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Study on the Formation of the ASEAN Power Grid Transmission System Operator Institution

Noord Pool Consulting

Study on the Formation of the ASEAN Power Grid

Transmission System Operator Institution

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List of Abbreviations

ABOM	Agreement Between Operating Members
ACE	ASEAN Studies Centre
ACER	Agency for the Cooperation of Energy Regulators
ACER	Association for the Cooperation of Energy Regulators
AEMO	Australian Energy Market Operator
AERN	ASEAN Energy Regulatory Network
AGC	Automatic Generation Control
AGTP	ASEAN Power Grid Generation and Transmission System Planning Institution
AIMS	ASEAN Interconnection Master Plan Study
AMS	ASEAN Member State
APAEC	ASEAN plan of action for energy cooperation
APG	Asian Power Grid
APGCC	ASEAN Power Grid Consultative Committee
APP	ASEAN Power Pool
ATSO	ASEAN Power Grid Transmission System Operator Institution
AVR	Automatic Voltage Regulation
CACM	Capacity Allocation and Congestion Management
CC	Coordination Centre
DAM	Day Ahead Market
DIS	Division of Infrastructure Services
EB	Electricity Balancing
EC	European Commission
EH	Electronic Highway
EMS	Energy Management System applications
ENTSO-E	the European Network of Transmission System Operators
EPCO	Electric Power Company
ESIPC	Electricity Supply Industry Planning Council
EU	European Union
ExCo	Executive Committee
FCA	Forward Capacity Allocation
FTP	File Transfer Protocol
GMS	Greater Mekong Sub Region
GANM	Guidelines for the Admission of New Members
HAPUA	Heads of ASEAN Power Utilities/Authorities
ICCP	Inter-Control Centre Communications Protocol

IEC	International Electrotechnical Commission
IGMOU	Intergovernmental Memorandum Of Understanding
IPP	Independent Power Producer
ITU-T	International Telecommunication Standardization Sector
IUMOU	Inter-Utility Memorandum Of Understanding
JPY	Japanese Yen
kV	kilovolt
MANCO	Management Committee
MCP	Market Clearing Pricing Principle
MRC	Multi-Regional Coupling
MTP	Market Trading Platform
MW	megawatt
NEM	National Electricity Market
NEMMCO	National Electricity Market Management Company
NEMO	Nominated Electricity Market Operator
NER	National Electricity Rules
OCCTO	Organization for Cross-regional Coordination of Transmission Operators
OG	Operating Guidelines
PCI	Projects of Common Interest
PCR	Price Coupling of Regions
POP	Post Office Protocol
PDAM	Post Day Ahead Market
PPA	Power Purchase Agreement
RDIC	Research, Development and Innovation Committee
RD&I	Research, Development and Innovation
RPCC	Regional Power Coordination Centre
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SCADA	Supervisory Control And Data Acquisition
SDC	System Development Committee
SMTP	Simple Mail Transfer Protocol
SSTI	Sub synchronous torsional interaction
STEM	Short-Term Energy Market
STFM	Short Term Forward Market
SVC	Static VAR Compensator
TPA	Third Party Access
TSO	Transmission System Operator

TYNDP	Ten-Year Net Development Plan
ZESA	Zimbabwe Electricity Supply Authority
ZESCO	Zambia Electricity Supply Corporation

Executive Summary

This document constitutes one of the three main deliverables in the project "Study on the Formation of the ASEAN Power Grid Transmission System Operator Institution (ATSO)". It provides an overview of the international case examples that has been used as a basis in creating the ATSO project deliverables. The project is aligned and coordinated with the deliverables from the "Study on the Formation of the ASEAN Power Grid Generation and Transmission System Planning Institution (AGTP)" delivered by TEPCO.

The other two main deliverables in the ATSO project includes the ASEAN Power Pool (APP) guideline, which provides the basic structure and function of the APP, and the ASEAN Power Pool Implementation plan and roadmap, which sets the route for implementation of the APP.

The international case examples are the developments in the Southern African region, the EU area, Japan and the GMS region. Also, experiences from Australia and other areas are also brought up and referenced to throughout the report.

All of the mentioned regions (SAPP EU, Japan and the GMS regions) show that a regional cooperation of power generation and transmission is worth pursuing. Generally, utilizing the value of difference is one of the key reasons for regional integration and cooperation, giving positive effects on the security of supply and hence grid stability. Also, the economic benefits of having complementary production is one of the main drivers and reasons for building interconnections. Another positive effect of greater collaboration is that a closer cooperation might reduce capital required for generation capacity expansion in the ASEAN region. Optimising resources on a regional basis instead of a national basis in order to meet the demand for electricity in the region as a whole and at the least cost possible.

When speaking of regional cooperation, it is important to emphasize that increasing regional cooperation does not directly correlate on losing national control of the electricity sector. Both European cooperation and Southern African Power Pool coordination are living examples of this ideology.

While investigating the international case examples, several similarities have been found between the respective regions coordinating organizations. They all have similar structures and functions although names and the functional structures can be slightly different between the regions. A point worth mentioning is that one should never try to "copy paste" a regional cooperation structure into a new region, it will always be need for some adjustment to the local setting and regional specific requirements.

Another important point to highlight is that it has been found that it is very important that the planning and system operation part have a close cooperation to secure that the long-term and short-term aspects of the ASEAN Power grid will be aligned, this is the case within most of the other regional organizations mentioned as case examples. As a result, the APP Guideline document and the proposed APP organization is suggested to include both planning and system operation.

What also can be mentioned from the case examples is the need of a clear and effective agreement structure to establish a firm commitment from the participating countries. Both the developments in the Nordic and the Southern African region has taken several years and have been based on a stepwise process which allow member states to evolve in their own pace but making sure all are moving in the same direction. One should aim for market development through “Evolution, not revolution” when it comes to these types of implementations.

In this Literature report a potential ASEAN high-level market concept is discussed to give some food for thought of what the future developments within the market design could be and to introduce one the functions that the APP could potentially take on.

The last chapters of the Literature report summarize the ASEAN Power Pool Guideline and the implementation plan. The guideline document covers both the organisational considerations and technical considerations for the ASEAN Power Pool establishment. Additionally, the open access agreement is defined and discussed as part of the guideline. The objective is that the guideline can be used as base to define and start building the APP organisational with related technical aspects as well identify the key functions and tasks the APP should aim for after the establishment. The guideline proposes a set of ASEAN Power Pool working groups that will later define, review and harmonize the needed regional regulation and agreements.

The implementation plan and roadmap propose a way to develop and establish the ASEAN Power Pool (APP) based on the APP guideline document. The implementation plan takes into account multiple factors affecting the APP establishment. As a starting point the implementation considers the progress and current plans developed for the GMS region, current situation in the AMS and other initiated projects aiming for increased cooperation in the power sector. Further, different activities defined in the ASEAN Power Pool guideline will be listed and prioritized. From this a ranked number of activities is are identified and that are later presented in the ASEAN Power Pool roadmap, which is found in the final parts of this document.

Chapter 1

Introduction

This literature report constitutes one of the main deliverables in the project 'Study on the Formation of the ASEAN Power Grid Transmission System Operator Institution (ATSO)'. It provides background on the ASEAN Power grid (APG) situation and supporting information on the proposed solutions in the ASEAN Power Pool (APP) guideline and its related Implementation plan. The international experiences from the European Union (EU) (Chapter 2), Southern African region (Chapter 4), Greater Mekong Sub region (GMS) (Chapter 5), and Japan (Chapter 6) are summarized and presented in this document. This report also provides a summary of the proposed ASEAN Power Pool Guideline and its related implementation plan and roadmap to enable a quick overview of the ATSO project conclusions. Chapter 7 provides a high-level discussion on the possible future expansions of APP to host an efficient, multilateral regional trading in APG. The importance of the regional cooperation in power markets and the possible ways of achieving this are presented, drawing from some of the best practices from Europe and the Southern Africa Power Pool (SAPP).

The following section provides a background on the APG situation and awareness that are deemed important before looking into the details provided by the 'Study on the Formation of the ASEAN Power Grid Transmission System Operator Institution'.

1. Background: The Challenges of ASEAN Connectivity

There have been significant developments, although a bit slow, within the ASEAN region on increasing the regional trading based on bilateral deals and using the existing infrastructures to move power throughout the region, but there is still a long way to go to establish a full-fledged regional ASEAN power market. One of the reasons for the slow progress has been suggested to be the many types of power sector structures and markets throughout the ASEAN, creating problems and barriers on all levels of collaboration. To solve these issues several studies has been conducted, by both Heads of ASEAN Power Utilities Authorities (HAPUA), the ASEAN Centre for Energy and the Asian Development Bank. The findings suggest a need of harmonizing the legal and regulatory frameworks and creating technical standards and codes relating to planning, design, system operation, and maintenance.

Also, trading related agreements such as third-party access and wheeling methodology are important points to establish to further increase the regional trade. Another important cooperation is between the national regulatory authorities where the ASEAN Energy Regulatory Network (AERN) has been established to take responsibility for the review and approval of the set of needed Codes and Guidelines for the ASEAN Power Grid (APG) and monitor the effectiveness of the standards and procedures developed.

The ASEAN plan of action for energy cooperation (APAEC) (2014) is a series of guiding policy documents to support the implementation of multilateral energy cooperation to advance regional integration and connectivity goals in ASEAN. It serves as a blueprint for better cooperation towards enhancing energy security, accessibility, affordability and sustainability under the framework of the AEC for the designated period. The key initiatives under this APAEC include embarking on multilateral electricity trading to accelerate the realisation of the ASEAN Power Grid (APG).

The obstacles and barriers face now in the ASEAN region, have been faced, recognised and overcome by the other regions throughout the world that have established a regional market for power. As mentions above some of these international examples are presented and discussed in this literature report to utilize the experiences gained in these other implementations and to use this in the establishment of the regional cooperation in ASEAN.

As a first step to lay out a plan for increasing the interconnection infrastructure, the ASEAN Interconnection Master Plan Study (AIMS-I) was finished in 2003 and aimed to identify, evaluate and propose a viable regional power interconnection network. Due to rapid developments in the region a secondary study, AIMS-II, become necessary and was carried out in 2010 along with this study the APGCC was established as a mechanism to coordinate and lead the needed studies.

The AIMS-II study also aims to establish the following points as the priorities for further developments of the APG[1]:

1. To create APG through interconnections among all ASEAN countries;
2. To promote more efficient, economic, and secure operation of power systems through harmonious development of national electricity networks in ASEAN by region-wide interconnections;
3. To optimise the use of energy resources in the region by sharing the benefits;
4. To reduce capital required for generation capacity expansion;
5. To share experiences among member countries;
6. To provide close power cooperation in the region; and
7. To identify barriers to the implementation of APG.

Many new interconnectors have been built the last couple of years and more is scheduled to be commissioned.

[1] Executive Summary of the ASEAN Interconnection Master Plan Study no 2

Chapter 2

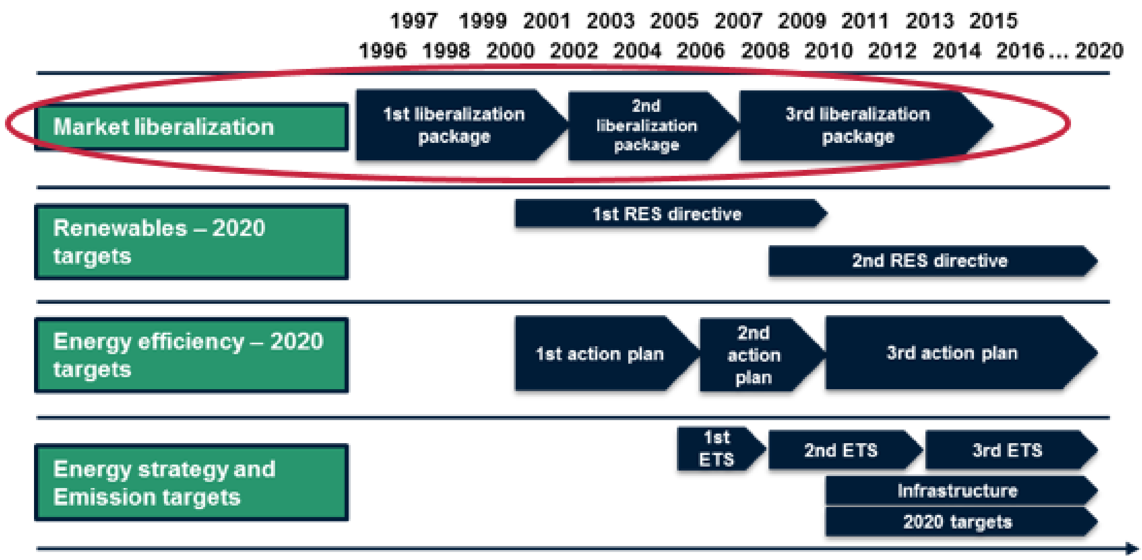
International Experiences:

The Nordic and the European union

1. Background

The Nordic region and Europe has long roots in the area of cooperation among the Transmission System Operators (TSO). Cooperation among the European TSOs has been guided by legislation within the European Union (EU). The push for electricity market liberalization in Europe originates mainly from the EU. The process towards liberalized national markets started already in the late 1996 (Figure 1), when the European Parliament introduced the first electricity market liberalization package. This directive provided progressive market opening scheme so that from 1999 to 2003, member states were required to liberalize 25%–33% of their national markets. This further began the unbundling of the electricity market activities.

Figure 1: Overview of the European Union's Energy Policy



Source: Overview compiled by Author.

The most extensive energy package was introduced in 2009. It continued from where the second package left off and extended the national electricity market opening. Directive 2009/72/EC further continued efforts to unbundle the different actors in the electricity market. All customers were given the right to choose their electricity provider and to change it easily within 3 weeks. In other words, all customers were deemed eligible. In addition, access to transmission system network was required to be granted to all third parties.

National authorities were given rights to participate in electricity undertakings, but these activities were required to be kept separate from the transmission and distribution services. The aim was to unbundle energy production and supply interests from the network. One important point was also to establish independent national regulatory authorities. Their roles are to (i) determine transmission and distribution tariffs, (ii) cooperate in cross-border issues, (iii) monitor the transmission system operators, and (iv) ensure user access to customer consumption data. Finally, an institution called the European Network of Transmission System Operators for Electricity (ENTSO-E) was established and given legal mandates to function.

TSOs are entities operating independently from the other electricity market players and are responsible for the bulk transmission of electric power on the main high-voltage electric networks. TSOs provide grid access to the electricity market players (i.e. generating companies, traders, suppliers, distributors, and directly connected customers) according to non-discriminatory and transparent rules. To ensure the security of supply, they also guarantee the safe operation and maintenance of the system. In many countries, TSOs are also in charge of the development of the grid's infrastructure.

The members of ENTSO-E consist of 42 companies in 34 countries. ENTSO-E's operations are regulated by the EU's cross-border transmission regulation EC No. 714/2009. The European TSOs must work together to promote the functioning of the electricity market and cross-border trade of electricity within the EU, ensure the optimal management and coordinated operation of the transmission system, as well as its technically sound development. In accordance with the cross-border transmission regulation, ENTSO-E must contribute to the preparation of network codes and 10-year network development plans for the European transmission system.

The supreme decision-making body of ENTSO-E is the general assembly where all members are represented. The general assembly is headed by a board, which has 10 members from all over Europe. The practical work is organized into four committees: Market Committee, Operations Committee, System Development Committee, and Research and Development Committee. Various working groups and regional committees work under these groups. Law and information technology specialists support the activities through their own group. The ENTSO-E secretariat is located in Brussels.

1.1. Governance in ENTSO-E

ENTSO-E is governed by a general assembly with representatives from 43 TSOs and by a board consisting of 12 elected members. ENTSO-E was formally established and given legal mandates by the EU's Third Energy Package, which was adopted in July 2009. Although the Third Energy Package did not formally apply until March 2011, ENTSO-E was created in December 2008 and was fully operational as of July 2009.

In December 2010, in order to be fully compliant with the obligations under Article 5 of Regulation (EC) No 714/2009 on the establishment of the association, ENTSO-E submitted its

Articles of Association and Internal Regulations to the Agency for the Cooperation of Energy Regulators (ACER) and to the EC. Based on opinions formulated by ACER and the EC, the general assembly of ENTSO-E adapted the documents in June 2011.The Articles of Association and Internal Regulations were further reviewed and improved in September 2014.

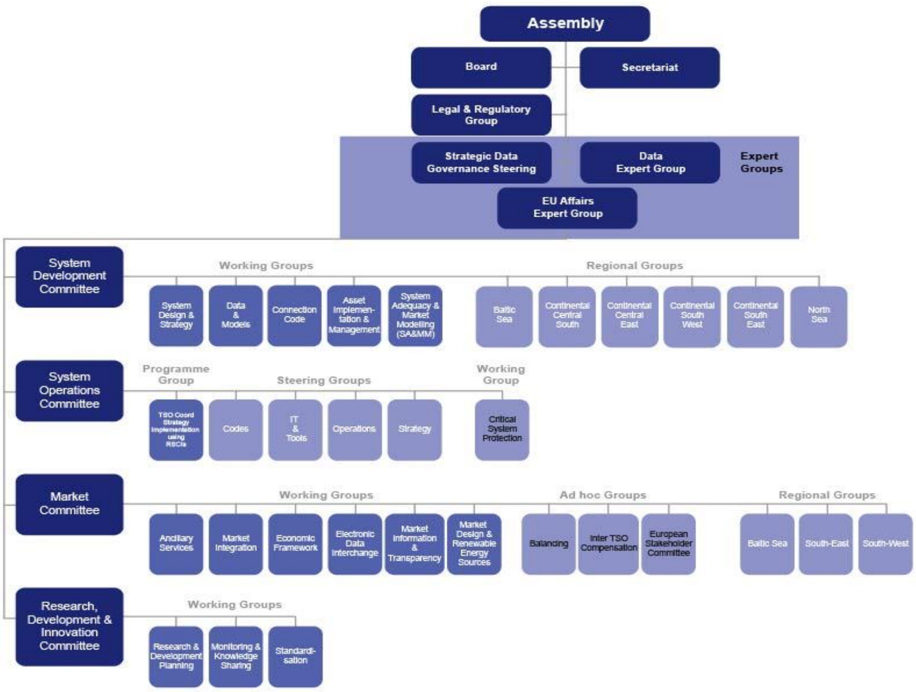
The Articles of Association govern, among others, the operation of ENTSO-E, its membership, the roles and relationships among the various ENTSO-E bodies, and the distribution of voting rights among the members. The Internal Regulations complements the Article of Association by defining the practical and technical rules and procedures governing the operations of ENTSO-E.

