Chapter 3

Institutional and Regulatory Framework

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CHAPTER 3

Institutional and Regulatory Framework

In this chapter, the current power transmission interconnections in the ASEAN region are outlined based on the power business system, power infrastructure development plan, and technical standards. Also presented is an introduction to the Nordic Grid that has, from long ago, enabled electric power interchange across country borders and established an efficient power supply system. Finally, based on indications from precedents, the future direction and tasks are summarised to realise an area-wide interconnection network in ASEAN countries.

1. Power Grid Interconnection Situation in the ASEAN Region

The significance of international interconnection of transmission lines is implied by the availability of a power pool, i.e. power imports and exports, amongst power systems. The effects of international interconnection can be roughly divided into improvement of power supply reliability and economic benefits through reduction of power generation costs, i.e. fuel costs and the costs of avoided peak-power capacities.

The former becomes significant, for instance, when a country's power supply suddenly becomes insufficient due to a sudden increase in electricity demand or a serious accident at a generation facility, and the nation's demand cannot be met by power sources in the country. Power imports then become important to bridge the supply and demand gap. Also, for instance, when peak-hour demands for electricity differ between two adjacent countries, the powersupply capability of a neighbouring country can be utilised as the reserve supply capacity for another country. In this way, international interconnection secures the same level of power supply reliability with lower reserve supply capacity than what is otherwise considered necessary for a single power system maintaining a certain level of power supply reliability.

The latter signifies that interconnection of power transmission lines makes purchase of electricity from power systems of other countries cheaper than what is generated by a country's power system. In the ASEAN region, energy resources such as coal, natural gas, and hydropower vary depending on the country and region. A large part of

potential resources exist in regions with relatively low demand, while supply capability and soaring generation costs due to lack of resources have become major tasks in regions with high energy demand. For instance, some ASEAN countries, especially Lao PDR, Cambodia, and Myanmar, have relatively high hydropower generation potentials. By comprehensively planning the development of power sources, utilising such potential resources, and establishing power transmission interconnection networks in the region, it may become possible to economically balance the power supply and demand across the region.

The ASEAN region is strengthening its international interconnection with 16 interconnectivity projects led by the Heads of ASEAN Power Utilities/Authorities (HAPUA). A steady rise in electricity demand in ASEAN is expected and a stable supply of electricity becomes increasingly important. There is no doubt that strengthening power transmission interconnections will further be promoted to gain economic benefits and ensure energy security in the region.

The power supply and demand situation, characteristics, background factors, and significance of international interconnection promotions are summarised below for the countries that participated in this study's working group. For details, readers can refer to the Appendix of this report.

Cambodia	● Power plants in the country are few and generation cost is high due to the energy mix centred on petroleum-fired thermal power. Power imports are advantageous in terms of stable supply and the economy. ● While development and diversification of power sources in the county are urgently needed, power import is necessary for the time being to fill the short- to medium-term supply-and-demand gap.
Indonesia	● Being an island country, there is constant shortage of power in regions where interconnection is difficult, and the country is forced to supply high-cost electricity generated by petroleum-fired power plants. ● Interconnection with neighbouring countries with different electricity demand peaks will enable efficient power supply and improvement of supply reliability.
Lao PDR	● By exporting electricity generated by hydropower resources that are relatively abundant compared to the country's power demand, it is possible to acquire foreign currency. ● Power import will supplement power shortage during dry season, a weakness of an energy mix focused on hydropower.
Malaysia	● The current interconnection lines are reserved supply mainly for emergency situations. ● Based on high-energy demand in Peninsular Malaysia, power transmission

