. Thus, this study focuses on electricity market integration in ASEAN by comparative analysis with successful case across different dimensions, to analyse and show the factors that could lead ASEAN to accomplish the ASEAN Vision in regional perspective. Moreover, this study will include an in-depth study of Thailand's electricity sector. It will show the current situation in the electricity sector and electricity trading with neighboring countries and will discuss policy implications for Thailand.

1.2 Research Objectives

This paper aims to study the past and current situation in ASEAN electricity market integration and to draw the implications for Thailand. The objectives of the study are as follows:

- To study electricity market integration in ASEAN
- To show the current situation regarding policies and collaboration in electricity market integration in ASEAN, and to show the push and pull factors of electricity market integration in ASEAN
- To identify advantages, challenges and opportunities for the electricity market of Thailand

1.3 Scope of the study

The study will focus on electricity market integration in ASEAN in term of plans and actions. In addition, comparison with successful electricity market integrations will provide the lessons learned and show the challenges for the electricity market of ASEAN. Also, in-depth interviews with participants in the business sector and academic institutions will provide data to show challenges and opportunities for the electricity market of Thailand.

CHAPTER 2
LITERATURE REVIEW

2.1 Theory of Economic Integration

Economic integration is one of the main trends in the development of international relations in the last few decades. It can be viewed as a way to support development and economic growth in developing countries through the related benefits to trade and welfare. According to Balassa (1961) economic integration can be defined as "the abolition of discrimination within an area." Kahnert defines it as "the process of removing progressively those discriminations which occur at national borders" (Kahnert et al, 1969). Different researchers also define integration differently.

According to the theory of economic integration by Balassa (1961), there are four different stages of economic integration – Free Trade Area (FTA), Customs Union (CU), Common Market and Economic Union. However, there is no consensus in economic theory of the exact number and characteristics of the development forms (stages) of integration. Thus, it can also be classified as eight stages of integration, based mainly on Balassa's approach. This classification is presented in Table 2-1.

BAS (2014) have studied to distinguish the economic determinants of integration agreements that can be divided in three main groups – general economic determinants (development perspective, macroeconomic policy coordination, size of participating countries, integration effects for small countries), market-related (employment and productivity effects, production specialization, protection for industrial development, international competitiveness), and trade-related factors and effects (benefits of trade diversion, initial tariff levels, change of trade structure and transport infrastructure). From the findings of the study above, it is obvious that there are many rationales behind economic integration among developing countries. To assess the integration benefits and costs for developing countries one must consider the stage of economic development, structure of the economy, production characteristics, demand preferences, and trade regime and policies.

Table 2-1 Stages in the Process of Economic Integration

Stage of integration process	Main feature
Preferential Trade Agreement	Lower trade barriers between members
Free Trade Area	Zero tariffs
Custom Union	Common customs tariffs
Common Market	Free movement of production factors
Economic Union	Harmonization and coordination of economic policies
Economic and Monetary Union	Common monetary policy, common currency
Full Economic Integration	Supranational competences, unification of economic policies
Political Union	Common policies in external relations, security, justice and internal affairs.

Source: Balassa (1961)

2.2 Electricity Market Integration: ASEAN

This study focuses on the electricity sector in ASEAN. The scope of the study is to investigate market integration at the regional level, namely, ASEAN. According to theories, market integration includes many stages of market development and requires harmonized market structures and policies. There are many studies that have focused on market integration in ASEAN. The previous studies are described below.

Wu (2013) presented a review of the trends in electricity market integration and drew implications for electricity market development in the East-Asian region. This project reviewed trends of integration in the world's major electricity markets and analyzed the experiences and lessons in those markets. In conclusion, the study showed the major initiatives so far share some commonalities. First, interconnections mainly occur among neighboring countries which have well-developed national markets. Second, sub-regional markets are outgrowths of bilateral electricity exchanges. Finally, market integration is accompanied by domestic reforms and

international harmonization of regulatory standards. These observations have important implications for the development of an integrated electricity market in the East-Asian region. Moreover, the findings in this report also demonstrated that a more open power trade regime encourages the development of renewable sources such as hydro and wind for power generation and hence the total cost of meeting region-wide electricity demand will be reduced.

Chang and Li (2013) focused on the power generation mix in ASEAN. The study built a dynamic linear programming model and simulated the optimal development paths of power generation capacities in ASEAN countries. The scenarios were built around a few different assumptions about the power trade policy regimes. It was found that a more open power trade regime encourages development of renewable sources of power generation, and accrues more savings in the total cost of meeting the growing future power demand from 2010 to 2030. Three scenarios were simulated to examine the impact of power trade policy regimes in ASEAN. The first scenario assumed no power trade. The second scenario assumed 20% of a country's power demand could be met by power trade. The third scenario assumed that 50% of a country's power demand could be met by power trade. The results showed that the ASEAN power grid enabled active cross-border power trade between countries rich in resources and countries with high demand. Moreover, the scenario also showed that Thailand has an advantage in geographical position that links northern ASEAN to the southern ASEAN countries. This implied that Thailand has the potential to be a power trading hub in the region in the future.

Sovacool (2009) assessed the challenges facing the Trans-ASEAN gas pipeline (TAGP) network in terms of promotion, implementation, and operation. The study explored the genesis of the TAGP project and the drivers pushing Southeast Asian investment in natural gas, with a special emphasis on the development needs of the region. The article concluded that plans for ASEAN energy cooperation does not match its actual practice, and that in many cases discussions of regionalism and energy security are intended to obscure opportunistic thinking within individual countries.

Yu (2003) focused on national interest, policy-making and institutional issues. It was argued that if regional cooperation is to be viable in the GMS, partner nations should work towards improving international relations, adopting a flexible approach to energy policy making and energy sector reform, and balancing the basic needs of local people for energy consumption and power market issues. Mitigating the social and environmental impacts of energy projects and establishing an effective regional energy agency are also great challenges to regional cooperation.

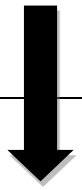
Moreover, this paper showed the advantage of regional cooperation that can create economic benefits through power trade between nations that should be more beneficial that self-sufficient supply within each country. Inexpensive hydropower from Laos can replace the development of more expensive hydropower in Vietnam and thermal power in Thailand. However, policy barriers are still important to consider. Regional power integration might limit individual nations' capabilities to achieve their goals in domestic energy supply and electrification, or it could undermine national security. There is a lack of clear policy or direction to identify the relationship between regional power trade and national energy development.

Regional cooperation for power trade requires energy sector reform in every country of the GMS (Cambodia, Laos, Myanmar, Vietnam, Thailand and China). To achieve greater power trade benefits and encourage competition, the World Bank strongly advocates that energy sectors in the region should be privatized, deregulated and fully commercialized. The institution recommended that regional energy development requires a well-organized approach. Regional cooperation should focus on developing national energy networks in each country. The main goal could be to meet the basic needs for electricity nation-wide, improve the energy sector's performance, enhance institutional capability in planning, policy, legislation and management and encourage foreign investment as well as bilateral trade projects. To support energy development and regional cooperation in the GMS, there is an urgent need to set up an adequate regional energy organization focused on energy development.

Karki, Mann et al. (2005) showed that increasing energy efficiency (on both the supply and demand side), exploitation of renewable energy resources (mostly hydro), and an integrated approach to energy resource management are some important approaches to the path toward sustainable energy through capital-intensive investment, cooperation and development of appropriate institutional structures and decision mechanisms across the region. Moreover, the study showed that there are several factors to make sustainable development in ASEAN, namely, hydropower development, utilization of biomass, geothermal and solar energy in power generation, Energy-efficiency improvements and cooperation in energy and environmental management are also important factors.

Pineau, Hira et al. (2004) reviewed three regions; the North European countries in the Nordic Council, the Southern cone of South America in MERCOSUR, and Mexico, the United States and Canada under NAFTA. The study was concerned with common market initiatives at different stages of integration that involved infrastructural, regulatory, and commercial decisions. The study suggested a framework for measuring the level of electricity sector integration, which is presented in Table 2-2.

Table 2-2 Integration Continuum across 3 Dimensions

	Infrastructure integration	**Regulatory integration**	**Commercial integration**
No regional integration	Isolated national power system	Independent national integration	National market with local ownership
	Cross-border transmission capabilities	Compatible regulation	Cross-border trade and ownership
	Coordinated effort in transmission investment	Coordination of regulatory agencies	Regional spot market
Full regional integration	Fully integrated regional system operations	Regional regulatory agency	Regional secondary/future market

Source: Unger (2003)

Adoracion M. Navarro (2013) is one of the studies of the ASEAN Energy Market integration (AEMI) initiatives. This study showed the pathway to AEMI by reviewing the different pathways toward energy market integration in the European Union, NAFTA, the MERCOSUR region and the central Asian region. For the European Union, the sequencing of steps in energy market integration has involved three successive waves of major reforms, called the first to third energy packages as described by (Roka, 2009).

The first energy package comprised European Union directives of 1996 and 1998 concerning common rules for the internal market in electricity and natural gas, respectively. It pushed for generation and transmission unbundling and established the minimum requirements for it, including the requisite accounting and management activities. Roka explained that this gave rise to a long and controversial discussion on the theory of monopolies, and spawned clarifications of core principles on free competition, transparency, free access to energy networks and security of supply. The second energy package, which was adopted in 2004, comprised new rules for the internal market in electricity and natural gas. The rules strengthened the separation of transmission and distribution, mandated the establishment of national energy regulators and allowed consumers to choose their energy supplier. By 2004, industrial consumers had the freedom to choose their energy supplier, and by 2007, domestic consumers were able to exercise this freedom. The third energy package, which was adopted in 2009 and had a transposition deadline of 2011 for the European Union directives, aimed for “ownership unbundling” or the effective separation of supply and production activities from the operation of transmission and distribution systems. It established the Agency for Cooperation of Energy Regulators and the European Network of Transmission System Operators for electricity and gas. It also set binding rules for cross-border network management and additional rules to ensure the transparency of retail markets.

Moreover, Zhai (2010) studied the energy sector integration in the GMS (Cambodia, Laos, Myanmar, Vietnam, Thailand and China) that helped these countries to achieve sustainable development. The article suggests that the experience of the GMS cooperation can be made a model for South-South cooperation in the global effort to address the challenges of climate change. This paper showed the current status of interconnection in the GMS. To fully achieve the sub-regional power interconnections, the GMS countries have prepared a roadmap with 4 phased development stages, which involve both infrastructure development and institution-building activities as comprising the following four stages; (1) the first cross-border transactions are developed; transactions between pairs of neighboring countries exist and are linked to power purchase agreements (PPAs). (2) Trading becomes possible through bilateral PPAs between any pair of GMS countries using the transmission facilities of a third regional country. (3) Multiple buyers-sellers are allowed to enter into cross-border transactions. (4) Most of the GMS countries change to the multiple sellers-buyers regulatory framework; a regional wholly competitive market exists.

ASEAN member countries have different national constraints that influence efforts toward market integration. Ruangrong (2013) reviewed the different regulatory reform is the challenging for ASEAN. The energy regulators in ASEAN members are shown in Table 2-3.

Table 2-3 State of energy regulation in ASEAN members

Country	Regulator	Independence	Structure
Brunei Darussalam	Department of Electrical Services	Not independent; under the Ministry of Energy	Single Buyer
Cambodia	Electricity Authority of Cambodia	Independent; set up in 2001	Single Buyer
Indonesia	Department of Energy and Mineral Resources	Not independent; under the Ministry of Energy and Mineral Resources	Single Buyer
Lao PDR	Department of Electricity	Not independent; under the Ministry of Energy and Mines	Single Buyer
Malaysia	Energy Commission	Independent; set up in 2001	Single Buyer
Myanmar	Ministries of Electric Power 1 and 2	Not independent; under the Ministries of Electric Power 1 and 2	Single Buyer
Philippines	Energy Regulatory Commission	Independent; set up in 2001	Price Pool
Singapore	Energy Market Authority	Not independent; under the Ministry of Trade and Industry	Price Pool
Thailand	Energy Regulatory Commission	Independent; set up in 2007	Single Buyer
Vietnam	Electricity Regulatory Authority	Not independent; under the Ministry of Industry	Cost-based Pool

Source: Energy Regulatory Commission , Ruangrong (2013)

2.3 Electricity Market Integration: EU

Gavin and Lee (2007) reviewed the regional energy cooporation from European experience and drew the implications for regional energy cooperation in three major oil importing countries of Northeast Asia- China, Japan, and South Korea.

Boethius (2012) examined the political forces that drive electricity grid expansion in the European Union (EU) and ASEAN. The most important factor accounting for this difference is the fact that there are contrasting energy scenes in the EU and ASEAN. Moreover, the study showed that there are several factors which made European electricity market integration more successful than ASEAN. In the EU, a central role is played by the EU institutions for promoting the integration of the European Energy Market, a regional electricity trading hub. The European Energy Exchange (EEX) is a successful public-private partnership. Also, there is unity among the EU nations on energy matters due to the fact that they are all energy importers. On the other hand, factors that delay the integration are the defense of political and economic sovereignty within the region and the lack of a central authority to provide leadership in grid expansion. Moreover, fossil fuel industries continue to play a large role in the Southeast Asian economy, which provides a strong disincentive to establish a functioning electricity market in the region.

Amundsen and Bergman (2006) explored the Nordic electricity market and investigated how the Nordic region has been successful in electricity reform, namely through strong political support for deregulation in the power industry. (Hellstrom, Lundgren et al. 2012) explored the causes behind electricity price jumps in the Nordic electricity market, Nord Pool, by using a time-series model. The results showed that the structure of the market played an important role in the shocks of demand and supply for electricity. Oseni and Pollitt (2016) focused on how to promote regional electricity cooperation in electricity by comparison of four cases, namely, the South African Power Pool (SAPP), West African Power Pool (WAPP), the Central American Power Pool (MER) and Nord Pool. The study provided preconditions for trading, institution arrangements and future prospects.

Newbery, Strbac et al. (2016) estimated the benefits of integrating EU electricity markets to increase the efficiency of the electricity trading system including day-ahead, intra-day and balancing trade across borders.

Joskow (2008) discussed the lessons learned from liberalization in the electricity sector over 20 years. The study showed the reform models and analyzed the effect of the market structure on market competition and regulation in many countries.

2.4 Electricity Market in Thailand

Thailand's rapidly expanding economy over the past two decades has spurred the need for building more generation capacity to keep pace with higher electricity demand. In addition, Thailand's installed capacity growth has exceeded its rate of power consumption growth which averaged about 5 percent a year over the past decade. Thailand now has one of the highest electrification rates in Southeast Asia and delivers electricity to nearly all of its population. Concern for electricity supply security and grid reliability has prompted the Thai government to create policies that promote planned capacity expansion, diversification of fuel sources and increase of alternative fuel use, demand-side management, and management of electricity import dependence. Thailand issues 20-year power plans to map out the capacity additions and goals to match the long-term power projections.

Thailand had an estimated installed capacity of 32.6 gigawatts (GW) in 2012, according to EPPO. The generating capacity from EGAT power plants of 15,010.13 MW increased by 0.08% from the previous year accounting for 46.04% of the country’s total capacity. The remaining 17,590.89 MW was accounted for by domestic independent power producers and the power imported from neighboring countries which increased 6.94% from the previous year, accounting for 53.96% of the total capacity. Natural gas-fired generation consisted of over 60 percent of the capacity mix, with coal and renewable energy making up most of the remaining capacity. In order to meet increasing demand, the government plans to double net electricity generation capacity to over 70 GW by 2030 with the largest additions to come from renewable sources and gas-fired plants.

Wisuttisak (2012) explored the issues related to regulatory reform and liberalization leading toward competition in the Thai electricity sector. The author asserted that there are problems within the Energy Commission and the Energy Industry Act BE 2550 (2007) that contribute to the continuance of an uncompetitive electricity supply.

The Thai electricity sector is dominated by state-owned enterprise in generation, transmission, distribution and retail. Electricity Generation Authority of Thailand (EGAT) is presently the largest electricity producer, owning and operating its own power plants throughout the country. It also has the sole right to purchase power from other private producers under government regulation of the Enhanced Single Buyer Scheme (ESB). In addition, EGAT has a monopoly and is able to control electricity generation and transmission based on the fact that: (1) it operates its own power plants (around 50% of market share), (2) it has the entitlement as a monopoly buyer of electricity generated from IPPs, SPPs, and neighboring countries, (3) it has majority share control over the two largest IPPs (RATCH and EGCO). In conclusion, the study urged that a reform of the Energy Act is necessary in order to create effective regulation and a regulatory institution that helps create structural reform toward a competitive electricity sector. More specifically, the Energy Act should be changed with the aim of creating structural change and reducing the monopoly market power of SOEs by building free and fair market competition.

Nikomborirak and Manachotphong (2007) also studied the reform of the electricity sector in the case of Thailand, Malaysia, Indonesia and the Philippines. The study analyzed five aspects of reform, namely privatization, wholesale competition, retail competition, and unbundling and independent regulation. In Thailand, Malaysia, Indonesia and the Philippines, privatization took two forms. One is through allowing IPPs and another is through privatizing state-owned enterprises.

Sustainability in ASEAN Energy is another interesting issue to consider. Vithayasrichareon, MacGill et al. (2012) evaluated key sustainability challenges in the electricity industries in the five largest energy consumers in ASEAN: Indonesia, Thailand, Malaysia, Philippines and Vietnam. The study used the sustainability analytical framework that is comprised of the "3A's" energy sustainability objectives (accessibility, availability and acceptability) to analyze the status of the electricity industries in these countries. The analysis showed that key sustainability challenges in the ASEAN-5 are attributable to satisfying rapid demand growth: enhancing the security of the supply; and mitigating the increase in CO_2 emissions from electricity consumption. This study suggested that there is an opportunity for the ASEAN countries to strengthen regional collaboration through experience and resource

sharing to enhance sustainability in the electricity industries. The possible shared resources in this region are renewable resources including geothermal, hydro and biofuels. Moreover, Watcharejyothin and Shrestha (2009) analyzed the effects of hydropower development in Laos and power trade between Laos and Thailand on the whole economy, energy resource mix, power generation capacity mix, energy system cost, the environment, as well as energy security. They used a MARKL-based model for an integrated energy system. Two national MARKAL-based energy system models of Laos and Thailand were formulated for the study. The results showed that 80% exploitation of water resources in Laos would induce power trade between the countries. The integrated energy system cost was found to decrease marginally but it would mitigate CO2 emissions by 2% when compared with the base case. Thailand is expected to gain benefits from the increased level of power imported from Laos in terms of lower energy system costs, better environmental quality, and greater diversification of energy sources. As compared to the base case, Laos would become a net energy exporter, earn significant export revenue, and the increase in revenue of energy exports from hydropower resources.