2. General Overview of ENTSO-E

ENTSO-E has four core secretariat teams to implement and develop guidelines, and other packages relevant to the core mission of ENTO-E. The organizational structure in Figure 2 presents four major work categories, as follows: [2]

- System development
- System operations
- Market
- Research, development, and innovation

Figure 2. ENTSO-E Organization



Source: https://www.entsoe.eu/

[2] The information presented in this chapter can be found at https://www.entsoe.eu/

The ENTSO-E Secretariat's **system development team** supports two of the four ENTSO-E committees: (i) the System Development Committee and (ii) the Research, Development, and Innovation Committee, as well as all of the associated working and regional groups. The System Development Committee is in charge of TSO cooperation on network development and planning. Its main mission is to coordinate the development of a secure, environmentally sustainable, and economic transmission system, which aims to create a robust European grid that can facilitate the creation of a well-functioning European electricity market and, from the planning point of view, a high standard of interoperability, reliability. and security.

System operations is the core activity of any TSO. It covers the actions taken to ensure the optimal and secure operation of the grid in real time. The ENTSO-E System Operations activities are about the following:

- Developing European operational standards notably through network codes,
- Protecting critical infrastructure systems,
- Developing and maintaining a common system operation channel: the electronic highway,
- Developing a common model of the grid that can be used for system operation,
- Defining a methodology for dealing with operational reserves – power reserves that can be activated to maintain the grid's balance,
- Classification and follow up of operational incidents, and
- Promotion and enhancement of coordinated system operation and services notably through the regional service providers.

ENTSO-E's **market team** supports TSO members in all areas relating to the development and harmonization of market rules. The progressive harmonization of electricity market rules is at the heart of promoting an effectively competitive internal market, delivering benefits to electricity customers, and opportunities to generators and energy traders. The objectives of the Market Committee are to ensure that the objectives of the third Internal Energy Market package are realized, and to facilitate the development of a well-functioning European electricity market. This is achieved by contributing to market design and developing market-related network codes in cooperation with ENTSO-E's 43 members, and in close consultation with stakeholders.

The **research, development, and innovation** performed by TSOs are complementary to the work performed by universities, research institutes, or equipment manufacturers. TSOs focus more on the integration of technology than on innovation or the production of new technologies. ENTSO-E plays a key role in developing the pan-European grid and in achieving the ambitious European decarbonization goals by 2050. ENTSO-E and its TSO members share a common vision for tackling the key challenges. TSOs are aware of the need to accelerate technological innovation. The development of new grid equipment technologies, modelling methods, and grid architecture will enable TSOs to fulfil their mission in an evolving energy system. This mission is shared by the Council of European Energy Regulators to encourage network operators to seek innovative solutions.

Table 1. List of ENTSO-E Members

Country	Member Company
Albania	OST sh.a – Albanian Transmission System Operator
Austria	Austrian Power Grid AG VorarlbergerÜbertragungsnetz GmbH
Belgium	Elia System Operator SA
Bosnia and Herzegovina	Nezavisni operator sustava u BosniiHercegovini
Bulgaria	ElectroenergienSistemen Operator EAD
Croatia	HOPS d.o.o.
Cyprus	Cyprus Transmission System Operator
Czech Republic	ČEPS, a.s.
Denmark	Energinet.dk
Estonia	Elering AS
Finland	FingridOyj
France	Réseau de Transport d'Electricité
FYR of Macedonia	Macedonian Transmission System Operator AD
Germany	TransnetBW GmbH TenneT TSO GmbH Amprion GmbH 50Hertz Transmission GmbH
Greece	Independent Power Transmission Operator S.A.
Hungary	MAVIR Magyar Villamosenergia-ipariÁtviteliRendszerirányító ZártkörűenMűködő Részvénytársaság
Iceland	Landsnethf
Ireland	EirGrid plc
Italy	Terna - Rete ElettricaNazionaleSpA
Latvia	AS AugstspriegumatÏkls
Lithuania	Litgrid AB
Luxembourg	Creos Luxembourg S.A.
Montenegro	Crnogorskielektroprenosnisistem AD
Netherlands	TenneT TSO B.V.
Norway	Statnett SF
Poland	Polskie Sieci Elektroenergetyczne S.A.
Portugal	RedeEléctrica Nacional, S.A.
Romania	C.N. Transelectrica S.A.
Serbia	AkcionarskodruštvoElektromrežaSrbije
Slovak Republic	Slovenskáelektrizačnáprenosovásústava, a.s.
Slovenia	ELES, d.o.o., sistemskioperaterprenosnegaelektroenergetskegaomrežja
Spain	Red Eléctrica de España S.A.
Sweden	Svenskakraftnät
Switzerland	Swissgrid ag
Turkey	TEİAŞ (observer member)
United Kingdom	National Grid Electricity Transmission plc System Operator for Northern Ireland Ltd Scottish Hydro Electric Transmission plc Scottish Power Transmission plc

Source: See https://www.entsoe.eu/

2.1. Specifics

In Europe, the TSO harmonization is mainly driven by the EC as the lawful entity with decision and intergovernmental enforcement right. For the TSO aspects, the most relevant codes are the Capacity Allocation and Congestion Management (2015), Forward Capacity Allocation (2016), and Electricity Balancing (2017).

Europe's cross-border electricity networks are operated according to these rules, which govern the actions of operators and determine how access is given to users. In the past, these grid operation and trading rules were drawn up nationally, or even sub nationally. With increased interconnections among countries in the internal energy market, EU-wide rules have become increasingly necessary to effectively manage electricity flows. These rules, known as network codes or guidelines, are the Commission Regulations, which contain legally binding rules. They govern all cross-border electricity market transactions and system operations alongside the EU regulation on conditions for accessing the network for cross-border electricity exchanges.

These codes and guidelines are developed based on EC procedures. The EC begins by drafting an 'annual priority list' of areas to be included in the development of network codes for electricity. It does this based on a public consultation and with the input of the ACER and the ENTSO-E. Once the annual priority list is established, ACER develops 'framework guidelines' that set principles for developing specific network codes. These framework guidelines are used by ENTSO-E to prepare a network code, which is submitted back to ACER for its opinion. If ACER deems that the code fulfils its framework guidelines and the EU's internal market objectives, and is fair and balanced, it recommends that the EC adopts the code. The ultimate responsibility for the text and content of the network codes lies with the EC. The EC studies it and then sends it to an Electricity Cross-Border Committee, made up of specialists from national energy ministries, for an opinion. Once the EC accepts the draft network code, it is adopted with the approval of the Council of the European Union and the European Parliament. Sometimes the regulations are adopted as 'guidelines' rather than 'network codes'. These are adopted under a different provision of the Electricity Regulation, but they have the same status – they are both legally binding regulations. [3]

In terms of ENTSO-E's authority in Europe, the institution does not have legal authority over governments and national TSOs. The work is focused on promoting completion and functioning of the internal energy market in electricity and cross-border trade. Furthermore, it has an active and important role in the European rule-setting process, in compliance with EU legislation (network codes, 10-year network development plans). TSOs within the EU are free to create their own grid operational procedures as long as they comply with the relevant codes and guidelines and any other regional agreement put in place. However, one important note is ENTSO-E's 10-year net development plan. The regulation defines the European's Projects of Common Interest, which are electricity projects that have significant benefits for at least two member states. It also stipulates that ENTSO-E's Ten-Year Net Development Plan

[3] See European Commission at https://ec.europa.eu/energy/en/topics/wholesale-market/electricity-network-codes

be the sole basis for the selection of Projects of Common Interest. ENTSO-E is also mandated to develop a corresponding cost–benefit methodology for assessing transmission infrastructure projects.

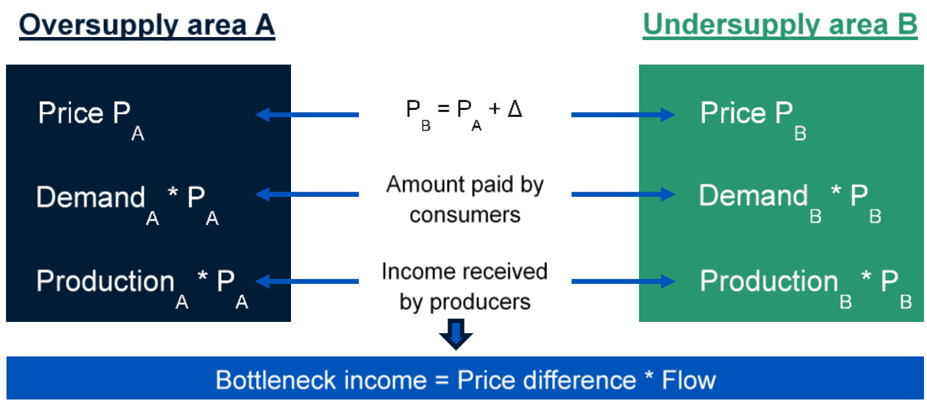
ENTSO-E also has a guiding role in other European-level regional sphere electricity projects, most notably in the following projects: Price Coupling of Regions (PCR), PX cooperation-owning Euphemia, and the PCR Matcher-Broker application; and in the following projects: Multi-Regional Coupling, Day Ahead coupling arrangement for TSOs, and Nominated Electricity Market Operators. However, ENTSO-E does not have formal decision-making role in these projects since these are EU guideline implementation projects, concerning mainly the national TSOs and the Nominated Electricity Market Operators.

3. Bottleneck income / congestion rent in Nordics

With implicit capacity auctioning, no additional wheeling charges are used between coupled systems. However, in the Nordics, the so-called bottleneck income or congestion rent is applied when there are price differences between market areas. Price differences between market areas occur when the surplus volume in one or more bidding area is greater than the total export capacity from this/these areas. The sales and purchase curves then have to be balanced by taking the transmission capacity into account. This will lead to a relatively low price in the surplus area and a relatively high price in the deficit area – utilizing the maximum capacity between the areas. These price differences generate an ownerless income on the spot market trading flow – from the area with a lower price to the area with a higher price.

This income (or cost) is referred to as the congestion rent and is aggregated within Nord Pool from the DAM settlement. Within the Nordic region, this income is allocated to the TSOs as owners of the transmission grid. Bottleneck income belongs to the interconnector owner. Since 2012, bottleneck incomes from an interconnector have been equally divided among the respective TSOs. EU legislation governs that bottleneck incomes must be used for cross-border capacity projects to aid in the relief of bottlenecks.

Figure 3. Bottleneck income



Source: Author.

4. Transparency and Data Collection

TSOs are often the primary source of relevant fundamental information. They are also used to collect and assess large amounts of information for system operation purposes. To provide an overall view of relevant information across the EU, TSOs should facilitate the collection, verification, and processing of data; and ENTSO-E should make the data available to the public through a central information transparency platform. [4]

Transparency has improved markedly in Europe over the past few years, culminating in Regulation (EU) No 5 43/2013 of 14 June 2013 on submission, which mandates a minimum common level of data transparency; publication of data on a non-discriminatory basis across Europe; and development of a central information platform, managed by ENTSO-E, to provide all market participants with a coherent and consistent view of the market. Through this regulation, it has now become mandatory for European member state data providers and owners to submit fundamental information related to electricity generation, load transmission and balancing for publication through the ENTSO-E Transparency Platform. In accordance with Regulation 543/2013, the ENTSO-E Transparency Platform was launched on 5 January 2015.[5] Generally, since the data collection is governed by EU- level law, ENTSO-E can dispute any misconduct of data collection through the European Commission dispute resolution process.

5. ENTSO-E Voting Rights and Budgeting

Most of legal and budgetary measures of ENTSO-E organization are governed in the Articles of Association. The rules on voting rights and budgeting were from this document.

5.1. Voting rights

In the ENTSO-E governance, the assembly members have voting rights while observer members do not have any voting rights. The ENTSO-E voting power has two parts: the first is the 'One country, one vote' principle and the second part is based on the population of the country. An average percentage shall be derived from the two-part voting power for each country. For example, in the votes for the president of the organization and the board members of the same, an average percentage of the proportional vote shares shall be calculated whereby 50% is determined based on the First Part of the Voting Power, and 50% is based on the Second Part of the Voting Power.

The first part of voting shall be attributed collectively as proportionate to the assembly members (i.e. full ENTSO-E members) and based on the number of votes that that country has as an EU member state in the Council of the European Union under the voting mechanism defined by the Lisbon Treaty. For non-EU member states, the voting power shall be defined according to the same mechanism (as if these countries were EU member states). The second part of the voting power shall be reviewed annually, as of the date of the publication in the

[4] See the Commission Regulation (EU) No 543/2013

[5] See the ENTSO-E articles of association

Official Journal of the European Union, based on the figures of the total population of each member state. For non-EU member states, the figures mentioned in the Statistical Papers of the United Nations shall become the bases. The first and second parts of the voting rights are presented in Table 2.

Table 2. Voting Power of the Members of the Association

Country	Member	First Part of the Voting Power ('one country, one vote' principle)	Second Part of the Voting Power (population of the country)
Austria	APG - Austrian Power Grid AG VUEN-Vorarlberger Übertragungsnetz GmbH	10 2	8 079,3 372,6
Belgium	Elia - Elia System Operator SA	12	11 161,6
Bosnia Herzegovina	NOS BiH - Nezavisni operator sustava u Bosni I Hercegovini	12	4 377,0
Bulgaria	ESO – Electroenergien Sistemen Operator EAD	12	7 284,6
Croatia	HOPS - Croatian Transmission System Operator Ltd	12	4 262,1
Cyprus	Cyprus TSO - Cyprus Transmission System Operator	12	865,9
Czech Republic	ČEPS - ČEPS, a.s.	12	10 516,1
Denmark	Energinet.dk IPC - Energinet.dk Independent Power Entreprise	12	5 602,6
Estonia	Elering - Elering AS	12	1 324,8
Finland	Fingrid - Fingrid OyJ	12	5 426,7
France	RTE - Réseau de Transport d'electricité	12	65 633,2
Germany	Amprion – Amprion GmbH TenneT GER – Tennet TSO GmbH TransnetBW -TransnetBW GmbH 50Hertz - 50Hertz Transmission GmbH	3 3 3 3	29 008,56 24 113,20 9 762,58 17 639,36
Greece	IPTO SA - Independent Power Transmission Operator S.A.	12	11 062,5
Hungary	MAVIR ZRt. - MAVIR Magyar Villamosenergia-ipari Átviteli Rendszerirányító Zártkörűen Működő Részvénytársaság	12	9 908,8
Iceland	Landsnet – Landsnet hf	12	281,1
Ireland	Eirgrid - EirGrid plc	12	4 591,1
Italy	Terna - Terna, Rete Elettrica Nazionale SpA	12	59 685,2
Latvia	Augstsprieguma tïkls - AS Augstsprieguma tïkls	12	2 023,8
Lithuania	LITGRID - LITGRID AB	12	2 971,9
Luxembourg	CREOS Luxembourg - CREOS Luxembourg S.A.	12	537,0

Montenegro	CGES AD - Crnogorski elektroprenosni sistem AD	12	620,0
Netherlands	TenneT TSO - TenneT TSO B.V.	12	16 779,6
Norway	Statnett - Statnett SF	12	4 979,9
Poland	PSE - PSE S.A.	12	38 533,3
Portugal	REN - Rede Eléctrica Nacional, S.A.	12	10 487,3
Romania	Transelectrica - C.N. Transelectrica S.A.	12	20 057,5
Serbia	EMS - JP Elektromreža Srbije	12	7 186,8
Slovak Republic	SEPS - Slovenská elektrizačná prenosovú sústava, a.s.	12	5 410,8
Slovenia	ELES - ELES, d.o.o., sistemski operater prenosnega elektroenergetskega omrežja	12	2 058,8
Spain	REE - Red Eléctrica de EspaÑa S.A.	12	46 704,3
Sweden	Svenska Kraftnät - Affärsverket Svenska Kraftnät	12	9 555,9
Switzerland	Swissgrid - Swissgrid AG	12	7 288,0
the former Yugoslav Republic of Macedonia	MEPSO - Macedonian Transmission System Operator AD	12	2 022,5
TOTAL		**408**	**531 906,4**
United Kingdom	National Grid - National Grid Electricity Transmission plc SONI – System Operator for Northern Ireland ldt SHE Transmission - Scottish Hydro Electric Transmission plc SP Transmission – Scottish Power Transmission plc	9 1 1 1	56 605,1 1 781,2 1 362,1 3 981,7

Source: ENTSO-E's Articles of Association.

5.2. Budgeting Measures

ENTSO-E is in principle a non-profit organization and entirely funded through membership fees paid to the association by its member TSOs. Its annual budget for 2014 was €17.7 million. The fees are divided into the following three categories:[5]

- Membership subscription fee,
- Associated membership fee, and
- Observer membership fee.

Membership subscription fee is paid annually by members by paying the amount as determined by their voting power – with 30% being proportionate to the first part of their voting power while 70% being proportionate to the second part of their voting power. Following its approval of the budget for the following year, the ENTSO-E assembly shall approve the amounts to be paid by the members for the ensuing financial year.

The associated member fee shall contribute to the budget of ENTSO-E at an equivalent amount of **€100,000 per year**.