	projects utilising the abundant indigenous resources in Sumatra (Indonesia) and large hydro-potential resources in Sarawak (Malaysia) are in progress.
Singapore	● Since the country has no domestic energy resources, enhancement of energy security is important. Importing electricity from neighbouring countries is one option. ● Because the nation is a small territory with high population density, it is difficult to introduce large-scale coal-fired thermal power or nuclear power plants. Currently, over 80 percent of Singapore's power supply is generated by imported pipeline gas and liquefied natural gas (LNG).
Thailand	● Since it takes time to establish new power plants, the country's rapidly increasing power demand is addressed by actively investing in power projects in neighbouring countries. ● The ratio of gas for power source is especially high, and its reduction is a task for the future. To diversify energy sources and reduce generation costs, electricity imports from neighbouring countries are positioned as one option.
Viet Nam	● Since the country is long from north to south, loss in power transmission is large, and power imports are more economical and efficient for some areas. ● Power demand is rapidly increasing, and in contrast the development potential of domestic power resources is likely to be reduced.

Is the system adequate to strengthen power transmission interconnection in the future? Let us visit the current situation of the 'power business system', 'power infrastructure development plan', and 'technical standards'.

Power market structure	● In many countries, a dominant national enterprise exists and a single-buyer system is adopted. ● The establishment of a regional institutional framework for cooperation or unification of regulations on power trading has started.
Power infrastructure development plan	● There is no common management or evaluation system for the region. ● Potentially HAPUA takes this role but should strengthen it.
Technical standards	● Currently vary depending on the country and project. ● Potentially HAPUA formulates common technical standards and rules.

1.1. Structure of the Power Market

A large part of the power sector in ASEAN countries used to be monopolised with a vertically integrated national enterprise. However, amidst rapid increase in power demand since the 1990s, to realise early expansion of power supply sources and provision of effective power services, structural reforms and introduction of the principle of competition were considered,[1] and privatisation and liberalisation progressed gradually.

[1] In 1998, the ASEAN countries fell into serious investment funds shortage due to the Asian financial crisis, and they requested various international financial institutions for supply of funds. As a condition of lending though,

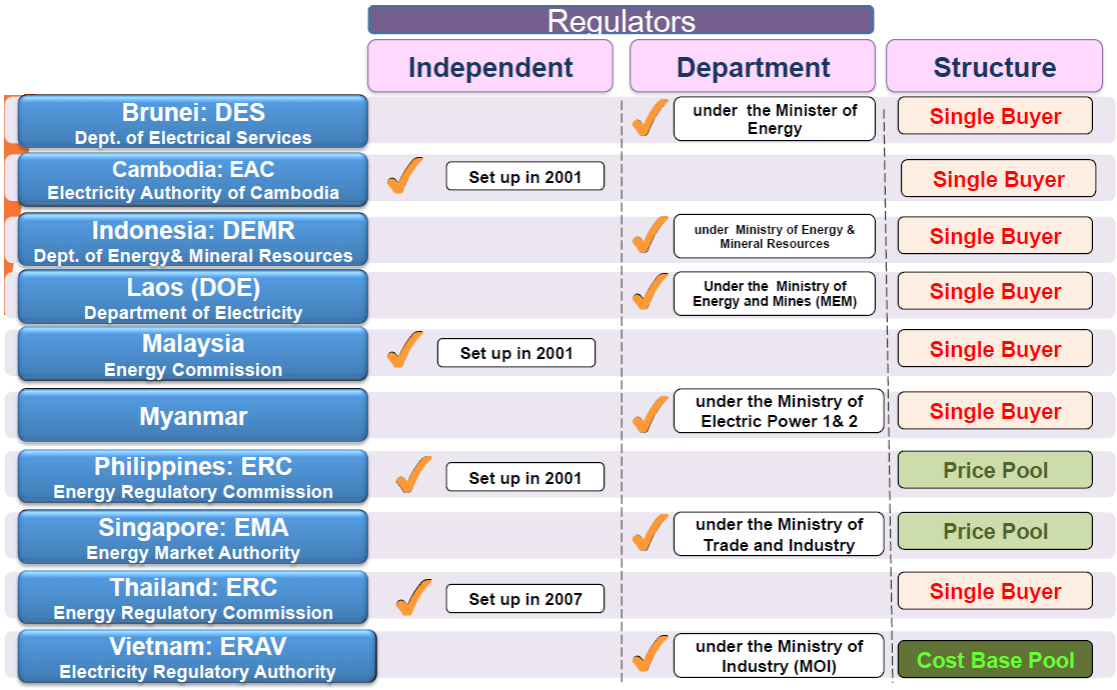
Currently, the single buyer system is adopted by many ASEAN countries, and the transmission sector is separated albeit in different forms. Generally, while only the power-generation sector is liberalised and independent power producers (IPPs) enter the market, the single buyer purchases all the generated electricity and sells it exclusively to power distributors. From such point of view can parties in the import and export of electricity be identified. As a side note, competition is introduced into both the wholesale and retail sectors in some countries (i.e. Singapore and the Philippines), and the price pool system, which is far more deregulated than the single buyer system, is adopted in such countries.

