MSc thesis in Sustainable Energy Technology

Electricity Market Design for African Power Pools

Taking Stock, Looking Ahead.

Mohamed Abbas Eltahir Elabbas

2021

TU Delft

ELECTRICITY MARKET DESIGN FOR AFRICAN POWER POOLS

Taking Stock, Looking Ahead

Master thesis submitted to the Delft University of Technology in partial fulfillment of the requirements for the degree of

Master of Science in Sustainable Energy Technology
Faculty of Electrical Engineering, Mathematics and Computer Science

by

Mohamed Abbas Eltahir Elabbas
Student Number 5038588

To be defended in public on July 8, 2021

Thesis Committee

First Supervisor:	Dr.ir L.J. (Laurens) de Vries	TU Delft
Second Supervisor:	Dr. A.F. (Aad) Correljé	TU Delft

For Maryam

PREFACE

Dear Reader,

This report marks the end of my master's in Sustainable Energy Technology. However, it also marks the beginning of my learning journey as a professional. The power system and market design are fascinating and never at rest. As an electrical engineer with a technical background, I was truly astonished by the concept of electricity market and all aspects of organizing the power sector. I fall in love with the field since the first course I had with professor Storm and de Vries, Economics and Regulations of Sustainable Energy Systems. I was captivated by all of the concepts that were brand-new to me and it was only natural for me to keep thinking about their potential and applicability to Africa where I came from and where I have never heard about them despite being an electrical engineer. Ergo, this report is really a personal satisfaction to my passion to learn more about the field and how things are in my beloved continent, Africa.

This report is textually dense and rich in information. I wrote it like this intentionally to contribute to the lack of materials about Africa in this field. However, I structured it in a way that allows readers with different interests to easily access the relevant information. Thus, it is better to read it selectively. Almost all the chapters can be read individually and standalone except for chapter 3 that explains the basis of the analysis. In the first place, this report is created as an advisory tool for policymakers and governments. To fathom the analysis, reading section 3.2 is necessary to understand the analytical framework. The entirety of recommendations is placed in chapter 8 along with a general framework on the development of regional power pools. The underpinning of these recommendations is found in chapter 7 that provides a comprehensive analysis and discussion of the three cases and the theoretical understanding. Chapter 7 can be read without having to read the individual chapters of the cases. However, the sources of information are found in the individual chapters 4, 5, & 6. A reader who is interested in more insights about a specific case can read its respective chapter. For each case, we provide separate analysis for who wants to be informed about only one case. The chapters of the cases are structured similarly to cover the same topics and to allow easy access to information. These chapters provide first the context of development and then an analysis of it. A well-informed reader about the situation of the case can jump directly to the analysis that is always found in section 7 of the chapter. For a reader with no background about the development of the power sector, chapter 2 gives an overview of the historical development, theory, and practice. This chapter can be skipped for a reader with sufficient background. Finally, chapter 1 gives a perspective for the entire report and chapter 9 summarizes its findings.

My two years as a master's student in Delft have been precious and extremely prolific. Being hungry for knowledge and passionate about learning new things, I have been able to successfully finish 151 study credits (EC) of which 120 EC for my master's degree, 20 EC for my honours degree (extra), and 11 EC additional courses just for me. While doing these courses, I worked in three different teaching assistant (TA) positions in the university, a board member at Energy for Refugees student organization for one year, and an intern at TenneT TSO. The amount of knowledge and skills I acquired were indeed transformative and befitting the reputation of TU Delft. I enjoyed the whole experience like nothing before and I was able to tour 15 new countries in Europe. Looking back to it now, it is unbelievable how all of this transpired.

Mohamed A.Eltahir Elabbas
Addis Ababa, July 1st, 2021

ACKNOWLEDGEMENTS

First of all, all praise and thanks are due to Almighty God, as the number of his creatures, the gratification of himself, the weight of his throne, and the extension of his words. For the physical and mental strengths bestowed on me, though He can never be praised or thanked enough.

Writing this thesis was the most challenging academic experience of my life. It was an extraordinary process often accompanied by many lonely hours and brief moments of 'Eureka!'. One faced all kinds of emotions like hope, despair and happiness. Sometimes, I felt proud, seeing the book slowly emerge from the pile of data, reports and interviews. At other times I felt helpless trying to pull everything together. Most of the time, writing this thesis just required much work and perseverance. I could not have done it without the help and support from all the wonderful people I came to know professionally and personally. To start with, I would like to thank TU Delft Global Initiative for granting me the Sub-Saharan Africa Excellence Scholarship for pursuing this master's degree. You are the game-changer who brings about impact around the world. I am honored to be part of your community and one of your alumni. I will treasure and spread your word "***Science for the benefit of people. All people Worldwide***".

I would like to thank my supervisors Prof. Laurens de Vries and Aad Correljé for their critical comments, support, encouragement, and guidance in seeing me through the project. Special thanks to Laurens who introduced me to the electricity market in my first quarter and has continued to generously and patiently share his knowledge and experience, and give me all kinds of opportunities to develop myself beyond academics. I have been fortunate to have him as a teacher and mentor. I would like to thank Prof. Ignacio J. Pérez Arriaga for providing the first contacts for interviews that led to others. I am grateful to all my interviewees for their valuable insights and for giving me from their personal time. I would like to thank the three power pools for being very responsive and supportive, especially the Eastern African Power Pool (EAPP) for hosting me in their headquarter in Addis Ababa, Ethiopia. I hope my research will contribute to the great work you are doing. I would like to extend my thanks to Eng. Mohamed Elsaeed who provided me with important information and contacts to EAPP.

I wish to thank my incredibly supportive family and friends. Being an international student in a foreign country is truly challenging in many ways. I have been lucky to be surrounded by wonderful people who made the Netherlands a second homeland to me. My colleagues Ivan, Sang Jae, and Maria were the best companions in every tough course and during the gloomiest period of COVID-19. My friends Ali, Mohamed, Amna, Parastoo, Swsan, and Rayan were my second family in Delft who made it livable. When I started my thesis, I had an unfortunate accident in which I lost a fingertip and could not use my right hand for more than a month. Without the help, support, and care from my friends and colleagues, I could have never been able to make it. I am also thankful to the academic counselor Marielle Nijsten who helped me greatly during that period and attended to my condition. With them all, I was able to get back on track and finish my courses and thesis on time. And to all my friends back home who have been remembering me and checking on me. I would like to give a special thank you to Duaa, Parastoo, and Amna for reviewing, editing, and proofing a large portion of the thesis, especially Duaa for her thorough review and being the ultimate support to do my very best in the final phase.

Saving the best for last, my deep gratitude to my parents for their unconditional love and support to get to this point in life, and to my lovely sisters Maab, Malaz, and Matab for being such giving and forgiving siblings. I wish to make you proud of me. Lastly, to my niece Maryam, you are my hero and source of aspiration, this thesis is dedicated to you.

EXECUTIVE SUMMARY

INTRODUCTION

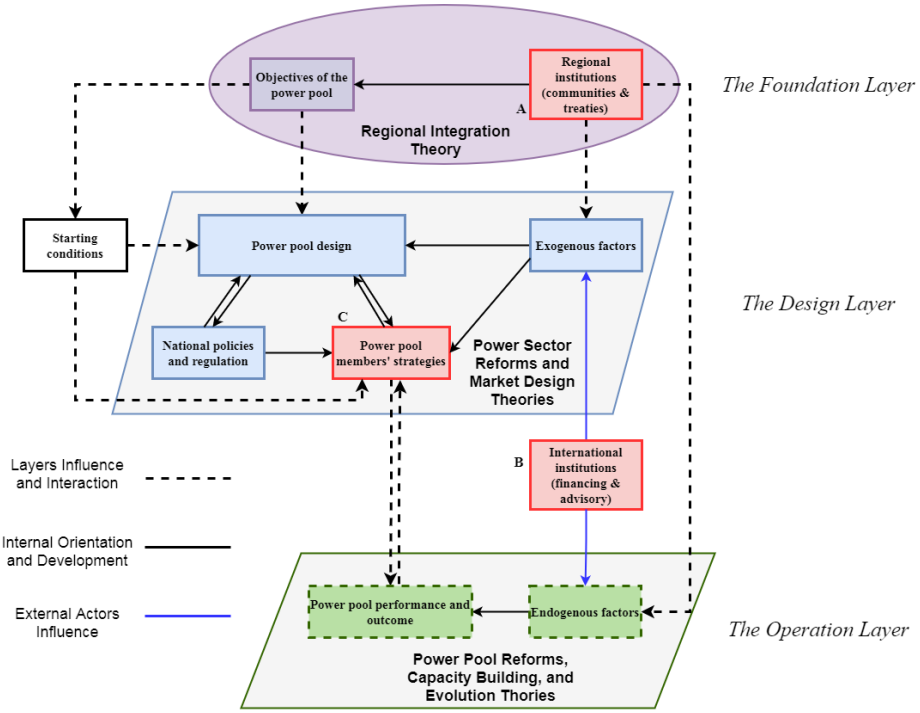
The liberalization of the electricity sector has been historically sought after as a way to increase competitiveness, ensure the security of energy supply, enhance environmental sustainability, and reduce public expenditure by attracting private investment. The successful experience in western developed countries encouraged developing countries to follow the same path of liberalizing the electricity sector to create a market through sector reforms. In some cases, power system reforms were imposed on those countries as a condition to obtain international funds, loans and support (e.g., from the World Bank and the International Monetary Fund).

The situation of power system reforms in Africa displays incomplete reform steps and unfulfilled goals. The performance statistics of the power system are very low and tremendous efforts remain to be exerted to bridge the gap. Reforms in Africa were pursued with the end goal of creating an electricity market on both the national and the regional levels. While none of African countries' experiences was successful in creating a national market, the regional efforts succeeded in creating a regional competitive market. Currently in Africa, five power pools are under development for creating regional markets that cover the entire continent of Africa. These are, on the order of their establishment, Maghreb Electricity Committee (COMELEC), Southern African Power Pool (SAPP), Western African Power Pool (WAPP), Central African Power Pool (CAPP), and Eastern African Power Pool (EAPP). These power pools are established under the regional economic communities (RECs) in Africa. In this research, we investigate three power pools SAPP, WAPP, and EAPP to answer the following main research question:

"How can the design of regional power pools in Africa be adapted to facilitate the sustainable energy transition, improve service quality and economic efficiency?"

RESEARCH FRAMEWORK

So far, the scientific literature on African power pools is limited and focuses on technical modeling as a technical exercise for designing a regional market, and social science studies do not provide a formal way to study African power pools or regional power pools in general. The power pools in Africa are founded as organizations for promoting regional integration in the energy sector. Thus, their development is affected by their organizational aspects and the situation in the region. In this research, we provide a comprehensive understanding of African power pools by building on market design theory and integrating the theories of organization, capacity building, and regional integration. Based on theory and our empirical findings, we formulate a framework that explains the factors and dynamics of developing and designing regional power pools. We use desk research and interviews to collect data and fill in the framework (depicted in the figure in the following page). We analyze each case separately then we perform comparative analysis to identify crucial factors, barriers and lessons learned. Based on this, we provide policy recommendations for improvement.



The Research Framework

ANALYSIS OF THE CURRENT SITUATION

Our analysis shows that the physical conditions in the region, in terms of interconnections between countries and distribution of natural energy endowments, had the most prominent effect in establishing a regional market. A region where some countries have rich resources of energy and others have limited resources exhibits regional demand for trading between countries. This demand for trading stimulates interconnections between countries to be built. The presence of hydropower plays an important role in creating this demand because in rainy seasons there is excess generation for export while in dry seasons there is a shortage to compensate with import. This natural dynamic creates a level of interdependence between countries. In both the cases of SAPP and WAPP, we observe high level of interdependence while it is low in EAPP. SAPP was able to establish a regional competitive market by taking advantage of the already existing interconnections and the huge generation in South Africa. A regional competitive market was not established in WAPP as there were not enough interconnections, and countries suffer bad economic conditions and political instabilities.

Besides the natural dynamic, the dynamic of regional integration plays a role in creating a regional market. In this context, we identify three driving forces that we call *motors of change* (illustrated with letters A, B, C in the figure above). The first motor of change is the RECs. How member countries pursue regional integration in the RECs determines the authority of the power pool. The second motor is the international institutions. The degree of involvement of the technical and financial institutions with the power pools affects the progress of establishing the necessary soft (developing market rules and regulations) and hard (investing in interconnections and generation) infrastructures. The third motor is the members' strategies toward the power pool. Countries that are exporters have interests in creating and designing the regional market. In the case of SAPP, the development is classified as ***Members Lead***. South Africa played a salient role in establishing SAPP. The country's good geographic position connects five neighboring countries and provides the wire for power exchange. SAPP also had strong technical support

from Nordpool, the first regional market in Europe. In the case of WAPP, the development is classified as ***Regional Lead***. Countries in the region pursue integration through ECOWAS (the REC). ECOWAS Commission played an important role in issuing directives for establishing the regional market and providing frameworks for attracting foreign investments. Financial institutions are actively involved with WAPP and financing interconnections. The competitive market is expected to be launched in a year or two when the entire region is connected. In the case of EAPP, the development is classified as ***Donors Lead***. EAPP is not anchored in any REC and member countries are in different RECs. EAPP was adopted by COMESA (REC) but the relation is loose as COMESA does not include all EAPP member countries. Donors played a role in establishing and financing EAPP, especially the World Bank.

DETERMINANTS OF DEVELOPMENT

The first determinant of establishing a regional market is establishing the necessary soft and hard infrastructures. As there is no national market in Africa, African staff are inexperienced in developing the necessary market rules, procedures, and regulations. Building the organizational capacity of the power pools at the operation layer is the first challenge. At the starting phase, support from international institutions is indispensable to acquire the expertise. Because of the different degrees of interdependence between countries and their economic conditions, the infrastructure is not developed equally between countries. The traditional role of the power pool is to promote infrastructure development by conducting feasibility studies. However, the pool can play the role of centralized infrastructure development by mobilizing financial resources and overseeing regional projects. This role is enabled at the design layer and is facilitated when member countries pursue a centralized approach to regional integration which stimulates external investments. The role also requires regional institutions for protecting foreign investments.

The second determinant of the development is the degree of members' engagement with the power pool. The pool provides basic services to its members like conducting studies, providing training, developing regional planning, coordinating and resolving disputes over power exchange. The issue with members' engagement is that some countries join the pool just as a defensive necessity against possible exclusion from the market (Baldwin's domino effect), these countries retain protectionist policies and could block certain decisions at the design level. The other issue is that major exporters with a strong interest could exert leverage and attempt to dominate over the pool. Such a strategy could lead to inefficient design and pushing away other members. Differently, members might avoid engaging with the pool when the market design is complex and the benefits of implementation are not obvious. To overcome these issues, it is important to align these issues at the design layer with the operation layer. The performance of the power pool provides corrective feedback when aligned with members' capabilities, needs, and interests. Gaining members' trust is an incremental process that is necessary to expand the development.

Finally, to reap the full benefit of the regional market, it is important to increase trade volume and competition. The main barrier to this is the structure of national systems that are mostly organized under monopolistic utilities. This reduces the number of market participants and increases the chances of exercising market power (the ability to manipulate the market price). To mitigate the first, independent power producers (IPPs) should be admitted to the pool and aligning this with regulations at the national level to allow their participation. For the second, the pool should establish market surveillance and rules or regulations to prevent market power.

POLICY RECOMMENDATIONS

Regional Economic Communities

Regional power pools have numerous regional benefits and could serve as a top-down approach for regional development in the energy sector. The RECs have an enabling role in adopting policies that allow the pool operation in the different jurisdictions. We recommend policies that give the power pool a fair degree of autonomy and authority in making decisions and performing regional projects to deepen the integration. The policy objectives should ensure the inclusion of the development and fair distribution of benefits to all members. The RECs have a role in supporting the development of the pool through regional institutions that facilitate their tasks (e.g., investment frameworks). Success examples can be drawn from WAPP and ECOWAS.

International Institutions

International institutions have a role in empowering the power pools. Policies for supporting programs should include non-technical support like capacity building programs, especially in leadership and financing, to help the pool with overcoming the development barriers and establish sustainable operations in opposition to just carrying out consultancy activities. Advisory institutions are recommended to coordinate with the power pool on working with national governments to manage regional trade and market opening to achieve economic efficiency. Success examples can be drawn from WAPP and Tony Blair Institute.

Member Countries

Member countries have the role of unlocking the potential of the power pool. Protectionist policies that inhibit regional trade should be avoided and regulations for allowing IPPs to participate in the regional market should be adopted. It is important that member countries work on harmonizing pricing and adopting cost-reflective tariffs to prevent worsening the overall welfare from trade. Member countries are recommended to introduce policies to rely on trade to fulfill peak demand and scheduling maintenance. Such policies increase the overall reliability and trust in regional trade. It is also recommended for members to coordinate in the execution of infrastructure projects which includes coordinating between existing sub-regional cooperation and the power pool on the long-term planning. Success examples can be drawn from SAPP and its members' policies.

Power Pool Staff

The power pool has a role in steering the development by being more proactive. We recommend the pool to devise a strategic plan to tackle the different barriers and improving its organizational capacity. The pool should focus and orient its activities to tackle notable issues and needs from members to incentivizes members' engagement. It is recommended for the pool to have policies for its own performance and evaluation to increase transparency and track its capacity building. Additionally, the market design prepared by the pool should consider the technical abilities of member utilities and allow easy implementation. Success examples can be drawn from SAPP in engaging with member utilities and WAPP in focusing its activities.

Renewable Energy Integration

With the increase of the supporting policies from member countries, it is recommended to facilitate renewable energy integration by design the regional competitive market to allow flexible bids formats, reduce the settlement time, delay the gate closure, and implement nodal pricing.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY OF ACRONYMS

ADAM African Day-Ahead Market . . . 99
AfDB African Development Bank . . . 5
CAPP Central African Power Pool . . . 28
COMELEC Comite Maghrebin De LElectricite . . . 28
COMESA Common Market for Eastern and Southern Africa . . . 31
DAM Day-Ahead Market . . . 57
DRC Democratic Republic of Congo . . . 26
EAC East African Community . . . 31
EACREEE East African Centre for Renewable Energy and Energy Efficiency . . . 91
EAPP Eastern Africa Power Pool . . . 28
ECOWAS Economic Community of West African States . . . 31
ECREEE ECOWAS Center for Renewable Energy and Energy Efficiency . . . 71
EIA Energy Information Administration . . . 6
EREA Energy Regulators Association of East Africa . . . 91
ERERA ECOWAS Regional Electricity Regulatory Authority . . . 70
EU European Union . . . 2
ENTSO-E European Network of Transmission System Operators for Electricity . . . 23
FiTs feed-in-tariffs . . . 19
FPM-W/M Forward Physical Market-Weekly/Monthly . . . 57
GDP Gross Domestic Product . . . 3
GERD Grand Ethiopian Renaissance Dam . . . 104
GW Gigawatt . . . 21
GWh Gigawatt hour . . . 73
ICC Information and Coordination Center . . . 71
IDM Intra-Day Market . . . 58
IEA International Energy Agency . . . 6
IGAD Inter-Governmental Authority on Development . . . 31
IGADD Inter-Governmental Authority on Drought and Development . . . 89
IGMOU Inter-Governmental Memorandum of Understanding . . . 46
IMF International Monetary Fund . . . 2
IPP Independent Power Producer . . . 10
IRB Independent Regulatory Board . . . 90
IREAN International Renewable Energy Agency . . . 6
ISO Independent System Operator . . . 20
IUMOU Inter-Utility Memorandum of Understanding . . . 46
KfW German Development Bank . . . 55
km kilometre . . . 76

Part I

THESIS DEFINITION

1 INTRODUCTION

"The truth is rarely simple and never pure"
Oscar Wilde

This chapter introduces the problem behind the research topic and the objectives for embarking on it in section 1.1 and 1.2. Following in section 1.3 is the methodology used in the research to develop the research questions and the method(s) to answer them. Finally, the social and scientific relevance is highlighted in section 1.4, and the chapter concludes with the research design and reading guide in section 1.5.

1.1 PROBLEM INTRODUCTION

The electricity sector originally was considered a natural monopoly and usually a state-owned business. There are many reasons behind this, starting from the system intrinsic characteristics, like the nature of the network functionality, the view of electricity as a special commodity that cannot be stored in its original form but rather must be consumed directly after the generation, and to the rationale behind the public sector domination, like the strong public interest and the national security argument.

During the 1980s, the growing dissatisfaction with the performance of traditional vertically integrated public sectors propelled the new paradigm shift from state ownership and centralized organization to private ownership, public regulation, and market competition [Jamasb, 2006]. In Europe, the idea of liberalizing the electricity sector goes back to the early 1990s, the first directive was introduced in 1998 to open European Union (EU) energy markets to competition. The goals of liberalization were to build competitiveness, security of energy supply and environmental sustainability [Streimikiene et al., 2013]. Since then, the energy sector has changed dramatically and the expected financial input of governments into the sector has been reduced significantly.

The situation in developing countries took a different trajectory. Most of developing countries faced external pressure from prescriptive conditionalities of funding organizations, like the International Monetary Fund (IMF), the World Bank and other international financial institutions, to impose structural changes on their electricity sector. Therefore, by 2009, more than 90 governments, especially in Africa, have amended their electricity acts in order to allow for greater private sector participation and as a condition to receive loans from the World Bank [Erdogdu, 2013]. Despite this, investment indicators show extensive growth in investment predominantly by the public sector [Hall and Nguyen, 2017] and many developing countries, especially non-oil exporting countries, still faces grave issues in energy security and adequate energy supply services [Chen et al., 2014].

The experience with the electricity sector reform in developing countries has proven to be more complicated than initially anticipated. Within developing countries, the reforms in African

developing countries is described as highly problematic [Kessides, 2012b]. African developing countries face a lot of instabilities and challenges in their macroeconomy and sociopolitical situation. Additionally, there is a lack of experience in constituting institutions and regulations to what suits the countries' conditions (see Eberhard [2007]; Eberhard et al. [2008]; Imam et al. [2019]). Consequently, the power sector in African countries is starkly underdeveloped and heavily draining public expenditure. In Sub-Saharan Africa, the quasi-fiscal deficits to subsidize the state-owned electricity companies in the region amounted to 1.8% of the Gross Domestic Product (GDP) in 2009–10 [Alleyne and Hussain, 2013] while the entire generation capacity is no more than that of Spain in 2008 [Eberhard et al., 2008]. Thus, the 'standard textbook model' of power sector reforms implemented by the United Kingdom has been deemed inefficacious in Sub-Saharan Africa [Eberhard and Catrina Godinho, 2017].

In order to overcome these challenges, African countries started to collaborate together by establishing power pools for electricity trade between neighboring countries. A power pool provides opportunities for African countries to reduce the cost of providing electricity and improve system reliability through the coordinated use of energy resources [Pastor, 2008]. However, unlocking the potential of a power pool requires careful market design supported by technical, economic, and institutional analysis of the systems as they exist today and as they will likely evolve in the future. The situation of the five African power pools is still ambivalent as to the nature of their operation and whether they constitute regional markets or merely over-border interconnections [Medinilla et al., 2019]. In any case, the amount of electricity exchange is still very limited and oftentimes caused by design failure [Eberhard et al., 2008; Medinilla et al., 2019].

1.2 KNOWLEDGE GAP AND OBJECTIVE

There is a growing consensus in the literature about questioning the adequacy of what came to be known as the "standard textbook model" of electricity market design in both the context of developing countries and the transition to sustainable energy [Yi-chong, 2006; Gratwick and Eberhard, 2008; Keay, 2016; Roques and Finon, 2017]. These critics shift the attention to the importance of electricity market design for regional markets and hybrid markets within their subsystems, which is the predominant mode of organizing the electricity sector in African countries [Eberhard and Catrina Godinho, 2017].

Despite the growing body of literature on regional market design in industrialized regions, the share of African countries is rather small [Economic Consulting Associates, 2010]. African developing countries need special attention due to the different situation in most countries. Key issues in African countries like low electrification, capacity scarcity, weak institutions, and corruption, pose unusual challenges for regional market design. Several authors identified the need for more focused work on developing countries and to adopt traditional modeling tools and institutional assessments to developing countries' context [Pandey, 2002; DESA, 2006; Urban et al., 2007]. However, efforts have not been translated into analysis and information about African power pools is very limited. Consequently, to address this gap, the study positions the following main research question:

"How can the design of regional power pools in Africa be adapted to facilitate the sustainable energy transition, improve service quality and economic efficiency?"

The objectives of the research are to provide contextual information on African power pools, to give a thorough understanding of their functioning, and to analyze the factors that led to their development and the reasons for performance differences. Additionally, the study aims to go further than identifying lessons learned and practical challenges to provide a framework for

power pool design and development and give design recommendations based on the specific contextual factors to ameliorate the development of the power pools and increase renewable energy integration in the competitive market.

1.3 METHODOLOGY

1.3.1 Research Strategy

The studies of market design evolution have been shifted from relying on neoclassic theories to the theories of evolutionary and institutional economics [Hodgson, 2007]. In those studies, the market design is perceived in a broader view by investigating the sheer amount of contextualities surrounding their historical creation and contemporary operations. These contexts include economics, institutions, governance, and politics. The same can be applied for studying power pools as special regional markets. It is believed that for such data richness requirement, the strategy of case study would serve best [Yin, 2003b].

Yin [2003b] defines three criteria for selecting any particular research strategy, for choosing the case study strategy; the form of the research question is 'how' or 'why', the focus is on a present event, and it requires no control over the event behavior. The research proposition aligns with Yin's criteria in which a single unit of analysis (the power pool) is investigated. Within the case study, an explanatory case study is pursued to understand the performance variance among African power pools and to move forward with how to improve them. This also follows the essence of explanatory case studies as Yin [2003b] describes it: "it seeks to illustrate a set of decisions: why they were taken, how they were implemented, and with what result".

1.3.2 Research Approach

Grover [2015] identifies three elements for any research approach, these are the philosophical world view, research methods, and research design.

The philosophical world view represents the beliefs that guide the research actions, this can be Positivism, Constructivism, Transformative, and Pragmatism. In this research, we select pragmatism as it is suitable for real-world practice-oriented problems which are consequences of actions [Guba, 1990]. Another reason is that market design concerns both theory and practice, which falls exactly within the paradigm of pragmatism [Sekaran and Bougie, 2016].

Research methods describe the way to collect data and perform analysis. The strategy of case study combines different data collection methods, interviews are used in this research to gather primary data while secondary data are collected via desk research. Data collection follows the requirement for answering each research question, which is discussed in subsection 1.3.3. Five African power pools exist with distinct structure and performances [IEA, 2019], to analyze them and uncover the possibilities of improving them, a comparative case method is useful to speculate the reasons for the contrasting results. Therefore, multiple-case studies are chosen in this research. Through conducting cross-case analysis, knowledge is mobilized from individual case studies to produce general knowledge that can be replicated by attending to the necessary conditions. We provide two levels of analysis: we first give a descriptive grasp of the specificities of each case, and then through individualizing comparison, we give a high level of analysis on the cases.

Following the philosophical world view of pragmatism, the research design follows a mix between qualitative and quantitative data [Grover, 2015]. This means the problem view is con-

structed by both numbers and words. Particularly, secondary data are utilized to construct qualitative and quantitative evidence. The specific qualitative and quantitative data, as well as their sources, is further discussed in subsection 1.3.3 and the research design is depicted in section 1.5.

In order to move beyond explanatory comparative case studies, a design-oriented sequel is built on the analysis. The analysis phase provides insights into decision-making processes, preferences, and development issues. This is used to identify the prospects of improving the performance of the power pools. Then, the design phase zooms into the short-term competitive market and is meant to elaborate on the possible design options to increase renewable energy participation. In this phase, we look into a specific set of design elements and best practices to identify practical options. The overall impact assessment of design variables will be of a qualitative nature and tradeoffs between the design choices are communicated for future technical modeling.

An initial step before commencing with case studies is to study the literature to identify the theoretical framework(s) and practical experiences to be used in the analysis and design phases.

1.3.3 Research Questions

"How can the design of regional power pools in Africa be adapted to facilitate the sustainable energy transition, improve service quality and economic efficiency?"

To answer the main research question, five sub-questions are derived. For each sub-question, we identify the function of the question, the type of knowledge, the type of research activity, the data type(s) needed, and the method(s) to answer it.

SQ1: *How can regional power pools be studied in the institutional context of Africa?*

The function of this question is to establish the theoretical framework for the research. The main research activity is the literature review. From the literature, concepts and definitions are discussed in the context of regional power pools. From our empirical investigation on the institutional context of Africa, an adaptation of the framework of Correljé and De Vries [2008] is developed for studying African power pools. The various factors and forces are integrated into a conceptual framework to understand the design, development, and performance of the power pools.

SQ2: *What were the factors and reform steps for establishing the African power pools?*

The function of this question is to contextualize the situation of the selected African power pools. The main research activity is desk research of various reports and scientific papers. The data concerning this question are mainly qualitative data (descriptive) from regional institutions (the power pools, regulators, and regional economic communities) as well as other agencies like the World Bank, the African Development Bank (AfDB), and the Africa Infrastructure Country Diagnostic. The method to be used here is document analysis of the collected secondary data to identify the factors and reform steps based on the literature review conducted in the second chapter.

SQ3: *What are the differences between African Power pools?*

The function of this question is to compare the selected power pools to identify the differences (and maybe similarities) that characterize the development of each case. The main activities to answer this question are desk research and analysis. Quantitative data are to be collected and integrated with the previous question in order to compare the physical conditions of the power pools, for example, the energy mix, installed capacity, network capacity, demand, etc. Sources

of such data are the World Bank open data, the United States (U.S.) Energy Information Administration (EIA), the International Energy Agency (IEA), and the Africa Infrastructure Country Diagnostic Database. The analytical framework developed from the first sub-question is used for cross-case analysis to identify the differences in certain elements.

SQ4: *How can the performance difference of African power pools be explained?*

The function of this question is to explain the performance variance and highlight the factors that fathered this variance. The main activities in this step are analysis and data collection. Initially, we analyze the performance variance based on the differences identified from the previous question. Then, semi-structured interviews are conducted with stakeholders to validate and discuss the author's initial findings. Stakeholders to be interviewed are representatives of the power pools and member countries (if possible). Moreover, as different actors have different objectives and perspectives, data is triangulated by conducting interviews with external experts involved with the power pools.

SQ5: *What are the reforms and design options for improving the performance of African power pools and renewable energy integration?*

The function of this question is to identify the possible design options for improving the performance of African power pools in achieving their objectives and increasing renewable energy integration in the competitive market. The main activities are analysis of structural improvements and desk research to identify best practices for renewable energy integrations from the scientific literature and technical reports (for instance, from the International Renewable Energy Agency (IREAN)). Interviews with stakeholders are conducted to identify the current efforts and trends of the development and renewable energy support. Both the power pools and regional renewable energy centers' representatives are interviewed. Interviews are supported by empirical data from the literature to attest to the validity of the options.

1.4 SOCIAL AND SCIENTIFIC RELEVANCE

The topic of electricity market design is strongly socially related in two ways. First, the electricity sector is the prime mover of today's modern society. The fast number of services the sector provides in the daily life of societies makes it one of the most important and critical infrastructures for sustaining the quality of living. In the context of developing countries, it became evident that in order to preserve the economic growth of the country, the electricity sector is to be developed at almost at the same rate [Narayan and Prasad, 2008; Eberhard et al., 2008] . Therefore, it is of paramount importance to prioritize the development of the sector and carefully assess the long-term potential and effects of the sector's structure and organization.

Second, it has been proven that societies have a central role in the design of the electricity sector. Since the early era of a state-owned monopoly sector, social welfare was an important factor in designing the system and setting the tariff. With the new paradigm shift, studies from the New Institutional Economics have shown how informal institutions like traditions, culture and values affect the design of formal institutions such as legislation, property rights, regulations and the entire role of the state in the region [Finon, 2003; Glachant and Finon, 2000; Williamson, 1998; North, 1990]. These social aspects are becoming increasingly important in the design for the sustainable energy transition. The role of communities has been well-recognized in pushing forward the transition towards renewable energy systems (see the renewable energy communities under the European Union Renewable Energy Directive (RED II), the Internal Electricity Market Directive (IEMD) and Regulation (IEMR) [Union, 2018]).