The observer membership fee shall contribute to the budget of ENTSO-E at an equivalent amount of **€10,000–€70,000 per year,** as determined in the observer membership agreement.

6. Third-Party Access in the Nordics and the European Union

6.1. European Internal Electricity Market[6]

Directive 2009/72/EC of the European Parliament, dated 13 July 2009,[7] sets down a number of key provisions for the internal electricity market in Europe. On third-party access (TPA), Article 32 says the following:

'Member States shall ensure the implementation of a system of third party access to the transmission and distribution systems based on published tariffs, applicable to all eligible customers and applied objectively and without discrimination between system users. Member States shall ensure that those tariffs, or the methodologies underlying their calculation, are approved prior to their entry into force in accordance with Article 37[8] and that those tariffs, and the methodologies — where only methodologies are approved — are published prior to their entry into force'.

The transmission or distribution system operator may refuse access where it lacks the necessary capacity. Duly substantiated reasons must be given for such refusal, in particular with regard to Article 3, and based on objective and technically and economically justified criteria. The regulatory authorities shall ensure that those criteria are consistently applied and that the system user who has been refused access can make use of a dispute settlement procedure. The regulatory authorities shall also ensure, where appropriate and when refusal of access takes place, that the transmission or distribution system operator provides relevant information on measures that would be necessary to reinforce the network. The party requesting such information may be charged a reasonable fee, reflecting the cost of providing such information.

Several important principles are covered by this high-level directive, as follows:

- Access to transmission and distribution systems for the purposes of trading electricity across borders should be granted to all parties who are enabled to trade electricity freely under the applicable market rules;
- This should be provided without discrimination;
- Tariffs may be charged for access to the transmission and distribution systems, but these are subject to national regulatory approval; and

[6]This section was supplied by Ricardo, subconsultant of Nord Pool Consulting during this project.

[7] See the Directive 2009/72/EC of the European Parliament and of the Council, 13 July 2009, concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0072&from=EN

[8] This Article 37 of the directive addresses the responsibilities of national regulatory authorities.

- Third-party agreement may be refused in situations where there is insufficient network capacity available, however, transmission and distribution system operators who refuse access to their networks are required to provide information on the technical measures that would be required to facilitate TPA and the associated costs.

The provisions of Directive 2009/72/EC are applicable to all European Union member states, however, it is the responsibility of the governments of each member state to implement the relevant measures within the law of their own countries.

6.2. Regulation (EC) No. 714/2009

Another EC regulation is in place – Regulation (EC) No. 714/2009 on 'conditions for access to the network for cross-border exchanges in electricity'.[9] This contains a number of key provisions that member states are required to comply with to facilitate TPA, including the following:

- A requirement for 'increased cooperation and coordination among transmission system operators … to create network codes for providing and managing effective and transparent access to the transmission networks across borders' (Recital [6]);
- The rights for transmission system operators to be 'compensated for costs incurred as a result of hosting cross-border flows of electricity on their networks by the operators of the transmission systems from which cross-border flows originate and the systems where those flows end' (Recital [11]);
- The development of a set of 'network codes', overseen by the Agency for the Cooperation of Energy Regulators (ACER), and developed 'for cross-border network issues and market integration issues' (Article 8[7]). Technical provisions of the network codes include the following:
    - network connection rules,
    - third-party access rules,
    - capacity allocation rules,
    - transparency rules, and
    - rules regarding harmonized transmission tariff structures; and
- The application of transparent access charges to networks (Article 14).

It is important to note that across the EU, legislation to ensure TPA is available and put in place at the highest level through a directive, and then implemented through regulations and through national legislation. The role of ACER as a regional agency is to advise on the content of regional network codes, in consultation with the national regulators – it does not, however, have any enforcing powers. These rest with the European Parliament, through which directives are enforced.

[9] See Regulation (EC) No. 714/2009 of the European Parliament and of the Council, 13 July 2009, on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No. 1228/2005. http://eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:32009R0714&from=EN

Chapter 3

International Experiences:

The Australian Energy Market Operator Cost Recovery

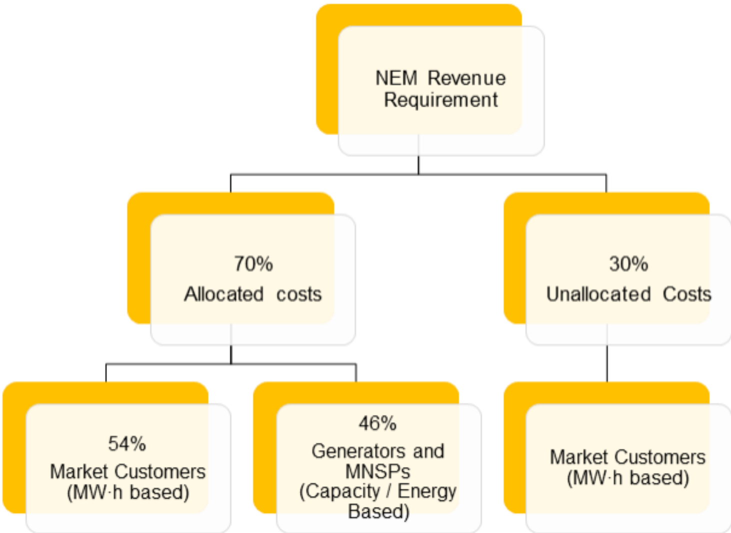
The Australian Energy Market Operator (AEMO) is an independent organization working for the long-term interests of Australian energy consumers by developing markets that offer affordable, safe, and reliable energy supplies. AEMO carries out the electricity functions previously undertaken by the National Electricity Market Management Company for the national electricity market (NEM) and the planning responsibilities of the Electricity Supply Industry Planning Council of South Australia. Within the functional work stream, the organizational structure distinguishes three types of organizational roles: (i) day-to-day operations, (ii) short-term market development and transmission services, and (iii) long-term strategic planning. These distinctions reflect the shared focus of operations within each energy market that enables the integration of common services to allow their efficient delivery to multi-market participants. Currently, there are approximately 500 employees within the AEMO organization, including those in the gas business.

In Australia, AEMO operates on a cost recovery basis as a company limited by guarantee under the Corporations Act (2001). AEMO fully recovers its operating costs through fees paid by participants. AEMO has a broad range of functions and each is underpinned by a fee structure developed in consultation with stakeholders and in line with requirements under the National Electricity Rules.

The NEM fees are calculated in accordance with the current NEM fee determination that became effective for a 5-year period from 1 July 2011 to 30 June 2016. In summary, the NEM fee determination requires the annual revenue requirement to be allocated as follows:[10]

[10] See the AEMO consolidated final budget and fees for 2016–2017

Figure 4. AEMO Revenue Recovery Model



MNSPs = Market Network Service Provider, MWh = megawatt hour, NEM = national electricity market.
Source: Australian Energy Market Operator (AEMO), n.d.

Table 3. AEMO Revenue Requirement and Fee Schedule [10]

Function	Budget 2015-16 $'000	Rate [1]	Paying Participants
NEM			
General Fees (unallocated)	20,053	$0.11258/ MW·h of customer load	Market Customers
Allocated Fees			
- Market Customers	25,267	$0.14185/ MW·h of customer load	Market Customers
- Generators[2] and Market Network Service Providers	21,524	Daily rate calculated on 2014 capacity/ energy basis	Generators and Market Network Service Providers
Participant Compensation Fund	Nil	Daily rate calculated on capacity/ energy basis	Scheduled Generators, Semi-Scheduled Generators and Scheduled Network Service Providers
Registration fees	280	Refer to Electricity schedule of registration fees	Intending Participants
Other	1,596		Dependent on service provided
TOTAL NEM	**68,720**		
FRC ELECTRICITY			
FRC Operations	6,474	$0.04000/ MW·h of customer load in jurisdictions with FRC	Market Customers with a Retail Licence
Other	78		Dependent on service provided
TOTAL FRC ELECTRICITY	**6,552**		
National Transmission Planner	3,658	$0.02054/ MW·h of customer load	Market Customers
Energy Consumers Australia	4,851	$0.00976/ connection point for small customers/ week	Market Customers
Additional Participant ID		$5,000 per additional participant ID	Existing Participants

[1] All fees and rates are exclusive of GST
[2] Excluding non market non scheduled generators

FRC = Full Retail Contestability, MWh = megawatt hour, NEM = national electricity market, NI = not indicated.
Source: Australian Energy Market Operator (AEMO), n.d.

Chapter 4

International Experiences: Southern African Region

1. Historical Perspective

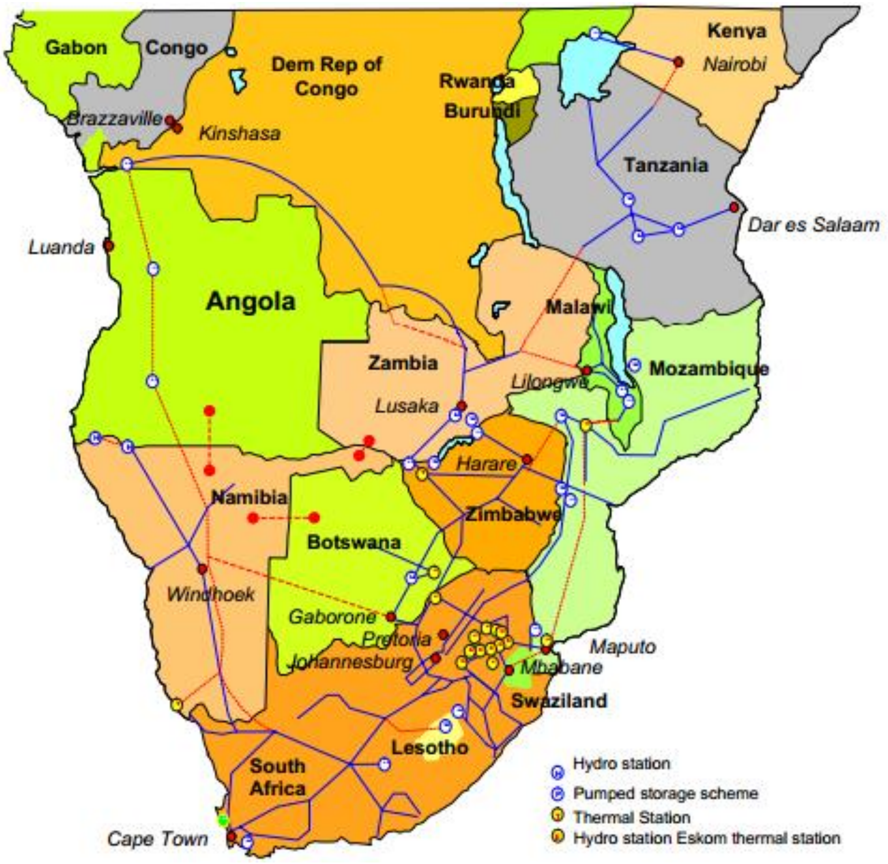
Before the establishment of the Southern African Power Pool (1995), the Southern African region operated with two exclusive but not interconnected systems. The northern part of the region comprising the Democratic Republic of the Congo, Zambia, Mozambique, and Zimbabwe operated a hydropower-dominated grid with only Zimbabwe having some thermal power. The southern part comprising Botswana, South Africa, Namibia, Lesotho, Swaziland, and Mozambique (some parts only) operated a thermal power-based grid with Eskom of South Africa being the main supplier. Countries/utilities on each network bilaterally traded power among themselves albeit with strict take or pay clauses and high contractual load factors. Long-term (5, 10, 15+ years) bilateral agreements were the trading platform. These were inherently inefficient as sometimes power was pushed onto utilities that did not need it at some periods of the day. Trade was not linked to market requirements.

When one network experienced a disturbance, the other could not assist as they were not coupled. The impact of system disturbances on the separated weaker networks was higher, resulting in higher unserved energy and negative economic impact in affected countries. The northern systems suffered power shortages whenever there were drought spells as the hydro energy resources were reduced. The south could not assist even though it had thermal power that was resilient to droughts. The drought of the early 1990s and the political change in South Africa triggered the concept of resource pooling, sharing, and mutual assistance between the two parts of the region. The formulation of the power pool started. Southern Africa remains dominated by vertically integrated national power utilities with single-buyer models in all the countries. Independent power producer (IPP) penetration increased in most of the countries in recent years. Only Zambia and Mozambique have independent transmission companies in addition to the national TSOs.

2. The Formation of the Southern African Power Pool

The SAPP is an association of 16 electricity enterprises from 12 mainland member countries operating under the auspices of the Southern African Development Community (SADC). The member countries are Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe. The main objectives of SAPP are (i) pooling and sharing of resources, (ii) mutual support under emergency situations, and (iii) technical and economic efficiency benefits. Of the SAPP members, 13 are from nine countries that are physically interconnected to each other through transmission lines at various voltage levels forming the SAPP grid. These are referred to as operating members. Three countries (Angola, Malawi, and Tanzania) are non-operating members because they are not interconnected as there is no infrastructure to do so. SAPP operates through a coordination centre that is located in Harare, Zimbabwe. Electricity trade in the region is through a hybrid of bilateral agreements and a SAPP Co-ordination Centre (SAPP CC)-administered competitive market. The SAPP CC is funded by members through contributions determined using an agreed formula. Funds are also raised through fees for market administration.

Figure 5. Interconnections among Operating Members of SAPP



Source: South African Power Pool (n.d.a). http://www.sapp.co.zw/

2.1. Enabling Documents

SAPP was conceptualized out of strong political will for regional economic and social integration through sharing of resources among the 12 mainland SADC member countries. Its governance structure, therefore, is anchored at national government-level where a founding agreement had to be promulgated to pave way for facilitative agreements to establish the organization. The intergovernmental memorandum of understanding (IGMOU) signed by SADC member ministers of energy in 1995, established SAPP as an institution in the region and paved way for the inter-utility memorandum of understanding (IUMOU) to be signed by the chief executive officers (CEOs) of all national power utilities in the same year. The IUMOU allowed the CEOs to establish the SAPP management structures. Through the use of specialist working groups, the CEOs produced and signed the agreement between operating members, which sets the SAPP functional structure, members' obligations, functional expectations, and operational modalities at high level. The operating guidelines that stipulated specific member roles, obligations, rules, standards, and procedures were then developed to guide the interconnected operations of the SAPP grid. The following is a list of the initial documentation in their order of hierarchy:

- Intergovernmental Memorandum of Understanding
- Inter-Utility Memorandum of Understanding
- Agreement Between Operating Members – signed only by interconnected members
- Operating Guidelines

2.2. Structure

To operationalize the SAPP, the structure comprised committees to enable the full participation by members and protection of their interests at all levels. At government level, a Council of Energy Ministers that meets at least once a year had to be in place to address policy issues, give political leadership, and establish institutions where necessary. At the SADC Secretariat, the Division of Infrastructure Services became the link between the ministers and the utility CEOs. An executive committee (ExCo) whose membership was CEOs of the national power utilities became the highest SAPP management decision-making body. The ExCo meets at least once a year and a Division of Infrastructure Services representative has to attend. Below the ExCo is the management committee (MANCO), which decides on issues from the subcommittees and refers matters beyond its jurisdiction to the ExCo for resolution. The MANCO directs the functions of the subcommittees. Four expert area subcommittees were established to address matters on operations, electricity trading, environment, and planning. The MANCO and subcommittees meet at least twice a year. The Co-ordination Centre Board was formed to address policy issues related to the coordination centre and to report to the MANCO.

Details of the duties and functions of the SAPP committees are contained in the IUMOU. Two-thirds of members form a quorum for meetings to proceed. Voting is based on a 'one member, one vote principle' but there are weights applied between national utilities and private entities. The following discussions provide some details on how the various entities function.

2.3. Executive Committee

The ExCo is the final decision-making body at utility-level in SAPP. It is composed of all CEOs of member utilities. The ExCo decides on issues referred by the MANCO and forms its own working groups where necessary. The MANCO chairperson sits in the ExCo without voting powers. The ExCo approves the coordination centre's budget and meets at least once a year. It interfaces with the political economy through the SADC's Division of Infrastructure

Services. It serves as the custodian of the IUMOU and upholds the IGMOU. It strategizes and gives direction to SAPP. The ExCo approves the membership of electricity enterprise applicants.

2.4. Management Committee

The MANCO is composed of a utility's senior member (normally the Director of Transmission Business but can vary with utilities) with sufficient authority to make decisions that bind the utility. An alternative member (normally one of those who sit on subcommittees) sits in the MANCO without voting powers. The MANCO meeting normally takes place on a day following subcommittee meetings to decide on reports made by chairpersons of the subcommittees and the board. The MANCO can form its own working groups. It refers all matters it cannot decide on to the ExCo. It screens the coordination centre's budget and presents it to the ExCo for approval. The composition, functions, responsibilities, and modus for meetings are specified in the IUMOU. Chairmanship of the committees rotates on a yearly basis but no member can chair for more than two consecutive years. There are no observers in the MANCO. Chairpersons of the subcommittees and the Co-ordination Centre Board sit in the MANCO without voting powers.

2.5. Subcommittees

The four subcommittees (Planning, Operating, Markets, and Environmental) comprise business area experts from the utilities – e.g. a representative to the planning subcommittee would come from a utility planning division, the one to the operating subcommittee would come from system operations, a markets representative from the trading division, and an environment representative from the environment division. Each utility must have a substantive member and an alternate. Their composition, functions, responsibilities, and modus for meetings are specified in the IUMOU, which is signed by all members as a sign of commitment to its requirements. Chairmanship of the committees rotates on a yearly basis but no member can chair for more than 2 consecutive years. Hosting of meetings also rotates. Observer status is granted to electricity enterprises that want to understand the operation of the pool before joining fully. Working groups are also formed by subcommittees, as required. The subcommittees meet at least twice a year.

Unanimity is the preferred decision-making process but committees are permitted to vote and pass motions on two-thirds majority. Voting rights are in accordance with weights allocated between national utilities and private entities.