Sawangphol and Pharino (2011) also reviewed the latest situation on renewable energy sources and development strategies toward low carbon electricity generation in Thailand. Finally, Bakhtyar, Sopian et al. (2013) presented an archival-statistical overview of the possibility of renewable energy production in five South East Asian countries, namely, Philippines, Thailand, Malaysia, Indonesia and Singapore, and their economic capacity. This article clarified the effective relationship between energy capacities and economic indices in these countries and analyzed the results.

CHAPTER 3
ELECTRICITY MARKET INTEGRATION

3.1 Conceptual Framework

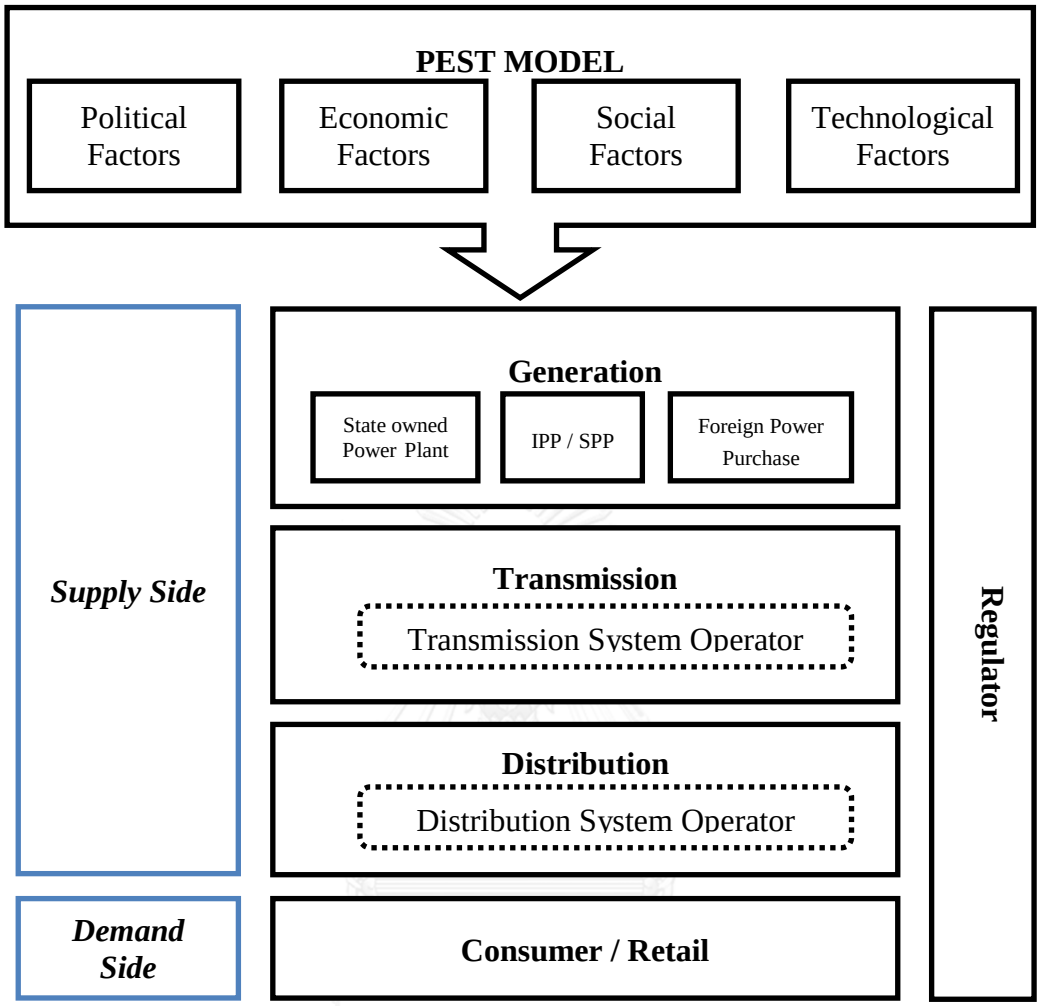
The electricity market structure consists of four main functions, namely, generation, transmission, distribution and retail distribution (to end users/consumers). The market structures vary in each country. Generation, transmission and distribution in some countries are bundled and operated by the government or state-owned enterprises. On the other hand, in some countries generation, transmission and distribution are separated and independently operated by private enterprise.

The system operator is the entity that manages the security of the power system in real time and co-ordinates the supply and demand of electricity. The system operator is required to maintain a continuous (second by second) balance between electricity supply from power stations and demand from consumers. Transmission system operators (TSO) are responsible for the wholesale electricity market to balance demand and supply and avoid fluctuations in frequency or interruption of supply. Distribution system operators (DSO) are tasked with reliably and efficiently transmitting electricity to residential consumers.

In addition, regulators are responsible for guaranteeing transparency and competitiveness in the market, checking overall policy on the market, defending consumer's interests and advising authorities on electricity issues.

Differences in market structure affect the competitive market. Also, these factors can affect market integration. To investigate electricity market integration in ASEAN, this paper will study four factors - political, economic, social and technological – according to the conceptual framework in Figure 3-1.

Figure 3-1 Conceptual Framework



3.2 Research Methodology

In this study, the analysis of electricity market integration in ASEAN applied PEST analysis to identify the political, economic, social, and technological factors that affect electricity market integration in ASEAN. In addition, study of successful case studies and in-depth interviews are particularly useful to illustrate the challenges and opportunities for the electricity market of Thailand

PEST Analysis, which stands for 'political,' 'economic,' 'social,' and 'technological,' is an analysis of the external macro environment in which a business operates for understanding risks associated with market growth or decline, and as such the position, potential and direction for a business. Originally, Harvard professor Francis Aguilar, the creator of PEST Analysis, called this scanning tool ETPS in his 1967 book, "Scanning the Business Environment." The name was later changed to the current acronym. In this study, the scope of PEST factors focuses on both the supply and demand sides, which includes electricity generation, transmission, distribution and retail sale in the market.

In this study, PEST analysis applied to the electricity sector illustrated in Table 3-1. The definition of each factor can be described as follows;

- **Political factors** are how the government intervenes in the market including determining market structure, laws and regulations, and regulatory bodies.
- **Economic factors** are those that affect electricity generation and operation. These factors include investment and cross-border trade in generation, transmission, and distribution.
- **Social factors** include population characteristics, demographic factors, and social trends such as electricity accessibility.
- **Technological factors** include research and development activities, technological incentives for production, technological shifts that affect the cost of production, and innovation which creates more competitiveness.

Table 3-1 Summary of PEST Analysis

PEST Analysis	
Political	**Economic**
Market structure Regulators Laws and Regulations	Electricity generation Cross border trade Investment -Public private partnership (PPP)
Social	**Technology**
Demographic factors and population characteristics Electricity accessibility	Research and development Renewable energy Technology incentives, cost of production Development activities

3.3 Lessons learned: Electricity market integration in the EU

The European Union (EU) is an economic and political union of 28 member states that are primarily located in Europe illustrated as Figure 3-2. It originated and developed from the European Coal and Steel Community (ECSC) and the European Economic Community (ECC), which were founded in 1951 and 1958 respectively. The EU operates through a system of supranational independent institutions and intergovernmental negotiated decisions by the member states. Institutions of the EU include the European Commission, the Council of the European Union, the European Council, the Court of Justice of the European Union, the European Central Bank, the Court of Auditors, and the European Parliament. The European Parliament is elected every five years by EU citizens.

Figure 3-2 Main European Region

Source: Institute of ständigen ausschuss für geographische namen (StAGN)

The EU has launched energy policies with five key goals;

- to increase competition in the energy market,
- to encourage investment and boost interconnection between electricity grids, and to diversify energy resources with better systems,
- to establish a new treaty framework for energy cooperation with Russia while improving relationships with energy-rich states in Central Asia and North Africa,
- to use existing energy supplies more efficiently while increasing renewable energy commercialization
- to increase funding for new energy technologies

In addition, EU policies aim to ensure the free movement of people, goods, services, and capital, enact legislation in justice and home affairs, and maintain common policies on trade, agriculture, fisheries, and regional development.

3.3.1 History and Development of Interconnection in European

At first, each member state in continental Europe had unique energy legislation. In 1951, "The Union for the Co-ordination of Production and Transmission of Electricity" (UCPTE) was established with the role to encourage economic activity through interconnection of electricity systems.

One significant step toward liberalization came in 1988, as the British turned against the process of liberalization, which influenced industrial end users in Europe to complain about high and unfair electricity prices. This created an idea of comparing energy prices, which led to changes in the energy trading market in Europe.

In response to this, a directive was issued in 1996 to solve the problem by introducing the concept of "Third Party Access" (TPA). The concept was that transmission line owners could not easily reject the accession to the network of the end user including when network-users required new paths of transmission networks from his location and the meshed network. This directive offered 2 implementation procedures for TPA - negotiated TPA and regulated TPA. Regulated TPA is the current approach used in most European countries. The network owner will publish tariffs and conditions for using the network. The second one is negotiated TPA, in which the network owner and the end user have to negotiate tariffs and conditions. This process wastes too much time and resources from both parties, so only a few of them use this procedure. Thus regulated TPA is the common implementation procedure used by most grid owners. Cross-border tariffs became a challenge and many arrangements were agreed, such as "first come first served," auctioning, and others. Therefore, new energy regulations and organizations were developed and in 2009 the Third Energy package was introduced by the European Council to enhance the free flow of electricity trade.

The Third Energy Package consists of two Directives and three Regulations:

- Directive 2009/72/EC concerns common rules for the internal market in electricity and repeals Directive 2003/54/EC
- Directive 2009/73/EC concerns common rules for the internal market in natural gas and repeals Directive 2003/55/EC
- Regulation (EC) No 714/2009 deals with conditions for access to the network for cross-border exchanges in electricity and repeals Regulation (EC) No 1228/2003
- Regulation (EC) No 715/2009 deals with conditions for access to the natural gas transmission networks and repeals Regulation (EC) No 1775/2005
- Regulation (EC) No 713/2009 of the European Parliament and of the Council of 13 July 2009 establishes an Agency for the Cooperation of Energy Regulators

The stages of European liberalization

During the period of market integration, the European Union has evolved its policies and regulations as shown in Figure 3-2. The stages of European liberalization can be separated into 3 stages; 1999-2003, 2003-2009 and 2009-present (Boltz 2013).

During the initial setup in 1999-2003, the European Commission proposed the first directive "concerning common rules for the internal market in electricity." The aim of this directive was to guarantee the free movement of capital to freely establish companies, construct and operate power stations in the whole community, and to allow the free flow of goods to serve final consumers. The vital importance at that time was the unbundling of transmission system operators (TSOs). However, the liberalization was delayed by seven years. In addition, the regulatory deficiencies were identified; the role of TSOs was not defined thoroughly, there was a lack of market transparency, there was no cross-border coordination, and regulations were enforced by authorities that were independent from the industry but not from politics.

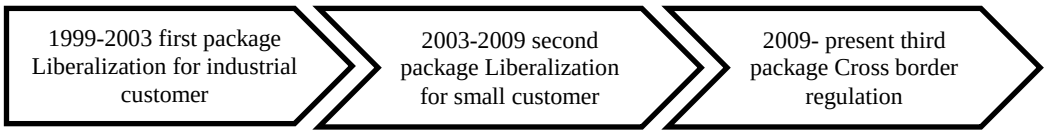
The regulations deepened in 2003-2009, as the second energy package came into force in national law by July 2004. The second package consisted of a directive and a regulation. The issues that were addressed included the transparency requirement for TSOs, third party access (TPA) for new interconnection, the independence of TSOs in the wholesale market and DSOs in the retail market, and regulators for oversight and enforcement. At that time, the most advanced model of market integration in Europe was the Nordic region, comprised of Finland, Sweden, Norway, and Denmark. The Norwegian power exchange and Nord Pool Spot ran implicit auctions to allocate the network capacity of the entire region.

In the period of cross-border regulation from 2009 to present, the core objectives have been structural unbundling of TSOs from vertically integrated utilities, governance proves for a future market design based on independent TSOs and regulators, and the establishment of institutions for the network and regulations at the EU level.

Meeus and Belmans (2008) presented that the EU market reform process has been very different from the process in markets elsewhere. To benefit from the freedom to choose a supplier, retail customers need an appropriate wholesale market organization, non-discriminating network access and transparent pricing institutions.

In addition, the Third Energy Package allows for the opening up of the electricity market in the EU. The package focuses on the need for greater coordination and cooperation amongst TSOs, particularly in the areas of the development of the market and technical codes. The European Commission has set the target that the single target model shall be implemented in the EU by the end of 2014. Initially, the countries in each region shall be combined and then integration shall be expanded to the continental level. If the Third Energy Package is successful, all member states will use a single trading system in a single electricity market. However, the integration plan has been delayed due to issues regarding international cooperation and differences between trading systems at each interconnection point. Therefore, currently the EU cannot implement the target model as expected.

Figure 3-2 Stages of European Liberalization



Source: Boltz (2013)

3.3.2 Electricity Market Player

Electricity Market players are comprised of 5 types of utilities.

1. Electricity Generators

Electricity generators are the first players in the chain, generating power either in 'traditional' ways (e.g. in nuclear power stations, combined-cycle gas turbine facilities or combined heat and power plants) or in units using renewable energy sources (like wind or solar farms and thermal or hydroelectric power stations). Current 'created' by these generators is then injected into the (high-voltage) transmission system or directly into (medium or low-voltage) distribution systems before being delivered to the end user (industrial users, institutions, SMEs, residential consumers).

2. Transmission system operators (TSOs)

A transmission system operator (TSO) is an entity entrusted with transporting energy in the form of natural gas or electrical power on a national or regional level, using fixed infrastructure. The term is defined by the European Commission. The certification procedure for TSOs is listed in Article 10 of the Electricity and Gas Directives of 2009.

Due to the cost of establishing a transmission infrastructure, such as main power lines or gas main lines and associated connection points, a TSO is usually a natural monopoly, and as such is often subjected to regulations. In the electricity market, a TSO is an operator that transmits electrical power from generation plants over the electrical grid to regional or local electricity distribution operators.

The role of the system operator in a wholesale electricity market is to manage the security of the power system in real time and co-ordinate the supply of and demand for electricity, in a manner that avoids fluctuations in frequency or interruptions of supply. The system operator service is normally specified in rules or codes established as part of the electricity market. They are financed either by the states or countries or by charging a toll proportional to the energy they carry.

The system operator is required to maintain a continuous (second-by-second) balance between electricity supply from power stations and demand from consumers, and also to ensure the provision of reserves that will allow for sudden contingencies. The system operator achieves this by determining the optimal combination of generating stations and reserve providers for each market trading period, instructing generators when and how much electricity to generate, and managing any contingent events that may cause the balance between supply and demand to be disrupted. System operations staff undertake this work using sophisticated energy modeling and communications systems.

In addition to its roles of generation and managing security, the system operator also carries out investigations and planning to ensure that supply can meet demand and system security can be maintained during future trading periods. Examples of planning work may include coordinating generator and transmission outages, facilitating commissioning of new generating plants and procuring ancillary services to support power system operation.

3. Distribution system operators (DSOs)

DSOs are tasked with reliably and efficiently running medium to low-voltage distribution systems. DSOs transmit electricity to residential consumers and SMEs, for example, and are also responsible for public lighting, among other things.

4. Regulators

In an environment where a number of players have a legal monopoly, regulators effectively 'police' the energy market. Their missions include:

- guaranteeing transparency and competitiveness in the energy market;
- checking that the market operates in line with public interest and overall energy policy;
- defending consumers' interests; and
- advising authorities on energy issues

5. Consumers

The end users can be anyone from individuals to major industrial players. Industrial users are often directly connected to the high-voltage grid, whereas individual users or SMEs, for example, are connected to the distribution system.

3.3.3 Associations relating to interconnection

1. Union for the Coordination of the Transmission of Electricity (UCTE) [1]

The Union for the Coordination of the Transmission of Electricity coordinated the operation and development of the electricity transmission grid for the continental European synchronously operated transmission grid, thus providing a reliable platform to all participants in the Internal Electricity Market and beyond.

Since 1951, the Union for the Coordination of Production and Transmission of Electricity (UCPTE) had coordinated synchronous operations through meetings of experts and managers from at first a small number of interconnected companies at the interface of Switzerland, France and Germany, and over various stages from a growing number of companies and countries. The UCPTE's operational and planning recommendations helped ensure a reliable supply of electricity in continental Europe.

In 1999, UCTE re-defined itself as an association of TSOs in the context of the Internal Energy Market. Building on its experience with recommendations, UCTE turned to make its technical standards more binding through the Operation Handbook and the Multi-Lateral Agreement between its members. These standards became

[1] http://www.ucte.org/

indispensable for the reliable international operation of the high voltage grids which were all working at one "heart beat": the 50 Hz UCTE frequency related to the nominal balance between generation and the electricity demand of some 500 million people in one of the biggest electrical synchronous interconnections worldwide.

In its final year of existence, UCTE represented 29 TSOs of 24 countries in continental Europe. On 1 July 2009 UCTE was wound up.

2. European Network of Transmission System Operators for Electricity [2]

The European Network of Transmission System Operators for Electricity (ENTSO-E) is an association of Europe's TSOs for electricity. It is a successor of ETSO, the association of European TSOs founded in 1999 in response to the emergence of the internal electricity market within the EU.

The creation of ENTSO-E was initiated by the adoption of the EU Third Legislative Package on the gas and electricity markets. In 2003, the European Commission conducted a sector inquiry concerning competition in electricity markets in six European countries. Examining competition in these countries, the final report stated serious issues to be solved. It was noticed that the integration between member states' markets was still insufficient. Additionally, the absence of transparently available market information was assessed. As a result, the Third Legislative Package on the EU gas and electricity markets was adopted by the European Commission in September 2007.