Scientifically, this thesis contributes to the understanding of the broad contexts of African countries in market design and presents the first comparative case study between African power pools. Following the pragmatic nature of the research, the thesis contributes to the practice of market design by presenting an in-depth analysis of the development and the challenges faced by African power pools. From our empirical investigation, we formulate an analytical framework for regional power pools based on the previous work of Correljé and De Vries [2008] on hybrid markets. Moreover, an essential question in this thesis is how to enable the energy transition, both technically and institutionally, in such a particularly challenging environment of African countries. Thus, this thesis also contributes to paving the path towards further exploratory designs of regional power pools. Unlike conventional social science studies on market design, the thesis goes further beyond the analysis and constructs the design settings upon which technical models can be simulated and optimized to support decision-making and give more insights into the tradeoffs.

1.5 RESEARCH DESIGN AND READING GUIDE

"Research design is the ordering of the key elements of the research, linking the empirical data to the research objectives of the study and subsequently to the conclusion" [Yin, 2003b].

The thesis is divided into nine chapters that are grouped into three. Chapter 1 provides an overview of the research problem and introduces the aim and objectives of the research. It also briefly explains the research methodology and design. Chapter 2 lays down the literature review of power sector reforms which includes the theory behind the reforms and the early experiences. The chapter finishes with a brief description of the reforms in Africa. Chapter 3 presents the concepts and definitions related to regional power pools; formulates the analytical framework used in this research; describes the methods used for collecting the data and filling the framework; and concludes with introducing the three case studies. This first group of chapters is the thesis definition.

The next four chapters constitute the analysis phase of the project. Chapter 4, 5, and 6 describe in detail the context of the three African power pools and give individual analysis to the cases. The chapters conclude with answering the second sub-question by highlighting the factors and reform steps for establishing the power pool in each case. Chapter 7 offers a comparative analysis of the three cases and reports the lessons learned and the challenges observed.

The last chapters form the design phase of the project. Chapter 8 identifies the structural design options for improving the performance of the power pools and the market design options for accommodating renewable energy in the competitive market. In the last chapter, 9, the research aims and questions are reviewed, the research questions are answered and recommendations are given. After discussing and reflecting on the main findings and research conduct, areas for further research are outlined.

Figure 1.1 shows the research flow diagram with the detailed structure of the master thesis.

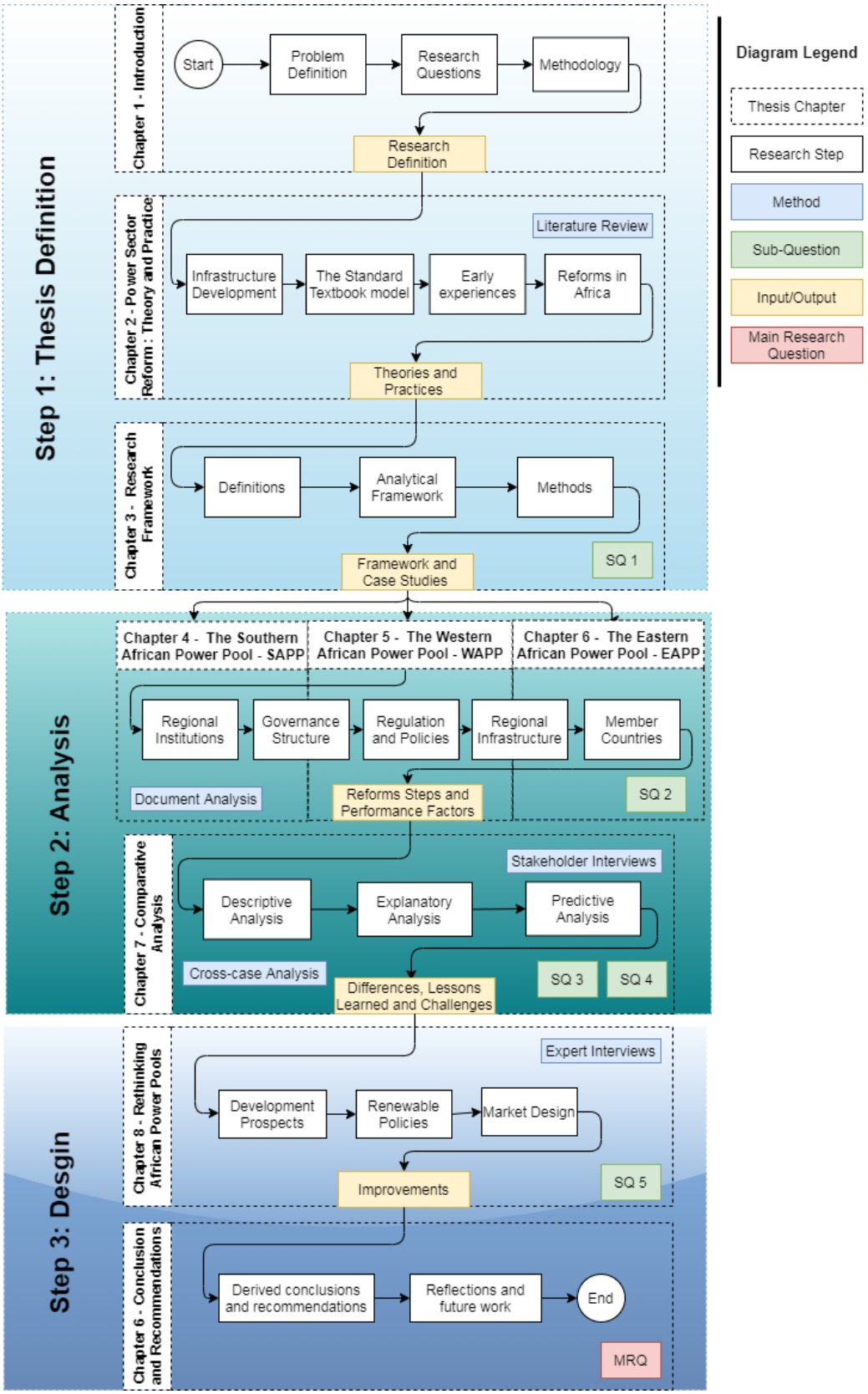


Figure 1.1: Research Flow Diagram.

2 POWER SECTOR REFORMS: THEORY AND PRACTICES

"We will make electricity so cheap that only the rich will burn candles"
Thomas A. Edison

In this chapter, the historical development and the theories behind power sector reforms are highlighted first focusing on the standard textbook model in section 2.1, 2.2 and 2.3. Second, the early experience and practices of countries' implementation of the standard textbook model are presented in section 2.4. Finally, section 2.5 gives an overview of the reforms in the continent of Africa.

2.1 ELECTRICITY SECTOR DEVELOPMENT

2.1.1 Traditional Electricity Sector: How it used to be

Like the rest of infrastructures, the electricity sector is characterized by high capital and sunk cost to establish the network. The investment payback also takes a considerable long-term time horizon [Jaag and Trinkner, 2009]. Such an undertaking is usually apt for the state to fulfill. Additionally, the sector was considered critical to national security and the state sought to secure the public interest by controlling it. Technically, the non-replicability of the transmission and distribution network makes the system naturally subject to a monopoly in the transportation segment. Adding to that, the economics of scale at the generation segment makes a compelling reason to vertically integrate the generation and transmission.

The economic rationale following this is that vertical integration eases the coordination between the segments and internalize the operation and investment interrelationships. Joskow [1998] states that the potential public goods and externality problems pertaining to the physical attributes of the power system can be solved with internal operating hierarchies instead of markets. All these features have led to the expansion of the electricity sector as a vertically integrated monopoly under public ownership [Eberhardt et al., 2005].

2.1.2 Paradigm Shift: From state-led to market-led

The main disadvantage of the old model is that it lacks sufficient incentives for economic efficiency and innovation. This was evident at the beginning of the 1980s. There was growing dissatisfaction with the performance of traditional vertically integrated public utilities exasperated with the oil crises of the 1970s in the developed world, the debt crises of the 1980s in Latin America and the failure of the planned economy in the communist countries in Eastern Europe [Jamasb, 2006; USAID, 2009].

The surge of an intellectual school of thought based on neoclassical economic principles between 1973 and 1980, and the conservative leaders ascending to power that wanted to implement their ideologies and associated policies led to a shift in the development paradigm of power sector organization. The economic textbook saw rapid development in both microeconomics and

macroeconomics theory. In microeconomics, theoretical models of consumer demand, firm production and cost functions, the foundations of competitive market equilibrium, and the understanding of market imperfections (e.g., externalities, oligopoly, asymmetric information) on firm behavior and market performance were all the base behind the new shift. In macroeconomics, a various number of theories were developed to explain key determinants of aggregate economic activity and the effects of government tax, expenditure and monetary policies [Joskow, 2004a].

By the early 1980s, pioneer governments like the late Ronald Reagan and Margaret Thatcher promoted the new paradigm shift that was associated with liberalism ideology. The trend was to reduce the role of the state where possible and replace it with market-driven competition [Correljé and De Vries, 2008]. Privatization and competition were early introduced to the energy sector in Chile and the United Kingdom (UK), this came to be known as the standard textbook model for restructuring which was followed by other countries. This process culminated in 1989 with the so-called "Washington Consensus". The new neoliberal paradigm dominated the realm of mainstream economics and development thinking in the 1990s [Imam et al., 2019].

2.2 THE STANDARD TEXTBOOK MODEL: THE HOLY GRAIL OF THE REFORMS

Although a number of variations are found in the literature (see Joskow [2000]; Hunt [2002]; Joskow [2003]), Littlechild [2004] was the first to propose five principles for the reforms, key components of the restructuring architecture were then identified by Joskow [2006] and finally Jamasb et al. [2015] pinpointed the sequence to eight steps that came to be known as the standard textbook model:

1. Corporatization of state-owned enterprise.
2. Law for electricity sector liberalization.
3. Establishment of an independent regulator.
4. Unbundling (vertical separation) of the main segments.
5. Incentive regulation of electricity networks.
6. Establishment of a wholesale electricity market.
7. Privatization.
8. Independent Power Producer (IPP).

This sequence was endorsed by the World Bank as the correct sequence to achieve the intended economic performance [Kessides, 2004]. Zhang et al. [2005] studies the effect of the sequence based on empirical data from 25 countries and confirms that following the sequence leads to performance improvement. Despite this, many countries did not adhere to the sequence.

In this study, we group the steps to six basic blocks, as endorsed by the World Bank [Bacon et al., 1999], following the same order above: Corporatization & Commercialization, Regulation, Unbundling, Competition, Privatization, and Independent Power Producers. Each is discussed severely in the following subsections.

2.2.1 Corporatization & Commercialization

Public utilities usually work under a soft budget constraint from the ministry/government which could lead to a number of inefficiencies and draining states' budget [Kessides, 2004]. Corporatization is the process by which public utilities are removed from the scope of the ministry and transformed into corporations with different administrations. The utility becomes a separate legal entity with new obligations like managing budgets, borrowing, procurement, labor employment, payment of taxes and dividends. One of the important topics of corporatization is how to improve corporate governance and reduce internal and external corruption.

Following corporatization, commercialization is the process by which utilities are obligated to operate according to commercial principles. This also adds new obligations like cost-recovery pricing, billing and collection, and accounting for all subsidies. Through corporatization and commercialization, the internal performance of the utilities is expected to improve under the cost-recovery pricing and the corporate governance, the structure is also likely to enhance.

2.2.2 Regulation

State-owned utilities are often self-regulated with mild regulations and an absence of transparency. In another case, incumbent utilities could also be private under monopoly regulation. The establishment of a clear regulation is sought to improve the performance of the utilities, increase private sector participation, and remove potential politicization of the utilities. Regulation starts with enacting electricity law that serves as a passage of the requisite energy legislation to provide a legal mandate for restructuring and the legal framework to allow private and foreign participation and ownership.

Although that regulation has many forms (e.g., outsourcing regulatory and regulation by contract [Eberhard, 2007]) the establishment of an Independent Regulatory Agency was considered to be one of the main steps in the standard model and the dominant form [Eberhard et al., 2016; Imam et al., 2019], as it signals the state intention for restructuring the sector. The independent regulatory agency aims to introduce efficiency, transparency, and fairness in the management of the sector, as well as prevent anticompetitive activities, encourage appropriate investment and protect consumers.

Regulatory reform has many important aspects. The regulator must ensure the balance of interest among different actors: government interest, operators interests and customer interests. The public interest theory and the economic theory of regulation are usually quoted to support regulatory interventions. The public interest theory of regulation argues that regulation is needed to protect the public interest at large when there are market failures to ensure the best possible allocation of scarce resources (following the rationale of social welfare economics) [Hantke-Domas, 2003; Den Hertog, 2010]. While the economic theory of regulation provides the general framework that includes analysis of political behavior, private interest theories and others [Stigler, 1971; Ogus, 2004; Baldwin et al., 2012].

There are several international principles to ensure efficient regulation, two principal areas are recognized for developing regulation/regulator [USAID, 2009]:

- *Regulatory governance*: institutional definition establishing clear roles and objectives, autonomy or independence, and accountability by which the regulator actions are bounded.
- *Regulatory substance*: associated with regulatory processes, including transparency, participation and predictability by which the actual legal interventions and regulatory decisions are made.

Two important topics for the regulator to address are tariff setting (per segment) and network access. This requires good information about the costs, service quality and comparative performance of participating firms. Therefore, a good regulatory design is expected to protect consumers and promote efficient operation and investment.

2.2.3 Unbundling

The unbundling function is perhaps the most important step to enable competition and breakdown the monopolistic function. In sector restructuring, two types of unbundling exist:

- *Vertical unbundling*: vertical separation of competitive segments (e.g., generation and retail supply) from regulated segments that are naturally monopolistic (transmission and distribution).
- *Horizontal unbundling*: horizontal separation of dominant companies in the generation and retail segments to create an adequate number of competing companies and mitigate market power (the ability to manipulate the market price) in the generation.

Vertical unbundling is thought to be necessary to guard against cross-subsidization of competitive businesses from regulated businesses and discrimination that might affect access to distribution and transmission networks.

2.2.4 Competition

Competition is the core of the standard textbook model and its wheel for economic efficiency. Competition between companies is developed in the generation and supply segments through contracting or introducing a power exchange. This sort of competition is called competition in the market. The other type of competition is competition for the market that could happen at the transmission and the distribution level (following a tender/concession model). It is an indirect competition stimulated through regulations to provide adequate infrastructure for the competition in the market. The competition in the market is stimulated by profit and has two forms:

- *Wholesale competition*: introduce competition in the generation market through a voluntary public spot market or through contracts. Different designs exist from an energy-only market to a capacity market, as well as various complementary mechanisms to ensure the system balance (e.g., ancillary services).
- *Retail competition*: introduce competition in the retailer market for consumers to choose their power supplier. Through the introduction of retailers, functions like marketing, billing and collection are transferred from distribution companies to retailers.

Competition is considered a reliable mechanism to enhance technical efficiency. The price signal reveals cost information in a competitive market and leads to improving internal efficiency. Thus, price is expected to decrease under competition and the supply is expected to increase.

2.2.5 Privatization

Privatization is the process by which state ownership is transferred to private investors through divestiture. Assets from the state generation, distribution and (sometimes) transmission companies are fully or partially divested in order to increase private sector participation, reduce public expenditure and increase the capital of the utilities. Another important cause, hypothesized under agency and public choice theories [Zhang et al., 2008], is that privatization increases economic performance by:

- Improving managerial behaviors by changing property rights.
- Exposing the utilities to the discipline of the private capital market.
- Imposing measurable objectives in association with principals monitoring management (agent) behaviour.

- Hindering the state's use of the utilities to pursue costly political agendas (e.g., patronage employment).

Thus, privatization is expected to increase labour productivity and utilization of capital stock. Another reason for privatization is that it is necessary for competitive activities as governments generally (and preferably) do not engage in these activities.

Although privatization in the standard textbook model is primarily denoted to asset divestiture, increasing the private sector participation could follow the form of management contracts, concessions, or greenfield projects. These different mechanisms differ in the component that falls under the private sector responsibility, namely: asset ownership, operation & maintenance responsibility, capital investment, and commercial risk. They also have different duration and application areas.

2.2.6 Independent Power Producers - IPP

According to Eberhard et al. [2016], IPPs are defined as "power projects that are privately developed, constructed, operated, and owned; have a significant proportion of private finance; and have a long-term Power Purchase Agreements (PPA) with a utility or another off-taker". IPPs differ in their ownership and financing structures, as well as technology choices and risk profiles. Most IPPs are wholly privately owned, though several involve public co-investment.

IPPs are enabled through proper regulation to show the benefits of private investment and management, as well as to prime the floor for competition by increasing the number of competing firms (consequently, increasing the capacity). IPPs are financed through different equity investments and predominantly through development finance institutions in developing countries [Eberhard et al., 2016]. The ways by which IPPs are contracted also vary from direct negotiation to competitive bidding.

Following the UK and Chile reforms in the 1980s, the EU and the U.S. soon started pressing for electricity liberalization. The role of international financial institutions, in particular the World Bank, was critical in disseminating the textbook model of electricity sector reform. The World Bank officially changed its lending policy in 1992 attaching conditions related to power sector reform including competition and privatization as key elements of the process. These policies were also initiated or later followed by other donors, including the IMF, the United States Agency for International Development (USAID), Asian Development Bank; the European Bank for Reconstruction and Development and the InterAmerican Development Bank [World Bank, 1993; Jamasb et al., 2015].

As of 1998, out of the 115 countries surveyed by Bacon et al. [1999], 73 (63%) had initiated a reform, 42 (37%) had taken no reform steps. Only 10 (9%) countries had taken five steps, only 12 (10%) had taken all the steps, and 15 (13%) had taken only one step. The most common step was corporatization and commercialization (44%) and the least common was privatization (around 20%). Efforts were uneven: Latin America was the most dynamic region in power sector reforms, completing almost four of the reform steps. Conversely, Sub-Saharan Africa and the Middle East and North Africa (MENA) region advanced poorly in the reform process, with a score around one step. Privatization processes were more common in Latin America whereas the introduction of IPPs have dominated the reform efforts in East and Southeast Asian countries [Bacon et al., 1999].

2.3 POST THE STANDARD

The standard reforms package implementation came to a halt in the 2000s. The outcomes were far from what was hoped for. Many countries witnessed stagnation in following the standard textbook model which led to the emergence of new market models. Other countries that fully implemented the model were reforming the model under a broader national reform.

2.3.1 Hybrid Markets

In the path of implementing the prescribed standard textbook model, many developing countries lacked the institutional prerequisites and the political will to fully implement the standard and renounce state participation in the sector [Kessides, 2012a]. New hybrid markets emerged in which the state co-exist with private sector participation.

An earlier survey by Besant-Jones [2006] categorizes the structure of 150 developing countries into six groups and found them matching the four models of the industry identified in earlier literature (see Joskow et al. [1988]; Hunt [2002]; Kessides [2004]). These four models are:

1. *Vertical Integrated model*: the old pre-liberalization model of one monopoly dominating the entire value chain of the sector.

2. *Single Buyer mode*l: the model consists of a single entity that purchases the electricity from generation companies (including IPPs) and sells it to the consumers. The single buyer could be a national generation, transmission or distribution company; or a combined national generation-transmission or transmission-distribution+IPPs. IPPs are commonly promoted in this model along with third-party access.

3. *Wholesale Competition model*: the model encompasses competition in the generation segment and the removal of the single buyer entity, i.e., no vertical integration with the generation is allowed and system operation becomes a separate activity. However, the model allows the integration of the retail and distribution segments and does not introduce retail competition. Consumers have no choice of supply in this model.

4. *Retail Competition model*: the model encompasses retail competition along with wholesale competition. All the four segments in the sector are vertical unbundled and consumers are able to choose their electricity supplier. This model is the end goal of the standard textbook model for sector reforms.

The four models are depicted in figure 2.1 in an ascending order based on the degree of unbundling. The two hybrid models (single buyer and wholesale) show significant departures from the standard model. Not only some steps were left out, but the sequence was different. For instance, many African countries followed almost the reverse order by introducing IPPs first and then regulators came into existence after IPPs' contracts were negotiated. The commercialization also often came post-IPPs [Eberhard et al., 2016]. This was driven by the fact that IPPs were contracted in a state of a severe chronic shortage. Therefore, the motivating force and the purpose of the steps were completely different from what was conceived in the standard model.

Hybrid markets present several questions in the literature. Perhaps two of the important questions are: Why do the different patterns of restructuring emerge? [Correljé and De Vries, 2008], and: Are these models incomplete progress or new models to remain? [Gratwick and Eberhard, 2008]. At this scene of market development, the contemporary development of New Institutional Economics (NIE) theories played an important role in understanding and analyzing hybrid markets emergence.

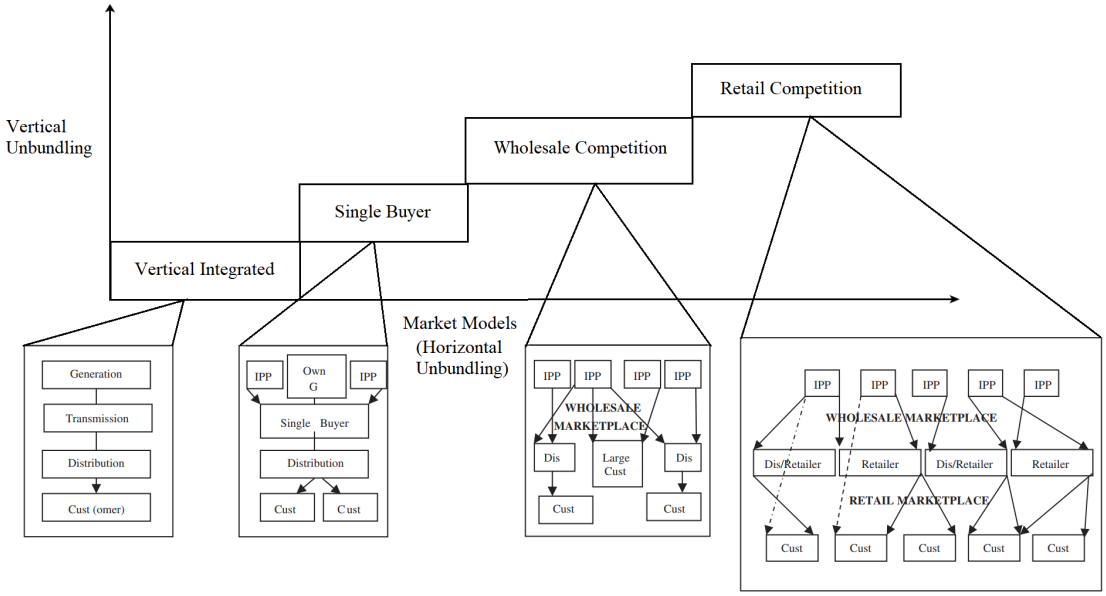


Figure 2.1: Degree of unbundling for market models. Adopted from: Hunt and Shuttleworth [1996]; Hunt [2002]; Markets [2004]. *Notes*: 'Own G' refers to state-owned generation, 'Dis' distribution company, and 'Cust' to customer.

Earlier, the neoclassic tradition used to adopt either an institutional or non-institutional approach to economic analysis, however, the term "New" institutional economics came as a reaction to distinguish the new research framework from the "old" institutional economics that gained a bad reputation among academic economists in the U.S. and some other countries post-World War II [Joskow, 2004a]. Institutions are defined as the humanly devised constraints that structure political, economic, and social interactions. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, and property rights) [North, 1991]. The field lacked rigorous and systematic theoretical foundations as well as support from empirical analysis. New institutional economics came as an effort to move economics beyond the limitation of neoclassical economics in showing that legal, political, social, and institutional economics have important effects on economic performance. These new contexts were particularly critical in understanding the idiosyncrasy of developing countries' situation.

Perhaps the most useful and frequently cited framework and theory of NIE are the four layers framework and transaction cost theory of Oliver Williamson [Williamson, 1998]. Based on this framework, Joskow [2004a] identifies three key progress areas in NIE:

1. allocation and enforcement of property rights,
2. vertical integration under transaction cost and agency theory, and
3. political economy.

The analysis of markets evolution was further expanded by path dependence, principal-agent, bounded rationality and other behavioral economics theories. The single buyer model was particularly justified under vertical integration theory as it reduces the transaction cost and the coordination issue as well as facilitating network planning (see Joskow [2006]). In fact, a number of national champions and cross border mergers appeared in continental Europe and led to a concentration process and revert to vertical and horizontal integration, most notably in Germany (see Brunekreeft and Twelemann [2005]). National champions retrieved a strong position

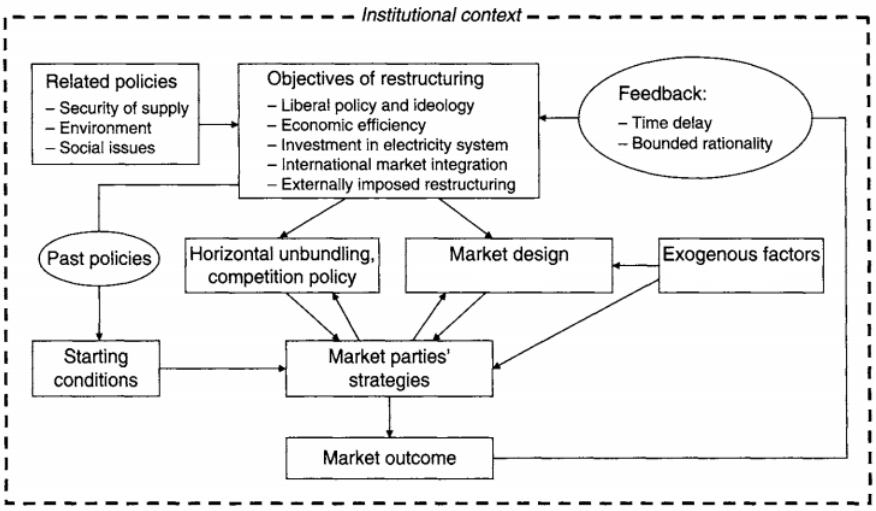


Figure 2.2: The analytical framework for hybrid electricity markets. Source: Correljé and De Vries [2008].

with the creation of regional markets and were expected to protect national interests therein [Correljé and De Vries, 2008].

Following the perspective of NIE, the framework presented by Correljé and De Vries [2008] provides a useful tool to analyze hybrid markets. In this framework, three sets of exogenous factors affecting the choices of the market design were identified: Physical, economic, and institutional factors. The choices for design the market are a function of the design variables as well as the dynamics of restructuring, wherein the initial conditions and the motivation for restructuring play an important role in shaping the market outcomes. Figure 2.2 shows the conceptual framework of analysis.

2.3.2 Regional Markets

Following the emergence of hybrid markets, there was a trend of integrating different national power systems into regional or supranational electricity entities that are called "pools", "interconnections" or "regional markets" depending on their organization [World Energy Council, 2015].

These regional entities offer the potential to significantly reduce the cost of providing electricity, improve system reliability through coordinating the use of energy resources across a larger supply area and allow for investment in large generation projects with lower per-unit costs which might be oversized and risky for a single country but feasible if they are used by the entire region [Pastor, 2008]. The first regional cross-country market was created in 1996 between Norway and Sweden based on market splitting. The market was named the Nordpool ASA after the joining of Finland and Denmark in 1998 and 2000, respectively [Ouriachi and Spataru, 2015]. Upon the success of the Nordpool, European countries followed the same path and several regional markets were established. On the other hand, power pools were created in the U.S. which were later transformed into regional transmission organizations and regional markets. Other regional markets are the National Electricity Market in Australia and the Regional Electricity Market (Mercado Eléctrico Regional (MER)) in central America. All these markets continue to evolve, as more advanced forms of organization are developed and accepted by member parties. Figure 2.3 shows the geographic distribution of regional markets. In blue areas are maturely integrated and functioning markets, while in green areas are markets at relatively early stages of development. The map shows that new regional markets are being developed among devel-

oping countries in South America, Africa, and Asia.

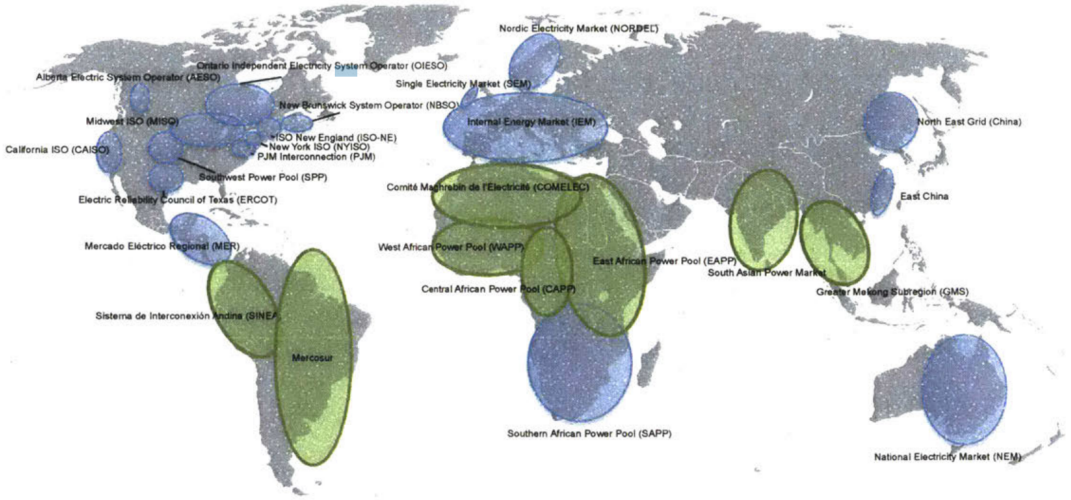


Figure 2.3: Regional electricity systems around the world. The blue indicates well developed systems and the green indicates developing systems. Source: Rose [2017].

The establishment of a regional market entails many challenges, three critical problems can be identified in the literature pertaining to market operations, regional infrastructure, and institutions and governance [Barker et al., 1997; Byer et al., 2009; Economic Consulting Associates, 2010; Olmos and Perez-Arriaga, 2013]. First, market rules are to be aligned with national concerns about the security of supply. Second, the market must have effective regional institutions and regulator. Third, the regional regulator needs to incentivize investments in regional infrastructure projects, particularly cross-border transmission. To tackle these challenges, different analytic tools are used to assess the performance of regional markets and support decision making for planning and organization. These tools range from quantitative decision support models based on optimization and simulation techniques (technical modeling) to qualitative analysis of institutions and policies (social science methods). Additionally, some studies utilized a hybrid combination of both tools by combining rigorous technical representations of the system with an understanding of the market context [Rose, 2017].

About pricing and clearing rules, the economic theory for market design foretells that under competition, the market price would resolve to the marginal cost of generation (cost of producing an extra unit) which maximizes the welfare [Ventosa et al., 2013]. Additionally, unifying the price for all transactions in the market sends an efficient signal for investments. These outcomes hold under the absence of economies of scale in generation and the absence of additional costs (lumpy cost, convex and non-convex costs) that are present in reality. Pricing and clearing algorithms in regional markets are centered around these issues. In the U.S, bidding formats contain both lumpy costs and lumpy constraints. In the EU, simple bids do not introduce these costs. Thus, it is mathematically impossible to find uniform prices that support the welfare-maximizing solution [Batlle, 2013; Scarf, 1994]. Thus, the practical implementation of marginal pricing results in two ways that include tradeoffs between the two objectives [IRENA, 2017]:

- **Optimal-dispatch-based (marginal) prices**: the volumes accepted on the market are those of the welfare-maximizing solution (optimal dispatch). However, a discriminatory pricing rule must be applied to guarantee cost recovery based on the additional cost incurred by certain generators. This sacrifices uniform pricing signals for investments. This way is followed in the U.S. model in which pricing and clearing are done separately.

- **Uniform-(marginal)-price-based dispatch**: all transactions in a given period (e.g., an hour) are settled at the same price that encompasses, as much as possible, the impact of lumpy constraints and costs. This price constraint requires that the market solution deviates from the most efficient (social welfare-maximizing) dispatch. This way is followed in the EU model in which pricing and clearing are done in one step and consequently, increases computational complexity and potentially reduces transparency in accepting complex bids.