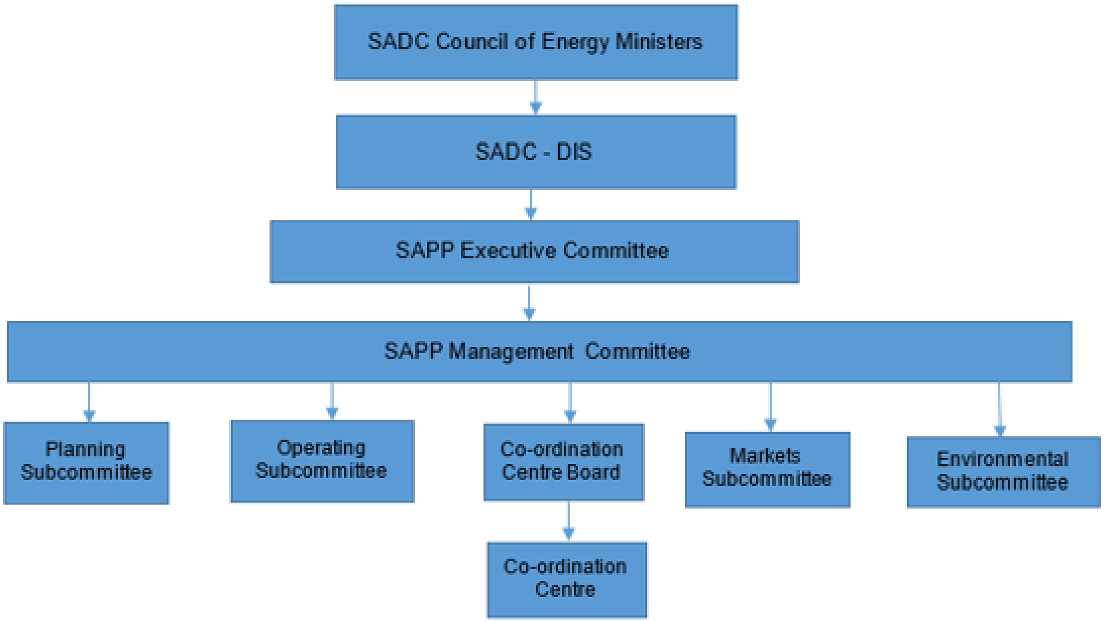
2.6. Co-ordination Centre Board

Each utility nominates a substantive and an alternate member to the Co-ordination Centre Board, which makes policy decisions on conditions of service, the running of the coordination centre, budget, and engagement/disengagement of the top three officials (the manager, chief engineer, and chief market analyst) with approval of both MANCO and ExCo. The members must be senior enough to make decisions that bind their utility in board meetings. The requirements are contained in the IUMOU. Chairmanship of the board is by voting. The board meets at least twice a year and it has its own constitution.

The SAPP Coordination Centre

The coordination centre is SAPP's legal entity that implements its projects, undertakes researches, and advises committees on expert matters. It operates the competitive market, monitors system operations, and carries out studies that may be required. The SAPP CC reports on member performance/compliance according to set criteria. It keeps records and exchanges of information among members. The centre acts as the face of SAPP, regionally and internationally. Figure 6 presents the SAPP governance structure.

Figure 6: SAPP Governance Structure



SADC-DIS = Southern African Development Community-Division of Infrastructure Services, SAPP = Southern African Power Pool.
Source: SADC Energy Monitor (2016).

3. Open Access and Transmission Capacity Calculation of the SAPP

3.1. Allocation of Transmission Capacity in SAPP

SAPP operates on an open access principle where all parties have access to the available wheeling capacity. However, available capacity depends on prevailing asset ownership and trade arrangements. All transmission assets within utilities were built to serve internal (domestic) requirements. Trans-network trade only utilizes surplus capacity. Investment in interconnectors between countries is normally anchored by trade transactions protected in power purchase agreements. These take precedence on the interconnector transmission capacity. A transmission equipment solely for wheeling purposes in the SAPP is yet to be built.

Due to these ownership rights and anchor contracts, available third-party wheeling capacity needs to be determined so that third-party trade may happen on the various interconnectors. The SAPP CC is tasked with determining available wheeling capacities on a daily basis to facilitate day-ahead market (DAM) and its derivative operations. The guiding principle is that the transmission infrastructure must first serve the purpose for which it was created. To determine surplus capacity, the SAPP CC needs to know transfer limits on each interconnector. The capacity allocated to bilateral contracts must also be known so that surplus capacity is determined after removing the bilateral capacity from the transfer limit. Basically, SAPP CC needs to know the available capacity and committed capacity to compute surplus capacity. Once determined, the surplus capacity is shared according to an established methodology. Since SAPP intends to increase IPP participation in the market, it has issued rules on the prioritization of access to transmission capacity for fairness and transparency purposes. Prioritization in wheeling capacity starts with bilateral contracts (firm then non-firm) on a grandfather rule basis, before competitive market transactions are cleared for transport.

There is a procedure for determining the capacities and declaring availabilities for day- ahead trade. On the day of trade, emergency power supply overrides non-firm and DAM transactions. Below is the summary of prioritization.

3.2. Transmission Capacity Prioritization for SAPP Use

Tables 4 and 5 are applicable to transmission capacity available to SAPP wheeling, after taking into account the asset owners' dedicated use.

Table 4. Transmission Capacity Priority for Day-Ahead Scheduling

Priority for day-ahead scheduling	Transaction	
	Type	**Remarks**
First (1)	Firm Power Bilateral Transaction as confirmed a day ahead	When competing, the oldest firm transaction takes priority.
Second (2)	Non-Firm Power Bilateral Transaction(s), (including energy un-banking) as confirmed a day ahead	When competing, the oldest non-firm transaction takes priority.
Third (3)	DAM transactions (DAM is run over and above bilateral transactions)	After DAM is closed, DAM transactions shall be firm and shall take priority over non-firm transaction(s).
Fourth (4)	Pay-back of inadvertent energy in kind	Spare capacity after bilateral and DAM transactions may be utilized in paying back inadvertent energy to reduce accumulation.

DAM = day-ahead market.

Source: Southern African Power Pool, operating guidelines (2012),

Table 5. Transmission Capacity Priority on the Day of Delivery

Priority for day-ahead scheduling	Transaction	
	Type	**Remarks**
First (1)	Firm Power Bilateral Transaction as confirmed a day ahead.	When competing, the oldest firm transaction takes priority.
Second (2)	Emergency Energy support	Includes any energy sourced for alleviating an emergency situation in the asset owner's system.
Third (3)	Non-Firm Power Bilateral Transaction(s), (including energy un-banking) as confirmed a day ahead.	When competing, the oldest non-firm transaction takes priority.
Fourth (4)	DAM transactions (DAM is run over and above bilateral transactions)	After DAM is closed, DAM transactions shall be firm and shall take priority over non-firm transaction(s).
Fifth (5)	Pay-back of inadvertent energy in kind.	Spare capacity after bilateral and DAM transactions may be utilized in paying back inadvertent energy to reduce accumulation.

DAM = day-ahead market.
Source: Southern African Power Pool, operating guidelines (2012).

3.3. Transmission System Operations

To enable smooth interconnected system operations, each TSO needs system control and data acquisition (SCADA) equipment to monitor power flows, dispatch generation, control loading, and configure the network as required. TSOs operate with 24-hour control centers staffed with specialists for this purpose. In an interconnected network like that of SAPP, internal utility load changes can cause disturbances and hardships on neighboring utilities due to relative responses of generators to system frequency, faults, or poor performance. To minimize such occurrences, utilities must install automatic generation control (AGC) equipment at its control center and form a control area that is capable of monitoring and controlling frequency and power interchanges with neighboring control areas. The AGC calculates the area control error (integrated frequency control and scheduled tie line flow errors) and takes corrective action automatically by sending portions of the area control error to selected generators so that local changes are corrected by local generators. Utilities without AGC must contract control area services from those that have. The basic requirements for control area operations are as follows:

- Control area operator must have AGC installed at its control centre.
- Each control area must be able to measure and transmit power flows at points of interconnection to the control centre and compare with scheduled flow to determine error level.
- Each control area must be able to measure system frequency and compare with scheduled frequency to determine error level.
- Each control area operator must have generation capacity on AGC that is capable of receiving control error signals and make required adjustment.
- Neighbouring control areas must measure interconnector power flows from the same meter.
- The AGC must be run in tie line bias mode.
- There must be telemetering and telecommunications to enable AGC functionality.

Area Control Error is defined mathematically as

Area Control Error = (NIA-NIS)-10β(FA-FS)-IME

where:

NIA = is the actual net interchange. It is the algebraic sum of tie line flows between the control area and neighbouring control areas.

NIS = is the net scheduled interchange. It is the net of all scheduled transactions with other control areas.

β = is the control area frequency bias

FA = is the actual frequency

FS = is the scheduled frequency

IME = is interchange (tie line) metering error

3.4. Transmission Congestion

Power flows across participating transmission equipment along a wheeling route are limited by established transfer limits. When transfer limits are reached, trade is curtailed. Along a wheeling corridor there is normally a piece of equipment or condition that limits transfer. For example, a transformer whose rating is below that of the associated line can limit transfer for equipment safety reasons, or when one line out of two or three operating in parallel is taken out of service, transfer must be limited to the capacity of the remaining line(s), or when increased wheeling volumes cause instability in a network, or generation levels at critical points are outside required levels. In SAPP, transmission limitation has resulted along the central corridor in Zimbabwe and Botswana – mainly due to voltage and system stability concerns. In Zimbabwe, transmission capacity is mainly dependent on generation availability at the Hwange thermal power station. Poor generation availability increases southward power flows within Zimbabwe and limits southward third-party transactions towards Botswana. On the same corridor, transfer is also limited by the Zimbabwe Electricity Supply Authority (ZESA) system stability when its net imports reach 450 MW. The 350 MW southward transfer limit on this corridor is lower than the northward transfer limit of 600 MW. Pn either side of Zimbabwe, the transfer limits are higher.

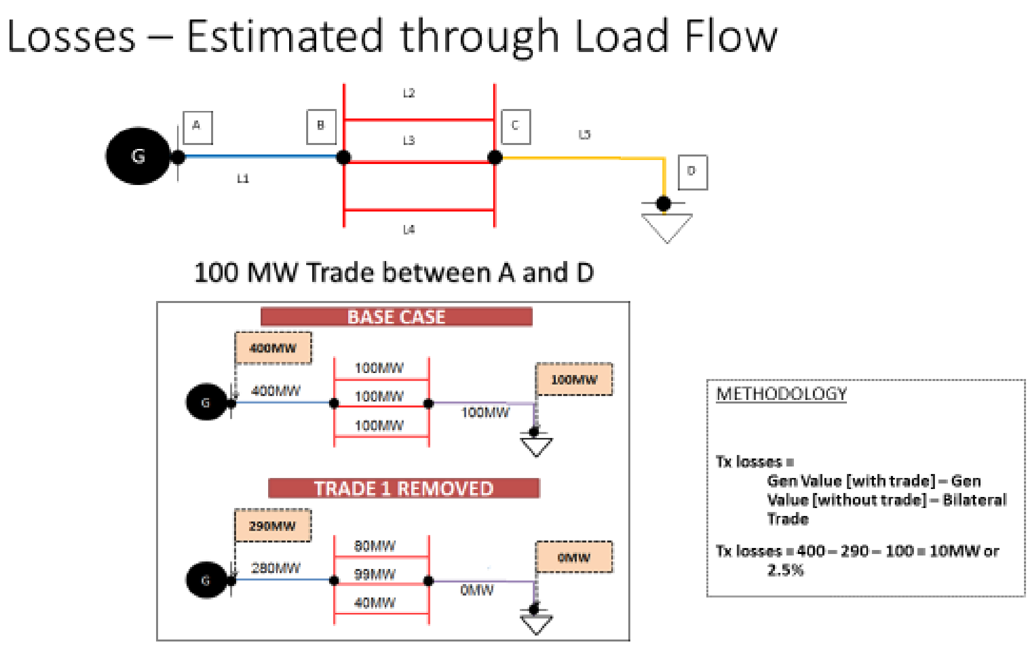
In South Africa, a transfer restriction normally occurs along the 2 x 765 kilovolt (kV) transmission lines from Mpumalanga to Cape Town when generation at the Koeberg nuclear power station in Cape Town is reduced. Outage of one generator (930 MW) causes a corresponding increase of power flow on the lines leading towards overload and instability. Exports to Namibia along this route necessarily have to be curtailed. Power flows from Namibia northward would reduce the transfer limitation.

3.5. Transmission Losses

Power system losses are the difference between power sent out into the system i.e. generation sent out + imports less exports, and power metered at the customer end. Transmission losses are the losses that occur on the transmission network between points of power/energy injection and points of delivery to transmission-connected customers or distribution off takers. Figure 7 demonstrates the principle. Losses associated with a wheeling transaction are better estimated through a load flow study where generation sent out is noted and then a transaction is floated and the change in generation is noted again. The transaction losses will be as follows:

- **Transmission technical losses** = Power sent out (gen + imports - exports) – power received at delivery point.
- **Transaction losses** = Generation with transaction – generation without transaction – transaction

Figure 7. Calculation of Transaction Losses



MW = megawatt.
Source: Author.

4. SAPP Markets

4.1. Pre-SAPP Period

Before the establishment of SAPP in 1995, countries/utilities bilaterally traded power among themselves albeit with strict take or pay clauses and high contractual load factors. Long-term bilateral agreements (5, 10, 15+ years) were the trading platform. These were inherently inefficient as sometimes power was pushed onto utilities that did not need it at some periods of the day. Trade was not linked to market requirements. The inefficient and uncoordinated market did not maximize opportunities nor produced accurate and consistent investment signals to utilities and investors alike. The drought of the early 1990s triggered the need for an exchange of power between the coal thermal-based Eskom and the drought-stricken hydro-based ZESA and the Zambia Electricity Supply Corporation (ZESCO). The 400 kV Matimba–Insukamini interconnector was built for this purpose.

4.2. Cooperative Power Pool Period

After establishing the SAPP in 1995, the northern and southern grids were interconnected in 1996 via a 400 kV AC transmission line between South Africa and Zimbabwe. Botswana was connected to the same line in 1997. All the power utilities (nine countries) could now trade electricity among themselves. The immediate relief came from the supply of thermal power from Eskom to the drought-stricken northern utilities – averting economic disruption from load shedding. The expanded interconnected grid became stronger and impacts of system disturbances lessened as the grid became more resilient to perturbations. Less expensive surplus power from Eskom became available to the northern utilities and trade expanded. When the drought lifted, cheaper hydropower from the northern utilities became available to southern utilities, further increasing trade and opening opportunities for short-term trade contracts. Due to cost advantages, utilities optimized their power supply options and increased both supply reliability and profitability. Shorter bilateral power contracts became possible. Trading efficiency increased somewhat. Utilities that were captive to one supplier for a long time started diversifying their supply portfolios.

During the short 'teething problem' period, there were technical and quality of supply issues, which the Operating Subcommittee resolved. What caused concerns were the quality of supply issues associated with frequency control on a grid dominated by thermal power in South Africa, and medium-sized hydro plants in the north without good experience in control area concepts. A small signal oscillation caused by the reaction of northern to southern generators caused blackouts in some countries and negatively affected trade. The Operating Subcommittee investigated and resolved these issues by tuning some control gear, and trade was normalized. A retired but seasoned power pool operations person from the New York Power Pool assisted in resolving many of the initial problems that resulted in increasing trade.

4.3. Transformation into a Competitive Power Pool

In 1999, the ExCo aimed to improve trade benefits and efficiency through competition among members. The SAPP had to create the enabling environment by reviewing pertinent documents and formulating others. The coordination centre was not originally envisaged to participate in electricity trading activities among members but now it was required to operate the market. A new set of rules had to be developed, and a trading system and platform had to be set up. Risks around security for trade settlement and mechanisms for transaction management had to be addressed. A domicilium of trading transaction accounts had to be determined by members. Roles, powers, and authorities of different players had to be allocated.

The SAPP CC constitution had to be reviewed to permit the centre to participate and operate the market. A Legal Agreement and Book of Trading Rules had to be produced to bind and guide market participants in their operations. The centre's structure had to be reviewed to accommodate the new trading functions. A trading system with strict timelines for the submission of bids; a publication of matched buyers, sellers, and prices; gate closure times; and a settlement process were all developed. A trading platform to match buy-and-sell bids, with invoicing capabilities, had to be developed and implemented. The centre's manager had to be empowered to invoice participants, make trade settlements from member bank accounts, and manage security deposits. Penalties for non-compliance had to be formulated. Cooperation was replaced with competition as buyers and sellers bid into the market.

4.4. The Short-Term Energy Market

The initial competitive trade market that commenced operation in 2001 was called the short-term energy market (STEM). It was based on matching buy-and-sell bids that are submitted hourly, for the following day. Participants whose buying price matched a sale price would equally share the matched energy. This would start with the lowest price match and ascend until the last matched energy is cleared. Unmatched bids would be posted on a bulletin board where participants would see available trade volumes and prices. From there, they could engage in short-term bilateral negotiations if required. Matched bids are considered firm contracts for delivery the following day, commencing at hour ending 01:00 and terminating at hour ending 24:00. Payment is based on schedule and not delivery. Mismatches between scheduled energy and actual delivery are settled through inadvertent energy management procedures. The buyer paid for wheeling services and the supplier paid for losses, in kind. Initially, wheeling was based on postage stamp principle, but it later changed to MW/km.

For the market to take effect, SAPP negotiated that bilateral contracts be relaxed to permit trade volumes and release transmission capacity on wheeling paths. Members responded positively and renegotiated some conditions in their bilateral contracts. Specifically, Eskom in the Republic of South Africa, and Botswana Power Corporation and ZESA in Zimbabwe agreed to allocate capacity to the 400 kV interconnectors for STEM trading.