Main tasks:

1. Elaboration and establishment of network codes
2. Ensuring coordination of network operation by common network operation tools
3. Developing a ten-year network development plan
4. Publishing an annual work program, annual report and annual summer and winter generation adequacy outlooks

[2] https://www.entsoe.eu/Pages/default.aspx

Objectives:

1. Ensuring security of supply
2. Meeting the needs of the Internal Energy Market and facilitating market integration
3. Promotion of relevant research and development and the public acceptability of transmission infrastructure
4. Consulting with stakeholders and establishing positions towards energy policy issues

Regional Structure:

ENTSO-E is divided into five regional groups and two voluntary regional groups (Northern Europe and Isolated Systems) as follows:

1. Continental Europe

The regional group of Continental Europe includes the former members of the UCTE, which was founded in 1951. Over time, most of TSOs of continental Europe joined the association and in 1999 UCTE re-defined itself as an association of TSOs. Before merging into ENTSO-E, UCTE represented 29 TSOs of 24 countries operating the synchronous grid of continental Europe.

2. Ireland

The region of Ireland consists of EirGrid and System Operator for Northern Ireland (SONI), the former members of the Association of the Transmission System Operators of Ireland (ATSOI).

3. United Kingdom

The region of the United Kingdom consists of the TSOs of the United Kingdom, former members of the UK Transmission System Operators Association (UKTSOA).

4. Nordic

The Nordic region consists of Finland, Sweden, Norway and Eastern Denmark, the former members of the Nordic TSO association NORDEL. NORDEL was founded in 1963 for co-operation between the TSOs of Denmark, Finland, Iceland, Norway and Sweden for the further development of a harmonized Nordic electricity market.

5. Baltic

The Baltic region consists of Estonia, Latvia and Lithuania. Before creation of the ENTSO-E, the Baltic TSOs were members of the Baltic Transmission System Operators association (BALTSO). BALTSO was founded on 30 March 2006.

6. Northern Europe

The members of the Voluntary Regional Group Northern Europe (VRG NE) are the following TSOs:

- Denmark (East): Energinet.dk
- Finland: Fingrid OyJ
- Germany: TenneT TSO GmbH (corresponding member)
- Germany: 50Hertz Transmission GmbH (corresponding member)
- Netherlands: TenneT TSO B.V.
- Norway: Statnett SF
- Poland: PSE Operator S.A.
- Sweden: Affärsverket Svenska Kraftnät

7. Isolated Systems

The members of the Voluntary Regional Group Isolated Systems (RG IS) are the following TSOs:

- Cyprus: Cyprus Transmission System Operator
- Iceland: Landsnet hf
- Italy: Terna - Rete Elettrica Nazionale SpA
- Spain: Red Eléctrica de España: S.A.

3.3.4 Case Study: Nordic Electricity Market

The Nordic electricity market is the most successful electricity market integration. To analyze the Nordic electricity market integration, PEST analysis focuses on four factors to examine the macro environment of the market.

1. Political Factors

The Nordic countries operate under the simple geopolitical fact that they are small countries with powerful neighbors; Denmark, Finland, Iceland, Norway and Sweden. The relationship is based on cultural and political similarity and a long history of interaction and cooperation (since the 19th century). A key factor in this cooperation is the similarity of the Scandinavian languages.

The Nordic countries have had more success with a more piecemeal approach, where focus has been on people-to-people interaction, professional networks and cultural cooperation.

In fact, Nordic cooperation has never been pursued with supra-national ambitions: no country has been forced by its neighbors to accept policies against its will. Instead, cooperation in the Nordic Council of Ministers (NCM) is based upon the principle of consensus, which means that action is pursed only when everyone is on board. The consensus is a consequence of the comparatively large common budget of the NCM, to which every country contributes.

Nordic energy policy cooperation followed the ordinary Nordic governance structures, rules and mode of operation with the Council of Ministers, supported by a committee of senior officials and a secretariat. This was characterized by an incremental development of cooperation based on consensus, mutual understanding and trust facilitated through exchange of experiences, work groups, seminars, educational activities and mobility schemes for energy policy officials.

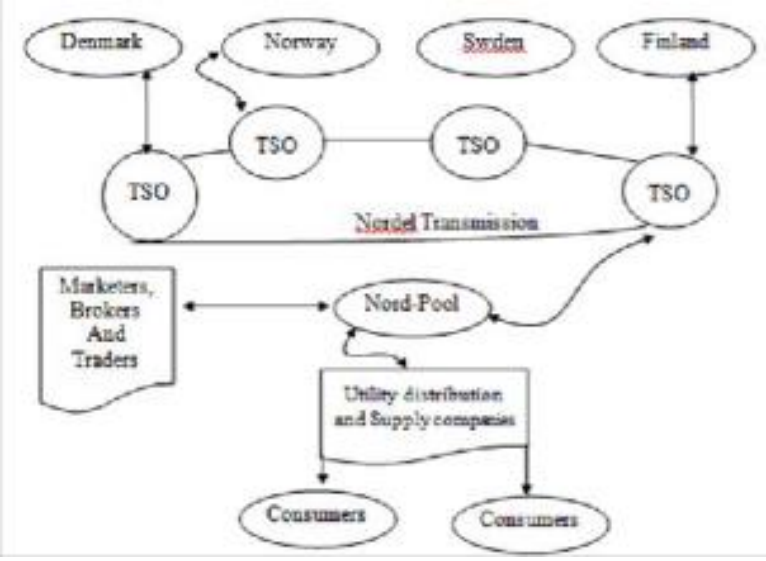
The Nordic countries established NORDEL in 1963. This organization was formed by TSOs from Denmark, Finland, Norway, Sweden and Iceland, which aimed to create the foundation for developing an effective and harmonized Nordic electricity market. NORDEL provided advice and recommendations, taking into account conditions in each Nordic country. In 2009, NORDEL was replaced by the European Network of Transmission System Operators (ENTSO-E). Regional cooperation

within ENTSO-E is now the official platform for developing transmission grids and an integrated electricity market.

Energy regulators from Denmark, Finland, Norway and Sweden cooperate through NordREG. The cooperation sets the targets to exchange views and experiences, mapping and analyzing electricity markets and preparing the common report and papers. NordREG regularly produces work programs, roadmaps and updates on harmonizing Nordic markets and coordinating grid expansion.

NordREG promotes legal and institutional frameworks and conditions necessary for developing the Nordic and European electricity markets.

Figure 3-3 Nordic Electricity Market Structure



Source:Singh and D.S. (2011)

As illustrated in Figure 3-3, each Nordic countries has transmission system operator that cooperate through Nordel transmission system. Then, NORDEL was replaced by the European Network of Transmission System Operators (ENTSO-E).

As illustrated in Table 3-2, the basic regulations adopted by the EU are crucial for the operation of the Nordic competitive electricity market. In particular, third party access to the network infrastructure is a key prerequisite for a competitive electricity market.

Table 3-2 Basic regulatory framework

	New generation procedure	**Unbundling of generation, transmission and distribution**	**Third party access**	*Market opening*
Denmark	Authorization	Accounting and management separation	rTPA	100%
Finland	Authorization	Legal separation	rTPA	100%
Norway	Authorization	Accounting and management separation	rTPA	100%
Sweden	Authorization	Legal separation	rTPA	100%
EU Directive	*Authorization or Tendering*	*Accounting and management separation as a minimum*	*Regulated (rTPA), Negotiated (nTPA) or Single Buyer*	*30 %*

Source: Amundsen and Bergman (2006)

The first and second EU Electricity Market Directives of 1996 and 2003 focused on unbundling the industry and on a gradual opening of national markets. The second directive further promoted competition by toughening regulation of access to networks and requiring independent regulators. Regulation of cross-border trade aimed to facilitate market integration (Table 3-3). The second directive aimed to achieve, by July 2007 at the latest:

(i) unbundling of transmission system operators (TSOs) and distribution system operators (DSOs) from the rest of the industry,

(ii) free entry to generation,

(iii) monitoring of supply competition,

(iv) full market opening,

(v) promotion of renewable sources,

(vi) strengthening the role of the regulator, and

(vii) a single European market.

Table 3-3 EU Electricity Directives

	Most common Form pre-1996		1996 Directive	2003 Directive
Generation	Monopoly	→	Authorisation → Tendering	Authorisation
Transmission Distribution	Monopoly	→	Regulated TPA Negotiated TPA Single Buyer	Regulated TPA
Supply	Monopoly	→	Accounting separation	Legal separation from transmission and distribution
Customers	No Choice	→	Choice for Eligible Customers (=1/3)	All non-household (2004) All (2007)
Unbundling T/D	None	→	Accounts	Legal
Cross-Border Trade[13]	Monopoly	→	Negotiated	Regulated
Regulation	Government Department	→	Not specified	Regulatory Authority

Source: Jamasb and Pollitt (2005)

As the Nordic electricity market is the most successful electricity market integration in the European Union, the Table 3-3 shows the EU electricity directives at different times. The key steps are unbundling in generation, transmission and distribution, changing in operation from single buyer to third party access (TPA), and regulated TPA for a more competitive transmission system. In addition, customers have more choices and can consume electricity at a reasonable price. Cross-border trade became more competitive, moving from monopoly to negotiated trade in 1996. Also, the regulations that were previously governed by political utilities became more independent. These are key stepping stones on the path toward success in the Nordic electricity market integration.

2. Economic Factors

This study focused on economic factors in electricity market. Therefore, the scope is restricted to economic factors that impact electricity supply in the Nordic electricity market.

Power Generation

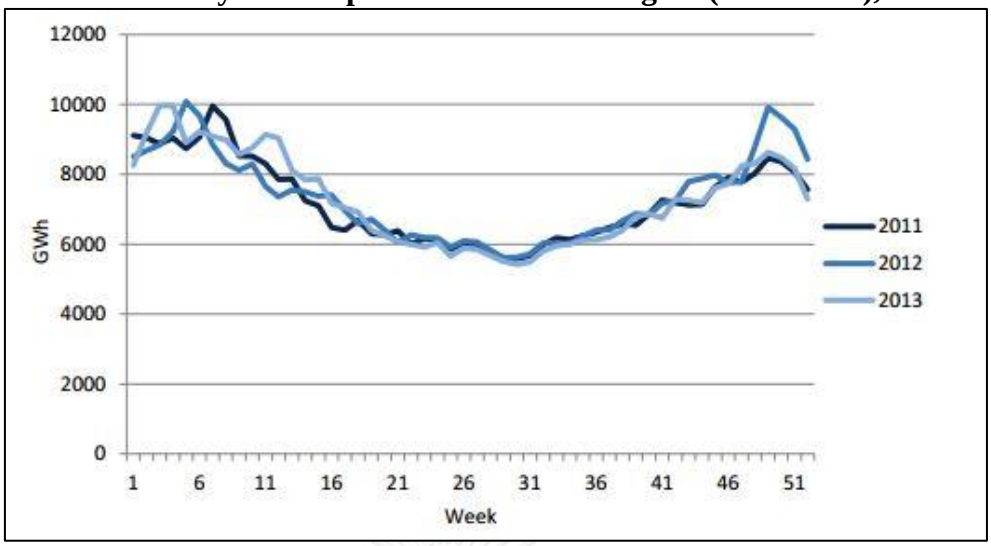
The Nordic region is powered by fossil fuels, hydropower, wind and biomass. Installed generation capacity reached more than 98 000 MW in 2011 and is very diverse. The total power generation in the Nordic region in 2013 was 380 TWh – 19 TWh. Power generations in the Nordic region is dominated by hydro power, as illustrated in Figure 3-5.

According to NorReg, the Nordic region has seen steadily increasing electricity demand, as shown in Figure 3-4. Investments in new power generation have not grown. That is evidence that the Nordic countries have sufficient interconnection capacity between each other. Furthermore, the Nordic countries have very diversified power generation as shown in Table 3-4, whereby;

- Norway is dominated by hydropower, which offers short-term flexibility and lower cost during rainy years.
- Sweden has a more diversified power sector, with hydropower in the north and thermal (including nuclear) in the south.
- Denmark has a high penetration of wind power.
- Finland has thermal resources (including nuclear).

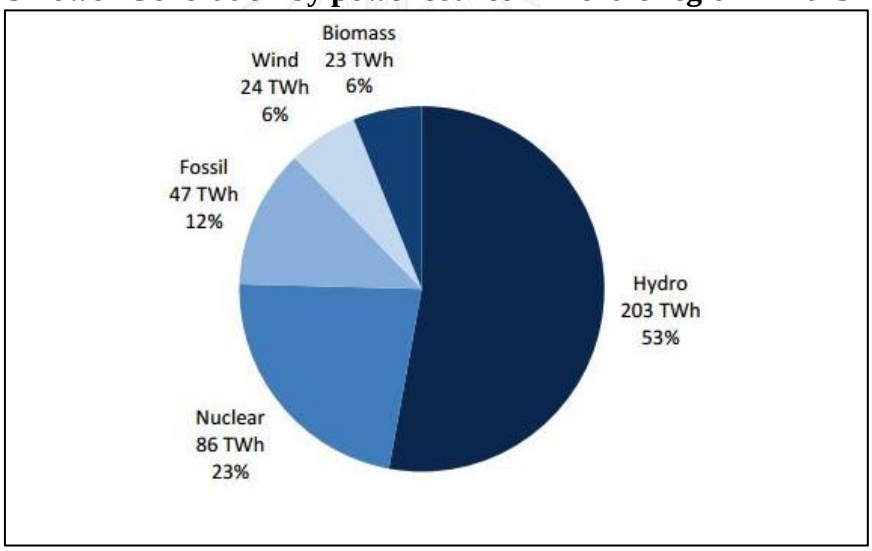
The transmission grid covers all the Nordic countries and combines all the national grids (excluding western Denmark) into one common power system. Voluntary cooperation between transmission companies takes place through NORDEL.

Figure 3-4 Electricity consumption in the Nordic region (Gwh/week), 2011-2013



Source: Nord Pool Spot

Figure 3-5 Power Generation by power source in Nordic region in 2013



Source: ENTSO-E

Table 3-4 Nordic Generation capacity (MW) by power source, 2013

	Denmark	Finland	Norway	Sweden	Nordic region
Installed capacity (total)	14,861	17,300	32,879	38,273	103 313
Nuclear power	-	2,752	-	9,531	12 283
Other thermal power	6,989	11,135	1,040	8,079	27 243
- Condensing power	-	2,465	-	1,375	3 840
- CHP, district heating	1,929	4,375	-	3,631	9 935
- CHP, industry	562	3,180	-	1,498	5 240
- Gas turbines etc.	-	1,115	-	1,575	2 690
Hydro power	9	3,125	30,900	16,150	50 184
Wind power	4,809	288	811	3,745	9 653
Sun power	563	0	N/A	43	606

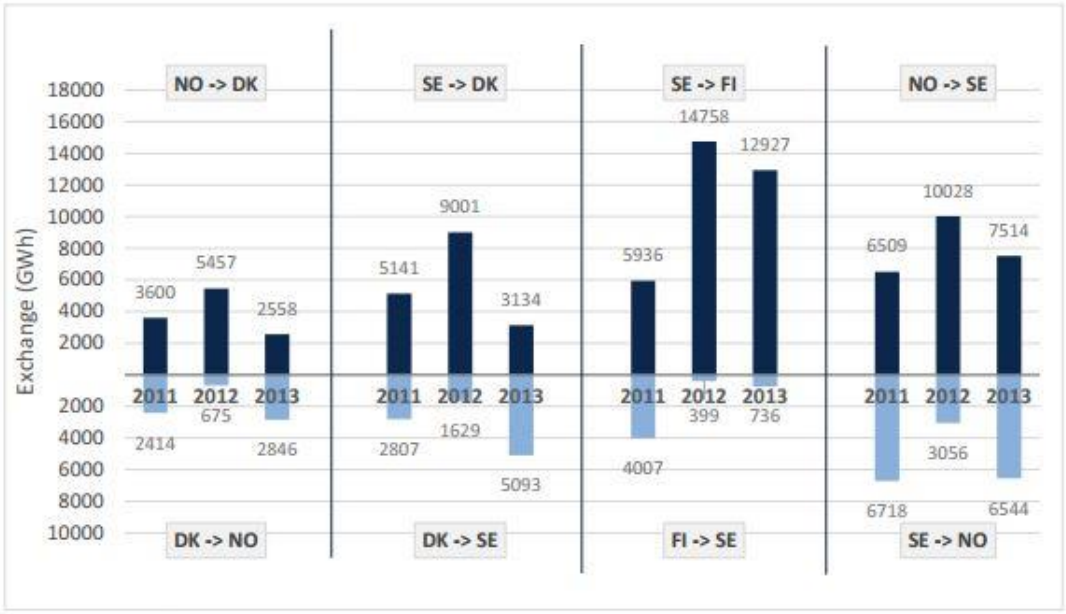
Source: Swedenergy

Cross-Border Electricity Trade

Norway has the highest installed capacity that can export electricity to other countries within the Nordic region. Moreover, statistics on Nordic power exchange, which are presented in Figure 3-6, show that Norway has surplus production with an abundance of hydropower that can be exported to Sweden and Denmark. The different types of sources reflect the generation capacity that hydropower can be stored, while wind power can significantly change during the year. Norway and Sweden have an excess of cheap hydropower in the seasons with high precipitation, but it's better to produce electricity using thermal energy resources from southern Sweden and Finland in a drier year. And considering the weather conditions, the structure of industrial and residential heating systems also reflect the variation of consumption.

In sum, the utilization of the power resources in the region allow the countries to support one another with reserves in different situations.

Figure 3-6 Nordic power exchange 2011-2013



Source: ENTSO-E

3. Social factors

Social factors influencing Nordic market integration include cooperation, demographic and population characteristics, and the demand for electricity or electricity accessibility.