Two mechanisms were developed to manage transmission congestion in a regional market among countries with national markets, these are market coupling and market splitting. Market coupling relies on the fact that high price areas will import electricity from low price areas resulting in a global decrease in prices. If there is not enough transmission capacity, the trades will stop before the prices could have been equalized. Market coupling connects different markets (often national) while market splitting is organizing the market into several pricing zones if there is not enough transmission capacity to harmonize the price between them. In case of limited transmission capacity, regulatory options adopted are split into two pricing algorithms:

- **Nodal pricing**: a detailed representation of the transmission network is used to apply security-constrained economic dispatch to derive a bus-by-bus Locational Marginal Prices (LMP) paid for the energy consumed or generated at a given transmission node. These prices are unified in case of no limitation on transmission capacity. This provides an accurate description of the technical and economic effects of the grid on the cost of electricity.
- **Zonal pricing**: a simplified representation of the transmission network consists of using a single market price except where significant grid constraints arise frequently between well-defined zones. Once zones are identified (on different degrees of spatial resolution), the internal grid nodes are grouped and given a unified price. A re-dispatch might be necessary to solve congestion in zonal pricing.

2.3.3 Reforming the Reforms

During the early 2000s, the implementations of the standard textbook model showed stagnation in most developing countries (especially in Africa), and some issues were uncovered in developed countries. Market failures, such as in the crisis of California's electricity market [1] [Bushnell, 2004], had a global echo for countries to revise their reforms. A number of studies investigating the effect of the standard textbook model implementation based on countries' experiences and empirical evidence were published around this time. Jamasb and Pollitt [2005] categorizes the literature in this period into four types: cross-country econometric analyses of electricity reform, efficiency and productivity analyses of electricity companies and reform, general economic growth studies which have some relevance for electricity reform, and single-country case studies of electricity sector reform. Additionally, the climate action agenda, particularly in Europe, called for government intervention in the electricity sector to reduce carbon emission footprint. The electricity sector was among the highest polluting industries and therefore was on the priority list for decarbonization. This period came to be known as the second wave of reform: "Reforming the Reforms" [Sen et al., 2016; Dornan, 2018].

The second wave of reform is centered around policy changes and shifts to serve two general purposes. The first purpose is to encourage new investment and ensure the adequacy of supply (fixing blockades). This was a topic for both developed and developing countries [Dornan, 2018; Godinho and Eberhard, 2019]. The development in this period focused on strengthening independent regulation and several mechanisms for ensuring the security of supply were

1 Strong opposition from states in the U.S. after the California power crisis questioned the ability of liberalized markets to ensure system reliability which forced The Federal Energy Regulatory Commission's (FERC) to reduce the Standard Market Design (SMD), that was intended to be a single template for the U.S. electricity market, to a set of recommendations released as a white paper in 2003

proposed (e.g., capacity market and reserve options). The second purpose is to enable climate action agenda by reducing carbon emission and stimulating renewable energy. The topic was predominantly taken in developed countries with the UK, the inspirer of the standard textbook model, taking the lead [Act, 2008]. Different instruments were developed to boost renewable energy contribution (e.g., feed-in-tariffs (FiTs), contracts for differences and renewable energy certificates) and discourage new investments in carbon-based generation technologies (e.g., carbon tax and emissions performance standard).

The new reforms fundamentally question the adequacy of the standard textbook model for both the context of developing countries (see Yi-chong [2006]; Gratwick and Eberhard [2008]) as well as for the decarbonization era (see Keay [2016]; Roques and Finon [2017]). The political and economic systems in developing countries were deemed incompatible with the standard textbook model and the technical performance was impacted by poor financial performance and vice versa. On the other hand, the way the market works in the standard textbook model is through marginal cost bidding in energy-only markets, this has little relevance for renewable energies with zero marginal cost and high intermittency (e.g., photovoltaics technology and wind turbines). Consequently, governments interfered with the natural way the market operates (in neoclassical theory). For instance, the competitive market in the UK experienced a radical change in 2013 under the energy bill [UK DECC, 2012] which was argued by Pollitt and Haney [2013] to dismantle the competition in the market. While the second wave of the reforms remain an ongoing debate, it became evident that the standard textbook model is undergoing significant renovation and reconstruction, which most likely will lead to a new hybrid design. Such a design process is a combination of theory and empirical art.

2.4 PIONEERS' SUCCESS STORIES AND PRACTICES

In this section, we turn to the early experiences and practices of pioneer countries in power sector reforms. We selected the very first cases for reforms at the national level and at the regional level (for additional cases of implementing the standard textbook model see Appendix A). In each case, first, a background of the situation at the outset of the reforms, in terms of political, economic, and institutional settings, is described. Then the sequence of the reforms and the timeline is presented, and finally, the restructured system is described.

2.4.1 Chile: Where the reforms were initiated

Chile was the first country in the world to start the process of reforming the electricity sector. The Chilean reform is characterized by being comprehensive, restrict and the longest in the world [Pollitt, 2004; Joskow, 2006]. Despite having no prior reference in the reform, the experience was marked down as very successful in improving the utilities' performance, companies' rate of return, sector efficiency and increasing rural electrification.

Country's Context

The political context of Chile at the outset of the reforms was interesting in that it was a military government but unlike most of military governments, it pursued neoliberal economic ideas inspired by Chicago economists at the U.S. (see MOFFITT [1977]). Many of the previously nationalized companies, by the deposed government of Salvador Allende, were being returned to their previous owners and large state-owned companies were forced to trade on a commercial basis.

As a result of the neoliberal ideology of the military government, the constitution was established with a strong defense of property rights and commercial information. The rest of the institutional settings were equally rigorous to ensure the protection of property rights, with a

legal system based on tangible proof of illegal activity coupled with a judiciary system to protect property rights from legislative and administrative abuses. Following the peaceful return to democracy, the institutional settings were strongly grounded to prevent the successive coalition governments from changing reform laws established under the military regime. Thus, the sector witnessed a stable regulatory regime with a fringe of stakeholders' influence.

In return, the institutional setting has a positive influence on the economy in stimulating private sector participation from both local and overseas investors and with a preferential to domestic ownership (until 1990s when the sector became dominated by foreign firms). The economy improved notably after the democratic transition with accelerated GDP growth of 6.2% per annum during the 1990s (GDP per head was $1,770 in 1982), which are known as the golden years [Schmidt-Hebbel, 2006].

The Chilean reform is relevant to developing countries not just as an early success story, but also because the sector is relatively small to exploit competition and the demand was low but increased rapidly by 6% annual rate [Pollitt, 2004]. The system was largely composed of hydro generation at 38% share with the rest generated by fossil fuels. The total installed capacity increased from 4,016 Megawatt (MW) in 1988 to 10,045 MW in 2000.

The Sequence of the Reforms

The start of the reforms was in 1978 when the National Energy Commission was established. Soon after this, corporatization and commercialization of state-owned utilities were initiated in 1981, shortly followed by vertical and horizontal unbundling. In 1982, the Electricity Act was enacted and massive privatization began in 1985 concurrently with establishing two regional power markets following the break-up of the incumbent. An Independent System Operator (ISO) was then founded in 1986 to supervise the two markets.

The regulation process was ongoing: the regulatory framework established in 1982 consists of two entities with different responsibilities. The National Energy Commission was responsible for policy advisory and setting of regulated distribution charges. The Superintendent of Prices of Electricity and Fuels was responsible for data collection, handling of customer complaints and implementing service quality fines and customer compensations.

During the early reforms, the IPPs was introduced lastly in 1997 at the time when the sector was largely privatized. Following the drought of 1998-99, the second wave of the reforms started and major amendments to the laws governing the sector were enacted under the passage of the Ley Corta in 2004.

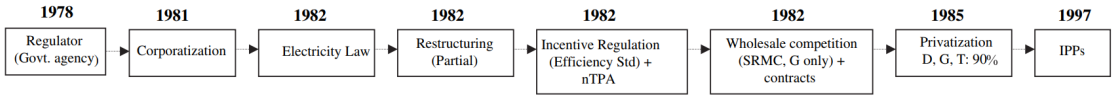


Figure 2.4: Chile's sequence of reforms. Source: Jamasb [2006].

Restructuring the Sector

The sector in Chile was restructured into two regional markets: the SIC covering the south and central areas, and the SING covering the north of the country. Generators in these two markets declare the availability and marginal cost every hour and are dispatched from the least price to the highest price that satisfies the demand. The influence of hydro generation was significant in setting the spot price, especially in the SIC where the main Laja reservoir is located. The system as a whole followed the Nodal price scheme in setting the price at different zones when the transmission lines are congested. Both generation and distribution prices were regulated. Generation prices are set based on the expected spot price of energy over the next four years and is fixed for six months. Distribution charges followed the incentive regulation principles. Charges were not related to the actual cost and were based on companies average model price with an

added value. This system was believed to incentivize companies to cut on their cost but analysis showed later that it led to strategic behavior by the distribution utilities in increasing the cost in their reports prior to the next control period of setting the price cap [Dyck and Di Tella, 2002].

Both the transmission and distribution access were regulated based on negotiated Third-Party Access (nTPA). In transmission, generators would have to pay for transmission to get electricity to their customers. Negotiation takes place for a new connection and generators could choose to build the connection themselves. Thus, transmission companies could not pass the cost to customers. Two types of customers were characterized in the system: regulated and free customers. Customers with demand above 2 MW were free to contract directly with generators. However, very few customers took an advantage of this and that's because there were no separate charges for transmission (until the second reforms wave) and generators were reluctant to take the distribution company's customers since the distribution company itself was a major contract purchaser of the generators [Joskow, 2006]. Other customers were obligated to buy from their local distribution network with the regulated price of the distribution plus the node price. Despite the radical initial restructuring, market power remained present as the two regional markets were introduced when the sector was dominated by 3 major companies. However, by 2013, the sector was comprised of 31 generating companies, 5 transmission companies, and 36 distribution utilities [Erdogdu, 2013]. Joskow [2006] argues that due to the strict regulation of the wholesale markets and the distribution charges, the markets were not competitive as was hoped for and the investment signal was missing, which led the government to tender for additional capacity.

The experience of Chile showed that the possible effect of the sector reform in small power systems with significant hydro and under military government. Key factors were strong institutions and enormous privatization.

2.4.2 The United Kingdom: Where the standard was made

Although Chile was the first to start the electricity sector reform, the British electricity sector has been regarded as the exemplary model that went down in history as the standard textbook model [Joskow, 2006; Correljé and De Vries, 2008; Jamasb et al., 2015]. Different instruments and best practices were developed during the UK experience and the golden standard was set for the rest of the world to pursue. Three different models existed in the UK: in Scotland, Northern Ireland, and England and Wales. The full liberalized model was observed in England and Wales.

Country's Context

At the beginning of 1980s, the conservative government under the leadership of Margaret Thatcher was pursuing national privatization of the economy. This came as a part of an international response to changes in the global economy that was advocated by the alliance between the UK and the U.S. under the presidency of Roland Reagan, which eventually became known as neoliberalism (predicated on the free market and supply-side economics) [Reitan, 2003]. Thatcher's government used liberalization of the electricity sector as a way to undermine the political power of the coal/miners' union that was considered hostile (driving the coal price) and caused the fall of one previous conservative government [Newbery, 1999].

The United Kingdom as the rest of the developed countries had a well-established institutional settings and mature economy among the top 10 worldwide during 1980-90 [IMF, 2020]. In England and Wales, the population was just over 50 million and with a peak demand of 49 Gigawatt (GW). The electricity sector was under public ownership: the Central Electricity Generating Board operated all generation and transmission as a vertically integrated monopoly with 12 Area Boards acting as regional distribution monopolies. Two interconnections existed

with Scotland and France. The energy mix during the 1980s was three-quarters coal and the remaining share was nuclear generation [Newbery, 2005].

The Sequence of the Reforms

The restructuring started in 1989 with the enactment of the Electricity Act whereby the Director General of Electricity Supplies was created as an independent regulator, with the support of the Office of Electricity Regulation. The Central Electricity Generating Board was split up into four companies: National Power, with 60% of the fossil capacity, PowerGen, with 40% of the fossil capacity, Nuclear Power, state-owned with the twelve nuclear stations, and National Grid Co. with the transmission assets and pumped-storage generation.

In 1990, the government restructured and privatized the British electricity supply industry, except for the nuclear power stations that were still subsidized, and created the electricity power pool [Newbery, 2013]. By 1996, the nuclear subsidy was removed and the last piece of the sector was privatized. After privatization was complete, IPPs were introduced in the same year and contributed significantly to the twelve regional distribution networks (later came to form the Regional Electricity Companies) by building gas-fired combined cycle gas turbine generating stations. The retail competition was opened gradually starting with large consumers (> 1 MW) in 1990 and until 1999 when all consumers were able to contest for their supply.

Restructuring the Sector

The British sector went through gradual and radical evolution overall. The reforms were planned to be introduced at different stages. Competition in both generation and retail underwent three phases and privatization was systematically extended with active regulation pushes.

On the generation side, first, a mandatory pool system was introduced in 1990. The pool worked as a compulsory day-ahead last price auction with half-hourly marginal biddings and capacity payments for plants declared available. Generators had access rights to and were compensated if transmission constraints prevent their bids from being accepted. In addition to the pool, bilateral-contracts took place either as Electricity Forward Agreements (screen-traded over-the-counter) or as a contract for differences.

England and Wales were almost completely unbundled and restructured before privatization. Unlike the case of Chile, the restructuring process included a comprehensive set of institutions and regulatory mechanisms to govern transmission operating cost and reliability, the allocation of scarce transmission capacity and approvals of transmission investment programs, as an integral aspect of the reform process [Joskow, 2006][2]. After privatization, almost all the Regional Electricity Companies became joint investors with IPPs in building gas-fired combined cycle gas turbine generating stations, whose high efficiency, low capital costs, modest economic scale, and use of cheap fuel, made them attractive competitors to the predominantly coal-fired generation of National Power and PowerGen. However, the regulator forced the regional distribution/retail supply companies to sell their stakes in the National Grid Company in 1995 and, in 2000, regional companies were pushed to make a full corporate separation of their retail and distribution businesses. Distribution and retail businesses can still be owned by one company, but there must be a full separation of activities [Thomas, 2004]. Retail consumers were gradually freed to contract with any supplier and the franchise monopoly of the local electricity companies was, therefore, slowly diminished. The first 5,000 consumers with more than 1 MW demand were freed in 1990. Another 45,000 customers were freed following the lowering of the franchise limit to 100 KW. By 1999, the regional electricity companies franchise ended, freeing at last 22 million customers [Newbery, 2013].

2 The network tariffs followed 'price-cap' regulation of 'RPI–X' formula. The price is allowed to increase in line with inflation (RPI is the Retail Price Index) minus X percent set by the government and revised by the regulator between 3 and 5 years. *Source: Thomas [2004]*

During the transition to low-carbon generation, the regulator imposed a Non-fossil Fuel Obligation on the Regional Electricity Companies and forced a Fossil Fuel Levy on all fossil generation (which was used to fund nuclear in decommissioning liabilities). As the British coal was considerably more expensive than imported coal, two fossil generators set the pool price over 90% of the time with significant market power [Newbery, 1999]. Subsequently, the British market had gone through two more stages of reform: one by New Electricity Trading Arrangements which included four voluntary, overlapping market segments: a bilateral market for long-term transactions, a forward market for standardized products, a spot market, and a reserve market (thus reducing the responsibilities of the system operators and abolish capacity payments); and second by the British Electricity Trading and Transmission Arrangements in 2005, putting both Scotland and England and Wales under a single-price area (one wholesale market).

The reforms in the UK recorded an impressive reduction in distribution and transmission charges as well as electricity price in general (but largely due to cost reduction of fuel) [Jamasb, 2006]. The system's reliability had been maintained at high levels and although a competitive market is achieved through further asset divestiture and new entry, vertical integration has not disappeared [Thomas, 2004]. The second reforms started in 2013 by introducing the Electricity Market Reform but with questionable results (see Pollitt and Haney [2013]). The political element was the main driving force to pursue the liberalization agenda.

2.4.3 The Nordpool: Where the first regional market was created

The Nordic market is the oldest regional power pool which existed before the European Directives 96/92/EC of 1996 for market liberalization [Pollitt, 2009] and was referred to by Jamasb and Pollitt [2005] as "the most advanced in terms of effective international integration".

Foundation and Institutions

The official establishment of the market was in 1996 between Norway and Sweden based on the Norwegian market Statnett. Statnett was initially a power exchange created in 1971 as a tool for the power industry to optimize usage of all Norwegian hydropower resources [Economic Commission for Africa, 2003]. The market was renamed later to Nordpool and included Finland and Denmark. Since establishing a regional market directly impact the Transmission System Operator (TSO), the NORDEL had already been established in 1963 which included the TSOs of the four countries plus Iceland. The aim was to develop an effective and harmonized Nordic electricity market (including master plans). There is no regional regulator but the four countries cooperate through NordREG, based on initiatives from the Nordic Council of Ministers and Nordic regulators. The NordREG cooperation includes the four national regulators and was formalized in a Memorandum of Understanding in 2002 with the main task is to "actively promote the legal and institutional framework and conditions necessary for developing the Nordic and European electricity markets" [NordREG, 2019]. In 2005, the market was connected with Germany via the Kontek cable. Having connected with the rest of Europe, Nordpool was slowly being integrated into the rest of the region institutionally. NORDEL was abolished and replaced by European Network of Transmission System Operators for Electricity (ENTSO-E) in 2009. Besides NordREG, the Agency for the Cooperation of Energy Regulators was established in 2011 to complement and coordinate the work of national regulatory authorities [Mundaca et al., 2013].

Member Countries

All four participant countries liberalized their electricity sector -starting from Norway in 1991, Finland in 1995, and both Sweden and Denmark in 1996- and adopted regulated Third-Party Access (rTPA). With the exception of Finland which has mixed ownership, the sector of the other

three countries remained mostly under public ownership [Pollitt, 2009; Erdogdu, 2013]. The 2009 EU Electricity Directive sets the rules for the electricity market and various unbundling deadlines. Nordic countries are all subject to the EU rules on competition, unbundling, network access, and related market surveillance and reporting to the European Commission. All countries adopted the choice of ownership unbundling. The creation of the exchange did not require prior privatization, but the transfer of ownership of the interconnectors to independent TSOs in each of the countries [Muller-Jentsch, 2001]. Countries' TSOs vary in terms of tasks and regulatory frameworks. The grid operation is decentralized, TSOs are responsible for operating and investing in the national network [Mundaca et al., 2013].

After expanding to Europe, the Nordpool participants included several countries. Currently, Nordpool grew to include TSOs, Producers companies (360), distributors companies (500), Suppliers companies (380), and traders/brokers. The power flows between 360 customers from 20 countries (the Nordics, the Netherlands, Germany, Poland, and the Baltics) [Nordpool, 2019].

Market Structure

The Nordpool is jointly owned by the TSOs of the participating countries (until 2019 when EURONEXT acquired 66% of the share capital and voting rights [Nordpool, 2019]). TSOs are responsible for operating and investing in the national network as well as determining the local bidding zones. Presently, there are five bidding areas in Norway; two bidding areas in Denmark (Eastern and Western); one bidding area includes Finland, Estonia, Lithuania, and Latvia; and four bidding areas in Sweden. The different bidding areas help indicate constraints in the transmission systems and reflect the regional conditions in the price [Nordpool, 2019]. The grid is part of the transmission network of Northwest Europe.

Physically, the capacity of the internal transmission system is 7.3 GW with 5.3 GW currently ongoing development including interconnectors with continental Europe [Statnett, 2019]. By 2015, the installed capacity reached 102,396 MW: 49% Hydropower, 26% Thermal generation, 12% Nuclear, 12% Wind, and 1% Solar. The installed capacity shares per country are Denmark 12.5% Finland 16.4% Norway 32.1% Sweden 39%. The largest three power producers are Statkraft 14.4% (Norway), Vattenfall 13.8% and E.ON 6.1% (Sweden). The region total consumption in the same year was 379 Terawatt hour (TWh) with a peak load 63 GW and net export of 18 TWh (see the dataset from [NordREG, 2015]).

The Nordpool spot market (sometimes referred to as the Nordic power market exchange) is a voluntary market that covers four wholesale markets. All day-ahead cross-border trading must go through the Nordpool, which consists of two sub-markets, the ELSPOT market (day-ahead) and the ELBAS markets (intra-day). The other two markets are the Eltermin (financial market) for forward-contract and the regulating power market for stabilizing the frequency of the grid. A Balancing Power Market takes place after the physical trade to settle the imbalances (known as a TSO-TSO market). Price formation in the Nordpool Spot is complex due to many factors, three types of prices exist within the market: system price (clearing price) without transmission bottlenecks, area price for each bidding area, and equilibrium price which is the final payable price.

Transmission tariffs are designed in largely the same way in the four countries and there are no border tariffs between them. Whenever there is congestion, the market splits into different price area and the internal congestion is then handled via countertrade or reducing interconnector transmission capacity at bidding area borders [NordREG, 2014]. In the countertrade, TSOs correct the electricity flow using market-based redispatch and have to pay for this service. Countertrade is often used after gate closure in the ELSPOT or day-ahead market. In the case of cross-border congestion, transmission from one area to another is priced with the difference of the area prices. The resulting congestion rent is then split between the TSOs [Weigt, 2009].

The Nordpool provides transparent information to all market agents, liquidity, equal access, and guarantees contract settlement and power delivery. Trade volume has been increasing

steadily and was recorded 381 TWh in the day-ahead market and 15.8 TWh in the intraday market in 2019 (+90% of 2018 volume) [Nordpool, 2019]. The market proved to be resilient in withstanding the supply shock of 2002-03. Amundsen and Bergman [2006] attribute the success to the simple and sound market design, dilution of market power, and strong political support.

2.5 REFORMS IN AFRICAN COUNTRIES: IN A NUTSHELL

Originally, the standard textbook model is introduced to usher competition and push for economic efficiency. However, in developing countries, especially in Africa, reforms were implemented out of necessity. The pressing need for expanding the generation capacity, reducing the fiscal expenditures, and acquiring international funds were the main driving forces behind the reforms in Africa [Eberhard and Catrina Godinho, 2017; Imam et al., 2019]. This motivational difference led to adopting specific steps of the standard model and overstepping others, leading eventually to hybrid markets and structures with dominant state-owned utilities in African countries [Eberhard et al., 2016]. Thus, in all African countries, with the exception of Nigeria and Ghana, the reforms have not been pursued to its full extent and has not begotten competition.

In this section, we give an overview of the reforms in the continent of Africa. We start with the same structure as in the previous section by giving a general background of the situation in African, then we describe the power sector organization in Africa, both at the county level and the regional level. Finally, we conclude the section with an outlook of the development in the continent.

2.5.1 General Background

Africa is home to 54 countries of which 48 reside on the mainland and the rest are six islands. Other than that, two areas remain disputed: Somaliland and Western Sahara. Out of the 54 states, 33 are among the group of least developed countries in the world with some of the lowest indicators of economic and human development and 13 of which are small states characterized by a small population, limited human capital, and a confined land area [World Bank, 2020c]. More than 20 of the countries in Africa are either in the midst of or recovering from prolonged civil conflict [Bakken and Rustad, 2018], and 25 are operating under authoritarian regimes according to the EIU Democracy index in 2019. Additionally, corrupt practices are deeply intertwined with ongoing conflict and state fragility in some African countries. In 2019, the Corruption Perceptions Index indicated that the public sector in Africa is the most corrupt of any other continent, especially in sub-Saharan Africa with a score of 32 out of 100 (global average is 43). Political corruption is prevalent in countries and takes many forms (e.g., patronage networks, opaque political party financing, and vote-buying) [Duri, 2020].

Economically, Africa's economic growth has slowed down from a decadal average of 5% to around 3% in 2014. This moderate growth continued in 2019, stabilizing at 3.4% [African Development Bank, 2020]. Inflation remains high in the region with an average of 9.32% in 2020. Inflation varies significantly between countries, with countries like Zimbabwe and Sudan scoring above 200% in 2020 in contrast with a country like Eritrea with a -16.4% score. The weighted average deficit-to-GDP ratio in Africa was estimated to be 4.8% in 2019, despite some countries lowering the interest rates to encourage investment [African Development Bank, 2020]. National public debts are high and rising in most African economies with the median ratio of government debt-to-GDP climbing over 56% in 2018 due to the slowing growth and export. A major share of the financing came from China [Eberhard et al., 2016]. Many African countries continue to have extreme poverty rate. In 2018, the African population under extreme poverty was 33.4 %

(429.1 million) with countries of Malawi, Liberia, Burundi, Chad, Sierra Leone, and Niger are regularly in the last places.

Institutionally, according to World Bank [2019a] the average quality of policies and institutions in International Development Association (IDA)-eligible countries remains unchanged since 2017 according to the Country Policy and Institutional Assessment . The assessment average score in the 38 eligible countries remained at 3.1 on a scale of 0 to 6, the spectrum starts from South Sudan with the lowest score of 1.5 and ends with Rwanda with the highest score of 4.0. In several countries, inconsistent fiscal policies and weak debt management undermined macroeconomic resilience. The rule of law, accountability and transparency, and the quality of public administration remained major areas that impede the efficient use of public resources across the region.

2.5.2 Power Sector Organization

Inasmuch difficulties and variances in the exogenous factors (political, economic and institutional), the power sector in African countries displays strenuous and contrastive patterns of reforms. Major patterns can still be observed from the legacy of the traditional organization, in other words, most of the power sectors are dominated by state-owned utilities with self-regulation and IPPs with long-term contracts. These patterns are products of having weak institutions with an urgent need to expand the generation capacity. Thus, there is almost always no room for competition on the country level due to the chronic shortage of power. In the following paragraphs, we briefly present the power system structure in Africa at countries level and then at the regional level of development.

The structures of the national systems could be organized into three main groups with variations within each, this can be seen in figure 2.5. The first group encompasses countries that have a vertically integrated structure without Private Sector Participation (PSP). Out of the 54 African countries, 13 countries fall into this group. Interestingly, this group contains all the lowest 13 countries by nominal GDP, with the exception of Lesotho, Togo, Sierra Leone, and Sao Tome and Principe. These countries vary in size from Seychelles the smallest country in Africa to Chad the fifth-largest country in Africa. Sectors in this group are monopolized by a signal state-owned utility and only in the Republic of Congo we observe more than one utility. Only four countries in this group have a separate regulatory agency.

The second group, and the largest group, covers countries with vertically integrated structure and PSP. Different variations can be observed in this group. Out of the 30 countries in this group, 19 countries have PSP in the form of IPPs. The other countries have a different form of concession management contracts for the distribution and/or transmission network. All the sectors of these countries are publicly owned by the state, the only exceptions are Cameron, Côte d'Ivoire, Gabon and Mali. These four countries, all previously colonized by France, have full private sector domination in all segments. Finally, with the exception of Libya, Democratic Republic of Congo (DRC) and small size systems in Benin, Togo, Madagascar and Mauritius, all other countries have a separate regulatory agency.

The final group consists of the remaining 11 countries with a vertically unbundled structure. This group is the most diverse with each country has its own unique variance. A different degree of vertical unbundling and horizontal unbundling can be seen in each country with some countries have no PSP, and the other countries have PSP mainly in the form of IPPs with Nigeria and Uganda have a concession management for the distribution segment. Naturally, all these countries have a regulatory agency and surprisingly an interconnection as well with other countries, the only exception is Sierra Leone.

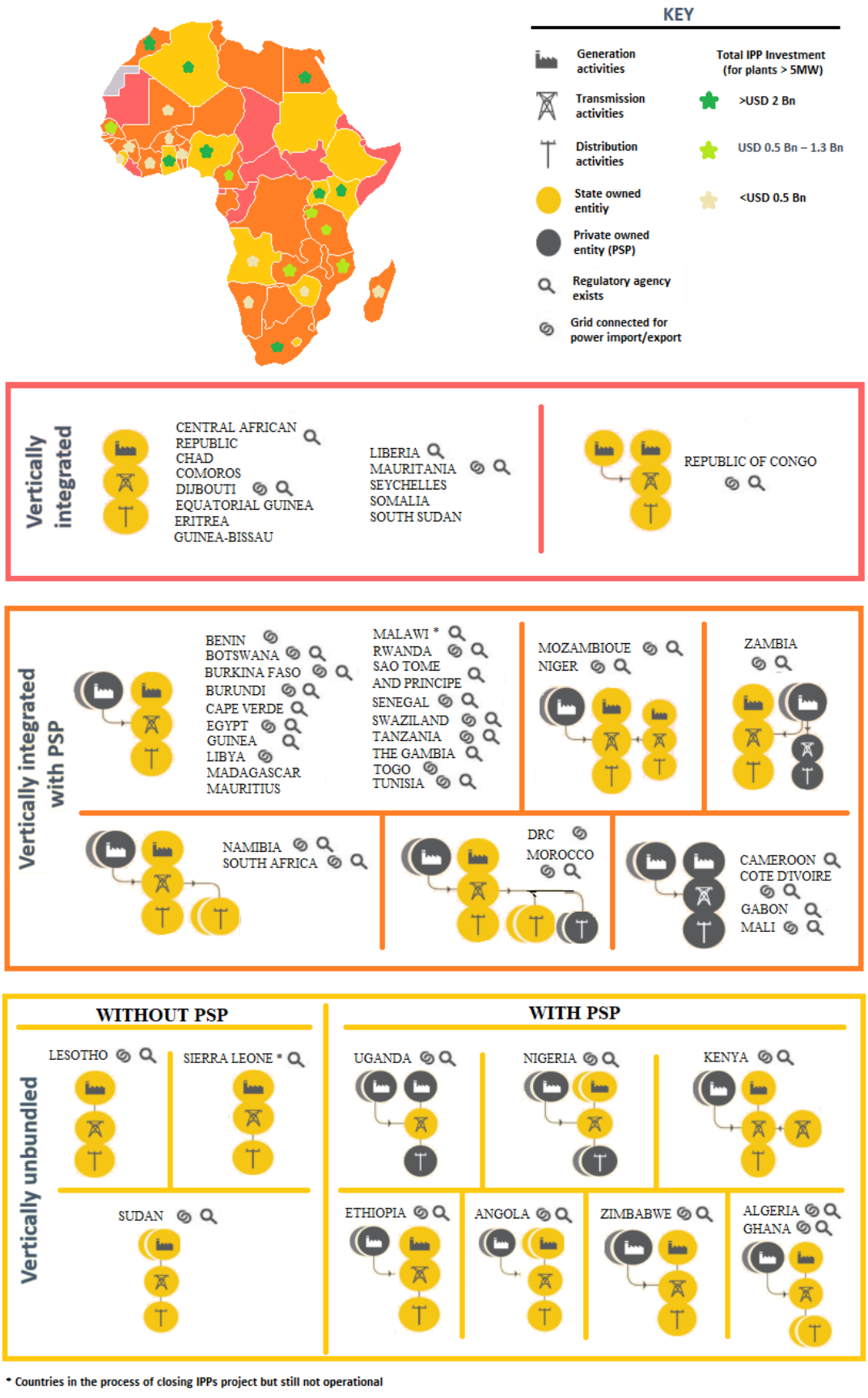


Figure 2.5: Power sector structure in African Countries. Composed by the author from various secondary data sources: Eberhard and Catrina Godinho [2017], Association of Power Utilities of Africa [2019], World Bank [2020b], and countries' reports

At the regional level, African countries have been following the same trend of creating regional power pools. The continent is divided into five power pools: Comite Maghrebin De LElectricite (COMELEC), Eastern Africa Power Pool (EAPP), Central African Power Pool (CAPP), West African Power Pool (WAPP), and Southern African Power Pool (SAPP). As their names suggest, these power pools are located in their respective geographic location with COMELEC located in the North, as shown in figure 2.6. Each power pool is different in terms of scale, governance, and effectiveness [IEA, 2019]. The most advanced power pool among the five is SAPP, established in 1995, while the latest and least developed is EAPP, established in 2005 [Association of Power Utilities of Africa, 2019]. Behind each power pool, there is a Regional Economic Community (REC). RECs are regional groupings of African states with a general purpose of facilitating regional economic integration between members of the individual regions and through the wider African Economic Community [ICA, 2018].