Meanwhile, amidst the gradual advancement of structural reforms for traditional vertically integrated power systems, it has become important to strengthen the roles of regulatory bodies that control an entire power sector. For instance, under the single buyer system, regulatory bodies are required to perform price control including determination of the cost for ancillary services and calculation of power transmission costs, in addition to conventional work. On this point, with the placement of regulatory bodies, rules that ensure transparency and independence of transmission companies and transmission system operators (TSOs) will prove worthy. In general, the system of regulatory bodies in the ASEAN countries is bipolarised depending on the country, where regulatory bodies are divided into those politically independent bodies and those organised under relevant ministries.

Power trading in ASEAN countries is currently limited to bilateral trading and projects centred on direct power transmission from power plants to areas of demand. Therefore, it is possible to operate power systems without specifically forming detailed rules. However, if interconnections in the future span more than two countries and power trading becomes bidirectional, a cooperative organisation by the regulatory authorities of each country for formulating common rules or realising fair management of power transmission lines will become necessary.

international financial institutions demanded market reforms of loan-receiving countries. This has led to promotion of structural market change in ASEAN countries.

Figure 3-1. Structure of the Electricity Supply Industries in ASEAN



Note: Lao PDR's Department of Electricity is now Lao PDR Department of Energy Policy and Planning.
Source: ERC's Role to Enhance Power Supply Security, February 2014.

Regarding this, a formal network under ASEAN was established with the timeline below.

- The Energy Regulatory Commission of Thailand has hosted annual meetings of ASEAN energy regulators since 2010.
- The 1st ASEAN Energy Regulators Network (AERN) meeting was held in March 2012.
  - Draft of AERN's terms of reference was circulated to ASEAN member states for comments.
  - The Energy Regulatory Commission of Thailand organised an interim AERN meeting on 28–29 August 2012 in Bangkok to finalise the terms of reference and work plan of AERN.
- The second AERN meeting was held in March 2013.
  - Final draft terms of reference of AERN and AERN work plan for 2012–2013
  - Preparation for the 31st Senior Officials Meeting on Energy in Indonesia
  - AERN chairmanship transition in 2014
- AERN will focus on regulatory issues related to regional power trade.

As such, the establishment of a regional institutional framework for cooperation or unification of regulations on power trading has started in ASEAN.

1.2. Power Infrastructure Development Plan

The benefits of establishing international interconnection transmission lines in the ASEAN region are obtained through 1) reduction in quantity of power plant development, and 2) effective utilisation of cheaper fuel for power generation in the region including potential hydropower.

About the first benefit, establishment and enhancement of interconnection power transmission lines can secure the same level of power supply reliability for a lower reserve supply capacity than what is considered necessary for a single network. However, this financial effect can be maximised by incorporating into the energy mix electric power interchange with other countries as one of supply abilities and by reducing duplicated investment in the development of power plants and interconnection transmission lines. That is because the establishment of power plants on the premise of self-sufficiency contributes to the improvement of a country's supply reliability, yet has an adverse effect to reduce the necessity and benefit of cross-border transmission lines for the ASEAN region as whole. Therefore, for this benefit to materialise, relevant parties of each country need to recognise this and prioritise construction of interconnection transmission lines over construction of a country's own power sources.