Trade volumes increased, trade tariffs reduced, bilateral contracts shortened in tenor, and time of use tariffs were introduced that resulted in the reduction or elimination of high load factor take or pay contracts. Previously, net importers began to sell during some time periods of the day e.g. off peak. The value of each megawatt to a trader and system operator increased as people could immediately relate to money value of trade. For the first time, most utilities separated electricity trading from system operations to remove bi-faculty and sharpen focus separately on technical and economic efficiency.

4.5. Current Electricity Trading in SAPP

The ExCo decided to increase trade competition and permit more players into the market sometime in 2004. The SAPP's MANCO was directed to create an enabling environment for such a market. The IGMOU, the IUMOU, the Agreement Between Operating Members, the Operating Guidelines, and the trading's Book of Rules had to be reviewed and approved by the ministers and the utility CEOs.

SAPP decided to establish the DAM, which commenced operation and superseded STEM in 2009. This trading platform came with a new trading tool that was more sophisticated and capable of more functions. The market-clearing price principle, in which a market price is determined based on the price at the crossing point of demand and supply, was implemented. All participants pay the market-clearing price for market-enabled supply. Buyers and sellers do not know who they are matched to, reducing the risk of market manipulation. Access to the transmission network is fair and open to all. The market- clearing price principle took into account transmission availability and congestion management. The market provides for short-term future (10 days) trade schedules and block bidding. Market splitting, with unconstrained and constrained pricing, became possible. Accurate investment locations and pricing signals for transmission infrastructure development could be sent as market prices were a clear indication of market forces and participant's willingness to pay for services. Since the trading platform was web-based, traders could make their bids into the market from any location in the world. Automated invoicing and settlement systems are incorporated, providing alarm and alert on security deposits, settlement defaults, and delivery mismatches. A new transmission pricing methodology (flow-based MW/km) was adopted. Transaction administration became easier.

There are prospects for setting up an ancillary services market, a balancing market, and a financial market.

The SAPP regional trading currently operates with bilateral market, DAM, post-day-ahead market (PDAM), intraday market, and the soon-to-be introduced short-term forward market. The bilateral market consists of firm, long-term bilateral contracts and short-term contracts that may be firm or non-firm with the latter being prevalent due to shortage of supply. The DAM is the main market operated by the SAPP Co-ordination Centre in Harare, whilst the PDAM is a DAM derivative. Trade bids that are not matched during the DAM process are posted on a bulletin board where members can view and engage in negotiation for short-term bilateral supply (PDAM) with the assistance of the SAPP trader. The intraday market facilitates trade gap closure and smoothing close to real time (i.e. on the day of trade) through negotiations for surplus power from the PDAM by buyers and sellers.The short-term forward market is in its formation stage. It is aimed at week-ahead and month-ahead trade contracts. A new market trading platform with more functionality than the previous one became operational in 2014/2015. Details of each type of trade are discussed below.

4.6. Bilateral Trade

Traditionally, SAPP members were locked into long-term, high-load factor, firm bilateral contracts for security of supply and captive sales reasons. Eskom was the major supplier to many countries due to the availability of its surplus power. The Société Nationale d'électricité of the Democratic Republic of the Congo, ZESCO of Zambia, and the Electricidade de Moçambique and the Hidroeléctrica de Cahora Bassa of Mozambique were net exporters. The major buyers were those countries that could not meet their peak demand like ZESA of Zimbabwe, Botswana Power Corporation of Botswana, NamPower of Namibia, Lesotho Electricity Company (Pty) Ltd of Lesotho, and Swaziland Electricity Company of Swaziland. The importers had supply portfolios that included firm and non-firm bilateral contracts from various suppliers. For example, the Botswana Power Corporation could have long-term firm bilateral contracts with Eskom; have medium-term bilateral contracts with Eskom, Electricidade de Moçambique, Société Nationale d'électricité, and ZESCO (firm and non-firm); and also have short-term bilateral contracts with NamPower, Eskom, ZESA, and Electricidade de Moçambique. Contracts could incorporate first right of refusal clauses. From 2000, when SAPP was preparing for competitive trade, some of the bilateral contracts had to be renegotiated to pave the way for competition. Trade volumes, conditions, and to some extent, prices, were renegotiated. Member trade portfolios changed. Some traditional net importers could also export in certain trade windows. For example, ZESA could have long-term firm bilateral import contracts with Eskom; have medium-term bilateral import contracts with Eskom, Electricidade de Moçambique, Société Nationale d'électricité, and ZESCO (firm and non-firm); and also have short-term bilateral export contracts with Botswana Power Corporation and NamPower. Some first right of refusal clauses began to disappear.

This kind of trade enabled security of supply concerns to be addressed and propelled economic efficiency. However, this was only possible when there was surplus power in the region up to 2007. Post-2007, utilities tried to lock as much power as possible into bilateral contracts for security reasons. Only few managed to get short-term bilateral contracts but most were with low-load factors and clauses for curtailment of supply at short or without notice. Importers were required to show certain demand management initiatives to qualify for certain supply prioritization.

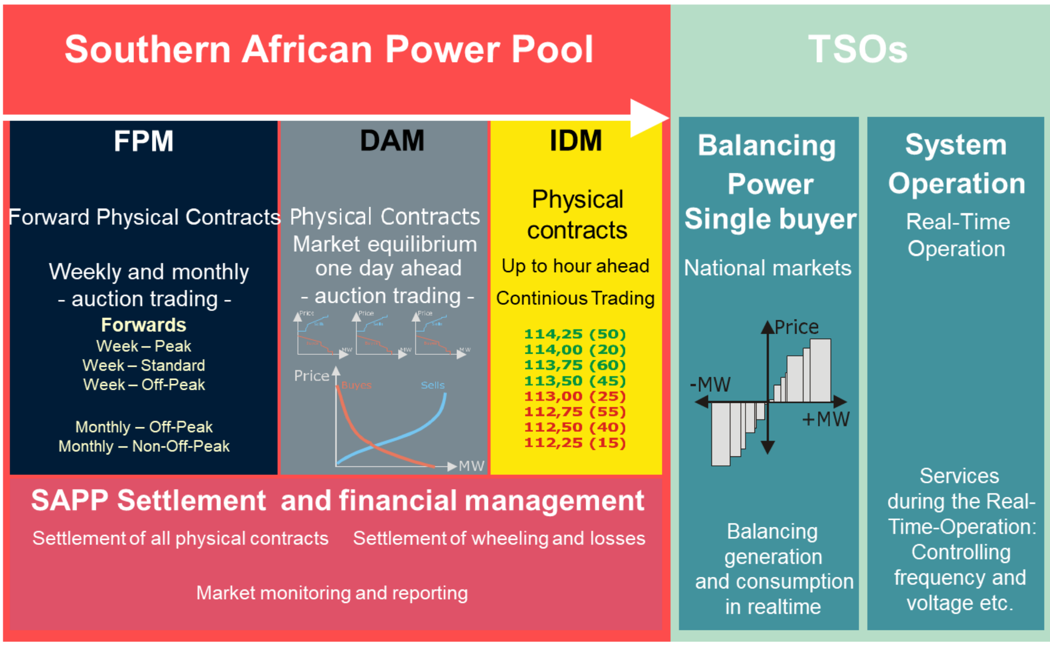
4.7. Competitive Trade (DAM and PDAM)

The STEM trading platform was not perfect and a more sophisticated day-ahead market (DAM) platform succeeded it, using NordPool donor funding and expertise in 2009 (the platform has since been upgraded during 2013–2014). There was no power to trade and where little power was available, the transmission wheeling paths were congested with bilateral contracts, which also suffered curtailments. As the deficit situation began to lift from 2012, trade volumes started to increase. The DAM platform has more sophisticated price determination (market clearing principle) and congestion management methodologies that send accurate investor signals; and manages the trade, reconciliation, and settlement processes centrally and faster. Matched participants are only known to the market operator, thus, reducing market manipulation chances. Since 2013, the DAM trend has been upward in volumes except for fluctuations on a month-by-month basis.

Comparison of Bilateral and Competitive Market Trade

During the SAPP financial year of 2013–2014, the competitive market share of electricity trade in the region was 1%. The rest (99%) was on the bilateral market. Security of supply concerns took center stage, especially with a general power supply shortfall in the region. Most utilities meet their base load with internal generation and firm bilateral contractual supply. The competitive market is used for economic optimization. Mismatch in prices between sellers and buyers in the competitive market combined with transmission constraints to limit trade volumes. Without transmission constraints during 2013–2014, the market could immediately grow to 3% of total trade in SAPP. Figure 8 illustrates the current SAPP market structure. As explained earlier in this chapter, the market segments consist of forward market, day-ahead market, intraday market, and TSO balancing market.

Figure 8. SAPP Market Structures



DAM = day-ahead market, FPM = Forward Physical market, MW = megawatt, SAPP = Southern African Power Pool.
Source: Author.

4.8. Balancing Market

SAPP is pursuing the establishment of a balancing market. Training on methodologies is being given to stakeholders involved.

4.9. Market Surveillance

To maintain integrity, the market must function without biases and abuse of market power or unfair advantage by members. SAPP has a market surveillance function in its structures to ensure proper market operation. An interim arrangement is functional at present with the longer-term solution being processed.

5. Third-Party Access in the Southern African Power Pool

As noted earlier, the approach to TPA in the SAPP differs from the examples described for continental Europe, in that the main driver for TPA is membership to SAPP itself and the desire to trade electricity internationally. Individual SAPP member countries are at widely differing stages of electricity sector deregulation, and so the legal and regulatory arrangements permitting access to national networks vary between countries. The agreements entered into between SAPP members, including those IPPs who wish to trade with SAPP utilities, contain a number of specific provisions relating to TPA. These are outlined in the following sections.

5.1. Hierarchy of Agreements

SAPP has a hierarchy of defined documentation, which sets out primarily the roles and responsibilities of the national governments and power utilities in the participating countries. These comprise the following:

1. The Revised Inter-Governmental Memorandum of Understanding of 23 February 2006.
2. The Inter-Utility Memorandum of Understanding of 24 April 2007.
3. The Agreement between Operating Members.
4. The Operating Guidelines.
5. Other approved guidelines, including a set of Guidelines for the Admission of New Members.

5.2. SAPP Operating Guidelines

The SAPP Operating Guidelines contain a section on the Connection and Operation of Independent Power Producers. This is found in Appendix C and begins with an acknowledgement of the increasing involvement of IPPs in electricity trading in SAPP. It places the onus on IPPs to liaise closely with the system operator in their host country to ensure that each IPP 'plays its part in making the SAPP interconnected system reliable, stable, secure and safe and also plays a part in minimising energy losses'.

The requirements that the IPP should comply with are defined, including the following:

- Provision of information by the IPP to the national system operator to enable technical studies to be undertaken.

- The IPP and the national system operator are to enter into a Connection Agreement covering both technical and commercial terms for the operation of the IPP.
- A series of technical requirements for control and monitoring equipment to be fitted to the IPP's generation facilities.
- Provisions requiring compliance with SAPP rules on information sharing, energy scheduling, delivery of energy, and energy accounting.

The SAPP Operating Guidelines, therefore, effectively function not only as a document that imposes technical conditions for participation in regional trading on IPPs, but *also* contains requirements that must be adhered to within the IPPs' national electricity industries. It is important to note, however, that this guideline provides a fairly minimal set of conditions that need to be satisfied.

This guideline also contains provisions on wheeling, and obliges the member utilities to make their networks available for wheeling purposes. Once an IPP has become a member of SAPP, it has a right, through the SAPP agreement structure, to wheel power to another SAPP member.

5.3. SAPP Guidelines for the Admission of New Members

The SAPP Guidelines for the Admission of New Members (Appendix B), and the SAPP Inter-Utility Memorandum of Understanding (IUMOU) use the term 'Electricity Supply Enterprise' to define a range of participants in the SAPP trading platforms. This definition covers power utilities, independent transmission companies, service providers, and crucially for the purposes of TPA, IPPs. The definition of an IPP carries with it the assumption that the generator is connected to the SAPP Grid, i.e. the transmission network is owned and operated by the SAPP member utilities. Condition 5 of the Guidelines for the Admission of New Members sets out the General Conditions for Admission to SAPP and states that applicants:

'Must be licensed and or authorised by a competent body/authorities within their jurisdiction to engage in cross-border electricity trade'.

There is, therefore, a stated assumption that any IPP that seeks to become a member of SAPP and to trade electricity across borders should possess an appropriate licence within its own national jurisdiction. The applicant is required to provide a copy of its licence as part of the application package.

Chapter 5
The Greater Mekong Subregion

GMS endeavours towards a GMS grid planning and system operation coordination process have been ongoing for some time and is still a long way from realizing all potential benefits of a coordinated GMS grid but below is an overview of the planned GMS structures. The proposed GMS coordination centre has been put on ice at present and the ASEAN Power Pool can learn a lot from the GMS work and its challenges.

Proposal for a GMS Coordination Centre

The Greater Mekong Subregion's (GMS) Ninth Meeting of the Regional Power Trade Coordination Committee (RPTCC-9), RPTCC-9 Sub-groups: Planning Working Group (PWG) and Focal Group presents the following summary of the position paper on the need, governance structure, implementation plan, and funding of the proposed GMS coordination centre.

1. GMS Need for Coordination Centre

There is a need to coordinate the efforts of each GMS member country for the following reasons:

- To increase cooperation in developing the regional plans and in investments that will expand sustainable generation and transmission,
- To systematically internalize the environmental and social impacts in the preparation of the GMS Power Expansion Plans,
- To facilitate common understanding of power sector reform strategies and harmonized regulatory regimes,
- To promote power trade and ensure equitable trading regimes, and
- To facilitate learning and support new information and communication technologies.

Therefore, it is proposed that

- the present regional organization for implementing the GMS Electricity Market (which is an intergovernmental agreement) be completed by establishing an Inter-Utility Memorandum of Understanding (MoU),
- this MoU is to be signed by the chief executive officers (CEO) of the electricity utilities, and
- this MoU will establish the basic management and operating principles of the Regional Electricity Market (REM) organization.

The following are the basic principles expressed in the MoU under which the GMS power trade organization could operate:

- To coordinate and cooperate in the planning, development, and operation of their systems to minimize costs and to protect the environment and offer equitable compensations to the people affected by these systems;
- To fully recover their costs and share equitably in the resulting benefits;
- To reduce the overall amount of capital needed for system expansion in the region by promoting the implementation of 'bankable' projects on a least-cost basis;
- To create an investment environment for the region's power sector that will facilitate the financing of priority generation and transmission projects;
- To create an ongoing forum in which regional power issues can be discussed and worked out within an agreed-upon policy framework and set of operating principles;
- To create a transparent and reliable mechanism for the prompt settlement of commercial electricity transactions;
- To address in good faith issues relating to interconnections in a spirit of cooperation and transparency; and
- To act in solidarity and refrain from taking advantage of each other.

The following are the proposed design criteria for the REM organization:

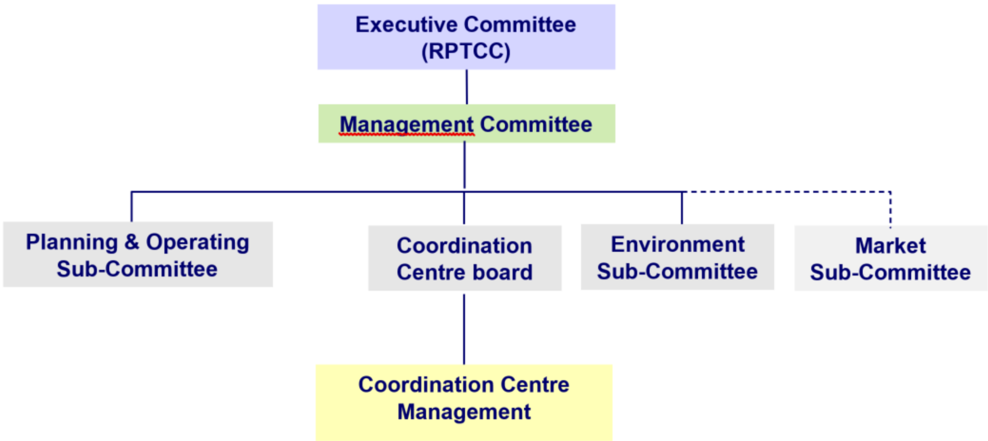
- The REM should be an independent legal entity.
- Funding for REM's own administrative operations should come from its members rather than be dependent on governmental budget appropriations.
- The REM should operate on a strict commercial basis with no interference by a government.
- The REM should be subject to appropriate regulation to prevent the accumulation of market power and the abuse of monopoly control over essential facilities.
- The REM's decision-making procedures should comport with international standards for transparency, documentation, and procedural integrity.
- Membership in the REM can include all entities that own or operate major generation or transmission facilities in the region, which have made a firm commitment to make a major investment in the generation or transmission facilities in the region, or that are or could be a bulk power customer.
- All entities that are physically interconnected and have an impact on system operation must be members.
- The process for developing and for changing power trade rules over the course of time must be perceived as transparent, fair, and well grounded, and it should not be subject to domination or manipulation by any one entity or one group.
- The internal organizational structure of the REM should not only provide for sufficient representation of interests, but also assure the timely delegation of decision-making to appropriate bodies.
- Members should be able to appeal, in a responsible manner, decisions made by the REM's various internal bodies and to receive a timely response.

- There should be a credible method of enforcing decisions.

2. Proposed GMS Governance Structure

Below is the proposed governance structure:

Figure 9. Proposed GMS Governance Structure



RPTCC = Regional Power Trade Coordination Committee.
Source: Compiled by authors.

Executive Committee

- It is the highest decision-making body for the REM.
- It comprises representatives of ministries that are in charge of energy and of operating members of the REM.
- It facilitates the coordination of appropriate measures towards the implementation of the GMS power trade organization.
- It engages the members in accordance with the prescribed provisions to facilitate the implementation of programs and projects.
- It approves the new applications for membership.