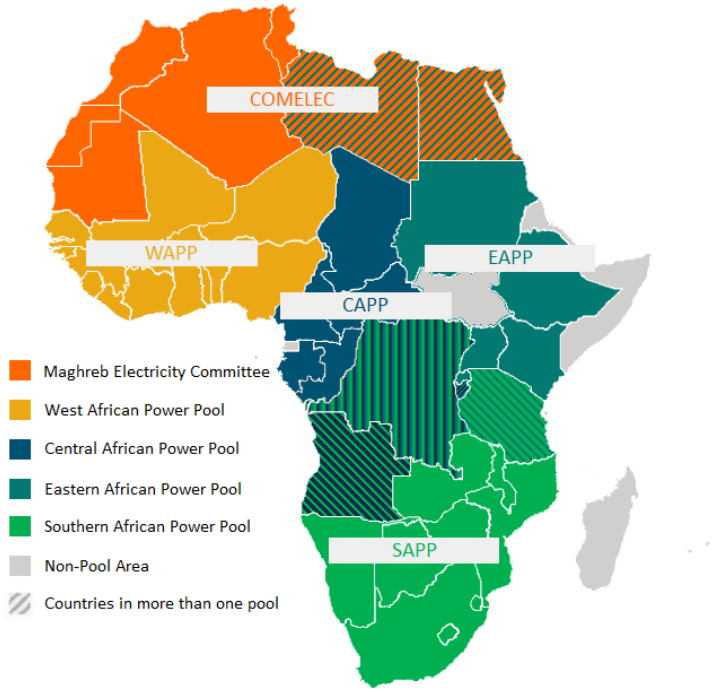


Figure 2.6: African Power Pools. Source: adopted from Attia [2019] and corrected based on IEA [2019]

Power pools stimulate investment in low-cost generation in countries with natural resources like hydropower in the Democratic Republic of Congo, Mozambique, and Zambia; natural gas in Côte d'Ivoire and Nigeria; and coal in South Africa. Such large -cale projects are viable in the presence of regional integration. However, most of the interconnections are state- or utility-owned and publicly funded since they require capital-intense investments with a high risk for the private sector. Currently, trade across the regions remains low and is mostly realized through bilateral contracts. Most of the trade happens in SAPP where the only functioning market is located and short-term trading is possible [Eberhard et al., 2008; IEA, 2019]. There is little attention in the literature towards studying African power pools [Economic Consulting Associates, 2010; Rose, 2017] and no study that compares them thoroughly to understand their factors of development and performance. Most of the studies are limited to technical modeling and future scenarios. Appendix B shows a list of found studies about African power pools.

2.5.3 The Current Status and Development

The power system in Africa remains largely underdeveloped with dismal statistics. In 2018, average losses amounted to 16%, which is seven percent higher than the average losses in other developing countries. High losses are usually attributed to the poor operational performance of the utilities and exacerbated by theft [IEA, 2019]. Containing 17% of the world's population, almost 60% of the population lives in rural areas with an access rate to the electricity of 5%. The overall electrification ratio is also as low as below 20% (e.g Burkina Faso) and just 45% average ratio in all Sub-saharan Africa. Only 13 countries in the region have power systems larger than 1 GW, while 27 have grid-connected systems smaller than 500 MW and 14 have systems smaller than 100 MW [Eberhard and Catrina Godinho, 2017]. The electricity consumption per capita is also very low: 54% of the countries have an average consumption below 200 kilowatt hour (kWh)/capita, with only 18% having an average consumption over 1000 kWh/capita [IEA, 2019]. According to World Bank Enterprise Surveys, power sector reliability in Africa is a major constraint for about 40% business in Africa [World Bank, 2019c]. Firms are experiencing outages on a regular basis on average between 200 and 700 hours per year with some countries much worse than this. The annual cost in some countries could be estimated up to 2% of GDP while annual finance gap to build the necessary infrastructure is estimated between 5-20 billion dollar ICA [2018].

Despite the progress made at the regional level, the development of the power pools is still ongoing. Currently, EAPP exists as three weakly interconnected sub-groups [SNC Lavalin International Inc and Brinckerhoff Parsons, 2011]. Three members of SAPP remain non-operating due to absent of access to the transmission network [SAPP, 2019]. Both CAPP and COMELEC still have to design and develop their power market institutions and rules while harmonizing regulations continues in WAPP. Improving the performance of the power pools requires proper analysis of developing factors and subtle considerate market design and institutions.

In conclusion, power sector reforms in Africa remains a work in progress. Despite the commitment of a number of countries to initiate reforms along the line of the standard textbook model, many countries are still in the state of the single-buyer model and seem to be reluctant in moving forward with restructuring. At the regional level, progress has been moving slowly in harmonizing national regulations, setting regional grid codes, and wheeling the necessary infrastructure development. A tremendous amount of effort is to be exerted to make up for the huge gap in the numbers.

2.6 CONCLUSION

This chapter highlighted various theories and reform practices related to power sector development. To establish an electricity market, restructuring has to take place to allow for competition. However, we saw that restructuring could serve different purposes like increasing the generation capacity by allowing IPPs as in Africa. Additionally, restructuring was not necessary for regional competition in African power pools. Therefore, drivers for change as well as reform purposes remain the determinants of the reform trajectory and the progress. From pioneers' experiences, there are different practical choices for reforms and market design that are affected by the contexts and circumstances of the country. Therefore, reforms usually take a pragmatic approach between theory and what works best given the different circumstances. History shows that markets, as well as the development of the power sector, evolve with time according to different factors (e.g., technology) and challenges (e.g., climate change). Similarly, the economic theories kept expanding from neoclassical to new institutional economics to encompass more complexity and provide different ways of explaining the development. From this point of view, we discuss in the following chapter what we consider a practical way of studying African power pools and formulate an analytical framework based on theories from interdisciplinary fields.

3 RESEARCH FRAMEWORK

"Faced with a choice between a theory which predicts well but gives us little insight into how the system works and which gives us this insight but predicts badly, I would choose the later"
Ronald H. Coase

This chapter answers the first research question *"How can regional power pools be studied in the institutional context of Africa?"* by providing an analytical framework. Section 3.1 gives an introductory prelude to studying a Regional Power Pool (RPP). Section 3.2 discusses the adaptation of the selected framework of understanding hybrid markets into understanding African power pools. Section 3.3 describes the methods we used in this research, and section 3.4 shows the ethical consideration we followed. Finally, section 3.5 provides the rationale behind selecting the three African power pool cases.

3.1 REGIONAL POWER POOLS: A PRELUDE

3.1.1 Defining Regional Power Pools

A power pool is defined as "a group of two or more utilities that coordinate their operation and planning" [Resource Planning Associates, 1980]. This could encompass several national (e.g., Norway and Sweden), state (e.g., Pennsylvania-New Jersey-Maryland (PJM)), or local (e.g., Northern Ireland) power systems that are characterized by having a highly harmonized and coordinated organization under a traditional or a market-oriented regulatory framework. A power pool is thus a higher hierarchical level of organization of several systems so that their original interactions become stronger and subject to well-defined commonly agreed rules [Olmos and Perez-Arriaga, 2013]. The degree of inter-utility coordination ranges from simple unspecific agreements on energy transactions to detailed arrangements for coordinated operation and planning among pool members. The World Bank classifies the organization of power pools to either "old style" or "new style" [Barker et al., 1997]. The "old style" power pool follows the organizational approach originated in the United State. These power pools were created to improve reliability, minimize operating costs through cost-based dispatch, and facilitate control of decision-making by vertically integrated utilities. The "new style" power pools differ from the "old style" tight power pools in that they aim to maximize competition in the generation, through price bidding and not cost, and to be open to all market participants. Regulation and governance are two key areas for organizing power pools [Oseni and Pollitt, 2014]. Governance is defined by "how decisions are made and implemented within a particular organization" while regulation is defined by "how governments review and change the decisions of the organization" [Barker et al., 1997]. Therefore, governance is an internal process to the pools while regulation is an external process. Internal governance could also serve as a way of self-regulation and avoiding the need for government intervention. Generally, governance relates to several fundamental questions: What decisions are made? Who makes them? How are decisions enforced? How are disputes resolved?

3.1.2 Establishing Regional Power Pools

The view that regional power pools are essentially regional markets suggests that they are subject to the same foundations. Compared to national markets, regional markets have different steps for their establishment, we call these "power pool reforms" for creating regional markets in conjugation with power sector reforms for creating national markets. Power pool reforms are different in that they are not centered around restructuring because unlike at the national level, competition at the regional level can happen without restructuring. The World Bank provides analogous steps for establishing a regional power pool. These reform steps are centered around creating common legal and regulatory framework, system planning and operation framework, and commercial framework [Pastor, 2008]. Olmos and Perez-Arriaga [2013] take this further by detailing the requirements for establishing a regional market and the number of technical, regulatory, and institutional challenges. From the two studies, we can list a number of reform steps for establishing a power pool:

1. Legal documents and agreements permitting trade.
2. Regional regulation for trade.
3. Commercial market rules for trade.
4. Wholesale energy market.
5. IPPs participation.
6. Regional market operator (and operation rules).
7. Regional system operator.
8. Regional grid development.

The different institutional arrangements of a regional market are to ensure equitable distribution of participant's obligations and benefits, shared use of the transmission grid and plants, coordinated operation, and establishment of the prices for energy transactions. This often entails different inherited tradeoffs between relegating national sovereignty to maintaining independence [Olmos and Perez-Arriaga, 2013; Oseni and Pollitt, 2014].

In Africa, the view of regional power pools is that they are a way of regional cooperation in the energy sector [Verhaeghe and Woolfrey, 2017; Karaki, 2017; Vanheukelom, 2017]. African countries have a history of mutual regional cooperation through establishing a REC.RECs are regional groupings of African states with the purpose of facilitating regional economic integration between members of the individual regions and through the wider African Economic Community [ICA, 2018]. The African Union recognizes eight RECs: the Arab Maghreb Union in the North; the Common Market for Eastern and Southern Africa (COMESA) in the South East; the Community of Sahel–Saharan States in the North; the East African Community (EAC) in the East; the Economic Community of Central African States in the center; the Economic Community of West African States (ECOWAS) in the West; the Inter-Governmental Authority on Development (IGAD) in the East; and the Southern African Development Community (SADC) in the South. These RECs are the cradle for the five African power pools that exist in Africa. They play a fundamental role in their establishment and nature. The view of regional cooperation gives African power pools a development element that affects their institutions. African power pools are institutionalized as a development organization for promoting regional integration [Medinilla et al., 2019]. This makes the establishment of African power pools is more than an exercise for designing a regional market but also building regional capacity and infrastructure. Thus, in this research, we adopt the definition of African power pools as Regional International Organizations (RIOs) because they match the definition of RIOs. Schimmelfennig [2018] defines RIOs for having "four necessary and jointly sufficient attributes":

1. **State Members**: RIOs are established by states and have them as their members.
2. **Organizational Capacity**: RIOs are organizations, having a physical headquarters and staff; having regular procedures such as meetings of their member states; and having the capacity to make decisions and to act on them.
3. **Multilateralism**: RIOs consist of more than two member states.
4. **Geographical Proximity**: RIOs' membership is geographically proximate and limited (in contrast to universal organizations).

3.1.3 Studying Regional Power Pools

The studies of African power pools insofar have been limited mostly to technical modeling and scenarios (see Appendix B). Within social science studies, African power pools have been investigated as regional markets compared with other regional markets like the Nordpool and PJM [Oseni and Pollitt, 2014]. Other studies look into the aspects of the reforms of African power pools (e.g., institutions and infrastructures) without explaining their development factors or providing recommendation [Economic Consulting Associates, 2009; ICA, 2011]. Norda and KPMG [2019] is the only study that investigates the power pools from the development perspective by evaluating their internal factors like financial capabilities and staff capacity but does not give insights into the broader context. This study was particularly commissioned as a review for a supporting fund program. Also, the other three studies were commissioned by international institutions involved with the power pools, the World Bank for instance.

In order to provide a comprehensive understanding of African power pools, the analysis should encompass both the view of a regional market and a development organization (RIOs) in explaining the performance. Therefore, in our research, we study African power pools carrying the two perspectives and attempting to formalize the analysis by developing an analytical framework combining relevant theories and empirical observations.

3.2 ANALYTICAL FRAMEWORK

African power pools seek to establish regional markets among mostly vertically integrated utilities. This structure of national systems limits the competition in the regional market as it is not conducive to competition [Barker et al., 1997]. The situation then unfolds into a hybrid market where state monopolies compete alongside IPPs sometimes. In this perspective, the development of the power pool could be explained with hybrid market theories and follows similar practices. Correljé and De Vries [2008] provide an analytical framework for explaining the patterns of restructuring. We take this theoretical framework as the base, adapt its various elements to the regional context, and integrate the perspective of the power pool as a development organization. We do this through the following steps:

1. Adapt the context to the regional power pool by modifying objectives, exogenous factors, and market design variables in accordance with our empirical observations.
2. Integrate the perspective of the power pool as a development organization by introducing endogenous factors from the theories of organization and capacity building (in line with Norda and KPMG [2019]).
3. Identify the dynamics of regional power pools through regional integration theory, policy-level interactions and the use of the "motors of change" concept from the transition management literature (based on evolution theory).

3.2.1 The Objectives of regional power pools

Since the earliest days of power sector reforms, the goals of the various development have been the same: availability, affordability, and acceptability. An RPP is another means to achieve these goals by reaping the benefit of regional cooperation and it can be viewed as another form of regional economic integration for utilizing natural resources and eventually fostering competition on the regional level. For each of the three goals, RPPs have recognizable theoretical benefits [Olmos and Perez-Arriaga, 2013; IRENA, 2019].

The goal of availability is generally twofold: the security of supply and adequate investments. From an economic perspective, RPPs allow for expanding power systems across borders which entails the potential of taking advantage of economies of scale on both the supply and demand sides, enabling the investment of larger resources and access to cheaper supply sources. An RPP potentially increases the security of supply by diversifying both supply and demand, allowing for the sharing of reserves, and increasing overall system security by increasing the diversity of available resources. The expansion of power systems also means a larger market with greater competition that would better attract private investors' participation and reduce the cost, hence, contributing to making electricity cheaper and affordable. Additionally, an RPP reduces the environmental impact of developing generation because it provides a better usage of energy sources as well as facilitates a higher renewable energy integration deriving from the fact that with larger balancing areas there is natural smoothing of the underlying resources.

These potentials are the primary driving forces for establishing RPPs. However, achieving regional integration is subject to many challenges that could limit the specific objectives of an RPP. Therefore, the objectives determine the role and the function of an RPP. These objectives are set by the participating members or through a regional body (REC) that governs the nature of the economic integration. Hence, these are the policymaker in the regional context.

3.2.2 The Contexts of Regional Power Pools

Similar to national market design, the context of the power pool constrain and limit its development and performance. We divide these into endogenous factors and exogenous factors. Endogenous factors are those internal to the power pool and can be managed from within. These are factors related to the power pool as a development organization (organizational capacity of RIOs) and determine its efficiency in performing its role. Exogenous factors are external to the power pool control and cannot be managed directly. These are factors related to the power pool as a regional market and constrain its establishment similar to the national market (as the original framework explains [Correljé and De Vries, 2008]).

Endogenous Factors

The literature on capacity building describes the different strategies and practices (e.g., evidence-based interventions) for increasing organizations' ability to perform their tasks. This literature employs diverse terminologies to refer to capacity building including "technical assistance," "facilitation," "knowledge brokering," and "prevention support," among other terms [Wandersman et al., 2008; Ward et al., 2009]. The capacity building of an organization is also viewed as enabling factor to adjust both internal and external factors [Fiszbein, 1997; Blumenthal, 2001]. Cairns et al. [2005] identify different internal factors including those targeted by capacity building programs to enhance organizations' performance. These include funding abilities, staff qualities, organizational structure, resources acquisition, and external relationship building.

African power pools are institutionally non-profit, international organizations [SAPP, 2021a; WAPP, 2019a; EAPP, 2020b]. They receive various supporting and capacity building programs

from international institutions. Norda and KPMG [2019] review and evaluate the performance of African power pools by investigating their internal organization through a framework on the theory of change. Based on this, we extract what we consider important endogenous factors that are determined by the pool and directly related to its performance.

Like other organizations, the power pool is responsible for establishing a governance structure for decision-making and daily operation. This structure affects the efficiency of the pool operation. The pool is also responsible for securing financial arrangements for its functioning, recruiting qualified staff, managing its relationships with stakeholders, setting internal dispute resolution for its members, and managing the technical resources for enabling trade. All these internal factors are essential for sustainable operations of the pool and impact the performance, as shown in table 3.1.

Factor	Impact
Governance structure	The organization of the power pool dictates the efficiency of decision-making and project execution. A fair and inclusive representation of the members increases the interest of other parties and the expansion of the power pool.
Financing arrangements	The daily operation of the power pool is affected by the financing arrangements from member countries and other organizations. Effective fee collection and payments of arrears are crucial for improving the performance of the power pool.
Staff capacity	Having high qualified staff and leadership accelerates the development of the power pool. A fully staffed power pool with a market committee enhances the performance of the power pool.
Technical readiness	Having the technical capabilities to establish a coordination center (market operator) for operating the power pool is a sine qua non for short-term trades.
Dispute resolution mechanism	Having a clear and fair dispute resolution mechanism enhances members' trust and essential for continuous trade operation.
Stakeholder relationships	Having a good reputation and relationships with various stakeholders help the progress of the power pool.

Table 3.1: Endogenous factors that affect the performance and outcome of the power pool.

Exogenous Factors

The external context of the power pool is more complex and includes many factors naturally due to its wide regional nature. This can be broken down into several contexts similar to the contexts of power sector restructuring [Correljé and De Vries, 2008], namely, physical context, institutional context, economic context, and political context. We separated the political context due to its prominent effect in the reforms in Africa [Eberhard and Catrina Godinho, 2017]. Each of these limits the settings of the power pool and constraints the participation of the members. Hence, the external context directly influences the development and design of the power pool and indirectly the performance of the power pool. Based on our empirical investigation of African power pools, we contextualize the different sets of external factors from their national nature in the original framework to a regional version. Table 3.2 shows an overview of the exogenous factors pertaining to the different contexts affecting the design of the power pool and members' strategies.

Context	Factor	Impact
Physical	*Transmission infrastructure*	The development of the internal transmission lines and interconnections affect the strategies of member countries and the regional trade. Low electricity access and network coverage limits its trade volume
	Structure of national systems	The organization of the national systems affects the governance structure of the power pool and its membership.
	Natural energy sources	The presence or absence of primary energy sources in the region drives the choice of primary fuels and trade opportunities. Seasonal resources like hydro are particularly influential to the dynamic of power exchange.
Economic	*Level of economic development and growth*	Influences demand growth of member countries, the potential for investments, and institutional stability.
	Demand growth in relation to generation capacity	Rapid demand growth and/or limited generation capacity increases import and the likelihood of congesting the network of member countries.
	Financing options	Limits the investments options especially in developing or transition countries; with a weaker economy financing options may be limited.
Institutional	*Regional institutional stability and rule of law*	Facilitate investment and external funding; helps adopt policy, regulation, and the decision of the regional institution.
	Regional institutional centralization degree and harmonization	The degree of harmonization and the mode of inter-jurisdictional governance arrangements determine the design options and the role of the power pool.
	Influence of stakeholders	Strong stakeholders may be able to influence the design and decisions of the power pool.
Political	*Ideology*	National supremacy undermine regional integration and the delegated authority to the power pool.
	Political stability	Member countries with a stable political system maintain a stable relationship and involvement with the power pool. The political situation affects the bilateral agreements between neighboring countries. Political instability, like military coup's, political revolution, and civil War, is inimical to attracting investment.
	Corruption	Affects the investment rate, the relationship with stakeholders, liberalizing trade, and the participation in the power pool.

Table 3.2: Exogenous factors that affects the power pool design and members' strategies.

The physical context of the region includes the development of the transmission network both on the national level and the interconnection level between countries. Having adequate regional infrastructure is a crucial element for trade to take place. Additionally, the patterns of trade follow the distribution of indigenous energy resources among countries. The presence of hydropower is particularly influential due to the seasonal variation. The structure of the national energy sectors also plays a role in the regional competition as well as the governance of the power pool. A power pool of vertically integrated sectors would exhibit less competition and less representation of stakeholders.

The economic context of the region includes the level of economic development, demand growth, and financing options. These factors limit the investment opportunities in the region, the expansion, and rehabilitation of the regional infrastructure. These conditions indirectly affect the solvency of participating members which undermines mutual trust and affects trade.

The institutional context of the region includes the quality of regional institutions and laws; the centralization and harmonization of these institutions; and the influence of stakeholders. This set of factors constrains some design options that require a high degree of coordination and responsibility allocation. The presence of a regional body and/or centralized institutions facilitates the enforcement of decisions. Additionally, clear institutions ease investments and stakeholder engagement. A strong stakeholder engagement could also influence the design of the power pool.

Finally, the political context includes the political stability of national countries, their ideology, and corruption. These factors enable or block trade among countries and are important for increasing trade volume and investment rate in the region. Having a political cover ensures the functioning of the power pool and playing a regional role.

3.2.3 Regional Power Pools Design

Empirical evidence shows that there is no single model for cross-border power system integration [IRENA, 2019]. However, it is possible to categorize cross-border integration efforts according to the mode and degree of integration. The form of cross-border integration starts primitively from bilateral agreements between countries and then formally takes the shape of a regional market or power pool that integrates multilateral trade between different countries. The degree of market harmonization and operation unification determine the design space of the power pool and the possible services by the market.

Starting from long-term power purchase agreements, the higher the degree of integration and coordination, the more short-term operations and services are enabled, such as ancillary services and real-time dispatch. However, the degree of integration is constrained by the regional situation, as discussed in section 3.2.2. Between the two extremes of simple bilateral trade to a unified market and operations (e.g., PJM), a set of design options can be obtained. Table 3.3 shows a list of design variables for formulating possible design options depending on the objectives of the power pool, the exogenous factors, and choices of the pool members.

Design variables, as defined by [Correljé and De Vries, 2008], are internal market settings that can be changed by the actors in the system and have a path-dependence impact and consequences of choice. We start with the list of variables identified in the original framework. Some of these variables are related to the market and are the same for the regional market: congestion management method, balancing mechanism, capacity mechanism, and position of the regulator. Other variables are the same but represented differently in the regional market: the degree of market opening is determined by the membership in the regional power pool; "integrated versus decentralized market" for power pools is "Loose versus tight pool" [Barker et al., 1997]; and network tariffs is the transmission tariff methodology [Olmos and Perez-Arriaga, 2013].

Variable	Consequences
Autonomy	Whether the decision-making authority is left to the members or in the hand of a political or regional body plays an important role in the decision dynamic and its enforcement.
Loose versus tight pool	A tight pool reduces transaction costs and allows for dispatch optimization, but combine both economic and physical control over the system in the hands of a single party, potentially facilitating governance. A loose pool is politically favorable.
Voluntary versus mandatory pool	Mandatory trade and/or bilateral agreements through the pool facilitates planning and reduces conflict, political interference, and trust issues between members.
Membership	Membership allowing for several classes ensures fair representation of stakeholders' interest and potentially increases trade volume.
Trading platform	The nature of the trading platform impact the volume of trade and members' participation. A shorter trading platform like intra-day provides more flexibility while physical and financial platforms increase the participation of various entities.
Transmission tariff methodology	The choice of the methodology affect the trade flow through the network, the cost incurred by members, and the investment in the transmission network.
Congestion management method	The method for managing network congestion and compensating parties affects trade opportunities between regions.
Balancing mechanism	Balancing mechanisms and financial settlement affect cost and revenues of type generation, especially for intermittent sources, and influence entry.
Ancillary services	Ancillary services provide opportunities for expanding the market and helping the operations of the system.
Capacity mechanism	Different types of capacity mechanisms exist in order to stimulate investment in capacity.
Investment unit (functionality)	Investment unit facilitates the execution of infrastructure project (or the master plan) and involves technical and financing partners in the operation of the power pool.
Position of the regional regulator	Internal to the pool or independent. Tying the regional regulator to the pool could result in a conflict of role and interest as well as inefficient resolutions.

Table 3.3: Power pool design variables.

The design variables are options for achieving goals [Correljé and De Vries, 2008]. From our observation of the current development and planning of the market in African power pools, we added three variables: voluntary versus mandatory pool, trading platform, and ancillary services. These options are different among the pools and can change with time. They also serve different purposes as described in table 3.3. Additionally, as the goals of African power pools extend to grid development, we added two more variables: autonomy as a function of the different governance structures of African power pools, and investment unit (functionality) as a way for fostering regional integration. These variables have important consequences on the performance of African power pools [Norda and KPMG, 2019]. We label the four design variables of autonomy, membership, investment unit, and regulation position as structural design variables because they pertain to the organizational structure of the power pool.

3.2.4 The Dynamics of Regional Power Pools

Similarly to national markets, the design space for RPPs at their inception is restricted to the starting conditions of the region. The situation of the regional infrastructure at the outset is the hard constraint that determining the pace of development. The presence of interconnections in the region, indigenous energy sources, and the structure of the national sectors shape the strategies of pool members. An RPP that was found in a vertically integrated environment would have a different design than another that was found among countries that have undergone sector reforms. The initial conditions of the economic development in the region and national policies and regulations influence members' strategies and the interest in regional trade. National policies, like renewable energy support, have direct implications on the regional market [Adiar and Litz, 2017]. Oppositely, the presence of a regional body, like the European Commission, that supervises the regional market could issue regional policies affecting the national policies and regulations [Mundaca et al., 2013]. This policy-level interaction is also observed in the context of African power pools and their RECs. The role and objectives of African power pools are set by the RECs or agreements between founding members, who are in this case the policymakers. This role is presumably aligned and complementary to the national systems with clear shared responsibility. Thus, the design of the power pool is a continuous process of interaction between national policies and regulations and choices made by members. Depending on the authority of the RPP, national regulation could be adopted to enable certain selected design options. The authority of the RPP in the region manifests itself through the degree of autonomy of the RPP and the strength of the regional body that enforces the decisions of the RPP.

The development and performance of African power pools are then restricted by the factors described in section 3.2.2. The theory of regional integration describes two ways by which RIOs can be established developed, by intergovernmental agreements in which member states are the key actors in the integration, or by a transnational body with supranational power [Schimmelfennig, 2018]. Both ways are observed in the establishment of African power pools. To put these into perspective, we use the transition management literature which describes the forces that incite the development trajectory in a system with various actors and interests. Hekkert et al. [2007] introduce the concept of "motors of change" to describe the driving forces and the paths for change within innovation systems. The same concept is used by Beyer [2007] to describe the role of organizations in policy-formation processes. In our empirical observation, we recognize three paths for the development and change in the context of African power pools. First, the different factors can be influenced by regional and international institutions. The nature and strength of the regional body (which could exhibit supranational power) determine the relationship with the power pool and to which degree it can support its development by steering the suitable regional environment or formally dictating the internal structure (endogenous factors). Second, the involvement of international financial and advisory institutions is another motor of change in the regional context. Financial institutions influence the development of the regional infrastructure and could directly provide financial and technical assistance for improv-

ing the capacity of African power pools. Through such support, the power pool design is also susceptible to influence. Advisory institutions working with national governments affect the political context and the institutional context in the region. Third, the other influential actor in the system is the pool member states. Depending on the degree of autonomy, pool members could directly change the design of the pool or could propagate it through a higher authority. While members' strategies shape the outcome of the pool, a well-functioning power pool increases members' trust in feedback process and could eventually impact their initial strategies to increase the degree of integration [Oseni and Pollitt, 2014; Schimmelfennig, 2018].

3.2.5 The Conceptual Framework

Synthesizing all the above elements gives us the conceptual framework presented in figure 3.1.

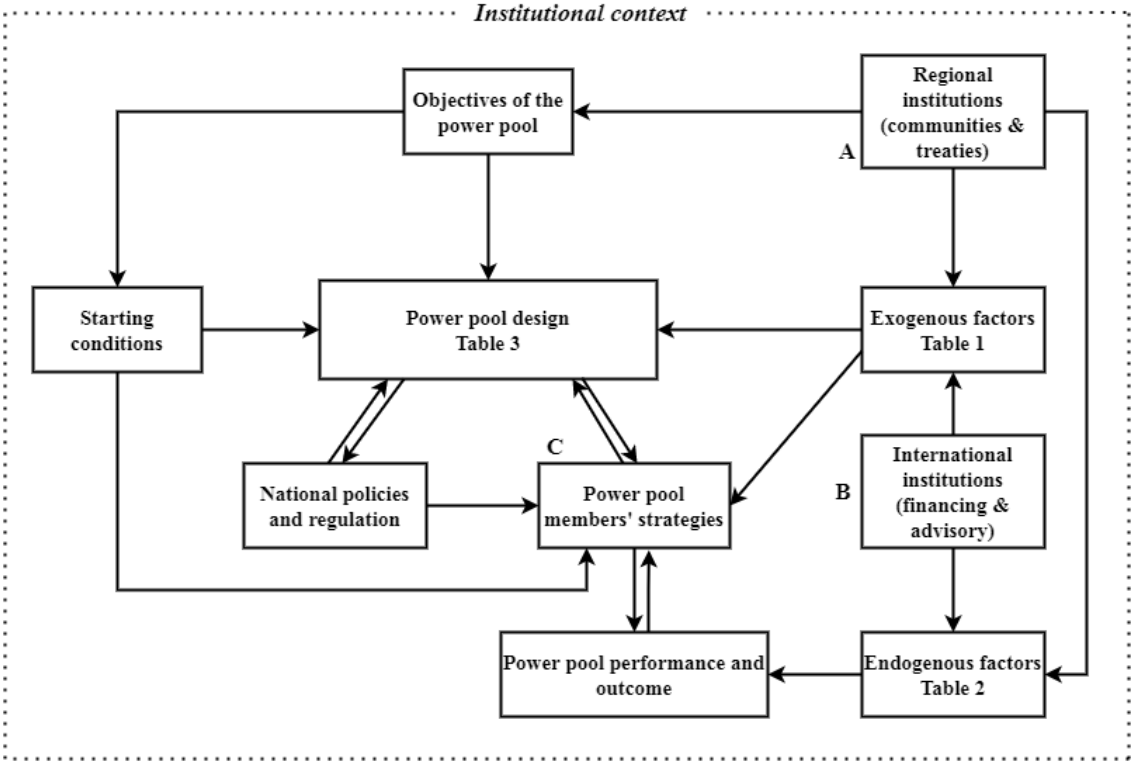


Figure 3.1: Conceptual framework for analyzing the regional power pools.

This figure summarizes the relations between the various discussed factors that influence the development and the performance of African power pools. The power pool design takes place within an institutional context comparable to the institutional context of electricity market design for national systems. The process is influenced by informal institutions such as culture and values and constrained by formal institutions such as international treaties, regional trade agreements, and the constitution. This context influences the regional objectives of the power pool and its effectiveness as a function of actors' power in the system. In this system, we identify three motors of change illustrated as (A, B, C). These are the three driving forces of the development and that shape the dynamics in the system, consequently the final outcome of the regional power pool.

3.3 METHODS

Data collection for the selected cases (described in section 3.5) was the main challenge in this research. The data covers 36 countries in Africa with very limited data sources. The selected methods for applying the analytical framework are desk research, interviews, and a visit to one of the power pools (that has no online available publications). These methods were chosen so that they help to analyze the situation with respect to the elements of the framework. Like any research method, the selected methods have several advantages and disadvantages. The next sections discuss each of them and argue how the critiques were handled within this research.

3.3.1 Desk Research

Desk research is utilizing existing data that has been collected and created by someone else, and can be accessible [Van Thiel, 2014]. The advantage of the method is that it is cost-effective. The initial desk research on African power pools and their member countries was done by looking into peer-reviewed papers, books, policy documents, white papers, technical reports, and authentic websites. The initial desk research was conducted with the guidance of the research questions. However, several iterations were required to validate the initial findings.

There are a couple of drawbacks to using desk research. First, the initial data is usually collected for a different purpose and presented in a certain way that could be unsuitable. This was the case with several quantitive data. To resolve this issue, efforts were made to access handy data as much as possible and adapt the information to match the set of research variables. Second, assimilating and organizing data takes time and rigor [Van Thiel, 2014]. A systemic approach and planning were used to solve this with the help of open software like Zotero. Third, the reliability and validity of data can be of concern. Data were collected from reliable sources and organizations like the World Bank and IREAN, as well as well-known journals. Additionally, most of the information was checked on an iterative search and triangulated with primary data. Interviews were used as a validation for the secondary data collected.