Most development plans for both power plants and transmission and distribution lines in ASEAN countries are formulated to maintain their own electricity supply and demand balance without import. Additionally, existing cross-border transmission lines are constructed at project-to-project basis, thus there is no coordinative formulation of plans or operation and management that are systematic and integrated for the entire region.

Regarding the second benefit, for instance, actively promoting the development of hydropower generation facilities through the IPP method and selling the generated power to countries of high demand within the region to acquire foreign currency are planned in Lao PDR, Cambodia, and Myanmar. However, most plans are one-on-one correspondence between some export-only power plants and power-importing country, or power plants are directly connected by power transmission lines to areas of demand and all electric power generated is traded according to power purchase agreements. Thus, even the surplus power generated cannot be interchanged for other systems. Meanwhile, most hydropower stations developed for domestic demands do not have interconnecting transmission lines with systems in other countries. Since electric power generation must

always be maintained at a level that matches the demand, water not used for power generation, for instance, is often discharged for no specific use.

What is required to effectively utilise such surplus power and power that could be generated if the idle discharge was utilised and to reduce fuel costs is a system that systematically coordinates power infrastructure development in each country and manages and evaluates establishment of power transmission networks that interconnect with systems in other countries.

1.3. Technical Standards

Each ASEAN member country carries out power supply and system operation by its own technical standards. Basically, there is no systematic or united management for the entire region. Also some countries have internal problems concerning the power business, such as weak organisation system, absence of an organisation that properly monitors the system for the entire nation, inadequate electric power technical standards, and improper system operations.

The current electric power trading across borders is mainly trading power generated by specific power plants. Power flow is often one-sided and trading is positioned as a power source with transmission line per project rather than a system interconnection. Thus, some countries adjust supply and demand only by a small number of power plants in fixed-power export destinations. Additionally, since only a small number of interconnections exist, power trading is unlikely causing crucial damage to power supply or system stability.

However, power systems are expected to grow in complexity and operational problems a cause for concern as the development of cross-border transmission lines progresses and interconnection expands in the future. While interconnections have advantages in terms of stable power supply and economic operation, failure of one interconnection may cause wide-area impact. For instance, an accident occurring in one country can infect the entire system and induce massive power outage.

Thus, as transmission interconnections become denser, measures to prevent the spread of power system faults will be necessary. Therefore, it is important to establish region-wide common technical standards and rules based on advanced power system technology, where coordination by HAPUA and/or other regional organisation would be effective.

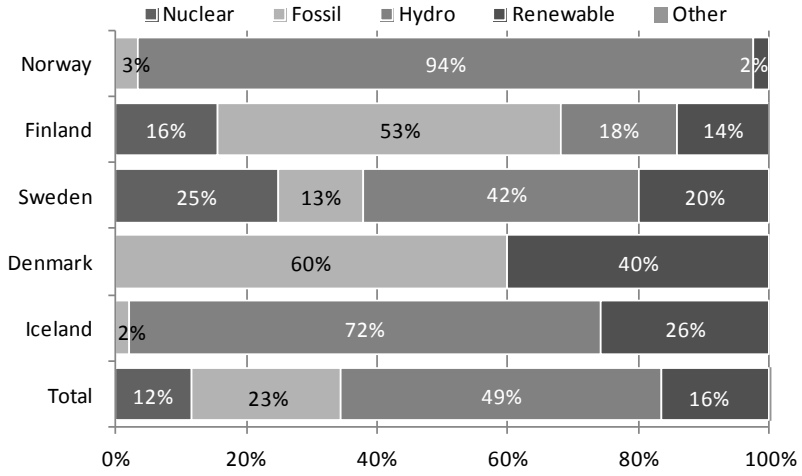
2. An Example of Nordic International Interconnection

Hydropower is the main power source for Norway, nuclear and hydropower for Sweden, thermal power for Finland, and thermal and renewable power for Denmark. Due to such differences in the energy mix, a long tradition in energy policy cooperation exists amongst Nordic countries. The political parties of Scandinavian countries widely recognise that individual country's possession of reserve power supply capacity incurs high costs. For that reason, interconnection of power systems has long been established and electric power interchange has been practised in the region.