Management Committee

- It is composed of the chief executives of transmission-owning/operating members or of national electricity utilities when they are vertically integrated.
- It has decision-making authority to develop and implement initiatives to achieve the mission of the REM.
- It acts as the governing authority, formulates the objectives of the REM, and approves the budget of the GMS Coordination Centre.
- It approves the governance structure of the REM.
- It oversees the work and decides on the recommendations of the subcommittees and of the Coordination Centre Board.

Subcommittees

- They provide support and advice to the management committee on all matters concerning collective policy formulation functions for developing, maintaining, and updating common 'rules of practice' on technical, planning, operational, environmental aspects, and market issues of the REM.
- They are composed of technical experts drawn from the REM membership.

Planning and Operating Subcommittee

- It establishes and updates common planning and reliability standards (Stage 1).
- It periodically reviews the GMS Master Plan (Stage 1).
- It establishes and updates the methods and standards used to measure technical performance (Stage 1).
- It conducts system operational studies (Stage 2).

Environment Subcommittee

- It alerts and advises the management committee on environmental, social, and other matters (Stage 1).
- It develops the environmental guidelines for GMS and reviews and evaluates such guidelines from time to time (Stage 1).
- It liaises with the environmental organizations of member states through their appointed representatives (ministries and EOC, for example) (Stage 1).

Market Subcommittee (2nd Stage)

- It designs and recommends suitable market structure for GMS (end of Stage 1 – Stage 2).
- It determines the criteria for authorizing members to trade (Stage 2).
- It is responsible for admitting and authorizing members to trade (Stage 2).

Coordination Centre Board

- The board consists of representatives of national power utilities with decision-making power, chairpersons of the subcommittees, and the Coordination Centre Manager as a non-voting member.

3. Implementation Plan: The Main Duties of the Coordination Centre

Stage 1

- Establish and update a database containing historical and other data to be used in Planning and System Operation studies.
- Develop the GMS Guidelines and Rules as applicable and provide advice on their use, such as on Operating Guidelines (to be established among the operating members), Market Rules and Environmental Guidelines, and others.
- Provide information and give technical advice/support to members of the GMS power trade, in matters on parallel operation.

- Evaluate the impact of future projects on the operation of the power trade and advise the management committee.
- Perform various operational planning studies to highlight possible operating problems.

Stage 2

- Monitor continuously the operation of the GMS power trade.
- Monitor transactions among operating members and between members and non-members.
- Monitor time correction procedures.
- Monitor the inadvertent power flows and the return in kind between the members.
- Provide routine daily reports, data, and information relevant to the operation of the GMS power trade to the Operating Subcommittee and to the members.
- Monitor and report on the control performance criteria to all the operating members.
- Convene a post-disturbance committee, following a disturbance affecting the parallel operation of the power trade.
- Advise on the feasibility of wheeling transactions.

4. Proposed Funding of the Coordination Centre

Members shall pay their contributions up front for the financial year based on the approved budget of the coordination centre.

Examples:

- a certain percentage shall be deemed to constitute a benefit payable only by the host member.
- a certain percentage shall be shared equally among all GMS members (including independent transmission companies, and IPPs, and service providers).
- a certain percentage shall be allocated among the operating members in proportion to the actual energy (measured in MWh) and those imported from other members or other parties during the financial year.
- a certain percentage shall be allocated among the operating members in proportion to the actual energy (measured in MWh) for exported energy to other members or other parties during the financial year.
- a certain percentage shall be allocated among all GMS members in proportion to their Annual System Peak Demand during the financial year.
- a certain percentage shall be allocated among operating members in proportion to the combined 75°C thermal rating of their interconnections with other members.

5. Intergovernmental MoU for the GMS Regional Power Coordination Centre

The Inter-Governmental Memorandum of Understanding for the Establishment of the Regional Power Coordination Centre (RPCC) was signed in December 2012. The objective of the RPCC is to promote the synchronized operation of the national power system towards a unified, fair, and transparent regional electricity market with the ultimate goal of providing the GMS countries with stable and reliable electricity supply at the most economic costs. This will be enhanced by facilitating the balanced development of the diverse energy resources of the GMS countries for their mutual benefit, long-term cooperation in the power sector, uninterrupted electricity transit, and increased cross-border power trade.

5.1. Functions of the Regional Power Coordination Centre

The RPCC coordinates the proper implementation of the regulatory and technical framework in a phased approach, represents the common interests of the member countries on matters relating to power trade, and undertakes the following:

a. Establish and update a regional database containing historical and other data to be used for planning and system operation purposes,

b. Develop and maintain an information system to monitor the activities of power trade in the GMS,

c. Develop and conduct necessary capacity building of members to advance regional power trade,

d. Assist the members in the resolution of conflicts,

e. Promote cooperation between the RPCC and other organizations, and

f. Recommend measures to strengthen environmentally and socially sustainable development of power trade in the GMS.

Another function of the RPCC is to encourage and monitor all participating national transmission system operators (TSOs), national power authorities, or power utilities in the GMS countries in the following functions:

g. Preparing a common criterion for coordinated system planning, common technical standards for operational reliability and quality of supply in the GMS's interconnected transmission system, and any proposed principles and procedures;

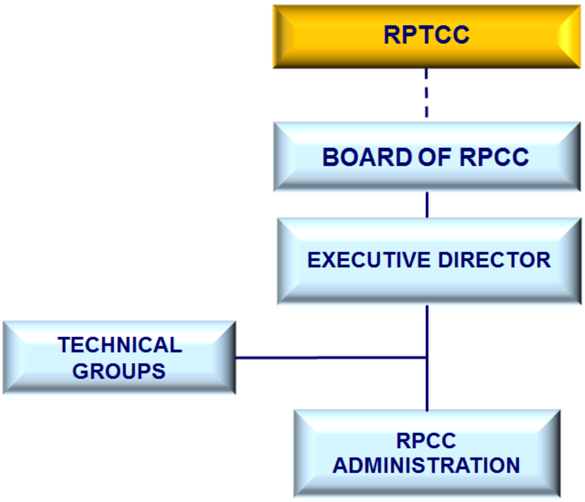
h. Facilitating the implementation of the GMS priority transmission projects, developing measurable standards to harmonize electricity planning, and operating the interconnected GMS power systems;

- Ensuring effective implementation and compliance with mandatory standards, and effective communication and information sharing to improve cross-border and reliable flows of electricity in the GMS; and
- Developing a common and shared position to progressively implement power exchange and move towards an agreed final market model.

5.2. Governance of the Regional Power Coordination Centre

The parties of the IGMOU are the members of the RPCC. The governance structure of the RPCC is composed of the following: the Board of RPCC, the executive director, the technical groups, and the RPCC Administration.

Figure 10. Governance Structure of the Regional Power Coordination Centre



RPTCC = Regional Power Trade Coordination Committee.

Source: Compiled by authors.

5.3. Board of the Regional Power Coordination Centre

The RPCC Board is composed of

a. One designated representative from the government, or the TSOs or national power authority or national power utility per member country; and

b. the executive director of RPCC as a non-voting member.

<u>Executive Director</u>

The executive director of the RPCC is appointed by the board for a term of 3 years, renewable only once. The executive director is the legal representative of the RPCC and is responsible for the management of the RPCC Administration.

<u>Technical Groups</u>

Technical groups shall be established by the board as deemed necessary and will be responsible for

a. providing technical support to the board to fulfil its missions,

b. organizing professional cooperation,

c. making decisions on relevant operative issues, and

d. coordinating regional activities in the interest of the GMS.

<u>Regional Power Coordination Centre Administration</u>

The RPCC Administration is responsible for

a. assisting and supporting the bodies and the processes of the RPCC,
b. communicating with external stakeholders under the guidelines set by the board,
c. drafting proposals for decision-making, and
d. informing the bodies and members on RPCC activities.

The RPCC Administration performs the secretariat function for all meetings of the technical groups. The RPCC Administration is composed of experts provided by the members or recruited directly, as well as technical and administrative staff necessary to accomplish its missions and to perform its functions.

5.4. Financing of the Regional Power Coordination Centre

The budget of the RPCC shall consist of contributions from members. In addition, the RPCC may receive contributions from donors and other sources for its operation, investment programs, and studies. Such donation shall not allow the influence of donors or other contributors on any decision-making process of the RPCC.

5.5. Location of the Regional Power Coordination Centre

The location of the RPCC Administration shall be decided by the RPTCC. A Headquarters Agreement shall be negotiated and entered into with the host government.

Chapter 6

International Experiences: Japan

This chapter is mainly based on the information received from the Tokyo Electric Power Company or TEPCO as part of the information sharing between the ATSO and AGTP projects.

1. Background

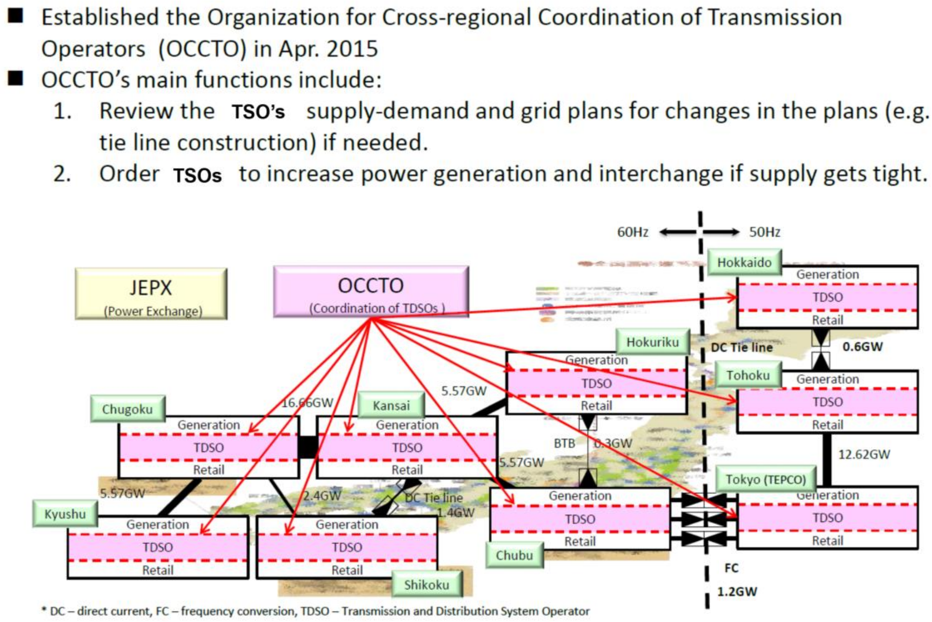
The Organization for Cross-Regional Coordination of Transmission Operators (OCCTO) is based in Japan. With the great East Japan earthquake and the nuclear accident that was triggered on 11 March 2011, it became clear that various limitations exist in the conventional electric power system mechanism – when exclusive operators supply their respective regions. Therefore, OCCTO was established in April 2015, based on the Electricity Business Act, to serve as an authorized organization that all electric power companies are obliged to join. The objective of OCCTO is to promote operations – covering an extensive task of monitoring the supply and the demand of all utilities. OCCTO is foreseen to improve parts of the system through the following:

- Utilization of diversified power sources, including distributed power sources and renewable energy;
- Giving more importance to minimizing the price of electricity;
- Utilization of power plants at the national level through the use of wide-ranging system operation;
- Providing response to the diverse needs of users by choosing retail companies, price menus, the type of fuels, and others;
- Recognizing the necessity of suppressing demand by implementing measures such as pricing differently for peak times and for other times; and
- Increasing social demands to further promote inexpensive and stable power supply.

The electricity power system reform in Japan, partly through the establishment of OCCTO, targets three distinctive areas. First, the reform aims to **secure a stable supply** by adjusting the supply and demand capacity and by ensuring electricity supply for the wide-area possible through the incorporation of ingenuity on the demand side while trying to neutralize the transmission and distribution (as was noted after the earthquake incident, it is unavoidable to utilize various power sources). Second, the reform focuses on the **reduction of electricity rates** by (i) promoting competition, (ii) applying nationwide merit order activation of production resources, and (iii) optimizing the power generation investments through demand suppression and other measures by users' ingenuity. The third and final target of the reform is the **expansion of customer options and business opportunities** to respond to users' needs for power selection with various options. This will be done by, inter alia, encouraging more innovation, allowing the participation and encouraging more innovation from other industries and regions, and utilizing new technologies for power generation and demand control measures.

OCCTO's influence in the power sector is further illustrated in Figure 11.

Figure 11. OCCTOs Role in Japan's Power System



Source: Tokyo Electric Power Company (TEPCO).

2. Governance and Organizational Structure

OCCTO's main governance is built around various secretariats, placed under the general meeting and the Board of Directors. The secretariats carry out the operational tasks of the organization, such as the formulation and review of rules, demand forecast, and consultation. OCCTO's roles and responsibilities include the following:

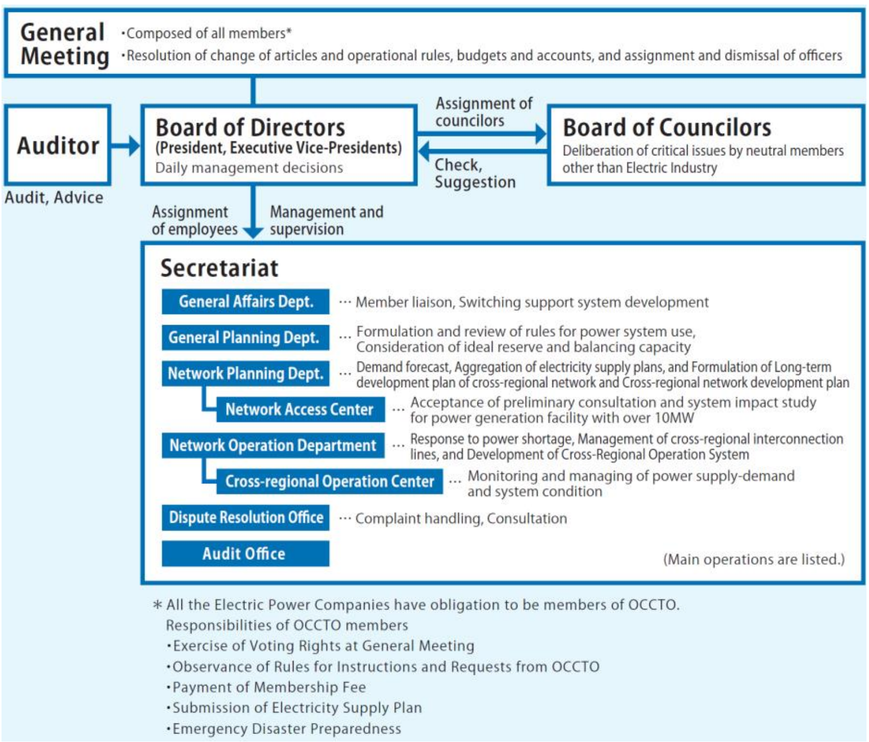
- Aggregation, review, and submission of electricity supply plans.
- Evaluation of future supply–demand balance.
- Recommendation of necessary network enhancement.
- Coordination in the maintenance of long-term to short-term work plans from the point of supply–demand.
- Issue instructions to balance the supply and demand through more outputs of generators or power exchange.
- Establishment and amendment of network codes.
- Reception of requests and reply of network access issues.
- Network information disclosure about interconnection and regional grids.

- Handling of complaints or inquiries from the electricity supply companies and conflict resolution.
- Undertake research, gather statistics, and implement public relations activities.

As shown in Figure 12, OCCTO's most high-level, decision-making body is the General Meeting. General meetings are held typically once a year after the yearly settlement has been finalized. The meeting can be held at the end of the fiscal year to determine the plan and budget for the following year. If any issues or decisions arise during the year, an ad hoc meeting will be organized accordingly. The voting rights in these general meetings are set so that each business classification at the point of implementation of full retail liberalization will have equal voting rights. A general meeting decides upon the following items:

- Matters to be resolved:
    - Change in the articles of incorporation.
    - Determination or change in the budget, settlement.
    - Change in business rules.
    - Election and/or dismissal of officers.
    - Matters concerning dues.
    - Business plan and business report.

Figure 12. OCCTO Organization and Governance



OCCTO = Organization for Cross-Regional Coordination of Transmission Operators.
Source: Tokyo Electric Power Company (TEPCO)

3. Funding and Cost Recovery

OCCTO is an authorized corporation and its funding plan for business operations is built around a membership fee system. The funding mechanism aims for equal cost-sharing so that the various companies that use the transmission and distribution networks should pay for the usage, rather than the TSO having to fully bear the costs. An important factor in the funding and cost-recovery scheme design is that it should not be a barrier for entry for small companies. The funding scheme basically has two levels, as follows:

1. Special dues **(¥3,956,164)** paid by 10 TSOs are as follows:
    a) Hokkaido (¥206,480)
    b) Tohoku (¥532,951)
    c) Tokyo (¥1,887,733)
    d) Chubu (¥868,709)
    e) Hokuriku (¥192,455)
    f) Kansai (¥951,692)
    g) Chugoku (¥402,442)
    h) Shikoku (¥181,351)
    i) Kyusyu (¥572,690)
    j) Okinawa (¥47,394)
2. Dues at ¥**10,000 per company**, divided as follows:
    a) Generation companies (567 entities)
    b) Retail companies (380 entities)
    c) Specified transmission and distribution operators (21 entities)

Chapter 7
High-Level Market Concept

One of the possible objective and future expansions for the ASEAN Power Pool (APP) is to host an efficient, multilateral regional trading in APG. There are multiple ways of organizing this trading, however, going into details of such arrangements are out of the scope of this project. In this chapter, the importance of the regional cooperation in power markets and the possible ways of achieving this is discussed, drawing from some of the best practices in Europe and the Southern African Power Pool (SAPP).