3.3.2 Semi-Structured Interviews

Primary data (data directly collected by the author) was collected through semi-structured interviews. An interview is defined by Sekaran and Bougie [2016] as "a guided, purposeful conversation between two or more people, requiring the interviewer to establish rapport and ask concise and unambiguous questions". Semi-structured interviews are between structured and unstructured interviews in the sense that there are predetermined questions but the interview follows a more flexible and conversational manner and consists of open-ended questions. In this research, the purpose for conducting semi-structured interviews is twofold: firstly, to validate the secondary data collected from desk research; secondly, to gain insights into the dynamics of the power pools by asking about the several elements of the framework. Thus, the answers to the interview questions helped with the operationalization of the variables in a deductive manner. Since interviewees have different backgrounds and roles, the order and the content of the questions were changed to fit the purpose. The guidelines by Jacob and Furgerson [2012] were used to prepare for the interview and an interview protocol was followed as presented in Appendix E.

Semi-structured interviews allow the interviewer to extract information on topics that might not be well studied or documented [Van Thiel, 2014]. However, the main disadvantage of interviews is that it is time-consuming and need a sophisticated interviewer for extracting relevant information [Adams, 2015]. This disadvantage was overcome by planning ahead, limiting the number of interviews and the length of interviews, and matching the interview questions with

research variables to help with the coding phase. Another drawback of interviews is that interviewees might not provide all information due to their roles and could be biased to their agenda. This is why it was important to get information from as many actors as possible and fact-checking the information without exhausting the resources.

The strategy in selecting the interviewees was based on the knowledge and perceived added value of the interviewees towards the findings of the research. We interviewed stakeholders and experts who are involved with power pools or knowledgeable about renewable energy in Africa and the competitive market role. Based on this, the interviews could be divided into three categories:

1. **Category 1**: Stakeholders who are directly involved with the power pools. This includes the operators and member countries. These interviews used for validating the collected secondary data and gaining insights into the dynamics of the power pools.
2. **Category 2**: experts who are involved with the power pools via consultancy or another way of cooperation. These interviews were used to gain a different perspective of the dynamics and more insights into the development.
3. **Category 3**: experts who are knowledgeable about renewable energy in Africa and the power pools' competitive market role. These interviews were used in the design phase to come up with improvements.

All the interviewees were approached to conduct a 45 minutes interview. Upon their consent, a brief text explaining the aim of the thesis and the objectives of the interview was sent along with potential questions (see Appendix E). This was done to accelerate the interview and prepare the interviewee for the topics to be discussed. Most of the interviews were conducted online through video call applications (Zoom, Microsoft Teams, and Google Meet) except interview 10 with EAPP Staff was conducted face-to-face as part of the visit to the power pool. Table 3.4 shows the details of interviews ordered based on the conduction date, and the summary is written in Appendix E.

While conducting interviews, it was difficult to reach out to stakeholders who are members of the power pools. The main reason could be that such a job-related interview is feared to yield negative consequences on the interviewee and also it is usually hard to obtain official approvals from these companies, only those that see the indirect benefit from this would spare some time from their employees. This was also noticeable for the power pools themselves; an official request was always needed but since they could be beneficiaries from the study, they were prepared for collaboration. While discussing the various topics related to our analytical framework, the governance and the dynamic of the decision-making was the hardest to approach and gain insights into it. Again, this is because it is particularly problematic for the interviewee to disclose sensitive information and the fear for retaliation was evident. Although we offer complete anonymity for the interviewees, they preferred not to answer these questions.

During our interview process, we followed the snowball methodology for finding potential interviewees from an already identified interviewee. For instance, interview 4 led to interview 2 that led to interview 9; and interview 12 led to interview 1 (the order of contact was different than the order of conduction). Although this method depends on the willingness of the interviewee for collaboration as well as his impression about the interview after its conduction, we found that all the interviewees were extremely collaborative and pleased to offer all kinds of help, and for that, we are deeply grateful. One particular platform that was very useful to find interviewees and that we recommend is LinkedIn. A simple post briefly stating your research topic and what you are looking for would open unimaginable doors for your research. It was always surprising for us how strangers can be helpful and generous.

No.	Interviewee	Category	Organization	Role	Expertise	The Power Pool
1	Saliem Saliem	1	SETCO	Former Acting General Manager of SETCO	Business in the power system	EAPP
2	Elias Zigah	2	-	Independent Researcher	Regional integration and energy transition in Africa	WAPP
3	Sergio Portatadino	2	TBI	Technical Lead and Deputy Chief of Party	Regional trade and governance	WAPP
4	Anonymous	2	-	Independent Researcher	Nigerian electricity market	WAPP
5	Federico Bruno Pontoni	2	TBI	Consultant	Energy Economist	WAPP
6	Stephen Dihwa, Elisha Mutambudzi	1	SAPP	Executive director of SAPP Coordination Center, Acting Chief Engineer Markets	SAPP	SAPP
7	Bruce Byiers, Alfonso Medinilla	2	ECDPM	Head of the African Institutions and Regional Dynamics Program, Policy Officer	Regional economic communities in Africa	SAPP, WAPP, EAPP
8	Eugenia Masvikeni	3	SACREEE	Renewable Energy Expert	Renewable energy	SAPP
9	Geoffrey Mabea	2	EREA	Executive Secretary	Regulation	EAPP
10	Hieromini Shirima, Haitham Hashim	1	EAPP	The Market Unit, The Grid Coordination Unit	EAPP	EAPP
11	Viviane Ahossi, Kam Sie, Ibrahim Soumana	1	WAPP	Legal Assistant, Market Expert, Project Coordinator	WAPP	WAPP
12	Mohamed Alhaj	3	Clean Energy 4 Africa	Director	Renewable energy	-

Table 3.4: The list of conducted interviews.

3.4 RESEARCH ETHICS

The ethical considerations refer to beneficence, veracity, privacy, confidentiality, and informed consent [Van Thiel, 2014]. Beneficence refers to a study striving to contribute to the existing knowledge in a field or resolving a problem [Van Thiel, 2014]. This study aims to fill the knowledge gap on African power pools regarding improving their development and performance. Veracity ensures that the research is not misleading research subjects [Van Thiel, 2014]. In this research, veracity is guaranteed by informing the interviewees about the aim of the study. Privacy is respecting the participants' right to disengage or keep information to themselves [Van Thiel, 2014]. All the interviewees were told to be comfortable during the interview and answer only when they want to. Confidentiality refers to the agreement between the researcher and participants about how the information is used [Van Thiel, 2014]. To guarantee confidentiality, we asked all interviewees for permission to record the conversation and use their names and affiliation in this report. Informed consent requires the researcher to have authorization from the participants for studying a certain topic and publishing the research results [Van Thiel, 2014]. Informed consent was ensured by requesting all interviewees to review, comment, and clarify any of the selected quotes reflected in this research. The interview summaries written in Appendix E were all approved by their respective interviewees.

3.5 CASE STUDIES SELECTION

In this master thesis, we aim to contribute to the lacking efforts for improving the power sector in Africa. We focus on the regional power pools for their recognizable potentials in improving the power sector performance among countries altogether. The governments of African countries have demonstrated their intentions for regional cooperation as the way to move forward, yet the scientific efforts are to follow up in supporting the progress. African power pools received little attention in the scientific literature compared to other pools around the world as well as other case studies in Africa at countries' level [Economic Consulting Associates, 2010;

Rose, 2017].

To expand the literature on market design and regulation in Africa, this research analyzes three power pools: SAPP, WAPP and EAPP, and moves beyond the analysis to provide design choices for structuring the three power pools and improving renewable energy integration in the competitive market. Between the five power pools in Africa, these three were selected because they present the largest and most diversified experiences with regional integration in Africa over the longest time period. Each power pool has its own settings of regulations, governance, and institutions: SAPP being the most advance, whilst WAPP and EAPP being on the development track and could draw lessons from the former to accelerate their progress. Another reason for the selection is that the three power pools fall in the same region, Sub-saharan Africa, and are usually discussed and grouped together in the international datasets and the paucity of literature that exists, which makes it more convenient to analyze as a group. The COMELEC power pool is located in north Africa and is usually associated with the MENA region, it is also connected with Europe via Spain—Morocco and Tunisia—Italy interconnections, which puts it in a different context. Although CAPP falls in the same region as the other three, however, due to being relatively new, data is significantly lacking and not much historical development has transpired. Insights from this study could arguably be applied to CAPP, given that the same challenges and opportunities are likely to be found.

In the following chapters we discuss each case separately by looking at the evidence on what happened to facilitate trade, the supporting institutions, the governance of these institutions, the regional infrastructure, the nature of the trading platform, and the structure of the national systems. We conclude each case with an analysis of the situation by filling in the blanks in our conceptual framework. Then we compare the three cases in a different chapter and confront the analysis with the relevant theories. Finally, the time span of the analysis follows from the establishment of the oldest power pool in the case studies, SAPP 1995, until the date this study is concluded, 2021. The geographical boundary is limited to Africa and to the territories of the three power pools.

Part II

AFRICAN POWER POOLS: TAKE STOCK

4 THE SOUTHERN AFRICAN POWER POOL – SAPP

"Successful reforms in the power sector depend on mutual accommodation of the various concerns of the funding institutions, government and local interests"
Allexon Chiwaya

In this chapter, we look into the situation in the Southern African Power Pool (SAPP). Firstly, we present the historical development of SAPP. We start by looking into the regional institutions in section 4.1, the governance structure in section 4.2, the policies and regulation in section 4.3, the regional infrastructure in section 4.4, the national systems in section 4.5, and the regional market in section 4.6. Secondly, we apply our analytical framework, discussed in chapter 3, in section 4.7. We conclude the chapter with answering the second research question *"What were the factors and reform steps for establishing SAPP?"* in section 4.8.

Among the five power pools that exist today in Africa, the Southern African Power Pool (SAPP) is the most advanced and the only one that has a functioning market [ICA, 2016; IEA, 2019]. The pool includes twelve countries, as shown in figure 4.1, and covers a total area of 9,061,120 km^2 and a population of 333.3 million [Worldometer, 2020].

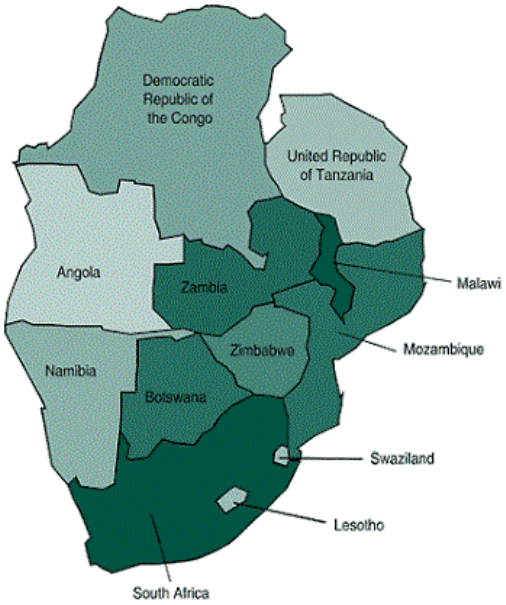


Figure 4.1: Geographic map of the countries of SAPP.

4.1 REGIONAL INSTITUTIONS

The Southern region of Africa witnessed a long historical collaboration between neighboring countries started in 1980 with the establishment of the Southern African Development Coordination Conference (SADCC). With strong support from the then European Community, SADCC was instituted with a memorandum of understanding on common economic development between nine countries: Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland (official name Eswatini), Tanzania, Zambia, Zimbabwe. SADCC was primarily a response to the threat posed by the apartheid in South Africa which had the region going into a full cold war [Vanheukelom, 2017]. In 1992, following the end of the cold war, the democratization process in South Africa, and the independence of Namibia from the apartheid, SADCC was transformed to the SADC under Article 2 of the SADC Treaty in Windhoek, Namibia. The membership of SADC was extended to 16 countries including the former members of SADCC plus Comoros, DRC, Madagascar, Mauritius, Namibia, Seychelles, and South Africa; with a mission of "promoting sustainable and equitable economic growth and socio-economic development" [SADC, 2012].

The former SADCC institutional arrangements were decentralized and narrow in fields of cooperation. Thus, cooperation was built on specific sectors and policies that are uncontroversial. Transforming SADCC's memorandum of understanding, SADC Treaty brought about a legal obligation for participation and implementation of decisions. The regional protocols set the rules of the game for the various sectors and form the legal foundation for cooperation. The energy sector and industrial sectors are the two important cooperation areas in SADCC. Member countries are in different states of economic development, institutional maturity, and political stability. Different factors contributed to this, including colonial history, resource variance, and the strategic geographical position of countries. Hence, countries have dissimilar interests in regional cooperation.

The development of the Southern African Power Pool was a result of cooperation in the energy sector. In the 16th summit at Johannesburg, the nations of SADC (excluding Mauritius) signed an Inter-Governmental Memorandum of Understanding for the creation of the Southern African Power Pool (SAPP) in 1995 as a cooperation of the national electricity companies. All member states of SADC are members of SAPP with the exception of the four unconnected islands: Comoros, Madagascar, Mauritius, and Seychelles. The goals of SAPP are to increase the accessibility of electricity to rural communities and improve the collaboration between member countries to provide the least cost, environmentally friendly and affordable energy [SAPP, 2021a]. The institutions of SAPP are governed by four agreements:

1. The Inter-Governmental Memorandum of Understanding (IGMOU) which enables the establishment of SAPP.
2. The Inter-Utility Memorandum of Understanding (IUMOU), which establishes SAPP's basic management and operating principles.
3. The Agreement Between Operating Members which establishes the specific rules of operation and pricing.
4. The Operating Guidelines, which provides standards and operating guidelines (currently under revision).

During the same year, the Protocol of Energy was proposed (signed a year later, 1996) to serve as a broader framework for regional harmonization between the different energy sectors. The Protocol of Energy sets the guidelines for collaboration and establishes the Energy Commission with the responsibility of enforcing the rules of the protocol [SADC, 1996]. In 2007, both the IGMOU and the IUMOU were revised. This has led to several changes including the reporting structure of SAPP, the expansion of SAPP membership to include participants other than the

national power utilities (e.g., Independent Power Producers) and the expansion of SAPP organization to include other facilities like the coordination center [SAPP, 2006, 2021a].

4.2 THE GOVERNANCE OF SAPP

The twelve member countries of SAPP are represented by their respective electric power utilities organized through SADC. SAPP is associated with SADC directorate of infrastructure and services. The governing structure, depicted in figure 4.2, consists of the executive committee, the coordination center board and the management committee under which there are four working committees: the environmental subcommittee, the markets subcommittee, the operating subcommittee and the planning subcommittee.

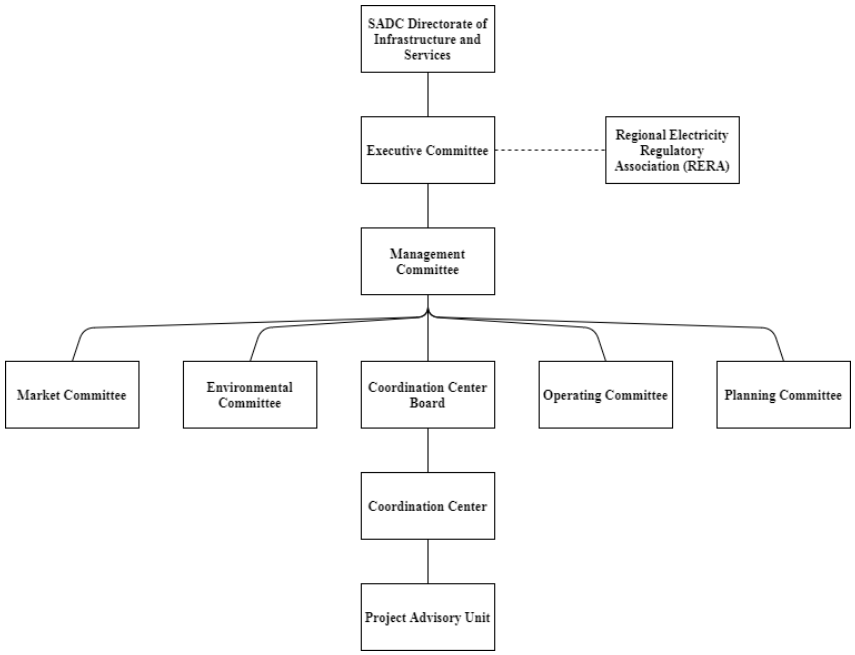


Figure 4.2: The governing structure of SAPP. Source: SAPP [2021a]

The executive committee, the highest authority of the organization, acts as the board of SAPP and is responsible for the coordination and formulating the objectives of SAPP, as well as reporting to SADC directorate. The committee includes the chief executives of only member electricity supply enterprises who generate wholesale and retail power to end-user customers. The committee can add new members to SAPP and grant the observer status, but such decisions are to be approved by SADC energy ministers. SADC records and keeps the minutes of all committees' meetings. Each member on the executive board has one vote and decisions are made by consensus or a two-thirds majority of the members present at the meeting. In case of a dispute between operating members, the matter is referred for arbitration or another procedure the members agree upon.

SAPP operation is facilitated through a managing committee and working subcommittees. The management committee is responsible for organizing staff training; managing data and facilities; improving and introducing pool services; determining the fees and payments of the members; and making all decisions that are not specifically delegated to the other subcommittees. The management committee is formed by officials from the member utilities with a maximum of three representatives per utility [Economic Consulting Associates, 2009]. The committee manages the following four subcommittees:

- **The Operating Subcommittee**: has duties such as establishing and updating methods and standards for generators testing and technical performance, determining the operating reserve obligations, monitoring compliance to the system peak and capacity obligations, updating operating procedures for interconnections, conducting system operational studies, and determining applicable penalties for non-compliance and failures.
- **The Planning Subcommittee**: has several functions and activities to the regional and national plans of the infrastructure. These include establishing and updating common standards and compliance criteria, reviewing members plans periodically, ensuring plans integration, assessing the network, forecasting future demands and capacity needed, and purposing adjustment for the wheeling rates.
- **The Environmental Subcommittee**: tasks include the development of environmental management guidelines for SAPP and reviewing them periodically, keeping abreast of world and regional matters relating to climate change mitigation and adaptation to ensure sustainability, helping in harmonizing regional environmental legislation, and establishing key performance indicators for environmental impact assessment for SAPP interconnector projects [SAPP, 2021b].
- **The Markets Subcommittee**: is a new subcommittee that was created along with the coordination center in 2007 after the signatory of the revised IUMOU [SAPP, 2021a]. The committee is responsible for revising the design and the structure of SAPP market, operating all markets of SAPP, determining the criteria to authorize members to trade, and conducting market surveillance.

Chairing of each committee rotates between representatives of the member utilities. All participants of SAPP must be situated in a country, which was a member of SADC in September 1994. The full membership is for national utilities only and is restricted to one per country as designated by the country's government and, thus, represents the country's interest in the executive board of SAPP.

The idea of establishing a coordination center was conceived prior to 1999 when the bid for hosting the center was won by the government of Zimbabwe. However, the official opening of the center was later in November 2002 [SAPP, 2006]. The coordination center was part of the operating subcommittee, as per the IUMOU of 1994. However, after the success of the Short-Term Energy Market (STEM), the completion of various studies approved and implemented, and the facilitation of meetings and dispute resolution among its members helped in making the coordination center a credible and respected organization [Economic Consulting Associates, 2009]. Thus, an independent coordination centerboard was lastly established in 2007 after the signing of the revised SAPP IGMOU [SAPP, 2021a]. The manager of the coordination center is also figuratively speaking the CEO of SAPP. The coordination center is responsible for day-to-day operations of the pool, preparing monthly and annual reports, and performing various studies for the operation and planning of the pool.

The center hosts and supervises the Project Advisory Unit (PAU) which was funded by the World Bank in 2015 (interview 6). The PAU was founded out of the necessity of delivering more projects for both transmission and generation. It is, therefore, responsible for the entire phases of project preparation and all its aspects (legal, technical. financial, managerial, and environmental) and its focus is primarily to facilitate moving brownfield and greenfield (IPPs) priority power projects to bankability.

SAPP is officially registered as a non-profit organization. Despite being a special institution of SADC, SAPP is financially independent of SADC and depends on members' contributions. Income is generated from membership fees, administration fees from managing the regional market, and the contributions of development partners. Annual reports indicate that between 80 to

90% of membership fees are directed to SAPP operations, while external funding is allocated for studies and projects. All members pay an annual membership fee of two thousand five hundred dollars (USD 2,500).

4.3 REGULATION AND POLICIES

4.3.1 Institutions

The establishment of the Regional Electricity Regulators Association of Southern Africa (RERA) came seven years later after SAPP was initiated. In 2002, SADC energy ministers approved the foundation of RERA to be based in Nambia. Nevertheless, the secretariat became functional in 2005 and was the first electricity regulator association in Africa [Sithole and Sichone, 2012]. RERA is composed of national regulators (as far as the national reforms create one) of ten countries, as shown in table 4.1. The mission of RERA is to facilitate harmonization of regulatory policies, legislation, standards, and practices and to be a platform for effective cooperation among energy regulators within the SADC region.

	Member	Abbreviation	Country
1.	Institute for Electricity Sector Regulation	IRSE	Angola
2.	Lesotho Electricity and Water Authority	LEWA	Lesotho
3.	Malawi Energy Regulatory Authority	MERA	Malawi
4.	National Electricity Advisory Council	CNELEC	Mozambique
5.	Electricity Control Board	ECB	Namibia
6.	National Energy Regulator of South Africa	NERSA	South Africa
7.	Swaziland Energy Regulatory Authority	SERA	Swaziland
8.	Energy & Water Utilities Regulatory Authority	EWURA	Tanzania
9.	Energy Regulation Board	ERB	Zambia
10.	Zimbabwe Energy Regulatory Authority	ZERA	Zimbabwe

Table 4.1: RERA Members. Source: SADC [2016]

The institution of RERA does not delegate any authority to establish or enforce the rules, but rather to work mainly to support national regulators and make recommendations for SADC. This institution and organization of RERA are currently under revision in collaboration with COMESA, as the regulation in SADC moves from electricity to energy regulation, to give it more power and authority for decision-making [Political Analysis, 2019; COMESA, 2019].

At the 34th meeting of SADC Energy Ministers 2015, the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE) was created as a subsidiary organization based also in Nambia with a mandate to support achieving the sustainable development objectives in the region [SADC, 2016]. The structure of SACREEE consists of the executive board, technical committee, the secretariat, and National Focal Institutions (NFIs). The NFIs are working groups from all the 16 countries of SADC, appointed by their respective energy ministers to cooperate with SACREEE in developing policies and legislation.

4.3.2 Regulatory and Policy Frameworks

Before entering the process of revision, the previous role of the regional regulator, RERA, was primarily consultative and does not give it enough regulatory authority for decision-making. RERA does not have a publishing platform (e.g., dedicated website) and mostly works with other national regulators to improve their capacity. Thus, the regulation of SAPP is a de facto self-regulation maintained with internal agreements and approval of the SADC council of ministers

(Interview 6). However, SAPP signed a memorandum of understanding with RERA to cooperate and define the areas in that RERA has a key role to play and where SAPP can play independently. Currently, part of this cooperation is coming up with the harmonization of grid code in the region (Interview 6). The general regulation of SADC also applies to SAPP, particularly, the SADC Protocol on Energy (1996) and the Declaration on Regional Cooperation in Competition and Consumer Policies (2009) are the main legal documents for region-wise compliance. SAPP operations are managed internally through the Agreement Between Operating Members and The Operating Guidelines which define the rules and procedures of the market, the pricing methodology, and the standards for the operations.

Contrarily to regulation, SADC has been keen on developing regional policies and strategies. Over the years, several regional development plans have been adopted by SADC to spur development in the energy sector. These include the SADC Energy Cooperation Policy and Strategy (1996), the SADC Energy Action Plan (1997), the SADC Energy Activity Plan (2000) and the Energy Sector Plan (2012). These strategic plans are revised periodically during the SADC Summit of Heads and State and Government. The most important plan is the Regional Indicative Strategic Development Plan (RISDP) which is a 15-year regional integration development framework, setting the priorities, policies, and strategies for achieving the long-term goals of SADC. It is intended to guide member states, SADC institutions, regional stakeholders, and international cooperating partners in the process of deepening integration to turn the community's vision into a reality [SADC, 2010]. The first RISDP was approved in 2003 for the period 2005-2020 and was assessed and revised in 2013. The second RISDP was published in October 2020 for a period of 10-year, from 2020-2030, including a vision for 2050 [SADC, 2020].

The regional renewable energy center SACREEE plays a role in developing policy recommendations for expanding renewable energy and energy efficiency programs for member states. As an independent organization, the center publishes status reports of renewable energy in the region, policy briefs, and conducts relevant projects with the NFIs and other partners (see SACREEE [2018b,a]). SAPP collaborates with SACREEE when taking renewable energy projects, energy efficiency initiatives, and carrying studies on the impact of renewables on SAPP's grid. Additionally, SAPP environmental subcommittee develops various guidelines for handling special materials and performing social impact assessments as well as other key documents like SAPP Environmental and Social Management Framework and the Climate Change Mitigation and Adaptation Strategy [1].

4.4 THE REGIONAL INFRASTRUCTURE

4.4.1 The Current Status

The regional infrastructure of SAPP is relatively well developed and covers most of the members. The transmission network connects nine countries out of twelve and has a total interconnection capacity of 10,891 MW. Each country has at least two interconnections, except for DRC and Lesotho, and the largest interconnection capacity is 3,370 MW between South Africa and Mozambique. According to the annual report of 2019 [SAPP, 2019], the installed generation capacity of the twelve countries is 73,2632 MW with an operating capacity of 58,928 MW, while the nine connected members have a total of 63,157 MW installed capacity of which the operating capacity is 53,028 MW.

The peak demand of all countries sums up to 50,775 MW with a surplus generation capacity of 1,239 MW. On the other hand, if we exclude unconnected countries, the peak demand is 47,111 MW with a deficit of 655 MW. Figure 4.3 shows the power grid of SAPP and the peak demand

1 Refer to the publication in SAPP website http://www.sapp.co.zw/sapp-environmental-management-guidelines

for each country.

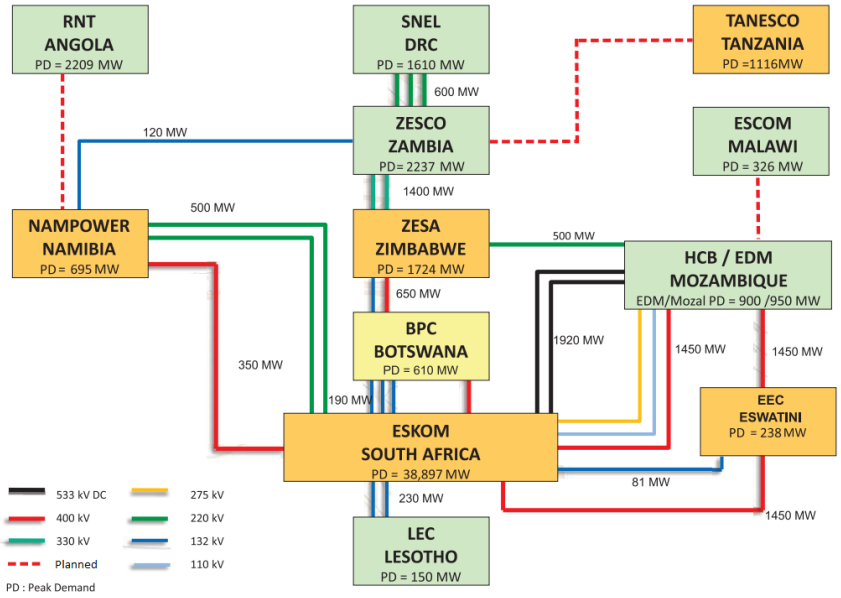


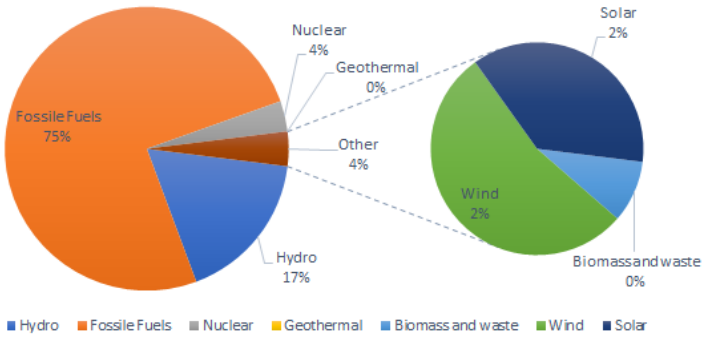
Figure 4.3: Peak demand and transmission capacity of SAPP regional power grid. Source: SAPP [2019]

The generation portfolio of SAPP, shown in figure 4.4, consists of 70% fossil fuels (of which 60% is coal), 18% hydro, 5% solar, 3% wind, 3% nuclear and 1% biomass and waste installed capacity. The lion's share goes to South Africa with 53.4 GW installed capacity which counts for 73% of the total. The second-largest installed capacity is found in Angola with 7%, however, among the connected countries all of DRC, Zambia, and Mozambique take 4% of the installed capacity.

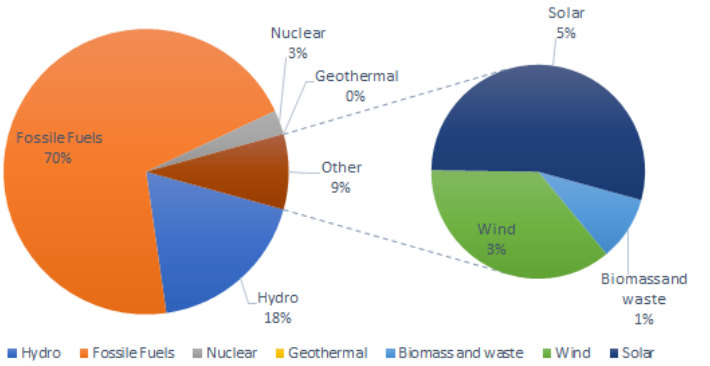
77% of the electricity generated in 2018 came from South Africa that produced 93% of the total fossil fuel generation in the region. The two following largest producers among the connected members are Zambia and Mozambique which both supply, almost equally, 51.6% of the total generated electricity from hydro while 19.7% came from DRC. 4% of the generated electricity was produced by nuclear in South Africa solely.

The energy trade patterns, shown in figure 4.5, follow a predictable scenario. Countries with a large installed capacity and generation are the net exporter in the region, these are South Africa, Mozambique, and Zambia. Both Mozambique and Zambia export their cheap hydro generation in rainy seasons while importing electricity in dry seasons. South Africa in return exports its surplus of electricity produced from the large reserve of coal generation while importing cheap electricity from hydro when its neighbors have an excess generation. These three countries are responsible for 87% of the total energy trade in SAPP. Another major player in the energy trade is Namibia with a share of 7% of the trading and mainly importing energy from both Zambia and South Africa.

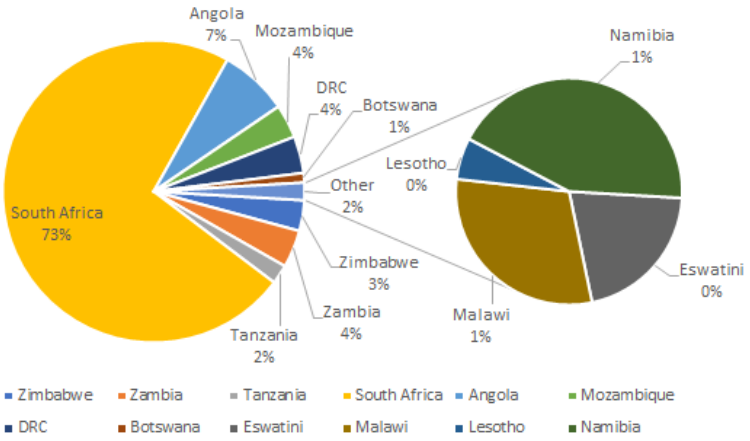
Countries with the largest generation have naturally the largest consumption, with the exception of Mozambique, these countries mostly fulfill their consumption with their local generation and then export the surplus. Three countries in SAPP are entirely energy importers, these are Bostwana, Eswatini, and Lesotho. Lesotho is particularly dependent on South Africa in its energy consumption, as it is not just landlocked, but South Africa-locked. 44.4% of the consumption of Lesotho is imported from South Africa. However, Lesotho is only the fourth in the importing ranking, the other three are Namibia, Mozambique, and Eswatini with imports percentages of 82.4%, 73.9%, and 60.6% of its consumption, respectively. With such a high



(a) SAPP generated electricity by source in 2018.