In the ASEAN region, cross-border power transmission projects are in progress, centred on the ASEAN Power Grid and Greater Mekong Subregion, to maximise the use of potential power generation resources in the region. However, due to various reasons, progress on some projects has not been going smoothly.

This section outlines the Nordic cooperation and describes in detail the lessons learnt from such venture. This precedent may be useful in establishing a transmission network in the ASEAN region.

Figure 3-2. Net Generating Capacity of Nordic Countries (as of 31 December 2013)



MW

	Nuclear	Fossil	Hydlo	Renewable	Other	Total
Norway	0	1,090	30,753	757	0	32,600
Finland	2,752	9,312	3,168	2,484	21	17,737
Sweden	9,531	4,999	16,150	7,593	0	38,273
Denmark	0	8,886	9	5,960	0	14,855
Iceland	0	52	1,860	663	0	2,575
Total	12,283	24,339	51,940	17,457	21	106,040

Source: ENTSO-E, Yearly Statistics & Adequacy Retrospect 2013.

2.1. Background of Nordic Cooperation

International interconnection lines amongst countries in the Nordic region have been developed since the 1960s as an economic operation for countries (Denmark, Finland, Iceland, Norway, and Sweden) with different energy mixes. In 1963, Nordel was established as an association for electricity cooperation in the Nordic region. In July 2009, Nordel was integrated with cooperative institutions of system operators in other regions of Europe, and ENTSO-E was launched as the legally mandated body of transmission system operators (TSOs) in Europe. Even now, the former name is inherited within ENTSO-E as the synchronous areas of the Scandinavian Peninsula and eastern Denmark.

The background of Nordic cooperation is described below, based on the *Nordel Annual Report* and the Nordic Grid Code.

Up to the 1960s, there was a strong national focus and rising demand for interconnection in the Nordic region. The first steps toward such endeavour were made by the power companies, all of which basically were state owned and vertically integrated.

During the 1960s, as electric power consumption increased considerably in the Nordic countries, the opportunities for linking together different power generation portfolios and creating shared reserve margins attracted great attention. The members of Nordel were seeking benefits from coordinating the expansion and operation of their grids.

In the 1990s, to increase efficiency in the electrical sector, Nordic countries, starting with Norway, elected to expose electricity generation and trading to competition, and to separate these functions from the transmission function which had a natural monopoly state. As there has been a trend since the 1980s toward free competition both in the European Union and elsewhere in the world, Nord Pool, the world's first international electric power exchange, was launched in 1996. Contributing to the rapid development of the open common Nordic electric power market were a well-functioning electric power

system and a good tradition of cooperation within Nordel.

Nordel was a body for cooperation amongst TSOs in the Nordic countries whose primary objective is to create the conditions for, and to develop further, an efficient and harmonised Nordic electricity market, regardless of national borders. Nordel also served as a forum for contact and cooperation between TSOs and representatives of the market players in the Nordic countries. To create the right conditions for the development of an efficient electricity market, it was important for TSOs to meet with the market players for mutual exchange of views.

Nordel's strategy was formulated on the vision that Nordel would act as one Nordic TSO and be the basis for a harmonised Nordic electricity market; be in the front rank in the development of the Nordic electricity market; be a strong force in the development of the European electricity market; and be able to react quickly to challenges, make decisions, and have a shared commitment to implement them.

The Nordel vision resulted in a number of tasks as follows:

- System development and rules for network dimensioning, including coordination of grid investments and congestion management
- System operation, operational security, reliability of supply, and exchange of information
- Principles of transmission pricing and pricing of ancillary services, including transit solutions
- International cooperation
- Maintaining and developing contacts with organisations and regulatory authorities in the power sector, particularly in the Nordic countries and Europe
- Preparing and disseminating neutral information about the Nordic electricity system and market

Most of Nordel's work was carried out by its permanent committees, i.e. planning committee, operations committee, and market committee, made up of the leaders responsible for corresponding sectors in the TSOs. The working groups were composed of technical specialists from the TSOs.