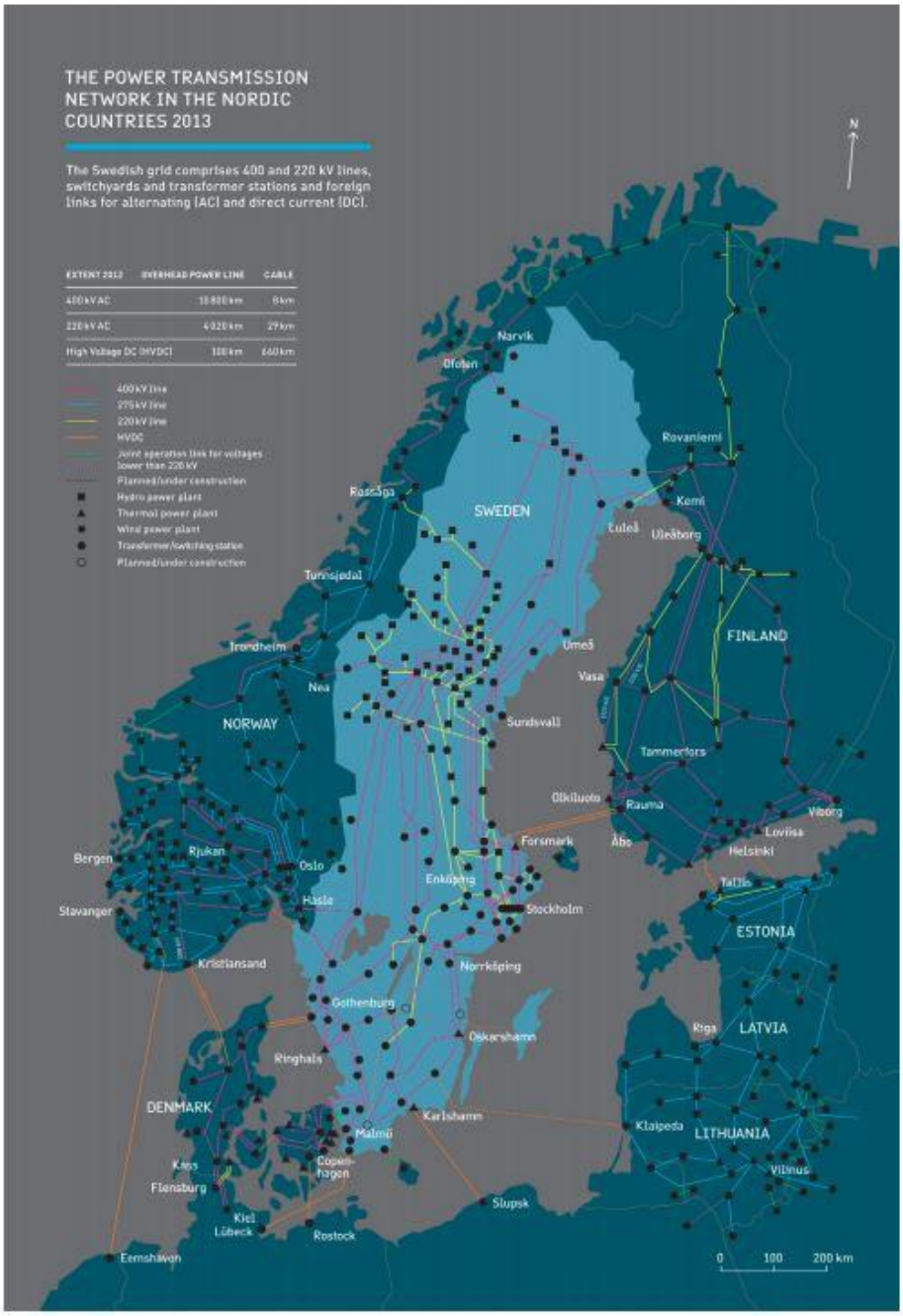
Demographics

The success of Nordic cooperation is also supported by the close relationship between the peoples and cultures of the region. The Nordic region is comprised of comparatively small countries with powerful neighbors (Sweden, Denmark, Norway, and Finland). Furthermore, the Nordic region has favorable preconditions for cooperation because of the similarity of the Scandinavian cultures and languages. The political similarity and the long history of interaction and cooperation, such as social policy and welfare, are some of the factors that have driven success in Nordic cooperation. In addition, the development of Nordic cooperation has thrived as it is based on consensus and mutual understanding, and is facilitated through experience sharing, mutual working groups, and interaction between energy policy officials.

Electricity Accessibility

Apart from demographic factors, the Nordic region has strength in terms of electricity accessibility. The Nordic region is competent in transmission grid interconnection that combines the whole Nordic region into one synchronous power system as shown in Figure 3-7. The Nordic transmission grid also links the Nordic market to Germany, Poland, Estonia, Russia and the Netherlands. Moreover, the Nordic transmission grid is part of the transmission network in north-western Europe. Eastern Denmark is synchronous with the Nordic grid while western Denmark is synchronous with the continental European grid.

Figure 3-7 Transmission network in north-western Europe



Source: Svenska Kraftnat

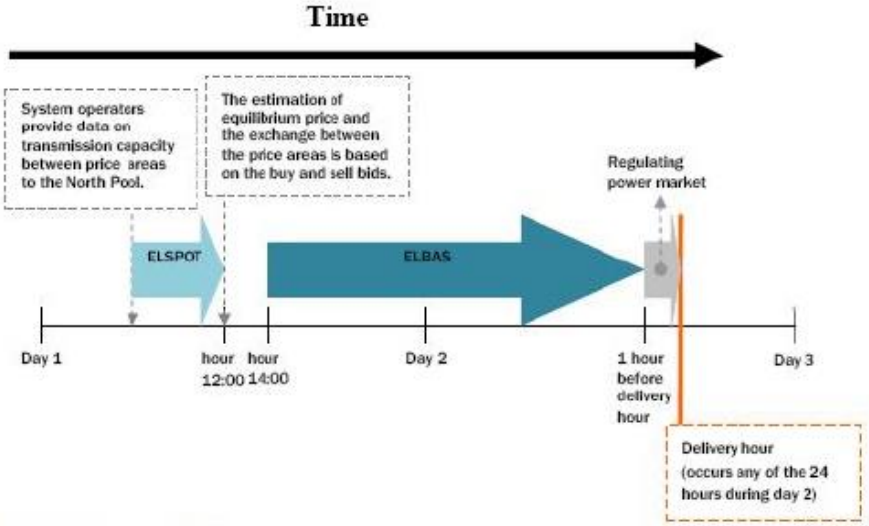
4. Technological Factors

The technological factors are research and development in the electricity market, including developments in power generation, such as new technology relevant to the electricity market. The interesting commercial integration of the electricity market in Nordic market is the electricity trading system, Nord Pool Spot.

Nord Pool is owned by the Transmission System Operators (TSOs) of Norway and Sweden. Nord Pool provides freedom of choice to the consumers. It organizes trade in standardized physical and financial power contracts. Close cooperation between system operation and market operation is the key feature of Nord Pool.

The Nord Pool Spot covers four wholesale markets that work together. These are essential for the power market exchange to function. The wholesale power market is a common integrated Nordic market, in which electricity is traded on the Nordic power market exchange, i.e. the Nord Pool Spot. Trading on the Nord Pool Spot is voluntary; however, all day-ahead cross-border trading must be done on the Nord Pool Spot, which consists of two sub-markets, the ELSPOT market (day-ahead) and the ELBAS markets (intra-day). These markets are described below illustrated in Figure 3-8 (Nord Pool Spot, 2013).

Figure 3-8 The different markets in the NordPool Spot



Source: Nord Pool Spot

The Nordic countries established the Nordic Energy Research Programme, whose funds were earmarked for projects of common interest to the Nordic countries. This created the necessary critical knowledge base regarding new energy technologies, energy systems and energy markets.

Key success factors of the Nordic Electricity Market

Electricity market integration in the Nordic region has shown progress and success, and provides lessons that can be summarized as follows;

1. Nordic cooperation is based on geographical proximity, as they are small countries with powerful neighbors, as well as cultural and political similarity, and a long history of interaction and cooperation. Another key factor is also the similarity of the Scandinavian languages. The development of Nordic cooperation has been based on consensus and mutual understanding, and has been facilitated through experience sharing, mutual working groups, and interactions among energy policy officials.

2. One of the key factors in power sector reform is the unbundling of power companies into separate companies. For example, the Norwegian power sector prior to the Energy Act was dominated by one official holder, a vertically integrated power company. It was a crucial step to unbundle the power sector into

- Transmission system operators (TSOs) that are the owners of the main grid and need to be operated and regulated by monopoly authority.
- Distribution companies that are responsible for distributing electricity to end users.
- Generation companies that are responsible for power generation and could be split into several companies.
- Retail companies that are responsible for selling power to end consumers.

3. Competition and establishment of both wholesale markets and retail markets

3.4 In-depth interviews

The in-depth interviews in this study provide information about the updated status of electricity market integration in ASEAN and opinions regarding the success of the Nordic region, the most advanced electricity market integration. The interviews were conducted with 2 parties. These included both an academic institution, the ASEAN Study Center, and a state-owned enterprise in the electricity market in Thailand, the Electricity Generating Authority of Thailand (EGAT). Both sources provided useful insights and information. The questions in the interview regarded the direction of the ASEAN electricity market integration, barriers to integration and the challenges of electricity market integration for ASEAN and Thailand. The details of the interviews are described as follows:

Dr. Nawal Kamel, the Director of the AEMI Initiative at the ASEAN Studies Center, expressed the opinion that there is no single model for achieving energy market integration because the 10 nations of ASEAN have different regulatory, legal, political and economic frameworks. Each region has unique socio-economic characteristics, different energy sources, and specific energy needs. Also, she emphasized that the big challenge for Thailand is to get the opportunity to establish an ASEAN Electricity Exchange (AEE). The AEE is now presented in HAPUA by study from Nordic model. In addition, a flagship feature of the success of the Nordic model has been the creation of a commodity exchange for electricity trading and price discovery. The Nord Pool Spot commodity exchange carries out the task of setting the price that balances supply and demand in the power market.

In addition, ideas about the Nordic model have been considered in the forum "Energy Security and Connectivity: The Nordic and European Union Approaches Forum" held in November 2015 in Singapore. The conclusion of the forum confirmed that ASEAN-relevant entities (ACE, APGCC, HAPUA, and AERN) should prepare a strategic plan together with a roadmap and step-wise approach to delivering it. The strategic plan would include addressing standards and legal frameworks related to multilateral commercial agreements, developing an approach for utilities to make the transition into a commercial mode of regional operation, conducting a feasibility study for the creation of an ASEAN power exchange inspired by the Norwegian commodity exchange, estimating expected electricity spot prices in ASEAN markets

as well as their competitiveness relative to current bilateral trading prices, and sending a delegation of ASEAN officials to visit electricity exchanges to investigate their operational models and learn from their successes and failures. These exchanges would include Nord Pool Spot (Oslo), Southern Africa and India.

Another forum that supported this concept was "Powering ASEAN: Can the Nordic model work?" held in May 24-26, 2016 in Jakarta, Indonesia. At this forum, it was also mentioned that the Nord Pool Spot model has been adapted and implemented successfully to create an integrated regional energy market in the 12 countries in Southern Africa, though in a simplified model where state-owned, vertically-integrated utilities sell their net excess capacity. The model has also been successfully adapted and implemented in less than a year in the 29 states throughout India. Thus, the creation of an ASEAN Electricity Exchange (AEE) would:

- allow utilities to sell power from excess capacity and purchase power to satisfy excess demand so as to balance the full operation of their national markets.
- create the possibility (and not the obligation) to share resources between countries where there is excess generation and those where there is a lack of sufficient generation.
- allow utilities to balance services on a more cost effective basis, by trading with other participating countries rather than through striving for self-provision, subject to the availability of sufficient APG transmission capacity between them.

Also, Dr. Nawal Kamel mentioned her viewpoints regarding the next phases for considering the creation of an AEE. There would be three phases. In the first phase, the Feasibility Phase (6 months), the objective would be to deliver an AEE Feasibility Study. Next, in the Design Phase, to goal would be to identify and conduct preparatory tasks needed to create the multilateral market. Finally, during the Implementation Phase, AEE would be delivered and ready to operate.

Finally, the conclusions to HAPUA Member States will be reported at the next SOME on 12-15 July 2016 in Naypyidaw, Myanmar. It will be reported that HAPUA will conduct a Feasibility Study for the creation of an ASEAN Electricity Exchange (AEE) to allow the APG to operate on a multilateral basis by 2018. That is the crucial stepping stone toward the development of an ASEAN electricity market.

Dr. Nawal Kamel expressed perspectives from an economic viewpoint and from an academic institution. Another view is considered from EGAT, the state-owned enterprise responsible for the electricity market in Thailand. This view also supports the idea that there are big challenges regarding the ASEAN power grid.

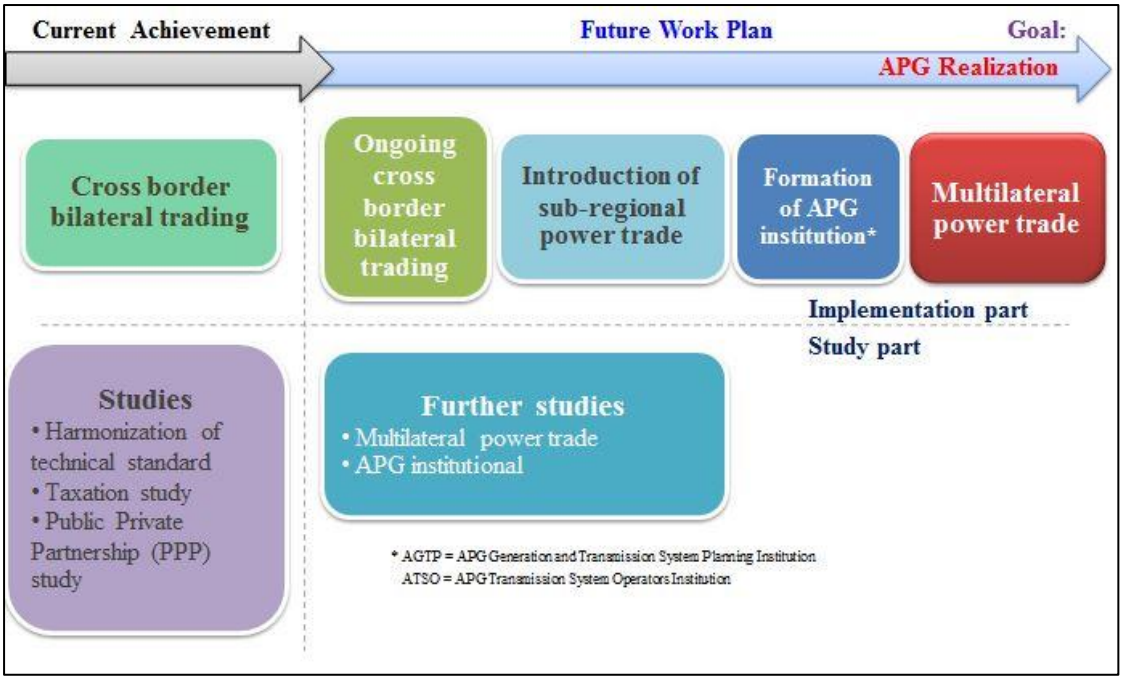
Mr. Paruhus Vongthanet and Dr. Suthep Chimklai, Assistant Governor from Electricity Generating Authority of Thailand (EGAT) expressed the opinions that the barrier to realization of APG currently is unequal readiness in both physical terms and economic terms. The physical terms refer to existing infrastructure and different characteristics of transmission systems. All power trading is firstly being implemented under bilateral PPA. Interconnection still requires development of the systems in networking and sharing the same standard; the neighboring countries of Thailand need more time and investment. Thailand has the opportunity to invest in transmission systems and related electricity infrastructure. Moreover, another important factor is self-sufficiency in domestic electricity production. Some countries in ASEAN are limited in the electricity access that they can provide, which means that the main challenge is to fulfil the domestic demand for electricity before expanding to the international market. This is the challenge that is the most important for some ASEAN member countries.

However, **Mr. Paruhus Vongthanet,** as the chairman of HWG2: APG/Transmission, presented updates on the progress of the ASEAN Interconnection Project. The total power transfer of 16 APG Projects as of March 2016 is 28,485-31,705 MW, which is comprised of of 5,212 MW from existing projects, 3,199-3,269 MW from ongoing projects, and 20,074-23,224 MW from future projects. In his opinion, the progress is quite clear and he also mentioned the establishment of AGTP and ASEAN Transmission System Operator (ATSO).

In contrast, The Laos-Thailand-Malaysia-Singapore (LTMS), the pilot project of multilateral trade, could possibly become a success. He mentioned that it is possible considering the infrastructure as there are transmission lines between Laos-Thailand, Thailand-Malaysia, and Malaysia-Singapore. However, the limitation of this project is due to commercial issues because of differences in trading system and market structure. Singapore uses a power pool system while Thailand, Laos and Malaysia use a single buyer system. In a power pool, electricity is traded by auction. The latest progress of this project is under study. It would be possible to create a company on behalf of Thailand, Laos and Malaysia to auction and sell the electricity from Laos. However, creating a trading system according to the Nordic model may be difficult for ASEAN. Because of the stability of the member countries, the Nordic group has strong members and a long history of market integration. ASEAN has also set an objective to be fully-integrated like the Nordic region. APACE 2016-2025 set clear targets and plans that we can see from AGTP and ATSO. Moreover, ASEAN may take a long time to integrate because of constraints such as commitment to collaboration and coordination of existing bodies with similar objectives in the region. In addition, AEE may be a concept that is quite far removed from the current situation in ASEAN. Although the South African market can work following this model, ASEAN may have to study other models and choose the best fit for ASEAN. The Nordic model may not work well for ASEAN. For Thailand's electricity market, Thailand has an advantage in infrastructure and geography. EGAT plans to serve the electricity demand in the future and extend the transmission system to neighboring countries. Compared to CLMV, Thailand's strength is in the capacity to supply the electricity while Myanmar and Vietnam still have low rates of electricity access.

In summary, Figure 3-9 show the current and future work plan of ASEAN electricity integration. ASEAN had completed bilateral trading in cross border trade among ASEAN countries. The future work plan is to introduce sub-regional power trade, form the ASEAN power grid institutions including ASEAN transmission system operator (ATSO) to accomplish the multilateral trade in ASEAN.