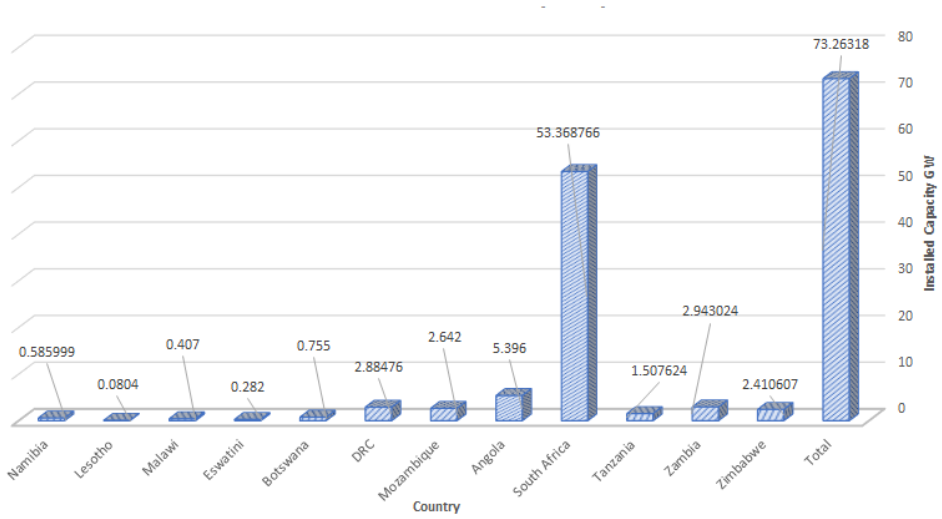


(b) SAPP installed generation capacity by source in 2018.

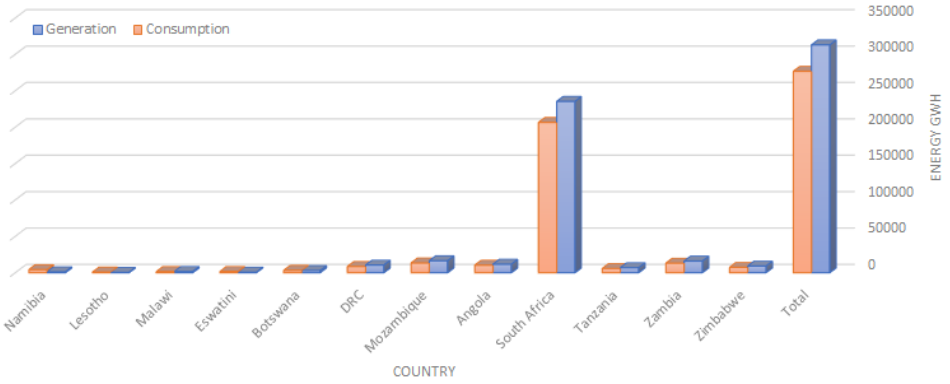


(c) SAPP countries' share of the installed generation capacity in 2018.

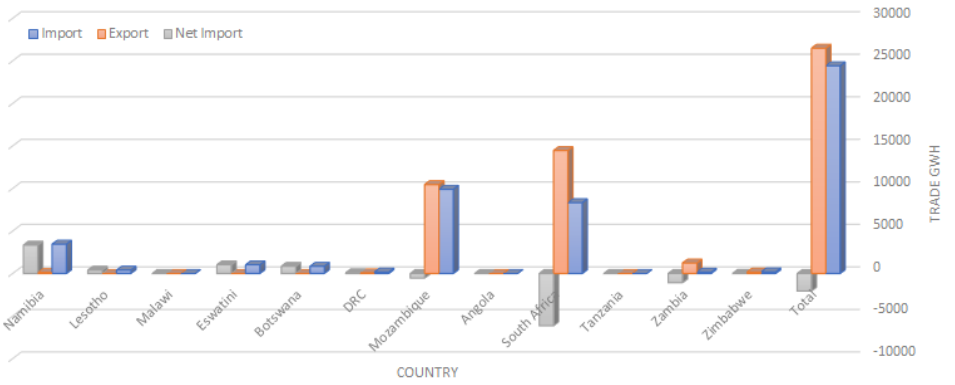
Figure 4.4: SAPP generation portfolio in 2018. Data source: EIA [2021]



(a) SAPP installed generation capacity per country in GW in 2018.



(b) SAPP countries' generation and consumption in GWh in 2018.



(c) SAPP countries' export and import of electricity in GWh in 2018.

Figure 4.5: SAPP energy trade in 2018. Data source: EIA [2021]

importing share and exporting, this means Mozambique has a cycle of extreme shortage and excessive surplus during the year.

4.4.2 Planning and Investments

The first Energy Plan was prepared by SAPP in 2001 and updated multiple times in 2005, 2009, and the last one in 2017. The Energy Plan sets seven key criteria for selecting the list of priority projects to be approved by SADC energy ministers. The projects list covers three sets: rehabilitation projects, generation projects, and transmission projects. The projects' implementation is carried out by each country on its geographic boundaries and SAPP is only responsible for the coordination of these projects. The PAU oversees the execution and provides financial bankability services to new IPPs. It also coordinates the transmission line projects that include more than one party, prioritizes the off-takers and allocates the risk among them. Each off-taker needs to agree on buying the capacity on the line for the duration of the debt period plus a "tail" [Vajeth, 2016]. The IPPs planning is decoupled from the transmission projects and follows the simple principle of "take or pay". PAU acts as an interface to provide finance from different liquidity pools, these are government support, financial institutions, private sector equity, export credit agency, development finance institution, and other capital markets. SAPP conducts several workshops with stakeholders and representatives from financial institutions to update them on newly adopted plans and the progress of committed projects.

Table 4.2 shows the planned and actually commissioned generation capacity in SAPP from 2004 to 2018. From the 3,878 MW installed capacity in 2018, IPPs contributed to 26% of the new capacity while 58.1% of the total capacity was installed in South Africa. The total deficit throughout the years sums to 7,764 MW and only in 2004 and 2016 there was a surplus in the installed capacity.

Year	Planned Capacity (MW)	Commissioned Capacity (MW)	Deficit (MW)
2004	260	320	**-60**
2005	520	490	30
2006	1,041	375	666
2007	2,441	1,696	745
2008	2,014	1,747	267
2009	2,400	2,187	213
2010	908	848	60
2011	1,751	1,230	521
2012	3,552	1,099	2,453
2013	1,992	1,210	782
2014	2,737	1,999	738
2015	2,763	1,864	899
2016	3,058	4,180	**-1,122**
2017	3,616	3,008	608
2018	4,842	3,878	964
Total	**333,895**	**26,131**	**7,764**

Table 4.2: SAPP's planned and commissioned generation capacity from 2004 to 2018. Source: SAPP [2019]

SAPP has several committed generation and transmission projects (in Appendix C) to be installed in each country from 2019 to 2023. 14.55% of the total capacity is planned to be installed via IPPs, the share of solar generation is expected to have 9.92% while wind 1.66%. The largest installation will be in South Africa and then Tanzania. SAPP Pool Plan of 2017 identifies 22 transmission projects to be realized between 2020 and 2025. Preparation of these projects are carried by the PAU and are primarily funded by the World Bank AREP program, Development Bank of Southern Africa, the AfDB, the Norwegian Agency for Development Cooper-

ation (NORAD), the German Development Bank (KfW), the Swedish International Development Cooperation Agency (SIDA), the EU, and others. Under the AREP Program, SAPP is developing a concept of the Regional Transmission Infrastructure Financing Facility, as a holistic solution to address the regional transmission constraints by developing a mechanism of equitably sharing costs and benefits of regional infrastructure and channeling pooled financing from the various parties [World Bank, 2019b].

The interconnection between Tanzania and Zambia is particularly important as it connects EAPP and SAPP. The project was planned in 2015 however until today, the interconnection has not been realized. The interconnection between the two power pools is expected to benefit SAPP by diversifying the generation mix with the planned hydro from Ethiopia and the geothermal from Kenya. The two power pools signed a Memorandum of Understanding to assess the dynamic stability impact of interconnecting the two pools and the seasonal variation on the power flow due to the large hydro generation. The study was finally delivered in October 2018 [SAPP, 2019]. According to the project documentation of the World Bank [World Bank, 2019b], the recommendations of the study were discussed in a joint workshop between SAPP and EAPP that included over 30 utilities and is published with the detailed implementation workplan.

4.5 MEMBER COUNTRIES

An overview of SADC member countries reveals the diversity in the region in terms of economic growth and electricity sector development.

Resource distribution varies between member countries. In the South, South Africa has the richest amount of coal in the region and the only accountable reserve of Uranium with Namibia. In the North, Mozambique and Zambia have the highest hydro resources and potential for generating electricity, Angola has particularly the highest oil reserve in the region, and Mozambique has the only significant natural gas reserve in the region [WEC, 2013]. The exploitation and development of these resources varied with the conditions in each country. The largest economy in the region is South Africa in terms of total GDP. However, in terms of distributing the GDP per capita, South Africa comes second to Botswana. The average total GDP in the region was $54.9 Billion and $2,678 per capita in 2019, as shown in figure 4.6.

The same variance can be observed in the development of the national electricity sector. The electricity sector reforms started after the establishment of SAPP in 1995 with most of the countries enacting an electricity law. None of the countries in the region pursued the standard textbook model to its last bit and in many cases, steps like unbundling, privatization and concession management were reverted (e.g., South Africa unbundling attempt). Some of the latecomers like Eswatini and DRC started the reforms after 2005. All countries in the region attempted at least five steps out of seven identified steps in table 4.3, except Eswatini and Botswana, and all countries introduced IPPs with the only exception being Lesotho due to its small size and being confined geographically be South Africa. Only Angola, Lesotho, and Zimbabwe have unbundled their electricity sector. It was just Angola that fully unbundled all the three segments while the other two unbundled the generation segment and kept the transmission and distribution segments vertically integrated.

It is still unclear to which extend were the reforms successful in the region. The electricity tariff differs significantly from one country to another. Angola has the lowest average electricity tariff of just 3.17 USc/kWh while the highest average tariff is 14.58 USc/kWh in Eswatini [SAPP, 2019]. The same goes for electricity access in these countries, as shown in figure 4.7. Although Eswatini and Botswana were the least pursuances to the reforms, they are both among the highest in electricity access and above the regional average of 47%. South Africa has the highest

Country	Electricity Law/Act	Corporatization & Commercialization	Regulation	IPPs	Unbundling	Management /Concession Contracts	Privatization
Angola	1996	2003	2011	2003	2014	1997	2019
Botswana	2003	2005	Pending	2007	Pending	Pending	Pending
DRC	2006	2010	2014	2000	Pending	2014	Pending
Lesotho	1996	2001	2004	None	2001	Pending	2001
Malawi	1995	1998	2007	2011	Pending	2001	2000
Mozambique	1997	2000	2008	2003	Pending	2017	Pending
Namibia	1995	1995	2000	2014	Pending	1996	2001
South Africa	1995	1995	2004	2003	Pending	2015	Pending
Eswatini	2007	2007	2007	2014	Pending	Pending	Pending
Tanzania	2002	2002	2006	2004	Pending	2002	Pending
Zambia	1996	1997	1997	1997	Pending	Pending	2001
Zimbabwe	1996	2002	2002	1998	2002	2009	2002

Table 4.3: SAPP member countries implementation of the standard textbook model. Collected by the author from various secondary sources including Kruger et al. [2019], Nworie [2017], Eberhard and Catrina Godinho [2017], Eberhard et al. [2016], UNIDO [2006], and the World Bank project documentations.

electricity access, 94%, while DRC has the lowest access of only 8.7% of its total population [IEA, 2021].

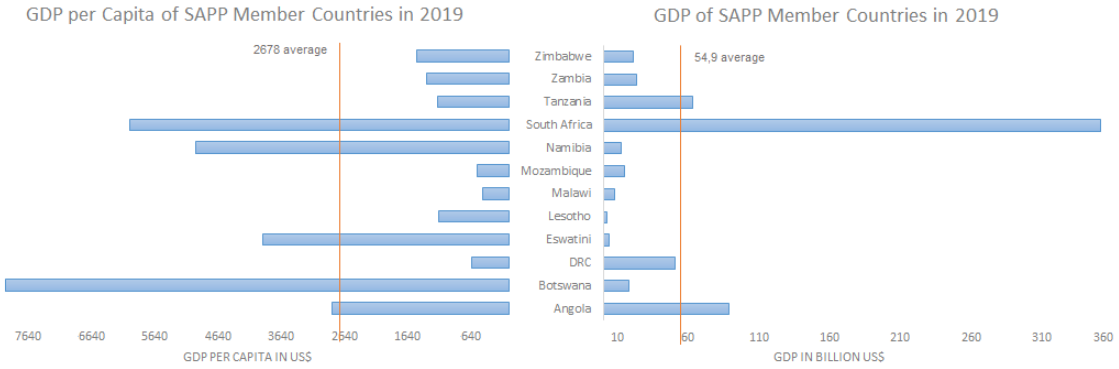


Figure 4.6: GDP of SAPP member countries in 2019. Source: World Bank [2021]

4.6 THE REGIONAL MARKET

The members of SAPP are licensed enterprises in a member country of SADC. Currently, there are 17 members including 12 national utilities and 5 private enterprises, as shown in table 4.4. The three largest utilities in terms of installed capacity are Eskom of South Africa with 50,774 MW, RNT of Angola with 5,235.8 MW, and ZESA of Zimbabwe with 2,412 MW [SAPP, 2019]. Three countries out of the twelve are classified as non-operating members as they are not connected to the regional transmission grid, these are Angola, Malawi, and Tanzania. SAPP's Network is divided into three control areas, each with its own control area system operator. Eskom serves as the operator for Botswana, Lesotho, Southern Mozambique, Namibia, South Africa, and Eswatini; ZESA is the operator for Zimbabwe and Northern Mozambique; ZESCO is the operator for Zambia and DRC.

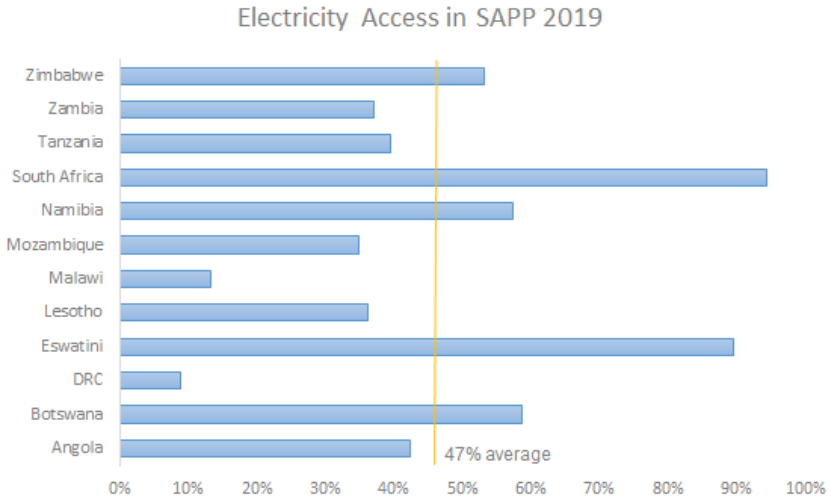


Figure 4.7: Electricity access in SAPP member countries in 2019. Source: IEA [2021]

4.6.1 Market Development

The trade between these countries was first operating under bilateral contracts of 1-5 year duration for trade in peak, off-peak and standard times. These contracts were already in place prior to the creation of SAPP. Under SAPP agreements, each member must meet its Accredited Capacity Obligation, have sufficient capacity to cover the forecast peak, supply emergency energy for up to six hours, allow wheeling through its system where technically and economically feasible, submit maintenance scheduled, disclose information about costs, and contribute toward the operating cost of SAPP [Economic Commission for Africa, 2003]. The goal was to move from bilateral contracts towards establishing a competitive market.

In 2001, the STEM was introduced. The STEM was created to serve as a competitive market (bid-based) and to constitute a transitional market towards a regional spot market. It deals with short-term energy contracts up to a month and provided for daily and hourly contracts operated chiefly in off-periods (countries lacked generation capacity during peak hours to trade). Utilities send their bids and offers to the coordination center that matches them and publishes the successful bids. The successful bids are then published on a bulletin board and members negotiate for bilateral trades. In 2002, the STEM was supplemented with an Over-The-Counter (OTC) trading for short-term needs during an emergency and planned outages (ad hoc basis).

From January 2004, SAPP started the development of the competitive electricity market. In 2006, the Nord Pool ASA signed a contract with SAPP to deliver a day-ahead spot market. 2009 witnessed the delivery of a non-regulated the Day-Ahead Market (DAM) in which bids can be submitted up to 10 days ahead. In 2013, SAPP introduced the Post-Day Ahead Market to increase the number of matched trade. The Post-Day Ahead Market takes place after the DAM is concluded, and the price is published, for the bids that were not accepted in the DAM. Until 2015, the trading system was owned and operated by the Nord Pool, when the Nord Pool ASA [2] was acquired by NASDAQ OMX in 2010, they increased the charges of maintenance and operation, this led SAPP to develop their own trading platform, SAPP Market Trading Platform (SAPP-MTP) in 2015. This was particularly important as now SAPP owns the system and can now modify, develop and add new features to it. Upon the launching of the MTP, SAPP immediately introduced three new markets: the Forward Physical Market-Weekly/Monthly (FPM-W/M) and

2 Different from Nordpool Spot AS

	National Power Utilities	Status	Abbreviation	Country
1.	Botswana Power Corporation	OP	BPC	Botswana
2.	Electricidade de Mocambique	OP	EDM	Mozambique
3.	Electricity Supply Corporation of Malawi	NP	ESCOM	Malawi
4.	ESKOM	OP	Eskom	South Africa
5.	Eswatini Electricity Company	OP	EEC	Eswatini
6.	Lesotho Electricity Corporation	OP	LEC	Lesotho
7.	NAMPOWER	OP	NamPower	Namibia
8.	Rede Nacional de Transporte de Electricidade	NP	RNT	Angola
9.	Societe Nationale d'Electricite	OP	SNEL	DRC
10.	Tanzania Electricity Supply Company Ltd	NP	TANESCO	Tanzania
11.	ZESCO Limited	OP	ZESCO	Zambia
12.	Zimbabwe Electricity Supply Authority	OP	ZESA	Zimbabwe
	Private Enterprises	**Status**	**Abbreviation**	**Country**
13.	Hidroelectrica de Cahora Bassa	IPP	HCB	Mozambique
14.	Mozambique Transmission Company	ITC	MOTRACO	Mozambique
15.	Lunsemfwa Hydro Power Company	IPP	LHPC	Zambia
16.	Copperbelt Energy Cooperation	ITC	CEC	Zambia
17.	Ndola Energy Corporation	IPP	Ndola	Zambia

Table 4.4: SAPP members as of January 2021, "OP" = Operating Member, "ITC" = Independent Transmission Company, "NP" = Non-Operating Member, "IPP" = Independent Power Producer, "OB" = Observer. Source: SAPP [2019]

the Intra-Day Market (IDM).

As of 2019 [SAPP, 2019], SAPP is still working on developing a balancing market in collaboration with the government of Norway and the SIDA fund and intending to establish a financial market in the future to facilitate the trade in the competitive market (the DAM, the FPM-W/M, and the IDM). The balancing market is currently under trial and is expected to be officially launched by the second half of this year, 2021 (Interview 6).

4.6.2 Market Progress

Figure 4.8 shows the trade volume in the competitive market of SAPP since its inception along with the average yearly clearing price of only the DAM. The volume of electricity traded through the market in 2018/19 was 2 TWh, this accounts for 32% of the total traded energy (85% DAM, 10% IDM, 3% Weak-Ahead and 2% Month-Ahead) with the remaining 68% bilateral contracts. The DAM yearly average market clearing price was 4.9 USc/KWh with a minimum monthly average of 3.25 USc/KWh and maximum 6.45 USc/KWh, while the IDM yearly average market clearing price recorded 8.96 USc/KWh for peak hours, 6.14 USc/KWh for standard period and 2.71 USc/KWh for off-peak period.

A total of $106.95 million was exchanged on the market, 87.93% was exchanged between buyers and sellers as cost of electricity, 4.4% was wheeling fees, 3.8% was administration fees, 3.5% was losses fees, and 0.4% was collected congestion income [SAPP, 2019]. Figure 4.9 shows the development timeline.

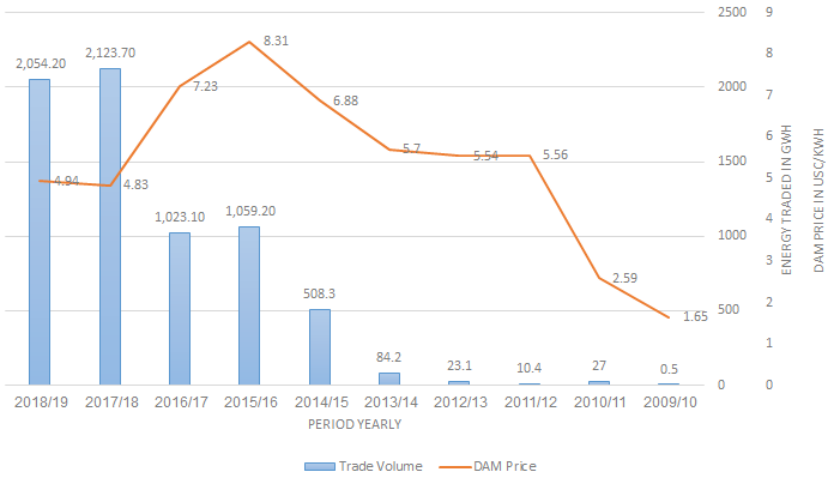


Figure 4.8: The trade volume in SAPP's competitive market and the DAM market price since its establishment in 2009. Data source: SAPP [2019]

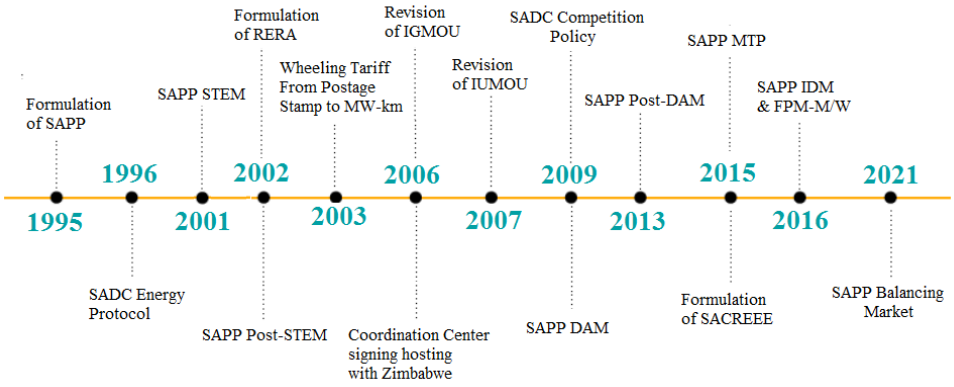


Figure 4.9: SAPP development timeline.

4.7 ANALYSIS

SAPP has the only functioning regional market in Africa. The fast development of SAPP was a function of the external factors in the region, the members' strategy, and the smooth build-up of the internal factors. Similarly, its design was strongly influenced by members' interests. In the following subsections, we elaborate on these factors and the process that shaped the market design following our framework of analysis.

4.7.1 The Objectives

The foundation of SAPP was formally laid by the regional institution SADC and from the regional objectives of SADC, the objectives of SAPP were grounded. In SAPP's own words [SAPP, 2021a], "Our objectives are to:

1. provide a forum for the development of a world-class, robust, safe, efficient, reliable, and stable interconnected electrical system in the southern African region;
2. coordinate and enforce common regional standards of quality of supply, measurement and monitoring of systems performance;

3. harmonize relationships between member utilities;
4. facilitate the development of regional expertise through training programs and research;
5. increase power accessibility in rural communities;
6. and implement strategies in support of sustainable development priorities."

This list of extensive objectives resembles SADC's objectives, particularly the first, fifth, and seventh objectives:

- "Achieve development and economic growth, alleviate poverty, enhance the standard and quality of life of the people of Southern Africa and support the socially disadvantaged through Regional Integration;
- achieve complementarity between national and regional strategies and programs;
- and achieve sustainable utilisation of natural resources and effective protection of the environment."

The objectives are aligned with the two goals of availability and acceptability. The goal of affordability is not explicitly included although it should be the primary goal of establishing a competitive regional market. This gap in the objectives could undermine SAPP's intention to take measures to increase competition in the market and one could infer that the founding utilities do not intend to compromise their position in their countries for the sake of providing cheap supply through competition (which we examine in the regional dynamics). As a matter of fact, the objectives of SAPP have little to do with the security of supply in the region, except for the coordination and enforcement of standards, and primarily focus on connecting member utilities. Thus, SAPP is effectively set to function as a cross-border coordination proxy. This institutional nature of SAPP can be understood when looking into the nature of SADC (as we will see in the rest of the analysis).

4.7.2 Development and Performance Factors

The conditions in the region of Southern Africa were in favor of the development of SAPP. The exogenous factors, namely the physical and economic, were the determining conditions to the dynamics of trade in the region. On the other hand, the endogenous factors were crucial for sustaining the development and expanding the volume of trade. Each is discussed in the following paragraphs.

Exogenous Factors

In the physical context, the natural energy endowments were influential on the patterns of trade. Countries in the north of the region, like Mozambique, Zimbabwe, and Zambia, have hydropower generation that suffered historically from cycles of drought. While in the south, South Africa has immense coal generation. This resource variance in the region created an interdependency in the region. During dry seasons, northern countries had to import from South Africa. In return, during rainy seasons, South Africa took advantage of cheap hydro generation. The second factor is the development of transmission infrastructure. The strategic position of South Africa and its well-developed network was a crucial element to enable cross-border trade. South Africa is connected to five neighboring countries and had a large generation capacity sufficient to export to all of them. This particular situation primed the floor for starting region-wide trade among the countries.

The economic context of the region played a role in shaping the trade. South Africa has the strongest economy in the region. And as the major exporter in the region, demand growth

in relation to generation capacity had a strong influence on the amount of cross-border trade. During the 1990s, South Africa had an excess generation capacity that made the reserve capacity in SAPP 25% in 1997 [SAPP, 1997]. This excess accelerated the opening of the STEM in 2001. In 2007, the demand growth exceeded the generation capacity in South Africa and lead to a chronic shortage of generation. As a result, the STEM was brought to halt. As South Africa was preparing to host the FIFA World Cup of 2010, new generation capacity was being commissioned as the economy was being revitalized. These external economic activities had a catalytic effect for opening the market and this time introducing an even shorter competitive market, the DAM, that provided flexibility and helped South Africa accommodating its demand. Indeed, SAPP played an important role during the World Cup of 2010 and member countries dedicated most of their electricity surplus supply to light up the stadiums in South Africa.

Putting South Africa aside, most of the member countries are limited in terms of financing options for large-scale projects and transmission projects. This is evident when looking at non-operating members. Despite the interconnection projects being considered in the priority projects list for a long time, investments did not take place and only Malawi interconnection reached financial closure (Interview 6). This financing limitation affects developing the necessary infrastructure for trading.

The regional institutional context had a little role in the development of SAPP. The regional institution SADC does not embody institutional centralization and harmonization in the region. The ratification of the SADC Treaty makes its implementation a legal obligation that can be subject to sanction (e.g., the sanction on Madagascar in 2010). However, when it comes to the implementation of SADC protocols, SADC agreements do not contain a binding obligation to translate or integrate these regional decisions into national legislation of member states. Hence, the power remains in the hand of national governments and member states uninterested in implementing those protocols have no consequences to fear. Consequently, SAPP has no authority over national utilities and only functions as a supporting organ. Large of SAPP's activities are dedicated to supporting national utilities, even after twenty years of the establishment of SAPP, the coordination center continues to organize training for the utilities on fundamental topics such as trading principles, bid submission strategies, and power system economics. This also true for the master plan developed by SAPP and endorsed by SADC only as a guidance for member states. These institutional settings limit possible design options for SAPP (as we will examine in subsection 4.7.3).

In terms of stakeholder influence, the powerful position of South Africa makes it a hegemonic force on SAPP. South Africa was the main force for pushing the energy agenda in SADC that led to the establishment of SAPP [Vanheukelom and Bertelsmann-Scott, 2016]. On the one side, this had a huge role in quickening the development of SAPP. On the other side, this makes SAPP heavily dependent on South Africa's interest. Hence, it can act as a blocking force for certain decisions. This particularly problematic when considering for example the wheeling tariff of SAPP since the transmission network of South Africa provides the wheeling part for most of the other countries. Thus, it gives South Africa the potential of limiting the design of the power pool.

The historical political tension in the region had a transient effect on the regional trade. During apartheid in South Africa, other members cooperated politically and economically to reduce the dependency on their powerful neighbor. The Southern African Development Cooperation Conference was deliberately held to minimize energy dependency on South Africa. In 1992, three events coincided that ushered the establishment of SAPP: the severe drought that hit the region, the creation of SADC, and the regime change and democratization process in South Africa. These events made member countries realize the need for trade and long-term cooperation (Interview 6). Following the establishment of SAPP in 1995, the political stability and coverage provided by SADC enabled sustaining trade agreements and entrenching confidence in trade.

Endogenous Factors

The performance of SAPP reflects the management of endogenous factors. With the exception of governance structure, all other factors were fairly controlled.

SAPP was able to launch the STEM six years from its establishment and shortly after founding the coordination center. The coordination center provides technical assistance to member utilities and hosts annual meetings with stakeholders. Thus, succeeded in maintaining good relationships with members and others. The coordination center also played an important role in dispute resolution and attending to all issues arise by member countries which increased the trust showed by member countries as well as donors. All these show that the coordination center was able to recruit and build good staff capacity. The rest of the organs of SAPP are also fully staffed. The trust placed on the coordination center resulted in increasing its level of responsibilities, which includes:

1. Market monitoring (both transactions and operations).
2. Monitor and advise on the implementation of SAPP operating guidelines.
3. Develop the grid code harmonization with RERA.
4. Track inadvertent or unexpected cross-border power flows.
5. Provide information and give technical advice to SAPP members on relevant issues,
6. Operate the PAU.
7. Develop operational studies to identify and highlight possible operating problems, and advise on how to address these problems.
8. Measure interconnector transfer capacities and monitor use to ensure capacity limits are not exceeded.
9. Advise on the feasibility of wheeling transactions.
10. Collect and securely store relevant data.
11. Facilitate trading in the day-ahead market.

The list goes on to 24 responsibilities and is not limited to it as indicated on SAPP's website. It begs the question of whether there is a need to incorporate all the necessary functions into a single body. This is also related to the government structure of SAPP as these roles intersect with other committees. However, the changing of the governance structure of SAPP is not entirely an internal factor but is subject to approval by the ministers.

Finally, the financial statements of SAPP show adequate financial arrangements of memberships and funds received from members and donors, which enabled SAPP to sustain operation and be financially independent.

4.7.3 The Dynamics

The exogenous and endogenous factors affected the design and development of SAPP. This has been a process of various forces in the system.

The Design

The starting conditions at the outset led to design consequences. In the beginning, the region was on a recovery track from a cold war and fear of the powerful economy and military of South Africa. This affected the foundation of SADC and naturally SAPP. As there was a risk of having a dominant power in the region that could take leverage on the regional institutions, the regional institutions were not founded on strictly binding agreements but rather intended to steer the direction towards cooperation on mutual interests. As the situation was fragile at the beginning, the authority was left in the hand of member states. Similarly, at the start, SAPP was governed directly by the council of ministers reflecting the government shared ownership of the pool. Hence, SAPP developed as a secondary voluntary market. Until today, SAPP does not interfere with bilateral agreements between countries but only monitoring them for technical purposes. In fact, this particular starting condition also led to similar situation with RERA, i.e., no regional authority but mainly as an association for supporting national regulators.

The structure of national sectors at the onset has played a role in constraining the design of SAPP. All member countries were operating on a vertically integrated structure and state-owned utilities (the first unbundling was in Lesotho 2001). Consequently, SAPP membership was not open for IPPs. In 2007, the electricity sector reforms in member countries were taking place and eight of the members had signed IPPs, only then there was pressure on SAPP to allow IPPs membership. This coincided was calls for restructuring the organization of SADC itself. Eventually, the governance structure of SAPP went from being under the council of ministers to SADC Directorate of Infrastructure and Services. At the same time, the IGMOU and the IUMOU were revised.