When speaking of regional cooperation, it is important to emphasize that increasing regional cooperation does not directly correlate with losing national control of the electricity sector. Both European cooperation and SAPP coordination are living examples of this ideology. To facilitate this common price calculation, the Price Coupling of Regions (PCR) relies on a decentralized sharing of data and on the robust market operations and procedures. However, in the PCR framework, each market area still holds its local control by having local power exchanges, transmission system operators, and national regulatory authorities. As can be seen from the PCR framework, the regional market solution does not necessarily require a centralized regional entity. Instead, regional markets and joint operations can also be achieved by retaining the local control and authority of the national market operators, and further, it does not mean that all of the market activities must be implemented in one place. SAPP is other good example, from a different point of view. From SAPP market, it can be seen that it is not always necessary to unbundle, privatize, and have a full national market deregulation to initiate an effective cross-border trading. In the African regional market, many different national market types coexist, and the flow on interconnectors can still be calculated using the implicit capacity allocation.

Figure 13 presents this multi-type regional market structure, where also a single buyer (without a national market) is presented together with a national market. Both of these types of markets can bid on the cross-border capacities. This model is beneficial because it allows the national markets to follow their own path at their own pace. Price coupling to determine the interconnector flows is the international best practice and should be seen as the most efficient way for the ASEAN region to fully utilize the potential of cross-border trading. The risk of dominance of the largest market can be considered low since the trading is based only on cross-border capacities.

Another important aspect of the regional cooperation is that it does not require total standardization of all markets to achieve an efficient cross-border capacity trading. Instead, successful regional cooperation allows the national markets to follow their own paths. However, spreading the ownership and operations of the regional market place among all involved countries in Southeast Asia is an important factor to support the effective evolution of the market.

The creation of an ASEAN multilateral trading has the potential to carry significant benefits, as follows:

(a) It allows the APG to operate on a multilateral basis, thereby unleashing the benefits as envisioned by the ASEAN leaders as the reason for its creation.

(b) It achieves a more efficient utilization of ASEAN energy resources by connecting countries with surplus power generation capacity to countries facing a deficit within the region.

(c) It helps ASEAN power utilities to balance their excess supply and demand, improve access to energy services, and reduce costs of developing energy infrastructure.

(d) It reduces the need for investment in power reserves to meet peak demand, therefore, lowering operational costs while achieving a more reliable supply and reducing system losses.

(e) It attracts additional investment in APG interconnection by providing a price signal as a key catalyst to investors for their financial returns.

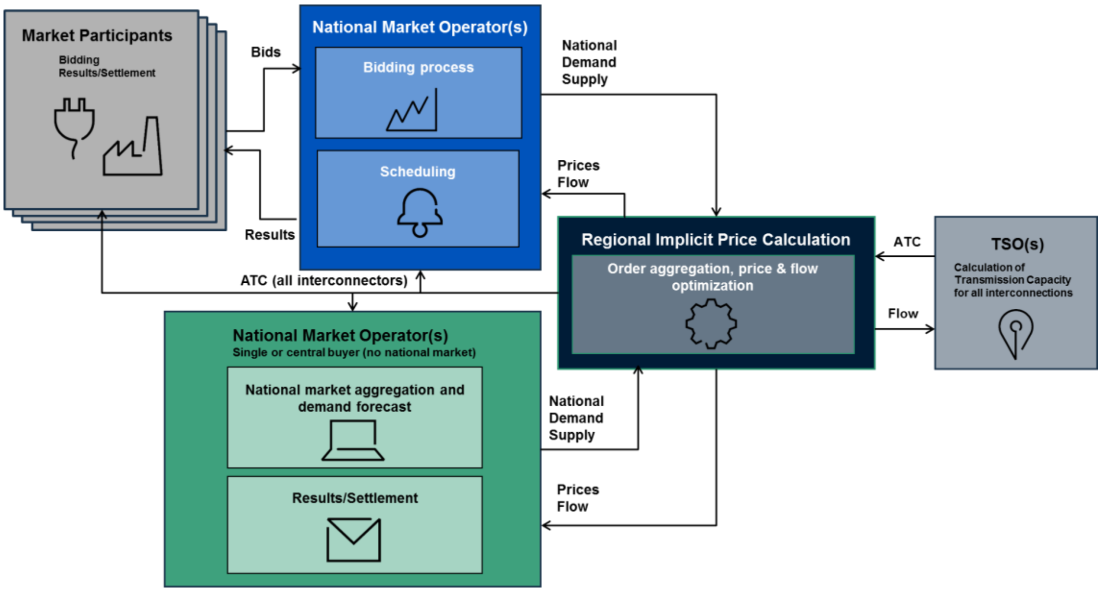
(f) It accelerates the development and integration of renewable power generation capacity into the APG. Such efficient sharing of renewable energy sources would also help hydropower to substitute present coal and other fossil fuels, thereby helping to curb emissions.

(g) It helps expand power networks and client base in a region where some 120 million people still lack access to electricity and clean cooking energy sources. In several cases, access to electricity will prove more economically viable through connections to the APG rather than extensions of the national grid, where additional investments are required.

(h) Countries with an energy surplus can benefit from regional interconnections by servicing their deficit areas more efficiently with power imports from the APG.

(i) It facilitates the introduction of national-level energy-efficiency schemes, such as Smart Grid and Smart City solutions.

Figure 13. Connection Flexibility: National Control – Regional Cooperation



TSOs = transmission system operators.
Source: Author.

Chapter 8

Summary of the ASEAN Power Pool Guideline Document

As an integral part of this project, a guideline for the ASEAN Power Pool (APP) was created. It constitutes one of the main deliverables in the project 'Study on the Formation of the ASEAN Power Grid Transmission System Operator Institution (ATSO)' and it is aligned and coordinated with the deliverables from the 'Study on the Formation of the ASEAN Power Grid Generation and Transmission System Planning Institution' undertaken by the Tokyo Electric Power Company.

The guideline covers both the organizational and technical considerations for the establishment of the APP. The open access agreement is defined and discussed as part of the guideline. The objective is to use the guideline as a base point to define and start building the APP organizational and technical aspects and to identify the key functions and tasks that the APP should aim for after its establishment. The guideline proposes a set of APP working groups that will later define, review, and harmonize the needed regional regulation and agreements.

The guideline is split into six chapters to capture all relevant aspects. Chapter 2 discusses open access, Chapter 3 defines the roles and responsibilities in the APG, Chapter 4 lays out the APP's authority and governance, Chapter 5 considers the organizational aspects of the APP, and finally, Chapter 6 illustrates the technical aspects of the regional cooperation. Annex 1 of the guideline, which contains the ATSO Project Questionnaire, gives a short summary of the responses from a questionnaire, carried out as part of this project, with a high-level analysis of what is already sufficient in terms of harmonization and standardization, and what should be the focus areas for the APP going forward.

It should be noted that this summary does not go into details since these are comprehensively discussed in the guideline document. However, the technical aspects are intentionally and briefly summarized here. Hence, this chapter summarizes the key points laid out in the guideline, as follows:

- Summary of the open access and common transmission mechanism
- Summary of the APP authority and governance aspects
- Summary of the APP high-level organization aspects
- Summary of the main technical aspects

1. Summary of the Open Access and Common Transmission Mechanism

To establish the concept of a greater ASEAN connectivity and develop the ASEAN Power Grid (APG) further, the APP organization will need to develop and agree on an open and non-discriminatory access to transmission in the ASEAN region. The open access can in this circumstance be divided up into two parts. The first is the need to establish and define third-party access (TPA) to the transmission grid in the different ASEAN member states (AMS). The second is the ASEAN common transmission capacity mechanism methodology, which needs to be developed and agreed to enable region-wide trade. With a common transmission capacity agreement in place, member states could use each other's available (spare) transmission capacities to transfer power, not only to the countries in absolute proximity, but could reach further by using countries as transit grid providers. It will also be important to establish a clear view on how the future ASEAN international transmission infrastructure shall allocate its future available transmission capacity.

A potential ASEAN transmission capacity mechanism methodology or wheeling arrangement needs to be transparent and must support the effort of making the APG more efficient. The cost or wheeling charge of sending power throughout the ASEAN grid should be calculated based on an agreed published wheeling methodology. This methodology should be developed and defined at the ASEAN level to ensure transparency and provide common capacity-pricing methodology for the whole region.

A stepwise approach is proposed when implementing these changes to the ASEAN region. It should be clear that both regional agreements and changes to national legislations will be needed. As the TPA might involve fundamental changes to national legislation, enabling access to available regional transmission capacities should be a priority for the APP. This can be done by establishing regional transmission capacity and pricing arrangement, or as named in this document as a common transmission capacity mechanism.

Table 6. Key Points in the Third-Party Access

	Key Points
•	The signing of an agreement between the national TSOs in each country, in which they agree to offer TPA to any IPP that seeks to connect to the national networks for the purposes of trading electricity.
•	Clear national licensing arrangements for the transmission owner and TSO in each country, either as independent organizations or as functions within a vertically integrated utility.
•	A national licence obligation to offer terms to new potential generators seeking to generate electricity for domestic consumption, or to export electricity under wheeling arrangements.
•	A national Transmission Connection Agreement that sets down clearly the rights and obligations of generators, the transmission owner, and the TSO when a new connection is sought.
•	A national Transmission Use of System Agreement that supports the right of the generator to be and to remain connected to and energized by the national transmission network.
IPPs = independent power producers, TPA = third party access.	

Source: Author.

2. Summary of the ASEAN Power Pool Authority and Governance

To establish this intergovernmental organization, high-level regional agreements and more needs to be in place to set a clear regional objective for the organization. The APP organization will also need more detailed agreements to give it the appropriate authority to function as a regional body. The APP will require mandate to facilitate and own certain processes and agreed principles within the APG. An intergovernmental agreement shall state the objectives of regional power trading and the need to collaborate and coordinate among the AMS, hence, the need for a coordinating institution. A second step would be to establish an ASEAN Cooperation Agreement for the establishment of the APP organization along with its different departments and working groups. In this cooperation agreement, the APP's proposed functions shall be stated and its role as a coordinating body in the ASEAN explained. In this agreement, the APP guidelines and codes shall also be acknowledged as official governing documents that the AMS shall adopt and follow.

As noted above, it will be very important for APP to have the correct reporting point in the ASEAN organization. This will ensure good alignment with other regional initiatives led by ASEAN and that power-related inquires will reach the right sector within the ASEAN. The recommended authority is the ASEAN Power Grid Consultative Committee (APGCC).

Table 7a. Key Points for ASEAN Power Pool Authority and Governance

A hierarchy list of governing documents includes the following:
1. ASEAN Intergovernmental Agreement on regional power trading
2. ASEAN Cooperation Agreement for the establishment of the APP organization (Parties: ASEAN TSOs) - (APP Articles of incorporation, business model, and a business plan structure that is dependent on the legal form of the vehicle – a company or another organizational type structure)
3. APP Operational Guidelines and network codes (a future work to be conducted by the APP) - APG agreed technical, performance, and operational standards - APG system planning, generation, and interconnection plan - APG wheeling methodology agreement - APG third-party access agreement - An ASEAN power market rule book (a future task for the relevant working group)

APG = ASEAN Power Grid, APP = ASEAN Power Pool, TSOs = transmission system operators.
Source: Author.

Table 7b. Key Points for ASEAN Power Pool Authority and Governance

The proposed governance structure comprises the following:
1. Executive committee
2. Chief executive officer
3. Department manager
4. Woking group manager and a subunit manager

Source: Nord Pool Consulting

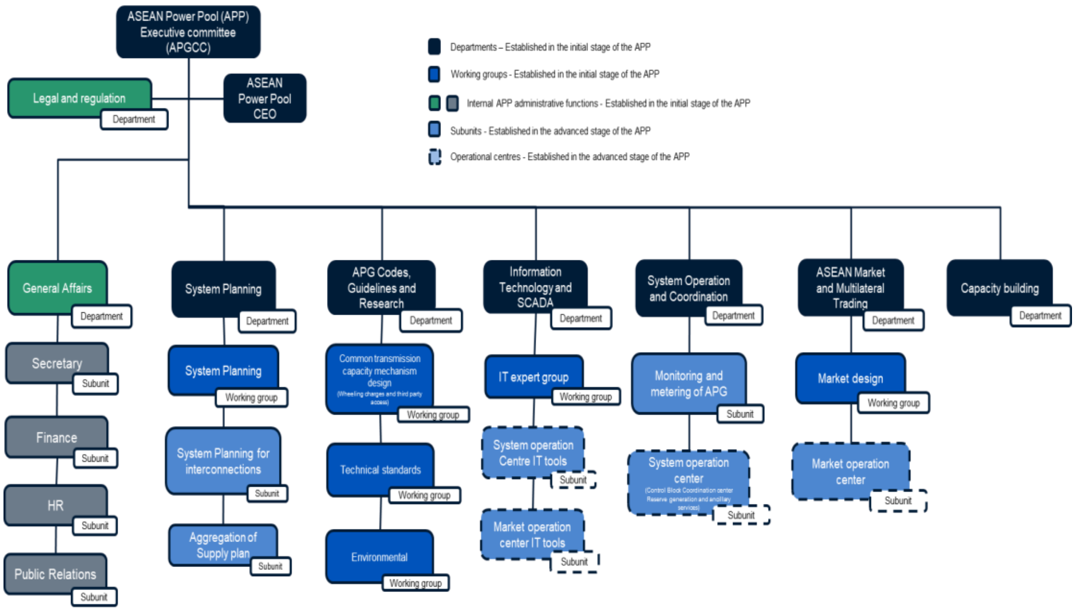
3. Summary of the ASEAN Power Pool High-Level Organization

The APP should act with full independence from buyers and sellers in the electricity market. The departments are responsible for carrying out the day-to-day work and are the main responsible units for APP operation. Each department may have one or several subunits with more focused and targeted tasks to carry out designated functions. Also, each department may have so-called working groups that are semi-internal units consisting of experts from relevant stakeholders. The working groups essentially feed in information to the departments on best practices in relevant topics, and have key role in defining, developing, and maintaining the framework of functions for each department. An overview of the proposed APP organization is presented in Figure 14.

The proposed APP organization is built upon main departments carrying out specific functions, which may have more focused working groups and subunits under them. Going forward, APP may choose to create more subunits with targeted specific tasks within the department. Organization-wise, these task force subunits will report to the department and the department leader. Resources for subunits will be allocated from the departmental resource pool. The subunits will utilize the departmental resource pool for people they will need to carry out certain development and operations within the APP functions.

In addition to the subunits, each department may have specific regional working groups under it. The reason for forming these groups is to gather specific field experts from each AMS to contribute and enrich the development process of APP tasks. Hence, these groups shall consist of part-time, consultancy-engaged experts from each AMS. These working groups have significant responsibility and opportunity to assist APP departments in creating, for example, the network codes or operation standards. Thus, these groups are important gateways for harmonizing the standards and procedures in the ASEAN region. It should be noted that some of the AMS have multiple TSOs, hence, establishing these working groups will need to take this into account to get them all represented. Working groups report directly to the respective departments and department heads. However, they should have formal decision-making power for their given tasks.

Figure 14. Proposed ASEAN Power Pool Organizational Chart



Source: Author.

4. Summary of Some Main Technical Aspects

The principle behind the need for harmonized technical standards is to ensure that all members of the ASEAN interconnected system maintain minimum technical, design, and operational criteria to ensure security and reliability of supply for the system. The technical standards apply to all systems that have an impact on security and reliability of supply. A full set of policies or grid codes will be required to be developed to define all the requirements for interconnected operations. This set includes but not limited to the following:

1. Preamble with definitions and glossary
2. Governance, which defining process to manage policies / codes
3. Connection Policies / Codes:
    - Demand Connection Code;
    - Synchronously Connected Generators Connection Requirements;
    - High Voltage Direct Current Connections; and
    - HVDC Connected Generators Connection Requirements
4. Operational Policies /Codes:
    - Operational Security
    - Operational Planning and Scheduling
    - Load Frequency Control and Reserves
    - Emergency & Restoration
5. Market Policies /Codes (Operational Aspects):
    - Capacity Allocation and Congestion Management
    - Electricity Balancing
    - Forward Capacity Allocation
6. Metering Policy /Code
7. Operator Training Policy /Code

The key technical aspects for regional cooperation, based from the guideline, are summarized in the following tables.