Figure 3-9 Current and future work plan of ASEAN



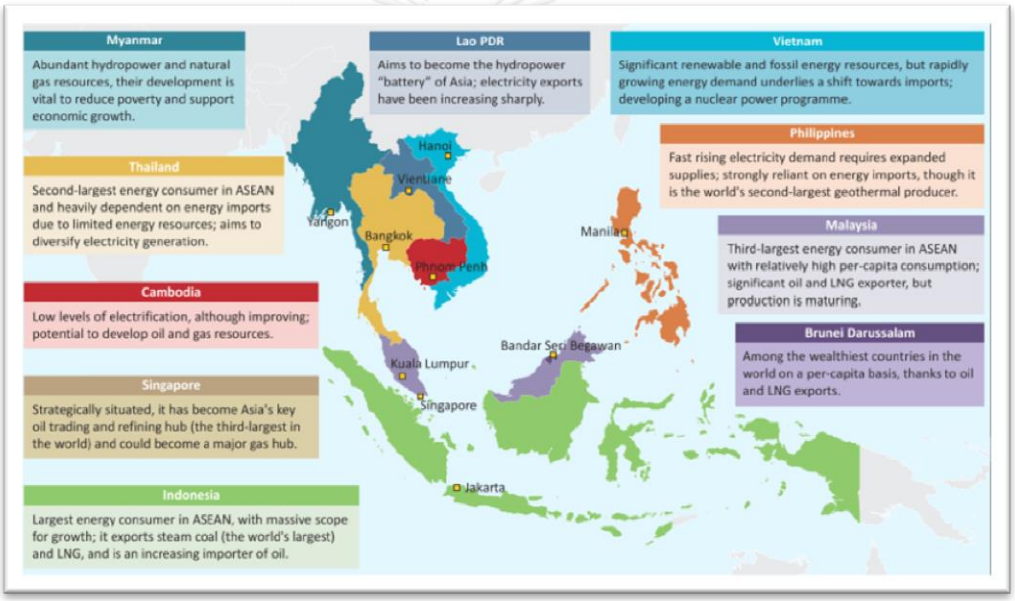
Source: EGAT

CHAPTER 4
ELECTRICITY MARKET INTEGRATION IN ASEAN

4.1 History and Development

Southeast Asia is a relatively resource-rich region. As shown on the map (Figure 4-1), eight of the ASEAN member countries have oil and gas reserves, and substantial coal resources. Indonesia ranks among the top 20 oil-producing countries in the world, and Brunei, Malaysia, Thailand and Vietnam also produce significant of oil (Nicolas 2009).

Figure 4-1 Energy in the ASEAN region



Source: ASEAN center of Energy

Indonesia, Malaysia, Philippines, Singapore and Thailand founded ASEAN on August 8th, 1967, partly in response to the spread of communism during the early 1970s. ASEAN members quickly adopted two treaties to provide greater economic cooperation, the Treaty of Amity and Cooperation in Southeast Asia and the Declaration of ASEAN Concord, which were both signed in 1976 at the Bali Summit. Since then, ASEAN has doubled in size to include Brunei (1984), Vietnam (1995), Laos (1997), Myanmar (1997), and Cambodia (1999). Taken together, the ASEAN region is home to about 10% of the world's population and encompasses economies

that produce $1.1 trillion in combined gross domestic product annually and annual total trade revenues of about $1.4 trillion. As an organization, ASEAN has two stated objectives: to accelerate economic growth and development in the region, and to promote regional peace and stability through cooperation (Sovacool 2009).

The vision of ASEAN Leaders to build an ASEAN Community by 2015 calls for a well-connected ASEAN that will contribute towards a more competitive and resilient regional community. ASEAN Connectivity is essential to achieve the ASEAN Community, namely the ASEAN Political-Security Community, ASEAN Economic Community and ASEAN Socio-Cultural Community illustrated in Figure 4-2.

ASEAN has developed the Master Plan on ASEAN Connectivity as a key step towards realizing the ASEAN Community of continued economic growth, reduced development gap and improved connectivity among member states and between member states and the rest of the world by enhancing regional and national physical, institutional and people-to-people linkages.

The Master Plan is both a strategic document for achieving overall ASEAN connectivity and a plan of action for immediate implementation for the period 2011-2015 to connect ASEAN through enhanced physical infrastructure development (physical connectivity), effective institutions, mechanisms and processes (institutional connectivity) and empowered people (people-to-people connectivity).

Energy infrastructure development is one of the physical connectivity goals outlined in the Master Plan on ASEAN Connectivity. ASEAN cooperation in the energy sector has been guided by a series of guiding policy documents to support the implementation of multilateral energy cooperation to advance regional integration and connectivity in ASEAN. The framework of ASEAN cooperation to enhance energy security, accessibility, affordability and sustainability, called The ASEAN Plan of Action for Energy Cooperation (APAEC), consists of four plans;

1. The ASEAN Plan of Action for Energy Cooperation (APAEC) 1999-2004
2. The ASEAN Plan of Action for Energy Cooperation (APAEC) 2004-2009
3. The ASEAN Plan of Action for Energy Cooperation (APAEC) 2010-2015
4. The ASEAN Plan of Action for Energy Cooperation (APAEC) 2016 – 2025 (the current action plan)

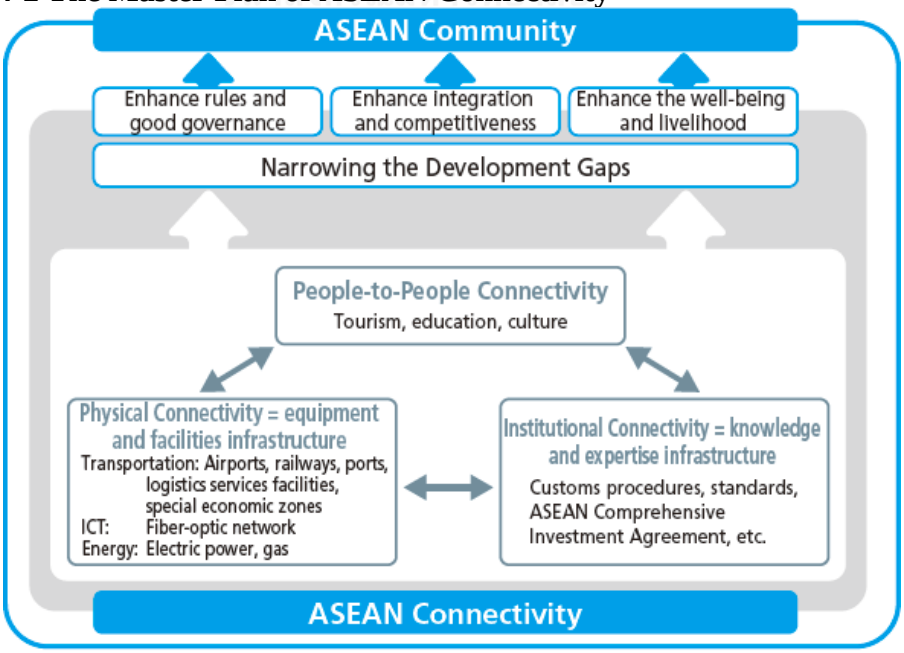
During the period 1999-2004, the conclusion of the Trans-ASEAN Gas Pipeline (TAGP) Master Plan by the ASEAN Council on Petroleum (ASCOPE) and the ASEAN Interconnection Master Plan Study by Heads of ASEAN Power Utilities (HAPUA) has paved the way for an enhanced regional energy security framework while promoting efficient utilization and sharing of resources.

In the second period (2004-2009) significant achievements were realized including the signing of the Memorandum of Understanding for the ASEAN Power Grid (APG), the establishment of APG Consultative Council and the establishment of ASCOPE Gas Centre (AGC).

The third period (2010-2015) placed greater emphasis on accelerating the implementation of action plans to further enhance energy security, accessibility and sustainability for the region with due consideration for health, safety and the environment, especially in relation to the ASEAN Power Grid (APG), Trans-ASEAN Gas Pipeline (TAGP), clean coal technology and renewable energy amongst others.

During the current period (2016-2025), ASEAN has launched the latest plan of action in 2015 that has been developed to further build toward achievement of the goals of the previous plan. The highlight and key initiative of this plan is to establish multilateral electricity trading.

Figure 4-2 The Master Plan of ASEAN Connectivity



Source: ASEAN centre for Energy

4.1.1 ASEAN Power Grid, the main flagship program

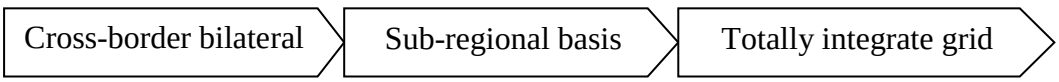
Under the previous plan, the objective of the APAEC from 2010-2015 was to enhance energy security and sustainability for the ASEAN region including consideration for health, safety and the environment. The APAEC 2010-2015 contained 26 strategies and 91 actions. Because this study will focus on electricity market integration, the plan that will be focused on is ASEAN Power Grid.

ASEAN Power Grid is a flagship program mandated in 1997 by ASEAN leaders, which aims to help ASEAN member states to meet increasing demand for electricity and improve access to energy services by enhancing trade in electricity across borders, optimizing energy generation and development and encouraging possible reserve sharing schemes. According to ACE (2000), the APG's strategies, the first one of seven program areas, stated in the APACE 2010-2015 are

1. Accelerate the development of the ASEAN Power Grid Interconnection projects.
2. Optimize the generation sector vis-à-vis the available indigenous energy resource in the region.
3. Encourage and optimize the utilization of ASEAN resources, such as funding, expertise and products to develop the generation, transmission and distribution sectors.

To pursue the program, ASEAN has adopted a strategy that encourages interconnections between 15 identified projects, first on cross-border bilateral terms, then gradually expanding to a sub-regional basis and, finally to a totally integrated Southeast Asian power grid system as shown in Figure 4-3.

Figure 4-3 ASEAN Plan of Action for Energy Cooperation 2010-2015

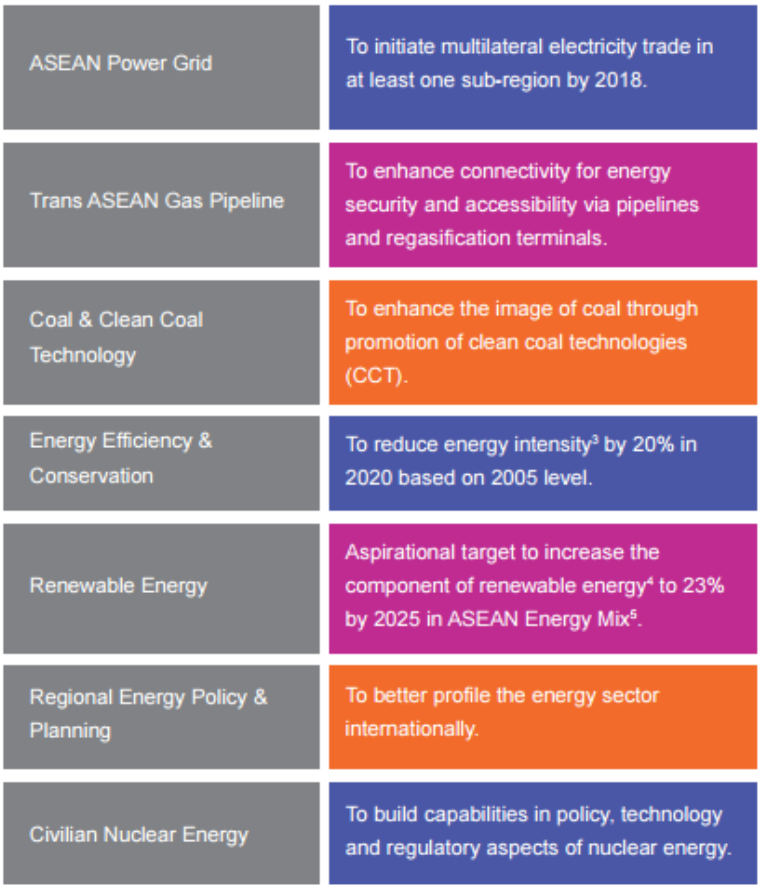


Source: ASEAN centre for Energy

The current plan, APAEC 2016-2025, has been developed by building on the progressive achievements of the previous plans. With the theme, *"Enhancing energy connectivity and market integration in ASEAN to achieve energy security, accessibility, affordability and sustainability for all",* this plan will implement outcome-based strategies and action plans through seven programme areas. The plan will be implemented in two phases. Phase I, from 2016-2020, will focus on the short to medium-term strategies required to achieve energy security cooperation and move towards greater connectivity and integration. A midterm review of Phase I will be conducted in 2018 in order to guide ASEAN in charting the roadmap for the next phase, Phase II, which will last from 2021-2025 (ACE 2015).

The key initiatives under this APAEC include embarking on multilateral electricity trading to accelerate the realization of the ASEAN Power Grid (APG) as shown in Figure 4-4.

Figure 4-4 ASEAN Plan of Action for energy cooperation 2016-2025



Source: ASEAN centre for Energy

4.1.2 Status of ASEAN Interconnection Projects

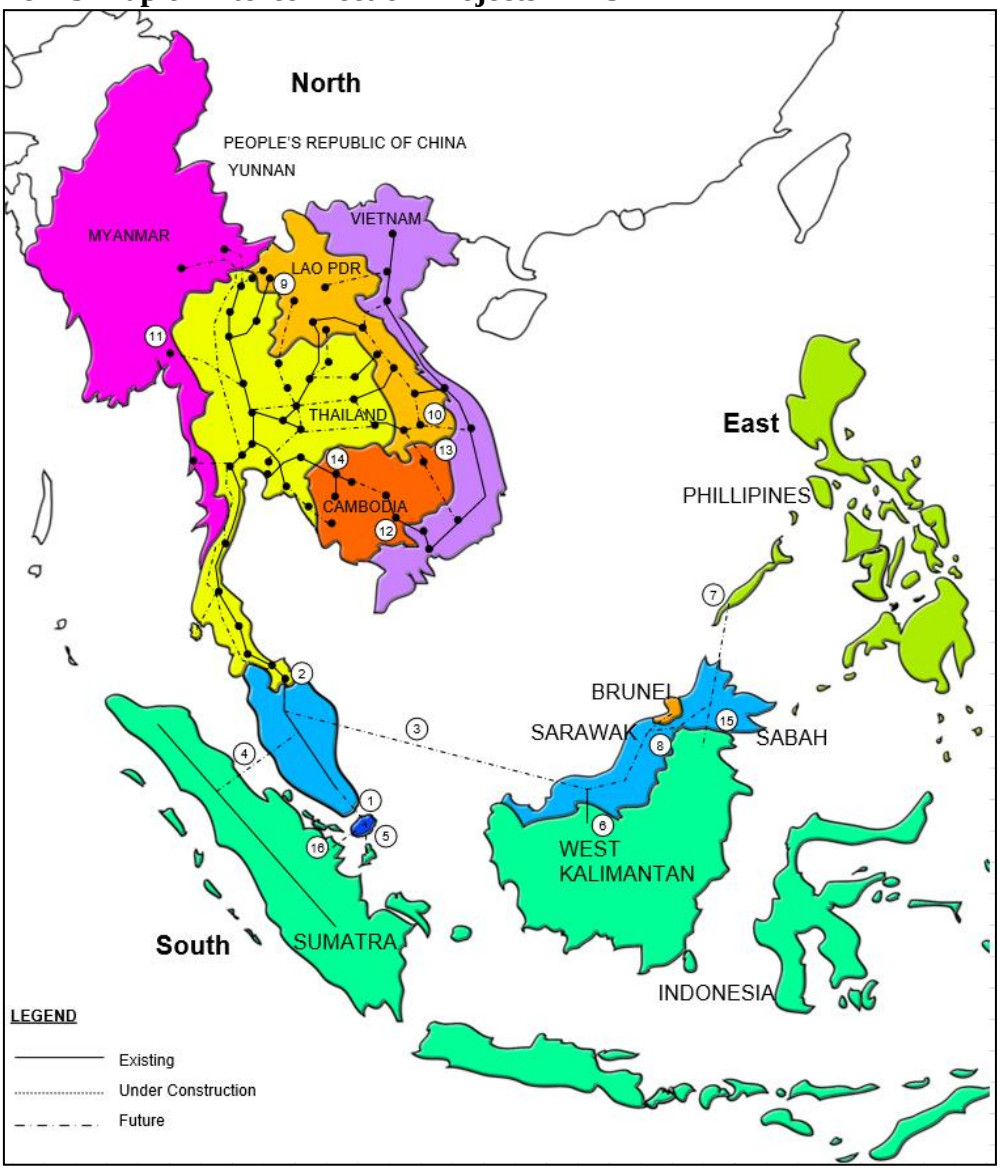
The construction of the ASEAN Power Grid is in progress with 16 interconnection projects. Figure 4-5 shows ASEAN power grid projects divided into 3 regions; the Northern System, Eastern System and Southern System.

1. Northern System is comprised of Myanmar, Vietnam, Laos, Thailand and Cambodia

2. Eastern System is comprised of Philippines and Brunei Darussalam

3. Southern System is comprised of Indonesia, Malaysia and Singapore

Figure 4-5 Map of Interconnection Projects in ASEAN



Source: HAPUA

The ASEAN Interconnection Master Plan Study (AIMS-II) firstly aims to create APG through interconnections among all ASEAN countries, and confirms that the power interconnection is economically and technically feasible within the region. Table 4-1 shows the 16 interconnections between ASEAN countries. The column "original COD" indicates the Commercial Operation Date (COD) of each project, which referred from the AIMS-II result. Another column, "earliest COD," shows updated information as of March 2016.