The presence of SAPP in the region has its own effect on the national policies and regulation. Member utilities enhanced their capacity by receiving training and advisory from the coordination center. Coupling this with the successfully launching of various trading platforms, from forward markets to intra-day, led to increasing members' reliability on SAPP. Both Botswana and Namibia rely on the import of electricity when having a deficit in their internal generation and demand. The possibility of relying on trade is considered in the planning of their power sectors. Other countries like Zimbabwe also have the policy to allow this consideration even when balancing supply and demand, and that import can always be put into supplement from an economic point of view (Interview 6). Because of this, there have been calls within SADC for reviewing the role and functions of SAPP to allow it to have more authority and power to enforce decisions and execute projects [SADC, 2016]. This would mean allowing more possible design options for SAPP.

On the other side, the presence of RERA pushed the national reforms to continue by helping to establish national regulators. When RERA was established, for the first five years only four countries had a national regulator and were members of RERA, but by 2017 all the members had regulators with the exception of Botswana. The regional regulator provided a collaboration platform for countries to learn from one another and supporting countries in capacity building for their institution establishment. Likewise, the institution and organization of RERA are also under revision in collaboration with COMESA, as the regulation in SADC moves from electricity to energy regulation and to give it more power and authority for decision-making [Political Analysis, 2019; COMESA, 2019].

Motors of Change

Among the three driving forces of SAPP development and design, members' strategy has the strongest influence followed by international institutions. While SADC had a lesser role.

Members' strategies were critical in the development and design of SAPP. South Africa was an important driver behind the creation of SAPP. The surplus capacity and transmission network developed under the apartheid, leverage the position of South Africa in the region. The episodes of shortage in the country were directly apparent in trade development. This regional champion role helped the trade progress but also created dependency. Members' strategies were influential on the design of the pool. As vertically integrated utilities, members are reluctant to recede their position. Thus, even after the external pressure of the reforms to admit IPPs to SAPP, utilities kept their dominant position by giving limited voting rights to IPPs. In another view, this is also a consequence of striping decision-making autonomy from the pool to a political body, i.e., the council of ministers. This reluctance is also observed for giving SAPP any sort of technical control or supervision responsibilities, for example on bilateral agreements.

International institutions played an important role in the development of SAPP by influencing the exogenous and endogenous factors. The governments of Norway and Sweden were particularly keen on helping SAPP developing the first competitive market in Africa, considering that these two countries are the godfathers of the regional electricity market. Nordpool was directly involved in delivering SAPP's first trading platform and helping with building SAPP's capacity for trade. Since 2003, SAPP receives continuous support from both governments and holds annual meetings with them. Technical assistance was also received from the United States Energy Association. Thus, not only endogenous factors (like staff capacity) were influenced by international institutions, but most likely the technical design as well.

International financial institutions also helped the development of SAPP. The World Bank was the funding provider for establishing the PAU (investment unit) that helps with project investments. Other institutions that provided funds include the EU, the NORAD, the SIDA, the Development Bank of South Africa, the AfDB, and others. These institutions were also involved in financing regional projects, hence, enabling the external environment for trade.

Although SAPP is an institution of SADC and reports to its Secretariat, SADC has little influence on the day-to-day activities of SAPP. SAPP's rules are changeable by SAPP without going to SADC's ministries, only the rules that affect the policies of SAPP, the changing goes through SADC, particularly if there is any cooperation requiring an entity outside the SADC region. SADC also does not enforce regulation on SAPP and leaves it to member utilities' internal agreements. Financially, SAPP is completely independent of SADC and even relies more on donors. Therefore, the regional institution exhibits a weak force in the development and design of SAPP.

4.8 CONCLUSION

SAPP is considered a success story of establishing a regional market in Africa. Against the eight power pool reforms (identified in chapter 3), SAPP implemented the following reform steps:

1. Establishing legal documents and agreements permitting trade, the IGMOU and the IUMOU.
2. Establishing commercial market rules for trade, the Agreement Between Operating Members and Market Book of Rule.
3. Establishing Wholesale energy market, the DAM, the FPM-W/M. and the IDM
4. Admitting IPPs participation.
5. Establishing regional market operator, the coordination center.
6. Establishing regional grid development, through the PAU.

The following factors were important in the establishment and development of SAPP:

1. The establishment of the regional economic community SADC.
2. The presence of sufficient regional infrastructure in the region (interconnections and generation).
3. The distribution of natural energy endowments in the region created interdependence and a need for trade between countries.
4. The presence of South Africa as a regional champion for pushing regional trade agendas in SADC.
5. The successful establishment of the coordination center.
6. The technical support received from international institutions.

Finally, although SAPP is a well-functioning organization, it has weak institutions, i.e., no regulations and a lack of enforcement mechanism for formal rules. The regional dynamic is characterized by strong actors, good relationships with technical institutions, and good physical, political, and economic conditions.

5 THE WESTERN AFRICAN POWER POOL - WAPP

"We strongly believe that the optimal solution for the energy crisis in Africa is to go regional"
Professor Mosad Elmissiry, Head of Energy Programmes, NEPAD (World Energy Council,2015)

In this chapter, we look into the situation in the Western African Power Pool (WAPP). Firstly, we present the historical development of WAPP. We start by looking into the regional institutions in section 5.1, the governance structure in section 5.2, the policies and regulation in section 5.3, the regional infrastructure in section 5.4, the national systems in section 5.5, and the regional market in section 5.6. Secondly, we apply our analytical framework, discussed in chapter 3, in section 5.7. We conclude the chapter with answering the second research question *"What were the factors and reform steps for establishing WAPP?"* in section 5.8.

Among the three selected power pools, the Western African Power Pool (WAPP) is the second oldest power pool and the largest in terms of the number of participating countries [ICA, 2016; IEA, 2019]. The pool includes fourteen countries, as shown in figure 5.1, and covers a total area of 5,028,940 km^2 and a population of 396.6 million [Worldometer, 2020].

Figure 5.1: Geographic map of the countries of WAPP.

5.1 REGIONAL INSTITUTIONS

The Western African countries have the longest historical collaboration that started in 1975 with the treaty of Lagos whereby the ECOWAS was established. ECOWAS is comprised of 15 member countries: Benin, Burkina Faso, Cape Verde, Côte d' Ivoire, the Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Sierra Leone, Senegal, and Togo. The group has a man-

date of promoting economic integration in all fields of activity of the constituting countries, including all infrastructure sectors, to promote the ideal of collective self-sufficiency for member states [ECOWAS, 2020]. Besides ECOWAS, there is the West African Monetary and Economic Union (WAEMU) (also known under the French acronym, UEMOA). WAEMU was established in 1994 between seven countries: Benin, Burkina Faso, Côte d'Ivoire, Mali, Niger, Senegal, and Togo. In 1997, Guinea Bissau signed the Treaty and became the 8th member. WAEMU is created to also enable regional integration, member countries adopted a common currency, CFA Franc, and unified external tariffs, however, it has less influence in the region compared to ECOWAS.

At its inception, ECOWAS followed an intergovernmental approach to governance by not interfering in the affairs of its member states but rather relies on the Heads of State and Government to integrate the regional goals in their national planning and policies. However, during the 1990s, ECOWAS started to adopt a supranational approach to governance to accelerate decision-making and enforce compliance. Major institutional reforms took place in ECOWAS in 2006 whereby the Executive Secretariat was turned into a Commission and the adoption of ECOWAS Parliament and ECOWAS Community Court of Justice [Bossuyt, 2016]. Although ECOWAS is primarily a regional body for economic integration, during the 1980s political crises, from civil wars to various military coups d'etat, forced ECOWAS to incorporate peace and security into its regional agenda. And instead of a top-down approach, ECOWAS deliberately attempted to spur regional dynamics 'from below' through close collaboration between institutional actors, civil society, and business organizations [Bossuyt, 2016].

Following the promotion of trade liberalization and regional integration among ECOWAS member states, the West African Power Pool (WAPP) was created by Decision A/DEC.5/12/99 of the 22nd summit of 1999 in Lome, Togo [ECOWAS, 1999; WAPP, 2018a]. WAPP includes all members of ECOWAS except for the unconnected island of Cape Verde. The goals of WAPP are to provide regular and reliable energy at a competitive cost in the medium and long term. However, it wasn't until the 29th summit that the Articles of Agreement for WAPP organization and functions was signed by ECOWAS member states under the Decision A/DEC.18/01/06 and since then, WAPP was accorded as a special institution of ECOWAS by the other approval of Decision A/DEC.20/01/06. A key condition for WAPP to become operational was the development of the Energy Protocol in 2003. The Protocol provides the necessary legal framework to promote long-term cooperation in the energy field and increase energy trade in the region [ECOWAS, 2003]. In 2007, the Protocol was ratified by the required number of national parliaments and became a regional law. It provides key provisions like:

- Protection of foreign investments.
- Nondiscriminatory conditions for trade in energy.
- Dispute resolution procedures.

The Articles of Agreement of WAPP institutes the management structure of WAPP, its organization and functioning, and provides the necessary framework of collaboration between its members. The document was recently amended in December 2020 to include criteria for membership, structure and functions of new committees [WAPP, 2020b].

5.2 THE GOVERNANCE OF WAPP

The Articles of Agreement recognizes WAPP as an international public interest organization that comprises four governing structures:

- The General Assembly.

- The Executive Board.
- The Organizational Committees.
- The General Secretariat.

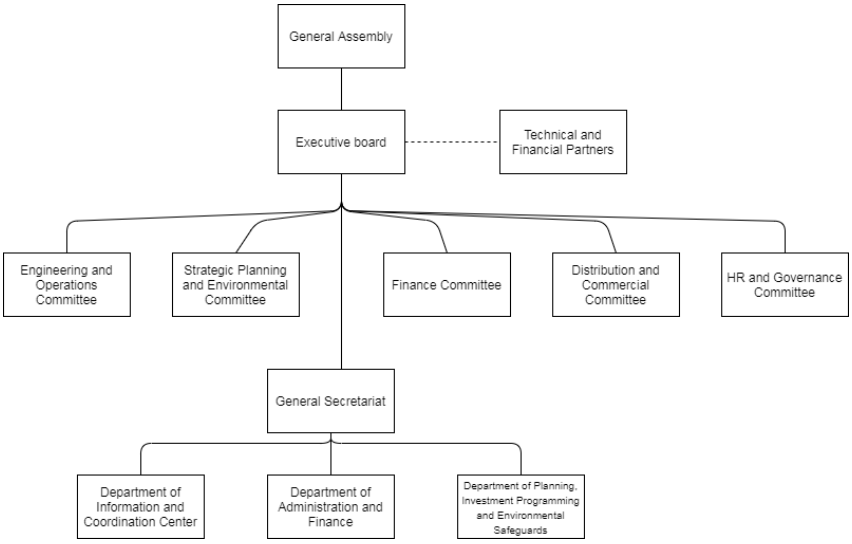


Figure 5.2: The governing structure of WAPP. Source: WAPP [2019b]

The executive board is responsible for implementing the decisions and policies of the general assembly. To this effect, it is vested with the broadest power to ensure the development and realization of WAPP mission and objectives. The authority of the board includes authorizing all major contracts and financial/debt instruments, formulating the organizational committees, approving the budgets and any additional expenditures, authorizing submission of files to relevant regulatory bodies, and recommending amendments to the Articles of Agreements for the general assembly.

According to the Articles of Agreement [WAPP, 2020b], the composition of the executive board shall consist of 14 members of which 11 are permanent (these are the 10 members indicated with a (*) in table 5.2 plus WAPP secretary general) and 3 are rotating. Additionally, the board may coopt honorary members for special services. The members of the board are elected among managing directors/chief executive officers of WAPP member utilities with a WAPP membership of more than three years and presently operational in their countries. The rotating members are elected for a two years term. These members must always consist of one private operator while the other two are selected based on their field of activity and country of origin. Nine members constitute a quorum and decisions are made by a simple majority vote of present members. The voting is done by secret ballot performed by the secretary general.

The organizational committees provide support and advice to the executive board on all matters concerning collective policy formulation functions for developing, maintaining, and updating common rules of practice on technical, operational, environmental, planning and governance aspects of WAPP. The committees are composed of experts from the members of WAPP and are appointed by the executive board [WAPP, 2019b]. All committees' meetings are public by default unless members of the committee decided to limit the attendance on a grounded reason. There are five organizational committees:

- **The Engineering and Operations Committee**: comprises of one representative of each WAPP member. The committee has an extensive list of responsibilities (see [WAPP, 2020b]) that includes all the technical details of monitoring, assessing, planning, and coordinate relevant regional activities.

- **The Strategic Planning and Environment Committee**: comprises of 11 representatives: three from the executive board and the rest are from WAPP membership nominated by the secretary general. The committee's responsibilities include assessing capabilities and competencies of WAPP, formulating strategies, reviewing delegated task forces assigned by other organizational committees, and developing action plans, schedules and budgets.
- **The Finance Committee**: comprises of six members: two from the executive board and the rest are member utilities nominated by the secretary general and approved by the executive board. The committee is responsible for helping the executive board in oversight WAPP financial affairs, including the financial condition, planning, operational and capital budgeting, external audit issues, and risk management.
- **The Human Resource and Governance Committee**: comprises of six members: two representatives from the executive board and the rest are from WAPP membership as nominated by the secretary general. The committee is responsible for ensuring manpower planning, formulation, review and compliance of staff regulations and code of conduct whilst facilitating performance evaluation of the executive board and the general secretariat. This also includes establishing a set of quantitative performance criteria to assess the performance of the executive board and the secretary general.
- **The Distribution and Commercial Committee**: comprises of eight representatives from power distribution utilities and four from power transmission/generation utilities and other members. The committee's responsibilities include monitoring the current supply, forecasting peak and annual demand, developing best practices for commercial activities, and responding to activities as requested by the strategic planning and environmental committee.

The Headquarter Agreement was signed between WAPP and the government of the Republic of Benin in 2006 to host WAPP secretariat in Cotonou. The secretary general is appointed by the general assembly through an open competitive selection process carried out by an independent consulting firm. The body is an administrative and technical organ in charge of the day-to-day management of the activities of WAPP and supporting the executive board in its duties. It provides secretariat function for all organizational committees and task forces and is composed of three Departments:

- **The Department of Information and Coordination Centre**: has two sets of responsibilities: the first responsibility is to promote operational coordination between transmission owning/operating members through day-to-day information exchange. Second, as per WAPP framework of the regional electricity market [ERERA, 2017b], the center shall also carry out the functions of the system and market operator. This includes coordinating the schedules of pool interconnectors, monitoring load flows to address inadvertent deviations, carrying out settlement activities, allocating transmission capacity, administering contracts, and managing disputes at the operational level.
- **The Department of Administration & Finance**: responsible for organizing and supervising all WAPP's activities pertaining to human resources, administration, internal finance, budgeting, accounting, and procurement.
- **The Department of Planning, Investment, Programming and Environmental Safeguards**: responsible for implementing strategies recommended by the Strategic Planning and Environment Committee and facilitating projects development and realization.

The membership of WAPP is voluntary and open to private and public entities. Members can be a Transmission Own/Operating member with a network operated at a voltage of 60 kV or above, a Transmission Using member that owns/operates generation facilities of at least 20 MW

and/or distributes/retails electricity, or Other member that does not fit into the two previous categories but is still interested in the electricity sector of the Western African Region.

A member can have observer status that allows for participating in the general assembly without voting rights and taking a seat only in the engineering and operating committee. Financially, an observer contributes a minimum of 50% of the amount of the least paying member. Other members pay an annually assessed contribution to recover costs associated with WAPP functioning. The contribution is a function of the energy sold by the member and follows the following formula [WAPP, 2020b]:

$$A = [0.25(1/N) + 0.75(B/C)]X$$

Where:

A = Member's share of WAPP assessment
N = Total number of members
B = Energy sold by the member two years prior to the year of assessment
C = Total of factor B for all members
X = Annual costs

The general assembly is the highest decision body of WAPP and is composed of all the members' utilities. It has many responsibilities including, inter alia, electing the members of the executive board, approving new applications for WAPP membership or removal or reinstatement of a member, and reviewing the performance of the secretary general. Decisions are made by majority rule of members present and voting, providing that the total vote of Other members (who are not transmission owners or users) does not exceed 25%. If Other members constitute more than 25% of the vote, the members will be divided into two groups with a 25% assigned to all Other members and 75% assigned to the rest of the members. The final result will be determined by adding the result of each group multiplied by its weight.

The membership application is submitted to the secretary general to review and recommend satisfying applications to the executive board for recommendation to the general assembly for the final approval. Dispute resolution among members is done through panel members of at least seven persons and is organized by the secretary general. Before resolving a dispute formally through panel members, an informal resolution dispute could take place through mediation or advisory proceeding.

5.3 REGULATION AND POLICIES

5.3.1 Institutions

Despite the fact that WAPP was officially established in 1999, the regional regulator was not instituted until 2008. ECOWAS Supplementary Act A/SA.2/1/08 sets the foundation for the ECOWAS Regional Electricity Regulatory Authority (ERERA), as a special institution of ECOWAS, and the legal capacity to exercise its functions across the entire region [ECOWAS, 2008]. The prescription of the organization, functions and operation of ERERA preceded the establishment act in 2007 under the regulation C/REG.27/12/07 of the fifty-ninth session of the council of ministers. ERERA has an extensive list of functions and missions (see ECOWAS [2007]), but its main responsibilities consist of the regulation of cross-border electricity connections and trading among ECOWAS member states. This includes, inter alia, establishing transparent tariff setting methodology for regional power pooling, adopting technical regulation, monitoring of regional market operations (including approving any contract for cross-border exchange), resolving disputes among regional market participants, contributing to the development of regional energy policy, and assisting in building capacity of national regulatory bodies.

According to the regulation [ECOWAS, 2007], ERERA is composed of the regulatory council, three consultative committees and external experts (when necessary). The regulator council is the decision-making and managerial body of ERERA and is composed of five members with a tenure of five years non-renewable. All the members of the council are to be independent of any other ECOWAS institution and with no interest for any participant in WAPP. Members are selected based on the provisions of the ECOWAS Staff Regulations and the recruitment is assisted by energy ministers and shortlisted by an independent international recruitment consultancy bureau. The council meets at least once per month and holds public hearings when needed. ERERA has three consultative committees with representatives of national electricity regulators, operators, and ECOWAS electricity consumers. These committees help ERERA with drafting relevant policies and meet at least once a year.

Decisions of ERERA can be appealed to the ECOWAS Court of Justice within 30 days. The decision of the court is final for any appeal and the enforcement of the decisions of ERERA is the responsibility of all member states, any failure or refusal to enforce the decisions shall be referred to the ECOWAS Commission to ensure the application of the provisions of the ECOWAS Treaty by which the violater shall be subject to sanctions and/or penalty.

Besides ERERA, the ECOWAS Center for Renewable Energy and Energy Efficiency (ECREEE) was established during the same year, 2008, by Regulation C/REG. 23/11/08 of the 61st Session of the ECOWAS Council of Ministers. Since then, ECREEE has worked as an independent agency with the mandate to promote renewable energy and energy efficiency in the region, with its secretariat based in Praia, Cape Verde. The governance structure of ECREEE consists of just the executive board and the technical committee. The center's responsibilities include policy development, capacity development, scenario development for WAPP master plan, promotion for energy efficiency and universal access to energy under the Renewable Energy Facility for peri-urban and rural areas initiative, and coordination of other projects with national and international stakeholders [ECOWAS, 2021].

Along with the other two institutions, ECOWAS has a general Regional Competition Authority still to be operationalized.

5.3.2 Regulatory and Policy Frameworks

The regulation of WAPP has been developed gradually and generally can be grouped into two sets of regulations. First, as a special institution of ECOWAS, WAPP adheres to the general regulation frameworks of ECOWAS. The three important frameworks are ECOWAS Energy Protocol (2003), ECOWAS Regional Competition Policy Framework (2007), and ECOWAS Procurement Code (2019). These general frameworks address topics like protecting foreign investments, establishing non-discriminatory conditions for energy imports and exports, resolving disputes between member states, establishing solid legal entities and institutions, and encouraging fair and transparent competition. Any executive officer of WAPP must by regulation be independent of any WAPP member [WAPP, 2020b]. These are Chairperson and Vice-Chairperson of the executive board, the secretary general, the directors of WAPP following departments: the Information and Coordination Center (ICC); planning, investment programming and environmental safeguards; and administration and finance.

On the other hand, the second set of regulations concern with the details of the functioning of WAPP, which are inspired by the general frameworks of ECOWAS and developed chiefly by ERERA as designated in the Directive C/DIR.1/06/13 on the Organization of the Regional Electricity Market by the council of ministers of ECOWAS [ECOWAS, 2013]. These include the following:

- **Regional market design and evolution phases**: Three resolutions have been approved by EREA for this: Resolution No. 005/ERERA/15 – Approval of the Regional Market Rules of WAPP that describes the rules governing the commercial transactions of cross-

border flows of electricity [ERERA, 2015a]; Resolution No. 007/ERERA/15 – Adoption of Operation Manual of the West African Power Pool that provides all the standards and technical details for operating the market and the exchange between different participants efficiently and effectively [ERERA, 2015b], with revision of its policies by the Engineering and Operating committee of WAPP when necessary; Resolution No. 010/ERERA/17 - Regional Electricity Market Procedures for WAPP that elaborates on the obligation and responsibilities of the participants, information exchange protocols, market scheduling timetable and process, and financial settlements [ERERA, 2017b].

- **Regulation for cross-border transmission tariffs**: Resolution No. 006/ERERA/15 – Tariff Methodology for Regional Transmission Cost and Tariff adopted by ERERA sets the method for calculating transmission pricing to be used by the Regional System and Market Operator. It defines steps to be followed and rules that govern transmission costs among participants involved in cross-border power exchange transactions. The methodology was agreed upon by the consultative committees of both the regulators and operators of the region [ERERA, 2015c].

- **Regulation for open access to regional transmission network**: Resolution No. 014/ERERA/19 - Approval of the West African Power Pool Transmission Service Access and Use Procedures describes the conditions and procedures for access, use and payment of transmission services in the regional electricity market [ERERA, 2019b]. The document is developed by WAPP members and approved by ERERA. However, as per Directive C/DIR.1/06/13, ERERA still has to specify with stakeholder consultation the conditions for third-party access to the Regional Transmission Network. It is left for member countries to enact the necessary legislation for open access with the help of ERERA.

- **Harmonization of contracts**: Two models for bilateral agreements were developed by ERERA for contracts up to one year (short/medium term) and more than one year (long term) as per Resolution No. 009/ERERA/17 – Model Bilateral Contracts [ERERA, 2017a]. Other regulatory harmonization remains a work in progress for ERERA.

Regarding regional policy, Decision A/DEC.24/01/06 of ECOWAS head of states adopted the ECOWAS/WAEMU White Paper for regional policy whereby the ECREEE was mandated for its development. In 2013, ECREEE published ECOWAS Renewable Energy Policy [ECREEE, 2013b] and ECOWAS Energy Efficiency Policy [ECREEE, 2013a]. The two documents provide targets and action plans for both renewable energy and energy efficiency to be achieved by 2020. With the help of ECREEE through various initiatives, member states are responsible for implementing the policies and the ECOWAS Commission is responsible for mobilizing the necessary financial resources.

Lastly, in October 2020, WAPP established the Procurement Code that sets the principles and procedures for the acquisition of any goods, services and works in WAPP secretariat [ERERA, 2020].

5.4 THE REGIONAL INFRASTRUCTURE

5.4.1 The Current Status

The regional infrastructure of WAPP is underdeveloped and covers two-thirds of the members, five countries remain unconnected as shown in figure 5.3. The transmission network has an interconnection capacity of 3,199.3 MW. Each country has at least two interconnections, except for Niger and Senegal, and the largest interconnection capacity is 777 MW between Nigeria and Benin. The total installed generation capacity of WAPP is 23,878.3 MW and the peak demand of all countries sums up to 13,741.5 MW, hence, a surplus generation capacity of 10,136.8 MW

is available from all the countries. The five unconnected members; Liberia, Guinea, Guinea Bissau, Sierra Leon, and the Gambia; are minorities with a total peak demand of 488.5 MW and generation capacity of only 1,156 MW.

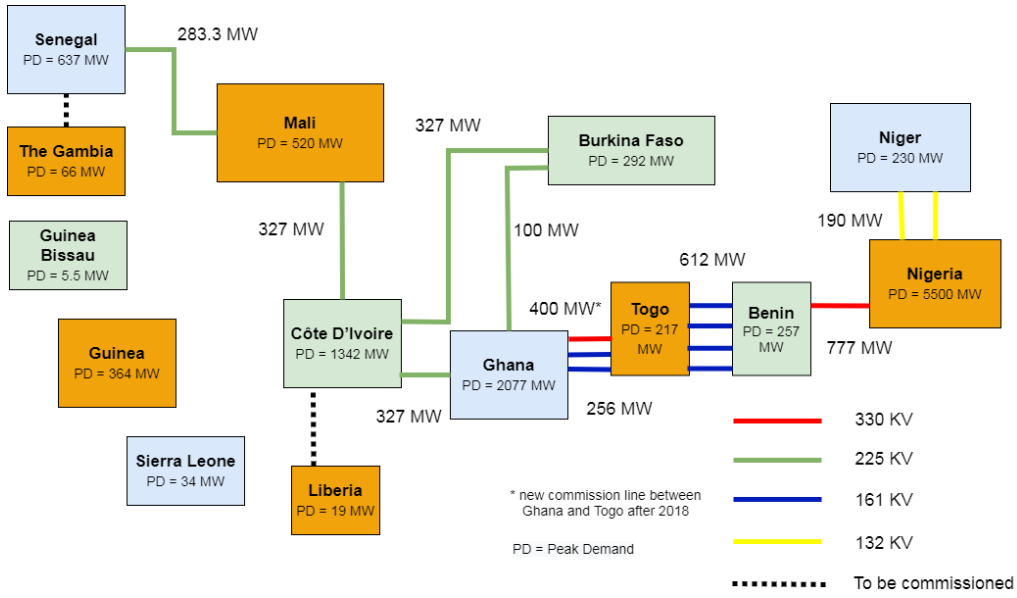


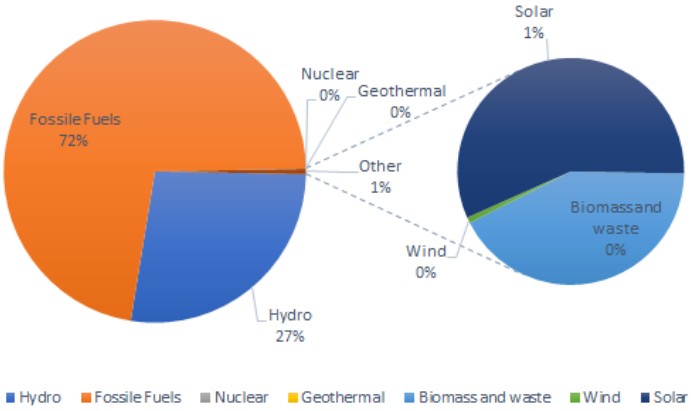
Figure 5.3: Peak demand and transmission capacity of WAPP regional power grid. Composed by the author from various secondary data sources: WAPP [2018c], WAPP [2020a], and projects documentations from the World Bank

As of January 2018, the regional power grid suffers from synchronization problem on two interfaces, and because of this, the regional transmission network is divided into three synchronous blocks:

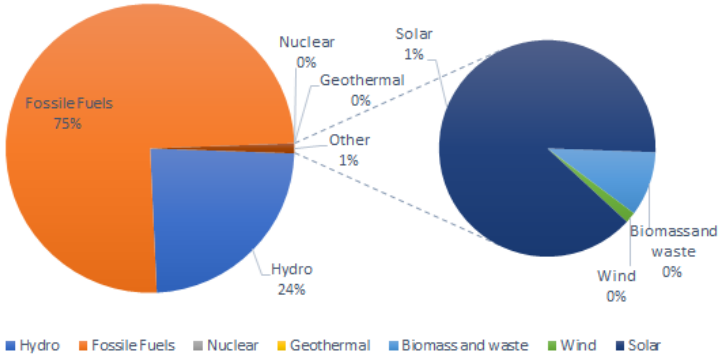
- Block A: Burkina Faso, Ghana, Côte d'Ivoire, part of Mali (up to Bamako) and part of Togo/Benin.
- Block B: Senegal, Mauritania and part of Mali (up to Bamako).
- Block C: Nigeria, Niger and part of Togo/Benin.

The major stability issues have been detected at the interfaces between the existing synchronous blocks, in particular, the interface between Block C and B is not secure and requires a Special Protection Scheme and minimum set of reinforcements [WAPP, 2018d]. This makes the network effectively fragmented.

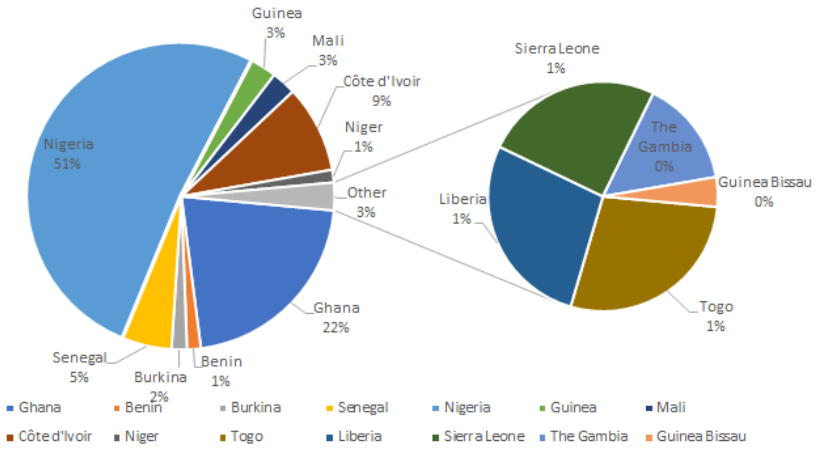
The generation profile of WAPP, shown in figure 5.4, is simple and consists of 75% fossil fuels (mostly natural gas), 24% hydro, 1% solar installed capacity. The lion's share goes to Nigeria own 12.3 GW installed capacity which counts for 51% of the total capacity. The second-largest installed capacity is 5.1 GW (22%) found in Ghana. 64,249.2 Gigawatt hour (GWh) of electricity was generated in 2018, 53.6% came from Nigeria that produced 60.4% of the total fossil fuel generation in the region. The other two largest producers are Ghana and Côte d'Ivoire which both generated 33.4% of total electricity and supplied, with a ratio of 2:1, 50.8% of the total generated electricity from hydro. The only other two countries with significant hydro generation are Nigeria and Mali, with hydro generation share of 36.5% and 7.8%, respectively. The five unconnected members generated only 4.5% of the total electricity.



(a) WAPP generated electricity by source in 2018.

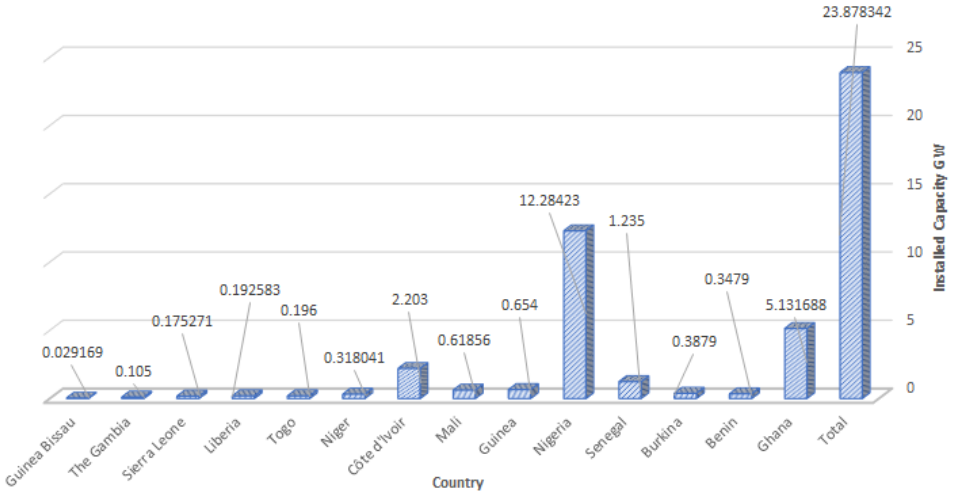


(b) WAPP installed generation capacity by source in 2018.