The planning committee was responsible for technical matters of long-term nature concerning the transmission system and the exchange of information in relation to the expansion of the electricity system. The objectives of the planning committee were:

- To achieve continuous and coordinated Nordic planning between the TSOs, so that the best possible conditions could be provided for a smooth-functioning and effectively integrated Nordic electricity market.
- To initiate and support changes in the Nordic power system, which would enable satisfactory reliability of system supply through the effective utilisation of existing and new facilities.
- To be instrumental in developing the Nordic power system. When planning transmission facilities, impact assessments must integrate the need to preserve and protect the natural environment.

To achieve the above-mentioned objectives, the following means were defined:

- The planning committee drew up future scenarios for the expansion of the Nordic power system with a time horizon of up to 20 years.
- Each year, the planning committee presented prognoses for future energy/power balance, energy forecast on normal and dry years, and power forecast on normal peak load and extreme peak load.
- Every second year, the planning committee presented a summarised Nordic Grid Master Plan which primarily consisted of projects that had an effect on the capacities amongst the Nordic TSOs.
- The planning committee continuously updated the Nordic Grid Code and had overall responsibility for the continuous updating of recommendations for shared rules of the dimensioning transmissions (planning criteria) for the TSOs and the Nordic main grid (Planning Code).
- The planning committee also had overall responsibility for compiling and updating common system-oriented requirements for future connection of generation, transmission, and consumer facilities to the grid (Connection Code).
- The planning committee ensured the gathering, updating, and application of shared grid, electricity supply–demand data. Planning tools were the responsibility of each TSO but Nordel played a coordinating role in relation to the TSOs choosing tools that facilitate their work.

The operations committee was responsible for short-term issues concerning joint operation of the various subsystems in the interconnected Nordic transmission system and

for defining a technical and market-focused framework for grid operation.

The operations committee coordinated operational cooperation between the Nordic TSOs and aimed to promote the ideal utilisation of the Nordic electricity transmission system as per market needs, taking into account the agreed technical quality and operational reliability.

The committee's work focused on system operation issues which concern the utilisation of the grid, operational reliability, as well as congestion and balance management. The Nordic system operation agreement constituted the formal foundation for this cooperation.

The market committee's goals were:

- to contribute toward creating a borderless Nordic market for the market players, thereby augmenting the market's efficiency and functionality; and
- to contribute toward the rules of play in Europe being formulated in such a way as to promote a positive market trend and an efficient interplay with the Nordic market.

2.2. Nordic Grid Master Plan

The Nordic TSOs have a long tradition of cooperation on grid development, market development, and operational questions. Before ENTSO-E was founded in 2009, the Nordic TSOs had produced several grid development plans under the Nordel umbrella:

- 2002: Nordic Grid Master Plan analysing the bottlenecks

The basis for the transmission planning and long-term capacity allocation in the Nordic region was the Nordic Grid Master Plan. This was the first joint Nordic Grid Master Plan building upon many years of Nordic cooperation in grid planning. The plan looked at the future transport patterns in the Nordic transmission network and identified a number of important cross-sections which were to be subject to more detailed analyses in the plans that followed. The Grid Master Plan was not an investment plan, but identified the cross-sections that were further analysed.

In the analysis for the plan in 2002, the foreseen future energy balance in the Nordic area for 2005–2010 was negative with increasing demand and decommissioning of old generation units and very few new plants taken into operation. The analysis indicated

an energy shortage and increasing interdependency on trade with neighbouring regions and a need for energy imports to the Nordic area. This identified two major predicted transmission patterns: in the east–west direction through the area, from Russia through Finland and Sweden to Norway and possibly to the United Kingdom, and north–south between Norway/Sweden and the Continent.