Table 4-1 List of 16 Interconnection Projects in ASEAN

	Original COD	Earliest COD
1) **P.Malaysia - Singapore**		
• Plentong – Woodlands	Existing	Existing
• P.Malaysia - Singapore	2018	post 2020
(2^{nd} link Plentong - Woodlands)		
2) **Thailand - P.Malaysia**		
• Sadao - Bukit Keteri	Existing	Existing
• Khlong Ngae - Gurun	Existing	Existing
• Su Ngai Kolok - Rantau Panjang	2014	TBC
• Khlong Ngae – Gurun (2nd Phase, 300MW)	2016	TBC
3) Sarawak - P. Malaysia	**2015 - 2021**	**2025**
4) P.Malaysia - Sumatra	**2015**	**2021**
5) Batam - Singapore	**2015 - 2017**	**post 2020**
6) Sarawak - West Kalimantan	**2012**	**2015**
7) Philippines – Sabah	**2020**	**TBC**
8) **Sarawak - Sabah – Brunei**	**2020**	**2020**
• Sarawak –Sabah	2020	2020
• Sarawak – Brunei	2012-2016	2019
9) Thailand - Lao PDR		
• Roi Et 2 - Nam Theun 2	Existing	Existing
• Sakon Nakhon 2 – Thakhek – Then Hinboun (Exp.)	2012	Existing
• Mae Moh 3 - Nan - Hong Sa	2015	Existing
• Udon Thani 3- Nabong (converted to 500KV)	2017	2019
• Ubon Ratchathani 3 – Pakse – Xe Pian Xe Namnoy	2018	2019
• Khon Kaen 4 – Loei 2 – Xayaburi	2019	2019
• Nakhon Phanom – Thakhek		2015
• Thailand – Lao PDR (New)	2015 - 2023	2019-2023
10) **Lao PDR – Vietnam**	**2011 – 2016**	**2016 - 2020**
• Xekaman 3 – Tranhmy	Existing	Existing
• Xekaman 1 – Pleiku 2		2016
11) Thailand - Myanmar	**2016 - 2025**	**2018-2026**
12) **Vietnam - Cambodia (New)**		
• Chau Doc – Takeo – Phnom Penh	Existing	Existing
• Tay Ninh – Stung Treng	2016	TBC
13) Lao PDR – Cambodia	**2011**	**post 2018**
14) **Thailand - Cambodia (New)**	**2015 - 2017**	**post 2020**
• Aranyaprathet – Banteay Meanchey	Existing	Existing
• Thailand – Cambodia	2015-2017	post 2020
15) East Sabah - East Kalimantan	**newly Proposed**	**TBC**
16) Singapore – Sumatra	**2020**	**post 2020**

Source: HAPUA

Note of Table 4-1

1.) Projects No. 4 and 13 are priority projects which refer to the APAEC 2016-2020

2.) TBC means ‘to be confirmed’

Currently, the total capacity from existing projects is 5,212 MW, which is mainly obtained from the Northern System. The on-going project, for which a tariff, MOU, and contract were signed, is around 3,199 - 3269 MW. Future projects will account for around 20,074 – 23,224 MW. After achieving all 16 interconnections in ASEAN, it will be possible to serve a total capacity of 28,485-31,705 MW, as illustrated in Table 4-2 (Vongthanet 2016).

Table 4-2 Status of ASEAN Interconnection Projects by regions

		Exist	On-going (Up to 2021)	Future	Total
	Northern System	**4,152**	**2,469**	**15,774-18,924**	**22,395-25,545**
9	Thailand - Lao PDR	3,584	1,879	1,865	7,328
10	Lao PDR -Vietnam	248	290	-	538
11	Thailand - Myanmar	-	-	11,709-14,859	11,709-14,859
12	Vietnam - Cambodia	200	-	-	200
13	Lao PDR - Cambodia	-	300	-	300
14	Thailand - Cambodia	120	-	2,200	2,320
	Southern System	**450**	**600**	**1,800**	**2,850**
1	P.Malaysia - Singapore	450	-	600	1,050
4	P.Malaysia - Sumatra	-	600	-	600
5	Batam - Singapore	-	-	600	600
16	Singapore - Sumatra	-	-	600	600
	Eastern System	**230**	**30-100**	**600**	**860-930**
6	Sarawak - W.Kalimantan	230	-	-	230
7	Philippines - Sabah	-	-	500	500
8	Sarawak - Sabah - Brunei	-	30-100	100	130-200
15	E.Sabah - E.Kalimantan	-	-	-	-
	Northern - Southern System	**380**	**100**	**300**	**780**
2	Thailand - P.Malaysia	380	100	300	780
	Southern - Eastern System	**-**	**-**	**1,600**	**1,600**
3	Sarawak- P.Malaysia	-	-	1,600	1,600
	Grand Total	**5,212**	**3,199-3,269**	**20,074-23,224**	**28,485-31,705**

Source: EGAT in-depth interview

4.2 Electricity Market Players

Electricity market players can be broadly divided into 4 sections.

1. Electricity generators – the role of electricity generators is to generate power either in traditional ways or using renewable energy sources, and to inject it into the transmission systems or directly into distribution systems before being delivered to end users.

2. Transmission system operators (TSOs) – TSOs are responsible for transporting electrical power on a national or regional level while maintaining the security of the power system.

3. Regulators – Regulators are responsible for controlling the energy market in order to make sure that the market is transparent and in line with stated energy policy for the consumers' interests.

4. Consumers – The end users can be individuals, SMEs or major industries. Individual users or SMEs are connected to the distribution system while industrial users often connect to the high-voltage grid.

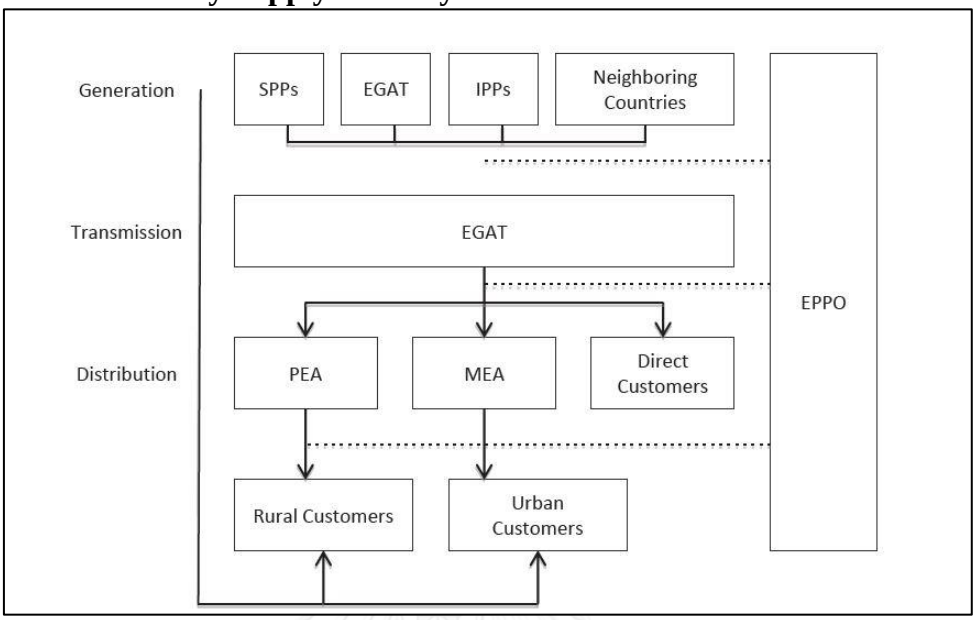
Case Study: Electricity Market of Thailand

The electricity supply industry in Thailand is an enhanced single buyer model (ESI). The government consolidated electricity organizations into one generation and transmission enterprise, called the Electricity Generating Authority of Thailand (EGAT). The Metropolitan Electricity Authority (MEA) is one of the distribution enterprises that distributes electricity to Bangkok Metropolis and the surrounding provinces. Another distribution enterprise, called the Provincial Electricity Authority (PEA), was assigned to distribute electricity to the rest of the country. EGAT controls most of the power generation and all of the transmission facilities in Thailand.

Under the Independent Power Producer (IPP) scheme, IPPs must sell to EGAT only. Under this situation EGAT is the single buyer. EGAT undertakes the responsibility for power balance as well as network management. The ESI structure is illustrated in Figure 4-6. EGAT sells its electricity primarily to the Provincial Electricity Authority and Metropolitan Electricity Authority, which have a monopoly on distribution. Also, EGAT sells a small portion directly to some large customers who are connected directly to its transmission system. The EPPO acts as a regulator

of ESI and the Ministry of Finance regulates the financial operations of all three state utilities.

Figure 4-6 Electricity Supply Industry Structure in Thailand



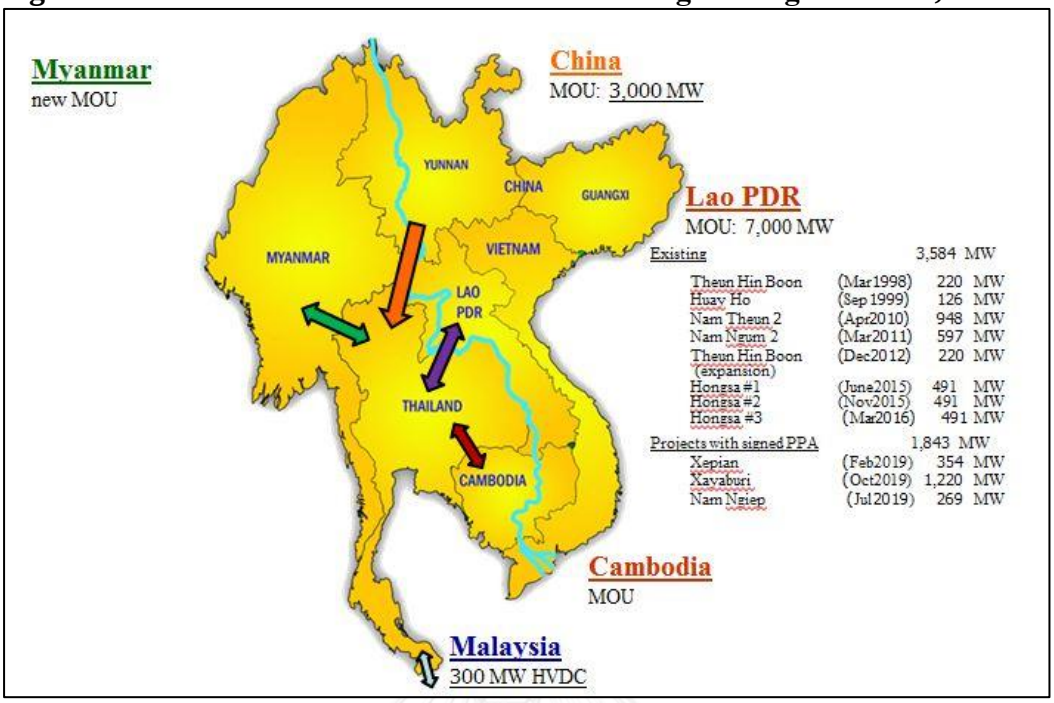
Source: Chirarattananon and Nirukkanaporn (2006)

Cross-border trade in Thailand's electricity market

Thailand has electricity cooperation agreements with neighboring countries following the intergovernmental MOUs illustrated in Figure 4-7.

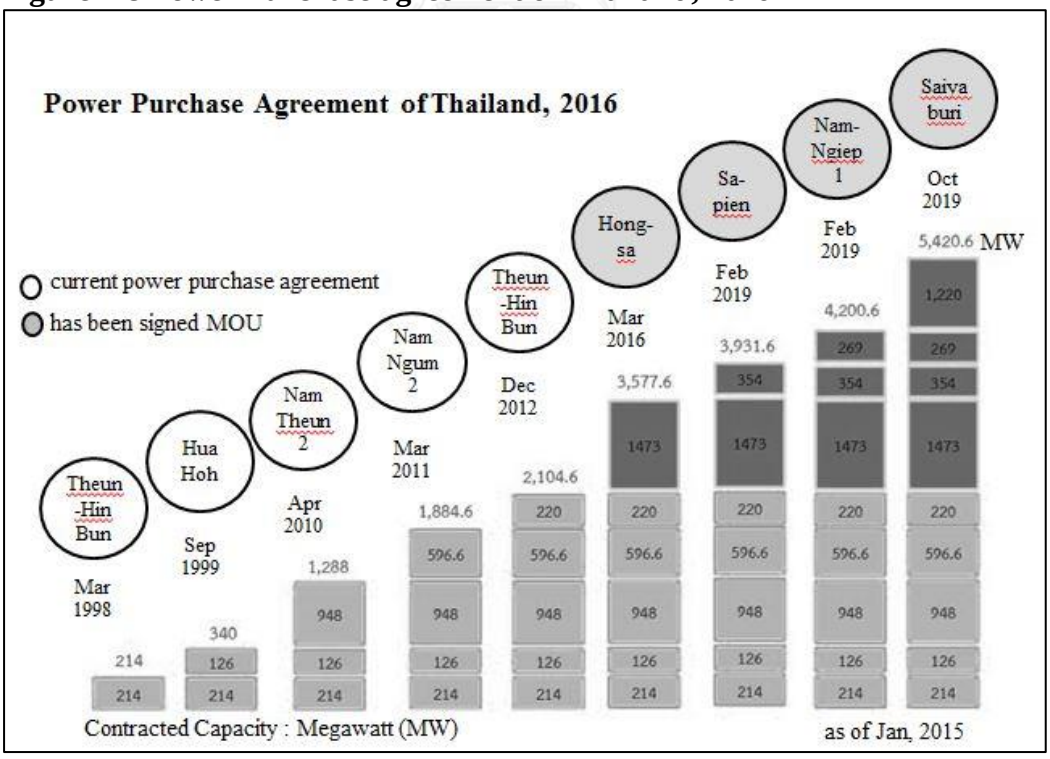
- **China**: Thailand signed a MOU with China to cooperate in power purchase between the two countries within the range of around 3,000 MW.
- **Lao PDR**: Laos accounted for the highest proportion of electricity trade among neighboring countries. The MOU on power purchase between Thailand and Lao PDR has shown in Figure 4-8. Currently, Thailand has signed an MOU for power purchase of around 5,400 MW by 2019.
- **Myanmar**: A new intergovernmental MOU was signed in 2015 in order to strengthen both countries' cooperation on the expansion of generation, transmission and distribution improvements as well as human resources development.
- **Malaysia**: Thailand has one interconnection link of HVDC with capacity of 300 MW.

Figure 4-7 Thailand's cross border trade with neighboring countries, 2016



Source: Electricity Generating Authority of Thailand (EGAT)

Figure 4-8 Power Purchase agreement of Thailand, 2016

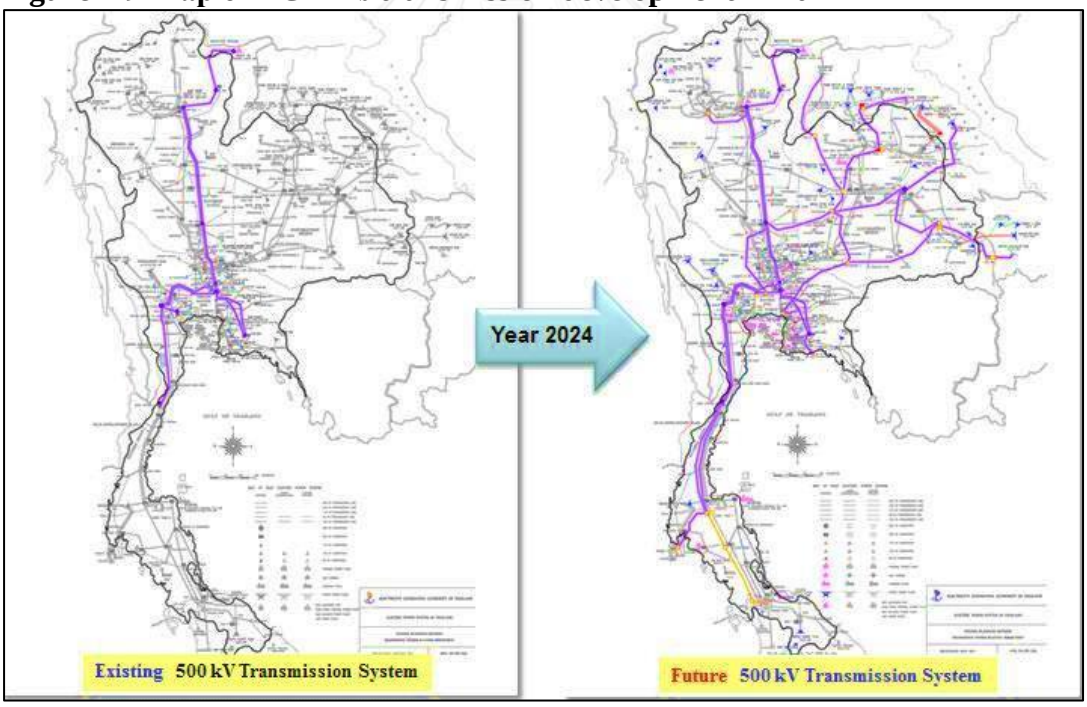


Source: Electricity Generating Authority of Thailand (EGAT)

Transmission grid of Thailand as a backbone of ASEAN

Thailand has a geographical advantage, as it is located between Laos, Myanmar, Cambodia and Malaysia and connects the north to the south of ASEAN. The strength of Thailand are the 500 kV transmission lines acting as a backbone connecting the northern and central regions. Figure 4-9 shows a map of EGAT's transmission development plan for 2024. EGAT has planned to further develop the 500 kV transmission system in order to strengthen the transmission system, ensure security of the power system and support new power projects according to PDP2015. Therefore, the 500 kV systems will strengthen the interconnections within ASEAN. In the future, the regional power trade on a multilateral basis will be a much larger challenge for the whole ASEAN region. The development of facilities and readiness for adaption will be the key factors in coping with these challenges.

Figure 4-9 Map of EGAT's transmission development in 2024



Source: Electricity Generating Authority of Thailand (EGAT)

4.3 Associations relating to interconnection

According to ASEAN Center for Energy, ASEAN cooperation developed the ASEAN Plan of Action for Energy Cooperation (APAEC) to enhance energy cooperation by promoting a more diversified power mix and to strengthen energy security. The scope of this study is to focus on the ASEAN Power Grid, which is one of the priorities in the APAEC areas. This section provides the associations relating to ASEAN Power Grid cooperation, Program Area No. 1 of APACE as illustrated in Figure 4-10.

The ASEAN Ministers of Energy Meeting (AMEM) provides overall guidance and advice on the implementation of the APAEC. The AMEM also provides guidance to address key issues, challenges and concerns of common interest and to set policy directions to achieve the goals of the energy cooperation under the framework of the AEC.