Table 8. Frequency Range for ASEAN Interconnections

Frequency Ranges for ASEAN interconnections	
Nominal Frequency:	50 Hz
In case of normal operation, the Frequency Deviation does not exceed:	±200 mHz for systems greater than 10,000 MW ±50 mHz for systems greater than 100,000 MW

Source: Nord Pool Consulting

Table 9. Voltage Control requirements for ASEAN interconnection/s

Voltage Control requirements	**Value for ASEAN**
Normal Condition	Nominal V ≤230kV +/-10% V>230kV +5%/-5%
Emergency Situation	Nominal+/-10%
The TSOs shall strive to maintain sufficient availability of dynamic and static reactive power capability in order to maintain transmission system voltages at connection points within the above specified levels at all times by means of one or more of the following measures: - the charging capacitance of the Transmission System; - user MVAR demand; - Transmission System MVAR losses; - generating unit MVAR production or absorption; - through on-load tap changing of generating unit step-up transformer; - voltage control facilities, such as capacitor banks and reactors; and - dynamic voltage support, such as SVC (Static VAR Compensator).	Yes
Voltage Control is an Ancillary Service; all Participants are obliged to provide minimum requirements as established in the Grid Code.	Yes
The excitation system of each generating unit shall be operated under the control of a continuously acting Automatic Voltage Regulator (AVR), which shall be set so as to maintain a constant terminal voltage. The generator may not disable or restrict the operation of the AVR except for the safety of personnel and/or plant, in which event the generator shall notify the TSO immediately.	Yes
The TSO shall endeavour to maintain sufficient availability of dynamic and static Reactive Power in order to maintain the Transmission System voltages at connection points within the level specified at all times. Determination of Reactive Transfer Limit (MW flow limitation across an interface to protect the system from large voltage drops 5% caused by a contingency). Reactive Transfer Limits shall be calculated every 5 minutes on EMS (SCADA).	Yes

EMS = energy management system, MVAR = Mega Volt-ampere, SCADA = supervisory control and data acquisition, TSOs = transmission system operators.
Source: Nord Pool Consulting

Table 10. Required Power System Studies for the ASEAN Countries

Requirements Studies	ASEAN
- **N-1 Criteria**	**Yes**
- **Load Flow**	**Yes**
- **Short Circuit**	**Yes**
- **Steady State Stability**	**Yes**
- **Transient Stability**	**Yes**
- **Voltage Stability**	**Yes**

ASEAN = Association of Southeast Asian Nations.
Source: Nord Pool Consulting

Table 11. Operational studies status of ASEAN countries which are also GMS countries

Operational Studies	Cambodia	China	Lao PDR	Myanmar	Thailand	Viet Nam
Steady-state analysis (N, N-1)	Yes	Yes	Yes	Yes	Yes	Yes
Credible N-2 steady-state analysis	Not often	Yes	No	No	Yes	Yes
Multiple time-point studies	-	Yes	No	No	Yes	No
Voltage stability studies	Yes	Yes	Yes	Yes	Yes	Yes
Transient stability studies	-	Yes	Yes	No	Yes	Yes
Transfer analysis	Yes	Yes	No	No	Yes	Yes
Sensitivity analysis	-	Yes	No	No	Yes	No

ASEAN = Association of Southeast Asian Nations, GMS = Greater Mekong Subregion.
Source: Nord Pool Consulting

Table 12. Proposed Fault Clearance Times Requirements for ASEAN Countries

Requirements	ASEAN
Maximum Fault Clearance times: 500 kV	80 ms
220–230 kV	100 (1) – 120 ms (2)
115–132 kV	120 (1) – 150 ms (2)
	Note: (1) Targeted value (2) Admissible transitory value

ASEAN = Association of Southeast Asian Nations, kV = kilovolt, ms = Milliseconds
Source: Nord Pool Consulting

Table 13. Proposed Short-Circuit Current Level Requirements for ASEAN Countries

Requirements	ASEAN
Short-circuit current levels: 500 kV	50 kA
220–230 kV	40 kA
115–132 kV	31.5 kA

ASEAN = Association of Southeast Asian Nations, kA = kilo amps, kV = kilovolt.
Source: Nord Pool Consulting

Table 14. Data Exchange Standards

Data Exchange Standards
Real Time Data Exchange using Inter-Control Center Communications Protocol (ICCP) or International Electrotechnical Commission (IEC) 60870-6/TASE.2)
File Transfer Exchange using the FTP server
E-mails on electronic highways using TSO mail server (SMTP protocol) or a remote mail server (SMTP/POP3 protocols) at another TSO
Information Publication on EH using HTTP Server. • Voice transmission standards. The voice quality should conform at least to the CCITT standards G729. • FAX transmission standard. For fax transmission, the standard usually adopted is the European Standard G3 (Group 3). • Video-conferencing transmission standard. For video conferencing, International Telecommunication Standardization Sector (ITU-T) standards H.320 and H.323 are applicable.

TSO = transmission system operator.
Source: ___

Table 15. Connection Conditions

Connection Conditions for Generators	Connection Conditions for Consumers
• Frequency tolerance, active power, and frequency control requirements • Synthetic inertia for non-synchronously connected generators • Voltage tolerance, voltage control, and reactive power provision • Fault ride through capability • Power oscillation damping requirements • Sub-synchronous torsional interaction (SSTI) damping requirements • Short-circuit contribution during faults • Power quality • Protection requirements • System restoration, islanding, and black start capability • Information requirements • Connection, compliance, and testing requirements	• Frequency tolerance, active power, and frequency control requirements • Voltage tolerance, voltage control, and reactive power provision • Short-circuit requirements • Reactive power requirements • Protection requirements • Control requirements • Information requirements • Demand disconnection or demand connection • Power quality • Connection, compliance, and testing requirements

Source: Nord Pool Consulting

Chapter 9
Summary of the ASEAN Power Pool Implementation Plan and Roadmap

The implementation plan constitutes one of the main deliverables in the project 'Study on the Formation of the ASEAN Power Grid Transmission System Operator Institution (ATSO)'. It will provide a suggested plan and roadmap for the proposed ASEAN Power Pool (APP) guideline document. The implementation plan takes into account multiple factors affecting the APP's establishment. As a starting point, the implementation considers the progress and current plans developed for the GMS region, the current situation in the AMS, and in other initiated projects aiming for increased cooperation in the power sector. The different activities defined in the APP guideline will also be listed and prioritized. From this, a ranked number of activities is identified and later presented in the final parts of the implementation plan of the APP roadmap.

The implementation plan is split into five chapters. Chapter 1 discusses the scope of the implementation plan and its alignment with the Greater Mekong Subregion (GMS) and previously conducted ASEAN Power Grid (APG) studies. Chapter 2 moves further to discuss the potential barriers of implementation, confidentiality aspects, and the approach taken to implement the milestones and specific activities. Chapter 3 describes a suitable capacity-building plan to be applied during the implementation. Chapter 4 goes into further details of the different stages of the APP establishment and development and identifies key activities for each stage and the responsible parties for these. Finally, Chapter 5 concludes by summarizing all the above into an APP roadmap.

It should be noted that this summary does not go into details in any of the aspects listed above since the details are comprehensively discussed in the implementation plan. Thus, this chapter simply summarizes the key points laid out in plan, as follows:

- Identified key milestones and activities
- Capacity-building plan
- ASEAN Power Pool roadmap

1. Identified Key Milestones and Activities

Based on the approach explained in the APP Guideline report, four high-level milestones and respective stages are identified and summarized in Table 16. However, it should be noted that these stages are not set in stone. Flexible sharing, moving, and identification of the activities between the different stages should be allowed. These stages aim to lay out a general overview of what should be prioritized and chronologically finalized within the APP development progress and what can be left for future enhancement to gain maximum efficiency and penetration of APP's development and functions.

Table 16. Milestones for ASEAN Power Pool Development

Milestone	Stage description and main activity to be finalized for the milestone
Milestone 1	Enabling agreements
Milestone 2	Organizational establishment
Milestone 3	Initial stage of ASEAN Power Pool operation
Milestone 4	Advanced stage of ASEAN Power Pool operation

The implementation plan goes into more detail of the key activities in these stages. Tables 17, 18, 19, and 20 summarize these findings.
Source: Nord Pool Consulting

Table 17. Enabling Agreements for Establishing the ASEAN Power Pool

Task No	Key Activities during the Establishment Process	Responsible Entity
1.1	ASEAN Inter-Governmental agreement on regional power trading (Parties: Governments)	APGCC/HAPUA
1.2	ASEAN Cooperation agreement for the establishment of the ASEAN Power Pool organization (Parties: ASEAN TSOs)	APGCC/HAPUA
1.3	ASEAN Power Pool Articles of incorporation, business model and business plan including the following: • Objectives of establishment • Scope of the APP business • Name of the organization • Office location • Related stakeholders • Executive committee composition • Organizational structure with departments and working groups • Funding, financial affairs, and accounting • Procedure of articles of incorporation revision	APGCC/HAPUA
1.4	Confidentiality agreement of APG system operational and planning data	APGCC/HAPUA
1.5	Other activities that might arise during the implementation phase	As applicable

APG = ASEAN Power Grid, APGCC = ASEAN Power Grid Consultative Committee, APP = ASEAN Power Pool, HAPUA = Heads of ASEAN Power Utilities/Authorities, TSOs = transmission system operators.
Source: Nord Pool Consulting

Table 18. The Process of Establishing the ASEAN Power Pool Organization

Task No	Key Activities	Responsible Entity
2.1	APP organizational formation and establishment of the APP Executive Committee	APGCC/HAPUA
2.2	Hiring the APP chief executive officer (CEO)	APP Executive Committee
2.3	Hiring of department managers and establishing the General Affairs and Legal departments	APP CEO
2.4	APP working groups formation using resources from AMS TSOs and other related functions. Defining the scope and focus area for each working group.	APP CEO
2.5	Other activities that might arise during the implementation phase	As applicable

AMS = ASEAN member states, APGCC = ASEAN Power Grid Consultative Committee, APP = ASEAN Power Pool, HAPUA = Heads of ASEAN Power Utilities/Authorities, TSOs = transmission system operators.
Source: Nord Pool Consulting

Table 19. Activities and Responsible Organizational Units – Initial Stage

Task No	Key Activities Needed in the Initial Stage	Responsible Body/Entity
3.1	Coordination among GMS regional market integration activities and the ASEAN Power Pool's future activities.	ASEAN Power Pool's chief executive office and department heads, GMS counterparties
3.2	Establish the agreed APG technical standards and performance grid code	Technical standard working group
3.3	Develop the data requirement, procedures, and criteria for APG system planning	System planning working group
3.4	Develop APG third-party access (TPA) agreement	Common transmission capacity mechanism design working group
3.5	Develop APG wheeling and losses methodology	Common transmission capacity mechanism design working group
3.6	Develop APG IT policies and communication standards	IT expert working group
3.7	Develop APG market design	Market design working group
3.8	Other activities that might arise during the implementation phase	As applicable

APG = ASEAN Power Grid, GMS = Greater Mekong Subregion, IT = information technology.
Source: Nord Pool Consulting

Table 20. Activities and Responsible Organizational Units – Advanced Stage

Task No	Key Activities Needed in the Advanced Stage	Responsible Body/Entity
4.1	Establish subunits: • System planning for interconnections • Aggregation of supply plan • Monitoring and metering of APG • System operation centre	System planning department manager System operation and coordination department manager
4.2	Control centre technology specifications for the APP (including computer system, energy management system (EMS) software, SCADA and communication system, and other relevant softwares)	IT and SCADA department
4.3	APP operational guideline The operational relationship between the APP and the various control centres in the AMS, including but not limited to communication, jurisdiction, and operational boundaries	Legal and regulatory group department APG Codes, Guidelines, and Research System operation centre
4.4	Establish IT operations • System operation centre IT tools (in the future) • Market operation centre IT tools (in the future, if applicable)	IT and SCADA department
4.5	Establish system operation	System operation centre
4.6	Establish market operation (if applicable)	Market operation centre
4.7	Other activities that might arise during the implementation phase.	As applicable

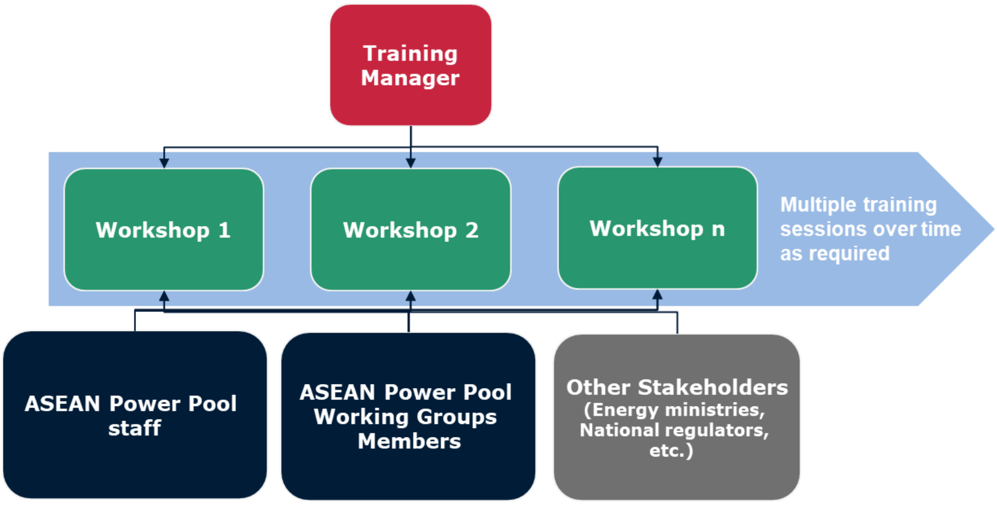
AMS = ASEAN member states, APG = ASEAN Power Grid, APP = ASEAN Power Pool, IT = information technology, SCADA = supervisory control and data acquisition.
Source: Nord Pool Consulting

2. Capacity-Building Plan

The introduction of the APP organization will create a need for training and capacity building, both internally for the APP organization and for relevant shareholders in the AMS. Similar international experiences in the energy sector during the establishment and organizational development show that personnel/staff of new organizations need trainings and capacity building. Since APP personnel/staff and other stakeholders who potentially need such trainings are occupied with other tasks, a capacity-building plan needs to be efficient and flexible enough to cover all persons involved. The training must aim for a sufficient number of persons and to a degree that makes them skilled enough to carry out the expected APP functions. Similarly, AMS stakeholders need to have a sufficient number of key personal trained to be able to actively support the APP functions. The training of AMS TSO controllers is key to ensuring operational security and reliability of the interconnection. Europe and US interconnections have a list of courses that are required to be completed to ensure that controllers have sufficient competencies. It should also be noted that the capacity building is most likely needed throughout the whole APP establishment and organizational building phase – from initial stage to advanced stage. The capacity building should be applied whenever and wherever a new function or field of work is added to the APP, where the employees require additional knowledge and know-how to run the new tasks and operation duties.

Before the APP is established, the responsibility of coordinating the capacity building is suggested to be given to an ASEAN-related unit or an organization with the capacity to take on the task. Later, when the APP is established, it is proposed that the capacity-building function be placed within the APP as a capacity-building department. The training for both internal and external purposes could at times be significant and it would, therefore, be wise to have a dedicated person for this task.

Figure 15. ASEAN Power Pool Capacity-Building Methodology

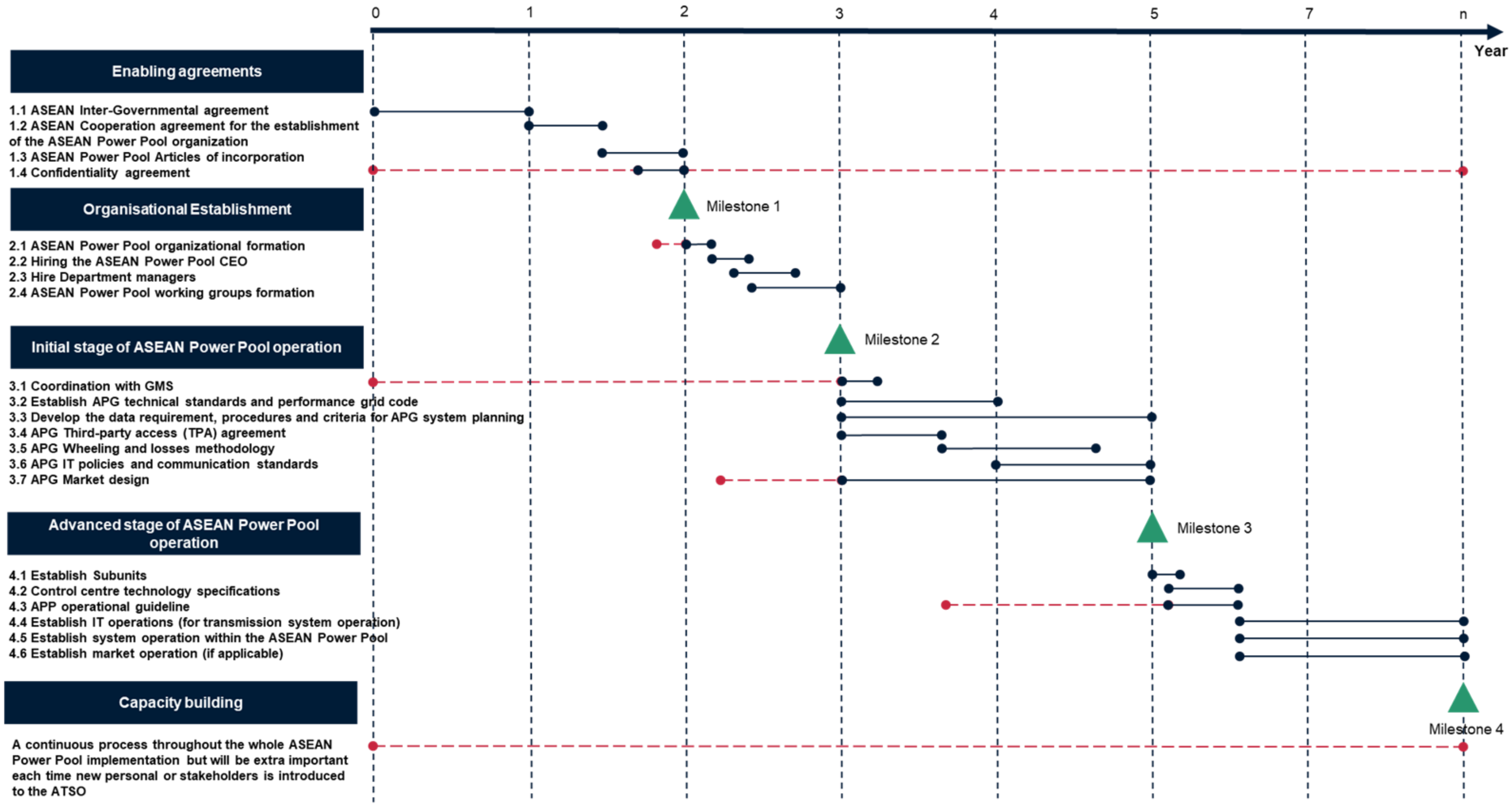


ASEAN = Association of Southeast Asian Nations.
Source: Author.

3. High-Level Roadmap for the ASEAN Power Pool

The implementation plan is summarized in the high-level roadmap for the APP (Figure 16). More detailed information can be found in the implementation plan.

Figure 16. ASEAN Power Pool High-Level Roadmap



APG = ASEAN Power Grid, ASEAN = Association of Southeast Asian Nations, CEO = chief executive officer.
Source: Nord Pool Consulting

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