- 2004: Priority cross-sections defining five prioritised projects

The follow-up to the Nordic Grid Master Plan 2002 was presented in 2004 in the priority cross-sections report, where an updated analysis of the predicted situation for 2010 was performed. The energy balance for the Nordic area looked more positive for 2010 than in the previous plan with the Nordic area roughly in balance between generation and demand. Behind the assumption were plans for new nuclear power in Finland as well as gas-fired generation and wind power in Norway.

The analysis identified typical transmission pattern in the Nordic area. Several transmission constraints were expected in these transport channels.

The report concluded that Nordel had identified five critical cross-sections that would be beneficial to reinforce.

- Between Central and Southern Sweden (Snitt 4)
- Between Funen and Zealand in Denmark (A Great Belt connection)
- Between Finland and Sweden (A new Fenno–Skan connection)
- Between Norway and Sweden (A new Nea–Jarpstrommen connection)
- Between Norway and Denmark (A new Skagerrak connection)

These five reinforcements were presented as a common Nordic reinforcement package, and the actual investments were to be handled bilaterally between the involved TSOs.

- 2008: Nordic Grid Master Plan; three new projects, analysing the connections to the Continent

A new Nordic Grid Master Plan was presented in 2008. It looked at the situation in the Nordic area and the capacity to neighbouring countries given that the reinforcement package from the previous plan was implemented. The analysis was made in a scenario representing 2015 with the reinforcements in operation. Possible further reinforcements were identified and tested for robustness in four scenarios representing different energy market developments until 2025. The scenarios covered a spread of Nordic energy balances

from a large surplus to a substantial deficit.

Based on the analysis, Nordel recommended that the TSOs started planning to reinforce the following internal Nordic cross-sections. All these reinforcements showed positive benefits in all four future scenarios.

- Between Sweden and Southern Norway (realised through the South–West link)
- Between Sweden and Norway north–south axis (realised through Orskog–Fardal)
- Arctic region (realised through Ofoten–Balsfjord–Hammerfest)

- 2009: Multiregional plan together with Baltic, Polish, and German TSOs

An extended, multiregional study was performed in 2008–2009 by TSOs from Nordel, BALTSO (the organisation of TSOs in the Baltic states) and Poland. The aim was the development of a coordinated extension plan of interconnections from the Baltic states to Poland and to the Nordel area to satisfy transmission needs between the regions. The study looked at the socio-economic benefits of three specific interconnectors: Estonia–Finland, Lithuania–Poland, and the Baltic states–Sweden

The methodology was similar to the previous Nordel study, using one base scenario for 2015 and three scenarios for 2025 and with benefits calculated from market model analysis.

The overall conclusion was that a solution with all three interconnections was the best solution. The results showed that the capacity provided by the interconnectors would be needed already in the scenario for 2015.

In 2009, European TSO cooperation was gathered in the new ENTSO-E organisation and regional cooperation in Nordel was suspended. Also, the cooperation on pan-European and regional grid development was reorganised, establishing regions comprising several countries in one region. This was an excellent opportunity for the Nordic TSOs to embed their existing cooperation into a wider regional context, thus ensuring further integration of the countries involved.

2.3. Nordic Grid Code

Each Nordic country had, until June 2004, its own instructions, but in June 2004, Nordel introduced a common Nordic Grid Code. The formulation of this common code for the Nordic grid was a step towards the harmonisation of the rules that governed the various

national grid companies. The purpose of the Nordic Grid Code was to achieve coherent and coordinated Nordic operation and planning between the companies responsible for operating the transmission systems, in order to establish the best possible conditions for developing a functioning and effectively integrated Nordic power market. A further objective was to develop a shared basis for satisfactory operational reliability and quality of delivery in the coherent Nordic electric power system.

The Grid Code was made up of general provisions for cooperation, planning code, operational code (system operation agreement), connection code, and data exchange code (data exchange agreement amongst the Nordic TSOs).