The Senior Officials Meeting on Energy (SOME) determines the implementation priorities and provides directions and advice on the APAEC to ensure coordination and integration of APAEC strategies and actions. In addition, SOME guides the formulation and implementation of the yearly work plan of each of the APAEC Programme Areas and provides annual progress updates to AMEM. To encourage the transfer of the latest technologies, SOME provides guidance on deepening engagement with partners such as international organizations and private sector organizations.

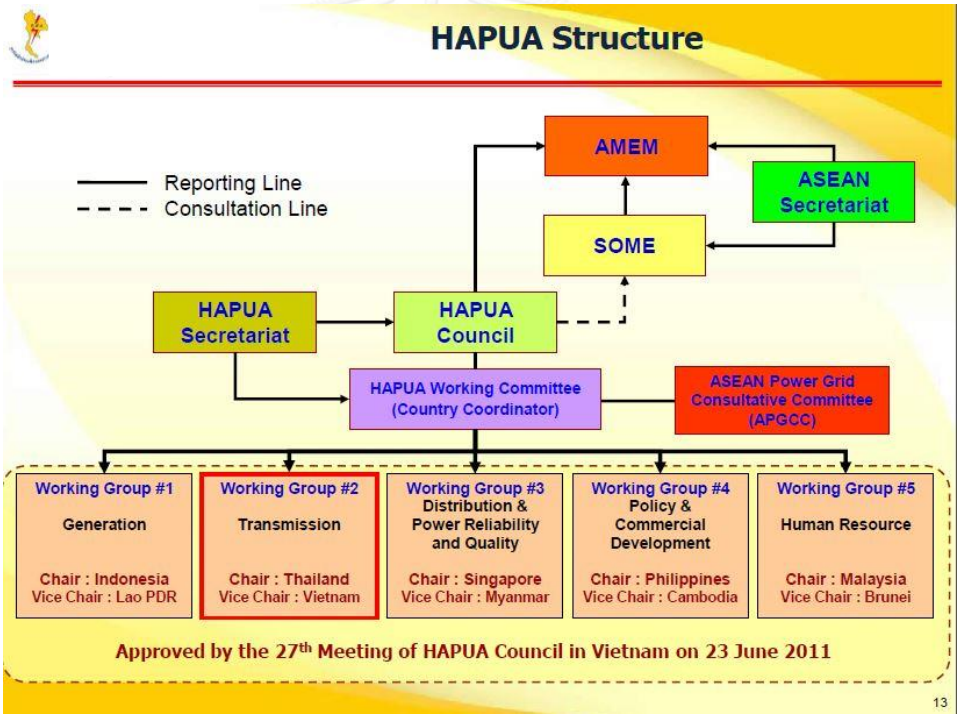
Heads of ASEAN Power Utilities/Authorities (HAPUA), specialized energy bodies (SEBs), is responsible for serving as SOME's implementing body in their respective Programme Areas, which composes the ASEAN Power Grid. HAPUA usually collaborates to arrange meetings to identify the priorities and implement the arrangements, to further develop the work programmes, and to prepare the necessary project proposals and documents.

HAPUA Working Committee is comprised of 5 working groups. Each working group is accountable for generation, transmission, distribution, power reliability and quality, policy and commercial development, and human resources. Each working group coordinates and reports the progress of implementation of

planned developments to committee. **ASEAN Power Grid Consultative Committee (APGCC)** undertakes joint studies on the regulatory framework.

Furthermore, there are specialized bodies in other program areas including ASEAN Council on Petroleum (ASCOPE), ASEAN Forum on Coal (AFOC), Energy Efficiency and Conservation Sub-sector Network (EE&C-SSN), Renewable Energy Sub-sector Network (RE-SSN), Regional Energy Policy and Planning Sub-sector Network (REPP-SSN) and Nuclear Energy Cooperation Sub-sector Network (NEC-SSN).

Figure 4-10 Heads of ASEAN Power Utilities/Authorities (HAPUA) Structure



Source: HAPUA

4.4 Analysis and Result

In this study, the analysis of electricity market integration in ASEAN applied PEST analysis to identify the political, economic, social, and technological factors that affect electricity market integration in ASEAN. It is an analysis of the external macro environment in which a business operates for understanding risks associated with the market. PEST Analysis was originally created by Harvard professor Francis Aguilar. In his 1967 book, "Scanning the Business Environment," he originally called this tool ETPS. The name was later created to PEST. In this study, the scope of PEST factors focuses on both the supply and demand side. This includes electricity generation, transmission, distribution and retail sale in the ASEAN Electricity Market. The definition of each factor can be summarized in Table 4-3 and described as follows;

- **Political factors** are how the government intervenes in the market, including market structure, laws and regulations, and regulatory bodies
- **Economic factors** are those that affect electricity generation and operation. These factors include investment, cross-border trade in generation, transmission, and distribution.
- **Social factors** include population and demographic characteristics, social trends such as electricity accessibility.
- **Technological factors** include research and development activities, technological incentives for production, technological shifts that impact the cost of production and innovation to create greater competitiveness.

Table 4-3 Summary of PEST Analysis

PEST Analysis	
Political	**Economic**
- Market structure - Regulators - Laws and Regulations	- Electricity generation - Cross border trade - Investment -Public Private Partnership (PPP)
Social	**Technology**
- Demographic and population characteristics - Electricity accessibility	- Research and development - Renewable energy - Technology incentives, cost of production - Development activities

4.4.1 Political Factors

Considering the market structure**,** the electricity market has 4 main components. These are generation, transmission, distribution and retail sale. The electricity market structure is different in each country. ASEAN Energy (2015) summarized the models of ASEAN electricity markets, as shown in Figure 4-11, into two monopoly models. The two models are Vertical Integration and Separated Retail.

1. Vertical Integration

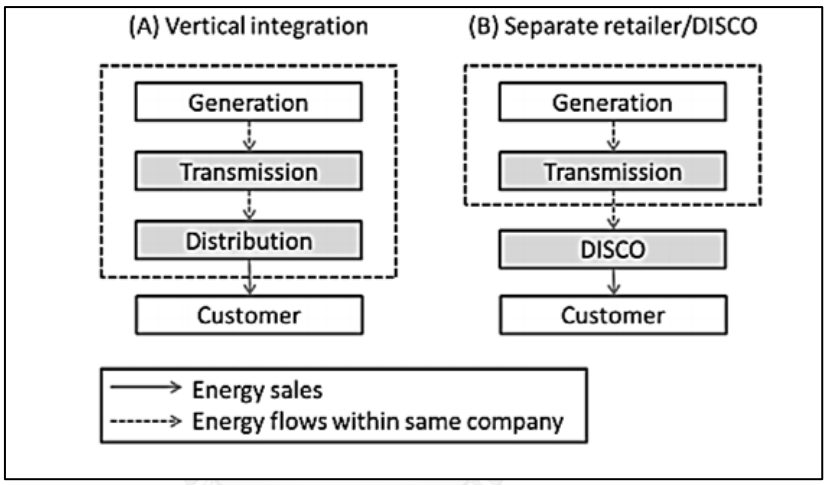
In this model, the market bundles generation, transmission and distribution within the same company, or all functions are administered by one company. Traditionally, this model has been in place in France, the United Kingdom and in most ASEAN countries including Indonesia, Philippines, Malaysia, Vietnam, Cambodia, Lao PDR and Myanmar.

2. Separated Retail

In this model, generation and transmission are separated from distribution and retail supply. This model has been in place in Germany, the United States, and Thailand. In these cases, distribution is handled by one or more separate distribution companies.

Singapore is the most competitive electricity market in terms of generation, transmission, distribution and retail sale in ASEAN. Singapore has a relatively mature and well-integrated national market. Initially, The Singapore Public Utilities Board (PUB) has been the sole provider of electricity until 1995. The regulatory roles were separate from business under Singapore Power. Competition has been introduced into generation, wholesale and retail sale. The Energy Market Authority (EMA) was established to regulate the industry (Wu 2013).

Figure 4-11 Two monopoly model of electricity market in ASEAN



Source: ASEAN Energy (2015)

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Political factors also include market liberalization, which encourages market integration. Nikomborirak and Manachotphong (2007) studied electricity reform in Thailand, Malaysia, Indonesia and the Philippines. The study analyzed the electricity sector liberalization in five aspects; privatization, wholesale competition, retail competition, unbundling and introduction of independent regulation. The electricity sector in most ASEAN countries was controlled by the government. Privatization could theoretically benefit competitive markets and could also lead to efficiency gains. However, in reality privatization has not been realized in Thailand. Even in Indonesia and the Philippines, privatization has been planned but not yet executed. Wholesale and retail competition has still not yet developed in ASEAN as long as state-owned monopolies continue to control the electricity sector.

Currently, APAEC 2016-2025 has planned to establish an independent regulator. This is an important challenge for ASEAN countries to develop a competitive market. The different market liberalizations are described as follows;

The Indonesian power sector is dominated by the state-owned Perusahan Listrik Negara (PLN). The IPP was adopted to country and regulatory reform was not accomplished.

The Philippines was one of the first Southeast Asian countries to allow IPPs in 1989. About 41% of power is produced by IPPs and the rest by the National Power Corporation (NAPOCAR). The full privatization to unbundle generation, transmission, distribution and retail was approved by the government but the implementation has been delayed.

The Malaysian electricity sector used to be controlled by a vertically integrated system. There is still monopoly in power purchase, transmission and distribution.

Vietnam first adopted IPP for production in 2004. Because generation capacity didn't meet the demand in the country, the reform was initiated to bring about full power market liberalization by introducing competition in generation, allowing private producer to sell electricity to a single buyer and deregulating wholesale sector and retail competition.

Cambodia, Laos and Myanmar are still in the process of expanding electrification in their economies. Their governments are now expanding electricity access and developing the national grid. The private sector is participating in electricity generation and is also engaged in cross border trade with neighboring countries.

Thailand first adopted IPP in generation sector in 1992. The reform initiated the establishment of the Energy Regulatory Commission (ERC) in 2007. The electricity sector is dominated by the state-owned Electricity Generating Authority of Thailand (EGAT). EGAT has a market share of 47%, followed by IPPs (39%), SPPs (7%) and imported energy (7%). EGAT has the sole right to purchase power from the private sector and neighboring countries. Thus, there is no competition in wholesale.

The electricity sector in Brunei Darussalam is controlled by two state agencies, namely, the Department of Electrical Services and Berakas Power Company (BPC). Electricity is generated through seven power stations maintained by the two agencies.

An independent regulator is what all ASEAN countries need. In most ASEAN countries, politics play an important role in the electricity sector. It is difficult to establish an independent regulator and it takes a long time to learn about and specialize in the electricity sector. The regulatory structures vary among ASEAN countries. Details of regulatory structures in ASEAN are shown in Table 4-4.

Table 4-4 Regulatory Structures in the ASEAN Electricity Market

	Regulators		Structure
	Independent	Dependent	
Brunei : DES Dept. of Electrical Service		under Ministry of Energy	Single Buyer
Cambodia : EAC Electricity Authority of Cambodia	Set up in 2001		Single Buyer
Indonesia : DEMR Dept. of Energy and Mineral Resources		under Ministry of Energy and Mineral Resources	Single Buyer
Laos : DOE Department of Electricity		under Ministry of Energy and Mine (MEM)	Single Buyer
Malaysia Energy Commission	Set up in 2001		Single Buyer
Myanmar		under Ministry of Electric Power 1 & 2	Single Buyer
Philippines : ERC Energy Regulatory Commission	Set up in 2001		Price Pool
Singapore : EMA Energy Market Authority		Under Ministry of Trade and Industry	Price Pool
Thailand : ERC Energy Regulatory Commission	Set up in 2001		Single Buyer
Vietnam : ERAV Electricity Regulatory Authority		Under Ministry of Industry (MOI)	Cost Base Pool

Source: Ruangrong (2013)

To integrate the electricity market, transmission system operators are the main bodies that need to cooperate to maintain the security of the power system. The current plan APACE 2016-2025 focused on the institutional structure of APG generation and Transmission System Planning Institution (AGTP) and APG Transmission System Operator Institution (ATSO). The latest meeting of HAPUA Working Group 2 (Transmission) on March 2016 has set the task force to collect information about power system studies and market structure to discuss future market development of ASEAN connectivity. Furthermore, Heads of ASEAN Power Utilities/Authorities (HAPUA) stated the commitment of ASEAN Power Grid to establish the system operator according to the following statement;

1. Reaffirming the commitment towards ASEAN energy security and economic community, the HAPUA Council is committed towards:

1.1 Implementing three priority projects of ASEAN Power Grid (APG), namely Lao PDR (Ban Hat) – Cambodia (Stung Treng) by 2017, Sarawak – Brunei by 2018 and Peninsular Malaysia – Sumatera by 2020,

1.2 Implementing Lao PDR – Thailand – Malaysia – Singapore Power Integration Project (LTMS-PIP) by 2018 where the lessons learnt from implementing LTMS-PIP will contribute to the resolution of issues of legal and tax harmonization towards the setup of the ASEAN Electricity Regulator and APG Transmission System Operator (ATSO) and APG Generation & Transmission Planning (AGTP) institutions.

2. The HAPUA Council reaffirms its commitment towards enhancing optimization of indigenous and renewable energy use, taking into consideration the ASEAN commitment to achieve 25% of renewable energy mix by 2020, while maintaining system reliability and power quality through proper integration of renewable energy sources with the grid.

3. The HAPUA Council is committed to enhancing power reliability and quality by modernizing the grid system and utilizing Smart Grid technologies.

4. The HAPUA Council is committed to explore the various possible financial modalities for APG projects by setting up the “Guidelines for PPP Financing Modalities in ASEAN Power Project”.

5. The HAPUA Council is committed for ASEAN utilities to share the same platform for recognition and utilization of technical experts among themselves.

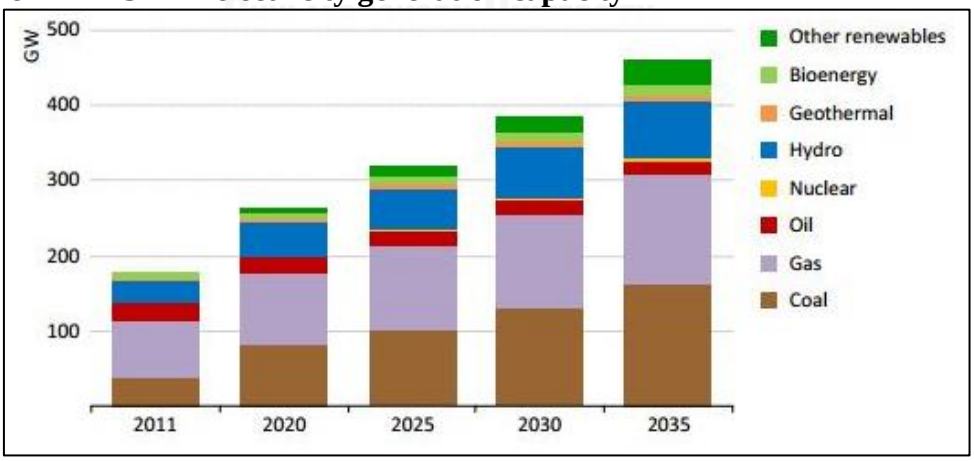
4.4.2 Economic Factors

Economic factors are those that affect electricity generation and operation, including investment, and cross-border trade in generation, transmission and distribution.

Power Generation

Electricity generation capacity in Southeast Asia is planned to grow steadily, from 176 gigawatts (GW) in 2011 to almost 460 GW in 2035, as shown in Figure 4-12. ASEAN’s power generation sources are predicted to shift towards coal in the future. Capacity is also planned to increase for production on gas and hydropower. Oil-fired capacity is predicted to fall because of rising fuel prices. Moreover, renewables-based electricity, especially hydropower, has high potential in ASEAN. Greater diversity in the power mix can contribute to energy security for ASEAN.

Figure 4-12 ASEAN electricity generation capacity



Source: IEA (2013)

Cross-border Trade

At present, trade among ASEAN members is based on long-term bilateral power purchase agreements signed between utilities and independent power producers (IPPs). The trend of electricity trading within the region continues to grow, as illustrated in Figure 4-13. The increasing demand of electricity consumption raises concentration on cross-border trade and investment. The efforts of HAPUA are to study the constraints of cross border power trade and investments on (1) taxation of cross border power transactions and (2) public-private partnership (PPP) for financing modalities for APG projects.

Figure 4-13 Net electricity import in ASEAN countries

Source: IEA (2013)

Public Private Partnership (PPP) is a form of project implementation that the government can use to work with the private sector to deliver services that require the development of new physical assets. PPP refers to long-term partner relationships between the public and private sectors to deliver services. PPP is an approach that the government would adopt to increase private sector involvement in the delivery of public services. More importantly, the PPP is a possible model to relieve constraints on public resources while recognizing the importance of investment in infrastructure for the growth of economies. More countries are turning to PPP as an alternative source of funding. Currently, the availability of PPP in ASEAN countries is shown in Table 4-5.

ASEAN countries implement different PPP schemes in each country. The PPP could also introduce new technology and innovation from private firms into the public sector. Each PPP model has pro and con, and the decision to move towards PPP would depend on the administrative and institutional arrangements of each country.

In addition, the degree of private sector participation varies from monopoly (by state enterprise) to full competition. These models are:

1. **State-Owned Enterprise Investment Model (SOE)** The approach requires direct equity from the state-owned utility, accompanied by a government loan guarantee to support the capital investment from the state utility. The advantage of this model is that the government can be assured that the public interest is served, such as through a low tariff regime. However, this monopoly environment will not create market competition to enhance performance and productivity. Currently, Thailand, Lao PDR, Indonesia, Brunei Darussalam and Vietnam apply this model.

2. Concession Model The structure concession model includes lending agreements, construction and operation contracts. This model could stimulate competition during the bidding period and relieve the state investment, but the relationship between the public and private sectors exists through concession contracts.

3. **Joint Investment Model** This investment model can bring more efficiency for the utilization of resources as the risk can be optimally allocated between the government and private investors.