The operational code and the data exchange code were binding agreements with specific dispute solutions. The planning code and the connection code were rules that should be observed. Ideally, these rules should be identical rules. However, this was not yet the case, partly for historical reasons and partly because the different subsystems were subject to different legislations and supervision by different official bodies.

The first edition of the Nordic Grid Code was based on Nordel's former rules (recommendations), the system operation agreement, the data exchange agreement, and national codes. Therefore, the content of the code still showed traces of being taken from numerous sources.

However, an objective was that the Nordic Grid Code should be a starting point for harmonising national rules, with minimum requirements for technical properties that influence the operation of the interconnected Nordic electric power system. The Nordic Grid Code must, however, be subordinate to the national rules in the various Nordic countries, such as the provisions of legislation, decrees, and the conditions imposed by official bodies.

3. Indications from the Nordic Model for Establishing an ASEAN Intra-regional Interconnection Network

The first point for attention is the power market structure. Contrary to the single-buyer system adopted in the ASEAN region (excluding some countries), the Nordic region formed, in 1996, a completely liberalised power trading market called Nord Pool, and transaction was carried out based on this. It must be noted, however, that unbundling of the transmission sector is not a requirement for interconnection itself.

Since the 1960s, as the rapidly growing electric power system in the Nordic region was being connected to relatively weak transmission interconnections, Nordel had to solve problems of control and stability. The long-term solution was to make the transmission interconnections more robust. Nordel's recommendations formed the basis of the technical regulations for generation and grid operations in the Nordic countries. The rules were complied with by all parties and came to provide the foundation for any formal regulations required in the individual countries.

Adoption of the liberalisation model in the power sector is progressing in many countries. It is, however, considered generally appropriate to take careful steps and procedures while observing the development stages of the power market, starting from the single-buyer system (where the competition principle is introduced to the generation sector only) to gradual development of the wholesale power market, and eventually to a fully liberalised and competitive market. In almost all countries in the ASEAN region, the important task is to secure supply capability that can meet the ever growing power demand in a steady and economic manner. Adopting a single-buyer system is the right course of action.

Meanwhile, essentially required to vitalise electric power interchange in the ASEAN region is an advisory and recommendatory association like Nordel for closer electricity cooperation in ASEAN countries. Regarding this, the HAPUA working group has suggested a road map to materialise the ASEAN Power Grid (APG) with the establishment of the ASEAN Electricity Regulators, the ASEAN Transmission System Operators, and the ASEAN Grid Planners. The electricity regulation activity is already performed by the ASEAN Energy Regulators Network (AERN). For the two remaining new functions of grid operation and planning, the HAPUA working group is pursuing the study on the formation of the ASEAN Power Grid Transmission System Operators Institution and the ASEAN Power Grid Generation and Transmission Systems Planning Institution.

Results of these studies are expected to be finalised and to be ready for endorsement by the 32nd meeting of the HAPUA Council in 2016.

The second point of attention is the power infrastructure development plan. The development plans in the ASEAN region basically presuppose maintenance of supply and demand balance in individual countries. As a result, while the interconnection projects in the region are progressing, no system systematically and collectively evaluates or manages

them. In the Nordic region, the Nordel planning committee developed the Nordic Grid Master Plan, conducted region-wide transmission planning, and proposed long-term capacity allocation until the establishment of ENTSO-E in 2009.

Compared to Europe, the US, and other regions, the power demand in the ASEAN region keeps on growing, and development of more power sources will become necessary in the future. To economically and reliably secure power sources in this region, the challenge is the formulation of power supply plans that assume power interchange of neighbouring countries and development plans on associated transmission lines with overall optimisation.

The third point of attention is technical standards. The current interconnections in the ASEAN region are bilateral and, therefore, no region-wide rules and system operations are carried out by the individual technical standards of member countries. When interconnection expands and the system becomes complex in the future, the possibility of an accident occurring in one country infecting the entire system and inducing massive power outage will become a major concern. For that reason alone, harmonising rules and recommendations in a common grid code will be an important issue.