4. Infrastructure Fund Model This model is gradually beginning to be used among ASEAN countries such as Indonesia, Malaysia and Thailand. This model can enable some risk sharing and ease the process of financing. But the incumbent bears all the risk and responsibility for security of supply.

5. Market Based Model In this model, the state will relieve all burden of investment for the development of infrastructure. However, there are much of the debate about benefits and costs of liberalization in many countries around the world. It was felt that the risks associated with regulatory failure will be far outweighed by the risks associated with competitive market failure. This model is used in Malaysia, the Philippines and Singapore.

Table 4-5 Financing Modalities in ASEAN Power Project

Country		SOE	Concession	Joint Venture	Infra-Fund	Market Based
Brunei Darussalam	Generation	/				
	Transmission	/				
Cambodia	Generation			/		
	Transmission			/		
Indonesia	Generation	/	/	/		
	Transmission	/				
Laos PDR	Generation	/	/	/		
	Transmission	/				
Malaysia	Generation			/		/
	Transmission			/		/
Philippines	Generation					/
	Transmission		/			
Singapore	Generation					/
	Transmission					/
Thailand	Generation	/	/		/	
	Transmission	/				
Vietnam	Generation		/			
	Transmission	/				
Myanmar	Generation	No data				
	Transmission					

Source: HAPUA working group No.4

4.4.3 Social Factors

Social factors influencing market integration in ASEAN include cooperation, demographic and population characteristics, and demand for electricity or electricity accessibility.

Demographics and Electricity Accessibility

The population of ASEAN was estimated at almost 600 million in 2011. Brunei Darussalam has the smallest population, with around 400 thousand people, while Indonesia, at 242 million people, is the largest country in the region and the fourth-largest in the world. Table 4-6 shows the number of people in the region without access to electricity. The growth of population has led ASEAN countries to improve electricity accessibility. Indonesia, Vietnam, Lao PDR and Cambodia have increased their electricity access rate over the past few years.

Table 4-6 Population without access to electricity

	Population without access to electricity		Population relying on traditional use of biomass for cooking*	
	Million	Share (%)	Million	Share (%)
Brunei Darussalam	0	0%	0	0%
Cambodia	9	66%	13	88%
Indonesia	66	27%	103	42%
Lao PDR	1	22%	4	65%
Malaysia	0	1%	1	3%
Myanmar	25	51%	44	92%
Philippines	28	30%	47	50%
Singapore	0	0%	0	0%
Thailand	1	1%	18	26%
Vietnam	3	4%	49	56%
Total ASEAN	134	22%	279	47%

Source: IEA (2011)

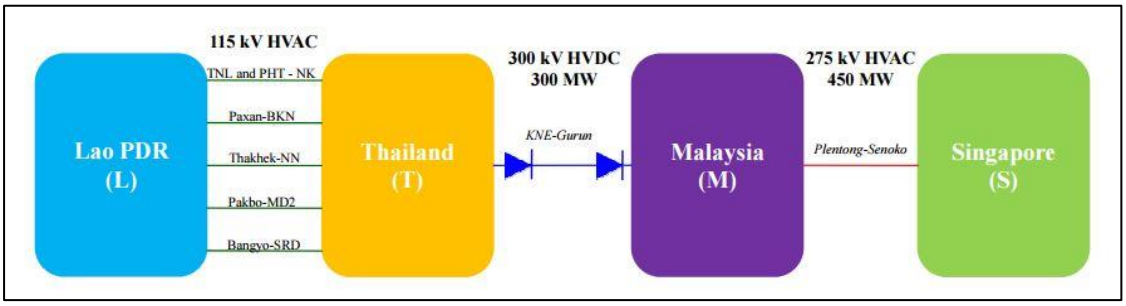
Electricity accessibility is one of the basic needs of the people of ASEAN. There are still great differences among member countries. Singapore and Brunei are the most advanced in providing electricity to the population. On the other hand, Cambodia has 66% of its population without access to electricity, followed by Myanmar and Philippines.

4.4.4 Technological Factors

The technological factors are research and development in the electricity market including the development in power generation, and other technology relevant to the electricity market. The interesting issue in electricity market development in ASEAN centers on sub-regional multilateral electricity trading, described in ASEAN Power Grid Phase 2. The sub-regional multilateral electricity trading was planned to be initiated by 2018. The **Lao-Thailand-Malaysia-Singapore (LTMS) Power Interconnection Project** is a demonstration to test the extent that the existing legal and regulatory rules in ASEAN countries can sustain multilateral trading of electricity. According to HAPUA, this will also test institutional and contractual arrangements important to multilateral trade, including third-party access arrangements. Currently, HAPUA has set the LTMS working group to study in more detail about market design, structure and operational details. One example of electricity market integration is the South African Power Pool (SAPP). The LTMS working group is finding the similarities between the markets and how multilateral trading appears to have been implemented without full harmonization of regulatory and legal frameworks.

Figure 4-14 illustrates existing interconnections and physical flows from Laos to Thailand. These are connected through five transmission lines. Transmission lines from Thailand to Malaysia are connected through 3oo kV HYDC transmission lines, and transmission lines from Malaysia to Singapore are connected through 275 kV HVAC transmission lines. The existing interconnections confirm the physical transmission grid can transfer the electricity flow from Laos to Singapore. Recently, LTMS working group has been studying the constraint of electricity trading through LTMS. Wheeling charge concept for LTMS-PIP refers to the process of transmission of electricity through the transmission lines. Therefore, there is often an associated fee which goes to the transmission system owners.

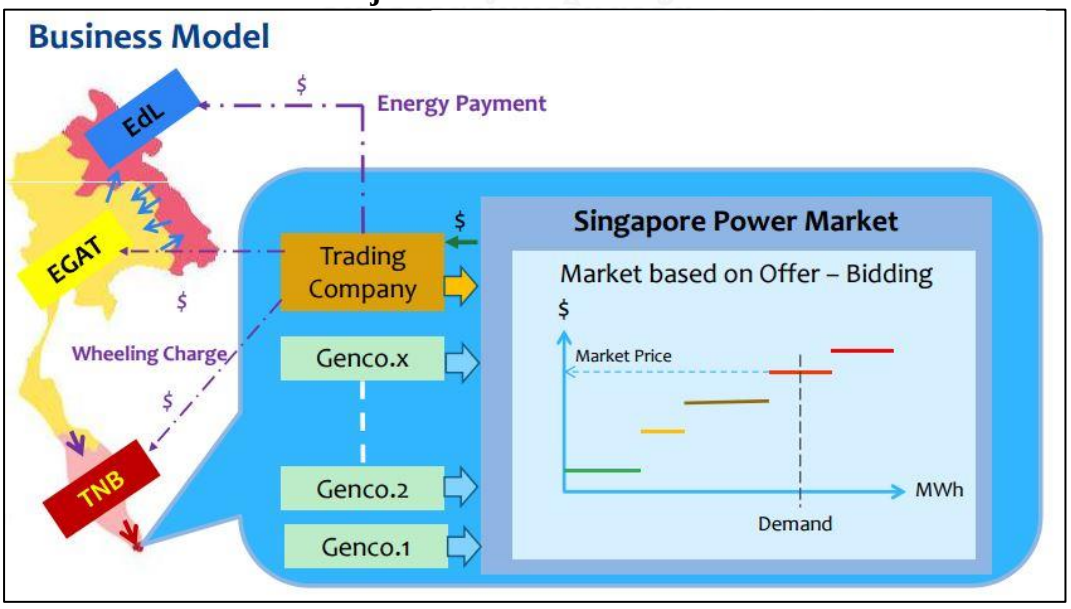
Figure 4-14 The existing interconnection and physical flow



Source: Electricity Generating Authority of Thailand (EGAT)

Moreover, the wheeling charge includes the transmission charge, loss charge, balancing charge or administration charge. However, electricity trade in Singapore's power market is based on offers and bidding. That is different from Malaysia, which uses a single buyer system with power purchase agreements. Figure 4-15 shows the business model of LTMS-PIP for electricity trading in the upcoming future. The model will establish trading company to participate in auction basis of electricity trading in Singapore. The electricity from Laos, Thailand and Malaysia will be charged on wheeling charges basis to sell to Singapore by offer-bidding mechanism.

Figure 4-15 Business Model of Lao-Thailand-Malaysia-Singapore (LTMS) Power Interconnection Project



Source: Electricity Generating Authority of Thailand (EGAT)

CHAPTER 5
CONCLUSION

5.1 Result

Electricity market integration requires infrastructure, regulatory and commercial integration. Successful market integrations have gone through a long history including market reform. The PEST analysis showed the political, economic, social, and technological factors that affect electricity market integration in ASEAN. The results of PEST analysis are shown as follows;

Political factors

One of the key success factors in the Nordic countries was electricity market reform. The Nordic electricity market is well-integrated through Norway's electricity reform in 1991, Finland's electricity reform in 1995, Sweden's electricity reform in 1996 and Denmark's electricity reform in 1998. The unbundling of generation, transmission, distribution and retail contributed to the efficiency of the electricity market. Nordic electricity policy cooperation has been based on consensus, mutual understanding and trust facilitated through exchange of experiences, seminars and educational activities. The electricity reform in Nordic countries has supported the integration in operations, especially transmission system operators (TSOs). NORDEL was formed by TSOs from Denmark, Finland, Norway and Sweden that successfully developed an effective transmission grid and integrated the Nordic electricity market. In addition, the establishment of NordREG, an electricity regulartory body, promoted legal and institutional frameworks for the Nordic electricity market. Therefore, the electricity reform also facilitated free entry into the market for generation, monitored competition in electricity supply, strengthened the role of the regulator and promoted a competitive market.

In contrast, the 10 nations of ASEAN have struggled with electricity reform. The history of ASEAN countries showed that the electricity sectors in most ASEAN countries were controlled by government. Although market reforms including unbundling, wholesale and retail market competition, independent regulation and

privatization can theoretically help to create a competitive market, most ASEAN countries have been unable to achieve this. Thailand and the Philippines postponed their plans for electricity reform. Currently, wholesale and retail competition has still not been developed as long as state-owned monopolies control the sector. However, electricity market integration is considering establishing the independent regulators that still different structure in each country. The upcoming challenge for ASEAN is to cooperate at the regional level to promote an effective integrated electricity market.

Economic Factors

Economic factors focused on the generation capacity that impacts the supply of electricity to the market. The Nordic countries have very diversified power generation capabilities, including electricity generation mix that is 53% reliant on hydropower, 23% reliant on nuclear power, followed by 12% on fossil fuels, 6% on wind and 6% on biomass. Moreover, the Nordic countries have sufficient interconnection capacity between countries. The transmission grid covers all the Nordic countries and combines all the national grids (excluding western Denmark) into one common power system.

In contrast, ASEAN's power generation is 43% reliant on gas, 32% reliant on coal, 14% on hydropower, and 6% on oil, with the rest supplied through renewable energy. Based on its National Energy Policy, Vietnam had planned to develop nuclear power plants which will provide an alternative choice for electricity generation. Although research studies have supported the efficiency in low cost per unit of electricity produced by nuclear power, nuclear power production was postponed in the ASEAN countries, Vietnam and Thailand. Cross-border trade is another issue to consider. Laos has a high level of hydropower production and is the biggest exporter of electricity to Thailand, Vietnam and Cambodia. The growing demand for electricity led ASEAN to develop investments in infrastructure. The administrative and institutional bodies may revise the investment model within ASEAN from the state-owned enterprise model in traditional investment model to a joint venture model or infrastructure fund model to allow private investment and encourage market competitiveness.

Social Factors

Social factors are based on demographic characteristics and demand for electricity in the market. Nordic cooperation reflects the close relationship between the neighboring countries, including people and cultural aspects. The political similarity and the long history of interaction and cooperation such as social policy and welfare are some of the factors that have driven Nordic cooperation to be successful. Moreover, the Nordic region has sufficient transmission grid interconnections that combine the whole Nordic region into one synchronous power system.

Electricity accessibility still limits the capacity for electricity market integration in ASEAN. According to in-depth interviews, a lack of self-sufficiency within some countries is the most important factor regarding cross border trade. Thailand's electricity market has sufficient electricity interconnections and is sustainable in operation, while Laos has an insufficient transmission grid and inefficient operation. Nowadays, differences in operation structure and unsynchronized power systems remain as barriers to a fully integrated electricity market. Therefore, sufficiency and sustainability at the national level is crucial prior to international market integration.

Technological factors

Technological factors focused on research and development activities, technological shifts and innovation to create greater competitiveness in the electricity market. Nord Pool is the Nordic electricity trading market. Nord Pool is owned by the Transmission System Operators (TSOs) of the Nordic countries. Nord Pool covers four wholesale markets which trade electricity based on auction. Nord Pool Spot calculates power prices based on supply and demand for every hour in Elspot market. The model of Nord Pool is an example of a competitive market in the electricity sector. Nord Pool provides freedom of choice to consumers. It organizes trade in standardized physical and financial power contracts. Close cooperation between system operations and market operations is the key feature of Nord Pool.

Currently, most electricity trade in ASEAN is based on bilateral trade agreements. HAPUA, regarding to ASEAN electricity integration, set the plan to implement multilateral electricity trade. The Lao-Thailand-Malaysia-Singapore (LTMS) Power Interconnection Project is a pilot project to test the extent of the existing legal and regulatory rules in ASEAN countries. The challenges for ASEAN countries are to harmonize institutional and contractual arrangements for multilateral trade, including third-party access arrangements. An in-depth interview with an academic institution supported the importance of this issue. The study on electricity market integration in the South African Power Pool (SAPP) was investigated to find the similarity between electricity market structures and to see how to operate multilateral trading without full harmonization of regulatory and legal frameworks. In contrast, in-depth interviews with EGAT officials showed that the electricity market in each region has unique characteristics. It is important to determine how ASEAN countries will be able to understand and implement the integration plan.

5.2 Discussion

Electricity market integration of ASEAN is challenging for ASEAN countries. To analyze the internal and external environment, the SWOT analysis shows the potential of ASEAN as follows;

Strength

ASEAN have different resources among member countries. The diversified resources could increase the security of electricity supply for ASEAN countries. The geographical in ASEAN mainland, Laos-Thailand-Myanmar-Cambodia-Vietnam have advantages in electricity supply. Moreover, the interconnection grids of Thailand strengthen the security of electricity supply for ASEAN.

Weakness

Most ASEAN countries are single buyer model. The electricity supply operated by Stated-owned enterprise that was controlled by government. These monopoly markets cause inefficient and less competition. The utilities that were controlled by government cause the difficulty for market integration.

Opportunity

The growing demand of electricity requires ASEAN countries for investing in infrastructures including cross-border interconnection grids. The investment could attract foreign investor and financing to establish the competitive electricity market in the future.

Threat

The self-sufficient of electricity supply is crucial for national level among ASEAN countries. The insufficient of electricity within country delay the electricity integration in regional level. Also, the political issues in national level led to the postponed development plans such as market reform in Thailand and the Philippines, or building nuclear power plant in Vietnam. Therefore, the self-sufficient of electricity supply and demand in national level is trouble for market integration in ASEAN.

5.3 Conclusion

This study has investigated the factors affecting regional market integration by focusing on the electricity market in ASEAN, ASEAN Power Grid. The objective of the study was to show the current situation regarding policies and progress toward collaboration in electricity market integration in ASEAN. The study also sought to identify advantages, challenges and opportunities for the electricity market of Thailand.

ASEAN has come a long way toward integration since the first established in 1967. ASEAN has launched 4 action plans, namely, APAEC 1999-2004, APAEC 2004-2009, APAEC 2010-2015 and the current APAEC 2016-2025 to integrate the ASEAN electricity market. However, the evidence shows that although a number of bilateral grid interconnections have been constructed, no electricity trade involving more than two countries has occurred.

In order to learn lessons from successful electricity market integrations, this paper has examined the most advanced electricity market integration, the electricity market in the Nordic region. The Nordic region consists of 4 powerful neighbors, which have strong relationships based on political similarity and a long history of cooperation. The key success factor has been electricity reform and restructuring, which vertically separated the generation and supply function from distribution and transmission networks. The first directive of electricity market integration had success in unbundling the industry; the second was able to promote competition by creating regulation of access to networks and requiring independent regulators. The wholesale and retail markets supported competition in electricity trading.

Furthermore, PEST analysis showed that the market reforms including unbundling, wholesale and retail market competition, independent regulation and privatization in ASEAN were postponed because of political issues for a long time. These factors caused difficulties in achieving cross-border integration in the electricity market structure in ASEAN. The increasing demand for electricity has led to challenges for ASEAN countries to develop cross border interconnections and to consider the alternative of nuclear power as an energy source for the future. The challenges facing ASEAN are to encourage investment and boost interconnections

between electricity grids, diversify energy resources with better systems and spur investment for new technologies.

In conclusion, the geographical advantages of Thailand could become a hub in the ASEAN electricity market. The development of the electricity interconnection grid supports an efficient transmission system, called the Back Bone of ASEAN. The goal to establish a regional power exchange presents a challenge for Thailand to reconsider market reform to create a competitive market in the future.

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APPENDIX

Member states of the EU (year of entry)

1. Austria (1995)
2. Belgium (1952)
3. Bulgaria (2007)
4. Croatia (2013)
5. Cyprus (2004)
6. Czech Republic (2004)
7. Denmark (1973)
8. Estonia (2004)
9. Finland (1995)
10. France (1952)
11. Germany (1952)
12. Greece (1981)
13. Hungary (2004)
14. Ireland (1973)
15. Italy (1952)
16. Latvia (2004)
17. Lithuania (2004)
18. Luxembourg (1952)
19. Malta (2004)
20. Netherlands (1952)
21. Poland (2004)
22. Portugal (1986)
23. Romania (2007)
24. Slovakia (2004)
25. Slovenia (2004)
26. Spain (1986)
27. Sweden (1995)
28. United Kingdom (1973)

Candidate countries of EU

1. Iceland
2. Montenegro
3. Serbia
4. The former Yugoslav Republic of Macedonia
5. Turkey

Potential candidates of EU

1. Albania
2. Bosnia and Herzegovina

Kosovo*

** This designation is without prejudice to positions on status, and is in line with UNSCR 1244/99 and the ICJ Opinion on the Kosovo declaration of independence*

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