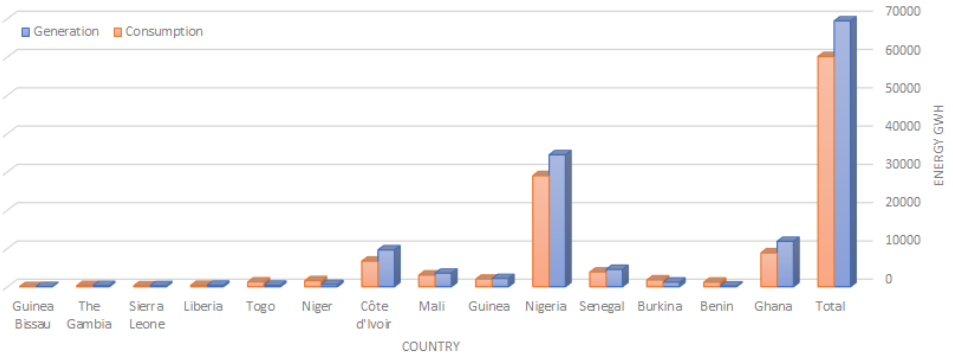


(c) WAPP countries' share of the installed generation capacity in 2018.

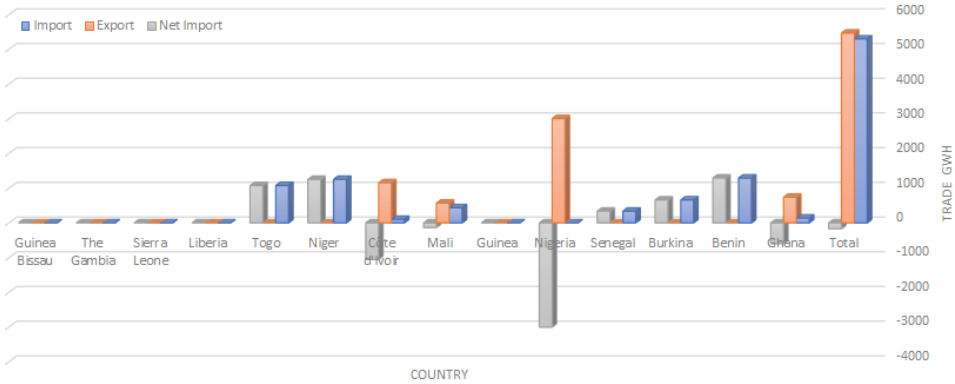
Figure 5.4: WAPP generation portfolio in 2018. Data source: EIA [2021]



(a) WAPP installed generation capacity per country in GW in 2018.



(b) WAPP countries' generation and consumption in GWh in 2018.



(c) WAPP countries' export and import of electricity in GWh in 2018.

Figure 5.5: WAPP energy trade in 2018. Data source: EIA [2021]

The energy trade in WAPP, shown in figure 5.5, is rather simple when considering countries' natural endowment. There are only four countries that export electricity, these are the same four countries with the significant hydro generation, they are in ascending order of installed hydro capacity: Nigeria, Ghana, Côte d'Ivoire, and Mali. The rest of the five connected countries are the importing bay of these four countries. Naturally, Nigeria with the largest installed capacity is responsible for 27.9% of the trade and does not import from any country. The other three net exporters do import from time to time with Ghana and Côte d'Ivoire import only around 1.5% of their consumption, while Mali imports 14.4% of its consumption.

The five importing countries rely heavily on the four exporters to fulfill their consumption. Particularly, Benin imports 108.8% of its consumption from Nigeria, while Niger imports 79% of its consumption also from Nigeria. The other two countries are Togo and Burkina Faso which import 86% and 37.5% of their consumption, respectively. Interestingly, the interconnection between Togo and Benin is only used for wheeling electricity either from Nigeria to Togo or from Ghana to Benin, as both countries had zero export in 2018.

5.4.2 Planning and Investments

WAPP has developed an extensive master plan consists of five volumes covering all aspects from project selection to investments and implementation strategy. The master plan was published in 2018 for the development of regional power generation and transmission infrastructure from 2019 to 2033. A previously preceded master plan was published in 2011 (for the period 2012-2025), however, only one interconnection (connecting Côte d'Ivoire and Mali) was realized since then [WAPP, 2018c]. Thus, the master plan of 2018 included a detailed action plan and was also followed by a business plan in 2020 for projects to be implemented until 2023 [WAPP, 2020a].

The master plan is divided into three stages: a short-term plan between 2018 and 2022, a medium-term plan from 2023 to 2029, and a long-term plan from 2030 to 2033. The plan makes use of several models to forecast future demand and potential growth in order to estimate the required capacity and needed interconnections. In the short term, 8,386 MW generation capacity is to be installed with 46% renewable energy that chiefly will be from hydropower in Nigeria and Ghana. In the medium term, 5,357 MW generation capacity is to be added that is also predominantly from hydropower with the installation of 3,050 MW in Mambilla, Nigeria. With this and other renewables, the plan is to rapidly increase the electricity generated from renewables to 38% of the total generation [WAPP, 2018b]. In the final long term, the planned capacity consists of 14,981 MW from thermal generation, 562 MW from hydroelectric generation, 16,700 MW from solar PV, and 750 MW from wind. The final mix will still be 62% from natural gas, 2% coal, and the rest from renewables.

The final priority investment program includes 75 regional projects with an estimated total investment cost of US$36.39 billion; 28 are transmission line projects of approximately 22,932 kilometre (km) of high-voltage transmission lines at an estimated cost of US$10.48 billion; 47 are generation projects with a total capacity of approximately 15.49 GW at an estimated cost of US$25.91 billion (list in Appendix C) [WAPP, 2018e]. These projects are financed by member governments, the World Bank, the AfDB, the KfW, European Investment Bank, the USAID, the EU, and others. Moreover, the priority list also analyzes interconnection projects connecting WAPP with the northern and central power pools (COMELEC and CAPP). Senegal already has an interconnection with Mauritania, this interconnection is however expected to go directly from Morocco through Mauritania to Senegal. The link with CAPP will be through Nigeria and until DRC. However, these two projects are still to be decided.

As of 2020, the implementation of WAPP priority projects is 65% complete according to the Planning, Investment Programming and Environmental Safeguards Department of WAPP that

is responsible for monitoring and coordinating the approved projects [WAPP, 2020a]. This mandate comes from WAPP Articles of Association that requires WAPP to ensure "the full and effective implementation of WAPP Priority Projects".

5.5 MEMBER COUNTRIES

Historically, the West Africa region suffered bad political and economic conditions. The region ranks particularly low regarding all human development indicators. With the exception of Ghana, all the thirteen member countries are classified in the low Human Development category and 60% of the population is estimated to live on less than one dollar a day [UNDP, 2020]. Despite these facts, the ECOWAS region is among the African regions with the most energy production potential both from conventional sources (oil, gas, uranium) and renewable sources (hydro, solar, and wind).

Conventional energy sources (oil and gas) in the region are concentrated in three countries: Nigeria, Ghana, and Côte d'Ivoire. Nigeria owns about 98% of proved crude oil and natural gas reserves in West Africa and is considered a core market for European businesses, like Shell, Total and Eni [IAEA, 2016]. On the other hand, renewable energy is distributed fairly among the member countries. Solar irradiation is higher than 5 kWh/m^2/day in all countries and hydro is found in most of the countries but with varying potential. Again, Nigeria accounts for about 43.4% of regional hydropower generation, closely followed by Ghana, which generates 40.9% of regional hydropower. The remaining production is shared by Côte d'Ivoire, Guinea, Mali, and Burkina Faso [Akoutou et al., 2014]. The region's hydroelectric potential is primarily located in the Senegal, Niger, and Volta River basins. Uranium is only found in Niger [WEC, 2013].

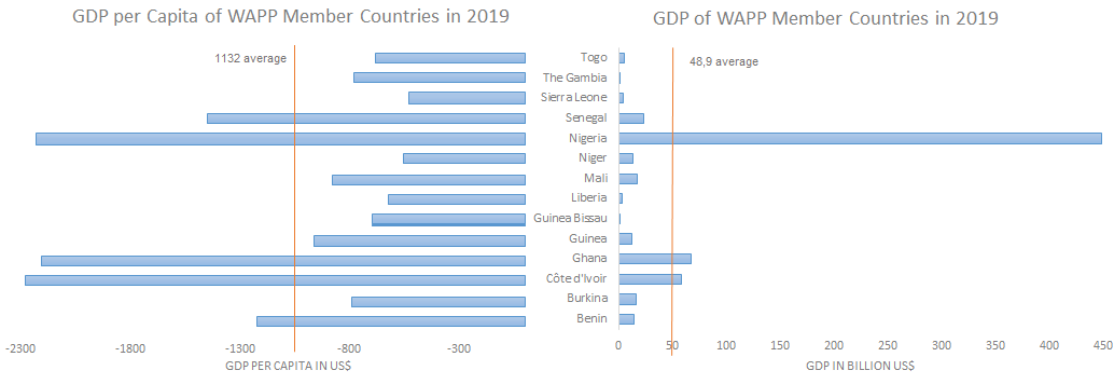


Figure 5.6: GDP of WAPP member countries in 2019. Source: World Bank [2021]

As a result of the natural endowment, Nigeria has the highest total GDP in the region that is more than all countries combined. However, in terms of GDP per capita, Nigeria is second to Côte d'Ivoire. The average total GDP is $48.9 and $1,132 per capita in 2019, as shown in figure 5.6.

The national electricity sectors in the region vary when mapped against the standard textbook model. While we find countries like Nigeria and Ghana that implemented the full steps of the reforms, countries like the Gambia and Niger only implemented three steps of the seven steps, as shown in table 5.1. Despite ECOWAS Directive C/DIR/1/06/13 that obliges member countries to ensure open access to the transmission network and unbundling their sector, most of the member countries remain vertically integrated with IPPs. Sierra Leone has partially implemented unbundling as the generation and transmission remain vertically integrated by the state utility. Countries like Côte d'Ivoire and Mali were early in privatizing most of their sector.

Country	Electricity Law/Act	Corporatization & Commercialization	Regulation	IPPs	Unbundling	Management /Concession Contracts	Privatization
Benin	2003	2006	2009	2006	Pending	2015	Pending
Burkina Faso	1997	2007	2010	2017	Pending	2010	Pending
Côte d'Ivoir	1989	1995	1998	1994	Pending	1990	1990
Ghana	1997	1997	1997	2000	2008	1997	2005
Guinea	1993	2005	2005	2013	Pending	2005	Pending
Guinea Bissau	2007	Pending	2010	None	Pending	1997	1995
Liberia	1973	1973	2015	None	Pending	2010	Pending
Mali	1994	1998	2000	1994	Pending	1995	2000
Niger	1991	Pending	2013	2011	Pending	Pending	Pending
Nigeria	2005	1988	2005	1999	2007	2013	2012
Senegal	1995	1998	1998	1997	Pending	1999	2003
Sierra Leone	2011	2011	2011	None	2016	Pending	Pending
The Gambia	2005	Pending	2001	2006	Pending	Pending	Pending
Togo	2000	2001	2000	2006	Pending	2000	Pending

Table 5.1: WAPP member countries implementation of the standard textbook model. Collected by the author from various secondary sources including Imam [2020], Nworie [2017], Eberhard and Catrina Godinho [2017], Eberhard et al. [2016], UNIDO [2006], ERERA [2016], and the World Bank project documentations.

Result-wise, the reforms were not successful in the region. With the exception of Ghana and Côte d'Ivoire, electricity access in the region remains low with an average of 47%, the lowest being Liberia with just 12% of the population have access to electricity (largely due to civil war), as shown in figure 5.7. While privatization was successful in Côte d'Ivoire, it failed to deliver better performance in Senegal, Guinea, and Mali. Privatization of state utility was attempted in Mali, Togo and Guinea but reverted under re-nationalization sometimes [Pineau, 2008a]. On the other hand, concession management in Guinea-Bissau was terminated two years from its signing due to conflict. The electricity tariff various also significantly in the region. The highest electricity end-user tariff is 35 USc/kWh in Liberia while the lowest is 1.3 USc/kWh found in Nigeria [ERERA, 2019a]. Thus, with the lack of cost-reflective tariff, the reforms in Nigeria is especially counted as a failure (Interview 4).

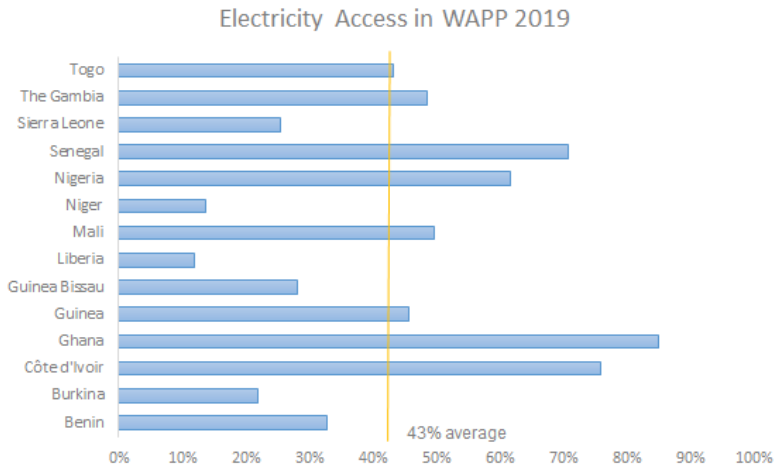


Figure 5.7: Electricity access in WAPP member countries in 2019. Source: IEA [2021]

5.6 THE REGIONAL MARKET

The members of WAPP are private and public entities interested in the pool operation. There are currently 36 electricity enterprises including one observer, the National Office for Electricity and Drinking Water (ONEE) of Morocco. Half of the members are from Ghana and Nigeria, nine members from each, and two members operate in more than one country, CEB and SOGEM. All the members are shown in table 5.2.

WAPP's Network is divided into five control areas, each with its own control area operator. These are:

- Area 1: Côte d'Ivoire-Burkina-Faso, operator is CIE of Côte d'Ivoire.
- Area 2: Ghana-Togo-Benin, operator is VRA of Ghana.
- Area 3: Nigeria-Niger, operator is TCN of Nigeria.
- Area 4: Guinea – Liberia – Sierra Leone, operator is EDG of Guinea.
- Area 5: Senegal – Mali – Gambia – Guinee Bissau, operator is SENELEC of Senegal.

5.6.1 Market Development

Electricity trade in the region can be traced back to the 1970s. Since 1972, Ghana's VRA has been exporting electricity from its Akosombo hydroelectric dam to Togo and Benin under the bi-national utility CEB. However, the infrastructure was highly underdeveloped and trade was controlled through ad hoc arrangements between parties that relied on voice telephone communication between adjacent systems and had no protection systems against fault propagation [Economic Commission for Africa, 2003]. The bilateral trading was developed the same you between adjacent countries and mostly around hydroelectricity generation. In 1972, the Organisation pour la Miseen Valeur du fleuve Sénégal (OMVS) (the Senegal River Basin Development Organisation) was established between the three riparian countries Mali, Mauritania, and Senegal for coordinated exploitation of the Senegal River basin resources initially for irrigation but later for building and trading electricity from hydro projects, the Manantali dam was the first in 2002. Other trading activities happened between Nigeria and Niger since the 1970s, and between Côte d'Ivoire and Ghana since the mid-1990s. These contracts, however, were not standardized and suffered from issues with billing collection and wheeling tariff [Gnansounou

	WAPP Member Utilities	Abbreviation	Country
1.	Société Béninoise d'Energie Electrique (*)	SBEE	Benin
2.	Compagnie Energie Electrique de Togo	CEET	Togo
3.	Contour Global	ContourGlobal	Togo
4.	Communauté Électrique du Bénin (*)	CEB	Togo, Benin
5.	APR Energy	-	Senegal
6.	Société Nationale d'Electricité du Sénégal (*)	Senelec	Senegal
7.	Compagnie Ivoirienne d'Electricité	CIE	Côte d'Ivoire
8.	Côte d'Ivoire Energies (*)	CI-Energies	Côte d'Ivoire
9.	CENIT Energy Limited	CEL	Ghana
10.	CenPOWER Generation Company Limited	CGC	Ghana
11.	Electricity Company of Ghana	ECG	Ghana
12.	Ghana Grid Company (*)	GRIDCO	Ghana
13.	Karpowership Ghana Company Ltd	KARPOWERSHIP	Ghana
14.	Northern Electricity Distribution Company Ltd	NEDCO	Ghana
15.	Aksa Energy Company Ghana Ltd	AKSA	Ghana
16.	Volta River Authority (*)	VRA	Ghana
17.	Sunon Asogli Power Ltd	-	Ghana
18.	Cummins Power Generation Ltd	CUMMINS	Nigeria
19.	Mainstream Energy Solutions Limited	MESL	Nigeria
20.	North South Power Company Ltd	NSP	Nigeria
21.	Pacific Energy Company Limited	PG&E	Nigeria
22.	Paras Energy and Natural Resources Development Ltd	-	Nigeria
23.	Sahara Power Group Ltd	SPG	Nigeria
24.	SAPELE Power PLC	SPP	Nigeria
25.	Transcorp Power	TRANSCO	Nigeria
26.	Transmission Company of Nigeria (*)	TCN	Nigeria
27.	Electricité de Guinée (*)	EDG	Guinea
28.	Empressa Publica de Electricidade e Agua de Guine-Bissau	EAGB	Guinea Bissau
29.	Liberia Electricity Corporation	LEC	Liberia
30.	Société Nationale d'Electricité du Burkina (*)	SONABEL	Burkina Faso
31.	Energie du Mali-SA	EDM	Mali
32.	Société Nigérienne d'Electricité	NIGELEC	Niger
33.	Electricity Distribution and Supply Company	EDSA	Sierra Leone
34.	National Water and Electricity Company Limited	NAWEC	The Gambia
35.	Société de Gestion de l'Energie de Manantali (*)	SOGEM	Guinea, Mali, Mauritania, Senegal
36.	Office National de l'Electricité et de l'Eau Potable du Maroc	ONEE	Morocco

Table 5.2: WAPP member Utilities as of December 2019. Members with a (*) are the permanent members of the executive board. Source: WAPP [2019a]

et al., 2007a].

Since the official establishment of WAPP in 1999, the vision was set to "integrate the national power systems into a unified regional electricity market" [WAPP, 2019a]. This includes devising a plan for market creation and also ameliorating the already existing trade by unifying the bilateral contracts in collaboration with the regional regulator, ERERA. However, The process took a considerable time as ERERA was established almost ten years after WAPP and it was finally in 2013 tha ECOWAS approved the Directive C/DIR.1/06/13 on the Organization of the Regional Electricity Market that sets clearly the roles of each institution. Following on, WAPP implementation roadmap for market development was divided into three phases: Phase 1 is dedicated for regional generation and transmission infrastructure (including communication) development until approximately 2015 with appointing a market operator and the approval of market rules (by ERERA), Phase 2 is dedicated to market formalization and end with establishing a day-ahead market, and Phase 3 is dedicated to the long-term vision of enhancing liquidity and competition [ERERA, 2015a].

Phase 1 was duly concluded in 2015 with the approval of the market rules and the appointment of the ICC of WAPP as the market operator. Despite this, the development of the infrastructure continues to be a work in progress with 65% accomplishment [WAPP, 2020a]. As for Phase 2, the market formalization, besides the market rules, the ICC developed market procedures, operation manual, market participant application procedures, market participant agreement, transmission tariff methodology, short, medium- and long-Term model bilateral contract, and the transmission service access and use procedures, which were all approved by ERERA. The remaining documents are minimum regional operating standards, grid code, market monitoring procedures, contract administration procedures (registering and approval), and transmission pricing model. The DAM was not also established, as the ICC technical preparation still ongoing along with the development of the regional WAPP dark fiber for the communication infrastructure. By the end of Phase 2, the ICC will be transformed to an independent institution from the general secretariat.

5.6.2 Market Progress

As we mentioned previously, the market development is still ongoing and the percentage of achievement relating to the establishment of the regional electricity market is estimated at 77% by WAPP [2020a]. Figure 5.8 shows the trade volume for the recent four years and figure 5.9 shows the development timeline.

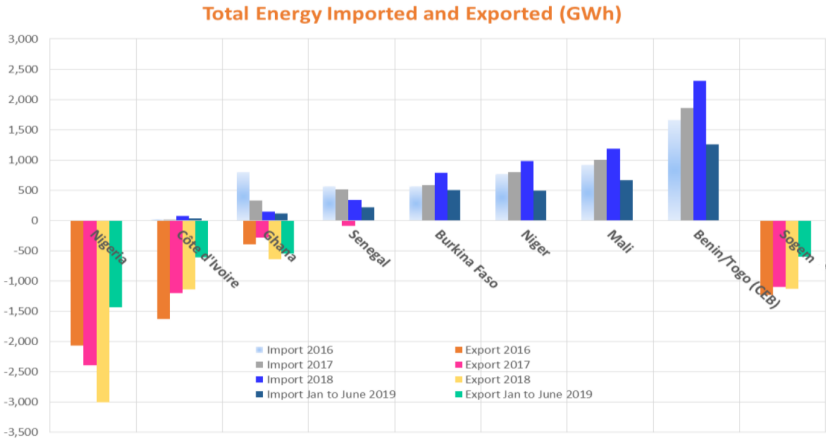


Figure 5.8: The trade volume in WAPP since2016. Source: WAPP [2020a]

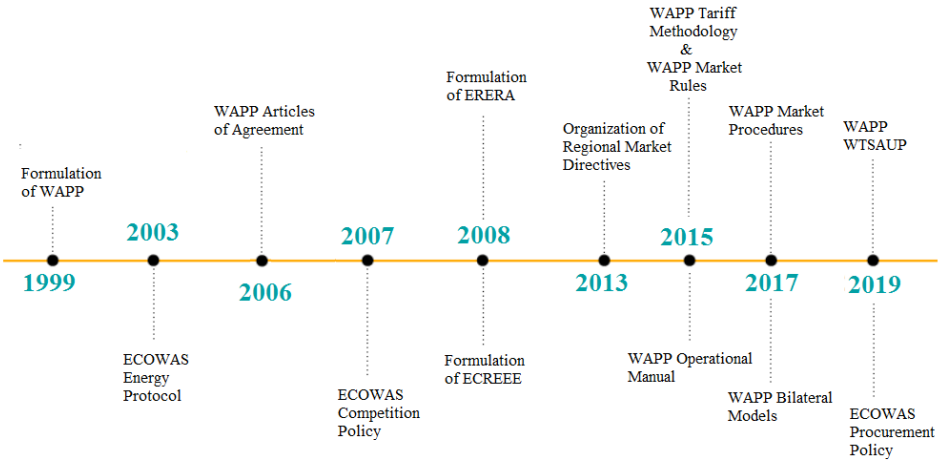


Figure 5.9: WAPP development timeline.

5.7 ANALYSIS

WAPP regional electricity market is currently underway and about to connect all member countries to one transmission network. The development of WAPP is speeding up due to the active involvement of international institutions and the lead of the regional institutions ECOWAS. In this context, the exogenous factors in the region and members' strategies are challenging the progress of WAPP and affecting its design. In the following subsections, we elaborate on these factors and the process that shaped the market design following our framework of analysis.

5.7.1 The Objectives

WAPP has developed rigorous standards for documenting, approving, and publishing all the relevant decisions, agreements, and other documents like the master plan. Despite stating clear objectives to all the organs within WAPP, like the secretariat and the ICC to be established, WAPP's objectives themselves are not to be found explicitly on their website or reports. The objectives are only mentioned clearly in the operation manual as follows [ERERA, 2015b]:

1. "Formalize an official and extended collaboration in the region in order to develop power generation and transmission facilities, thus enhancing power supply and strengthening power security within the sub-region;
2. improve the reliability of power system and quality of power supply in the region as a whole;
3. minimize operating cost of networks;
4. increase investments needed for power grid expansion in the region, with emphasis on the implementation of cross-border projects;
5. create an attractive environment for investments in order to facilitate the funding of power generation and transmission facilities;
6. create a common operating standards and rules in the sector;
7. create a transparent and reliable mechanism for the swift settlement of power trade transactions;

8. and increase the overall level of power supply in the region, through the implementation of priority generation and transmission projects that will serve as foundation for economic development and the extension of cheaper electricity supply to a greater number of consumers."

These objectives clearly stress the role of WAPP in achieving the availability goal by giving it responsibilities for ensuring investment and security of supply in the region. Such a focal objective is perhaps due to the regional situation and the prime focus of ECOWAS on economic development (as we examine in the exogenous factors). This overall objective of availability explains many of the current activities in WAPP. The objectives also highlight the goal of affordability by entrusting WAPP with minimizing the cost of operation, enhancing and extending power supply with cheaper generation projects. But it does not include reducing the cost of supply through fostering regional competition. The goal of acceptability is, however, missing from the objectives of WAPP. Based on these objectives, it could be said that WAPP has no role in providing clean energy supply. One reason could be that such a role is consigned to ECREEE. Such a gap could limit some market design options for renewable energy integration.

5.7.2 Development and Performance Factors

The conditions in the region of Western Africa were broadly not in favor of the development of WAPP. Almost all exogenous factors with the exception of the institutional context are hampering the development of trade. On the other hand, the endogenous factors are slowly improving for operationalizing the regional market. Each is discussed in the following paragraphs.

Exogenous Factors

In the physical context of WAPP, the transmission infrastructure was underdeveloped with low electricity access in all countries. Upon the official signing agreement of WAPP in 2006, the highest electricity access was 55% in Ghana [World Bank, 2021] and only a few interconnections existed between countries. In terms of energy sources, the distribution among countries varies substantially. The big three in the region Nigeria, Ghana, and Côte d'Ivoire are resource-rich in contrast to landlocked countries like Mali, Burkina Faso, and Niger as well as small coastal countries such as Liberia, Sierra Leone, Guinea, and Guinea-Bissau which are not particularly well endowed with exploitable energy. This led some of these countries like Benin, Burkina Faso, Mali, Niger, Togo to rely on importing electricity from neighboring countries. However, this is limited owing to the low electrification rate in the entire region.

The economic context was not better. The majority of WAPP member states were (some still) subject to borrowing restrictions as Highly Indebted Poor Countries. These restrictions are also placed on government-owned utilities [Karaki, 2017]. Consequently, there is a huge gap in the financing abilities of member countries that limits investment in generation and transmission projects. This is one of the main issues that ECOWAS is trying to mitigate through WAPP and the reason for stressing the investment responsibilities in its objectives. The financial shortage of member states resulted in insolvency issues between trading neighbors that further worsened the situation. Nigeria for example has a total of 13 million U.S. dollars unpaid dues from Niger, Togo, and Benin in 2020 (Interview 4). The demand growth also exceeds generation capacity in most countries. Even in Nigeria that has 50% of the installed capacity in the region, only half of this capacity is available (Interview 4). Therefore, the trade is limited in such economic conditions.

The institutional context is the sole set of factors that positively affected the development of WAPP. The regional body ECOWAS exhibits strong regional institutional stability and rule of laws. The ECOWAS Energy Protocol facilitates investment in the region and provides cooperation guidance. Additionally, through regional directives, ECOWAS eases the adoption of policies

and regulations (through ECREEE and ERERA). A clear example is Directive C/DIR/1/06/13 for opening up national electricity markets and ensuring open network access. The role of ECOWAS is equally crucial for harmonizing national institutions and, thus, adopting new role and design options for WAPP. WAPP authority is a direct function of the ability of ECOWAS to enforce decisions on member countries. Concerning the governance of WAPP, both Nigeria and Ghana are influential stakeholders that currently occupy half of the membership of WAPP. The two countries could formulate an enabling or blocking force.

The political factor in the region is perhaps the strongest factor constraining the development of trade in WAPP. The region has witnessed repeated civil wars, conflicts, and military coup d'état. This has been the main disturbing factor to the regional economic integration that pushed ECOWAS to step into peace and security agenda. This is evident from the series of ECOWAS military interventions in many countries like in Liberia 1990, Sierre Leone 1997, Geniue-Bissau 1999, Côte d'Ivoire 2007, Burkina Faso 2015, the Gambia 2017, and Mali 2020. These conflicts contributed to the damage and vandalism of infrastructure and are considered major constraints for private sector investments. The ideology of member countries toward the electricity sector is another constraining factor. All the members in the region view the sector as national supremacy and sovereignty that they do not want to recede to WAPP (Interview 2, 3, and 5). This is manifested as a lack of commitment which undermines possible integrated design options for WAPP. Corruption is also a prevailing feature in some countries like Nigeria (Interview 4).

Endogenous Factors

The endogenous factors of WAPP are showing improvement over time with respect to launching the regional market. Technical readiness remains the obstructive factor.

The governance structure of WAPP is independent of any regional entity in terms of internal decision-making, and employs democratic procedures and transparency in it operation (e.g., public meetings and fair recruitment), which avoids the risk of politicizing the pool and delaying decisions and increases members' participation. However, the voting mechanism (described in section 5.2) gives a higher weight to members who are transmission owners or users. This current not problematic as these are currently all the members of WAPP with voting right. But in the future, this might be subject to change to ensure fair representation. The financing of WAPP is arranged from members' contributions and donors. When looking into the formula of members' contributions in section 5.2, members that are active in trade through WAPP pay more than the others. The arrangements might be currently acceptable and even practical considering the stark difference between member utilities. However, in the future, this could discourage trade through WAPP and be seen as unfair if transaction cost is the same. On the other side, WAPP relies heavily on donors' funds to perform studies and planning. This is also the case for ECOWAS that has limited financial capabilities (Interview 2, Karaki [2017]).

Although the committees of WAPP are fully staffed, the staff capacity is questionable. This because the fact that almost all projects and studies are designed and conducted by foreign companies. Technical readiness for launching a trading platform remains a work in progress for installing basic infrastructure, like communication lines, and technical transmission system requirements, like synchronization and protection. WAPP is trying to mitigate these issues with the help of stakeholders. WAPP has the donors' coordination committee responsible for providing capacity building training and technical assistance with the help of various international institutions [WAPP, 2019a].

Finally, WAPP has formal procedures for dispute resolution that includes internal mediation and external appeal to the ECOWAS Court of Justice [1].

5.7.3 The Dynamics

The dynamics of WAPP describes the current design of WAPP, the impacts of the exogenous and endogenous factors, and the drivers of change.

The Design

The starting conditions at the time of WAPP creation explain some of the current design choices. The nature and presence of the central institutional body ECOWAS allowed for WAPP to take complete autonomy. ECOWAS functions through establishing independent institutions for different purposes and manages them formally through protocols, standards, and adoption of resolutions made by those institutions. Thanks to this, WAPP manifests itself in the region and takes its power via ECOWAS. Because of this, WAPP could exert the choices of a mandatory pool or even a tight pool, depending on the interest of the members and the enforcement power of ECOWAS. Indeed, in terms of bilateral agreements, WAPP and ERERA are responsible for unifying and approving all contracts between members. This can be understood given the political tension and financial issues between member countries, that ECOWAS is trying to mitigate.

The structure of the national systems at the beginning also affected the governance and membership of WAPP. Upon the signing of WAPP Articles of Agreements in 2006, several influential countries like Ghana, Côte d'Ivoire, and Senegal were already privatized and the numbers of IPPs were significant already including in Nigeria as well. Consequently, IPPs were given direct membership and fair representation from the outset. The private operator role is also recognized with a reserved seat on the executive board.

The presence of ECOWAS has also another significant in adopting policy and regulation of national systems. Directive C/DIR/1/06/13 for market opening is again a clear example of the top-down approach to policy and regulation in the region. This provides WAPP with an institutional shield from being affected or hindered by national policies and regulations. This is however subject to the commitment of member countries and the enforcement of the directives. In such a situation, the position of the regulator is de facto independent of the pool. The regional regulator ERERA, thus, is responsible for coordinating with national regulators to ensure compliance.

The severe economic and infrastructure conditions in the region also pose the need for WAPP to take on an investment role. Thus, the structure of WAPP includes technical and financial partners directly with the executive board as well as WAPP donors' coordination committee with the general secretariat [Karaki, 2017]. Moreover, WAPP has a Special Purpose Company/Vehicle functioning as an investment unit and deals with cross-border gas tariff issues as in the West Africa Gas Pipeline project connecting Nigeria with coastal countries. All these efforts explain the business-oriented activities of WAPP (that includes detailed business planning) for enabling trading environment and compensate for the shortcomings of member countries.

Motors of Change

The strongest driving force for the development in WAPP is the regional institution ECOWAS, followed by the strong engagement of international institutions. Contrastly, the members' strate-

1 In October 2019, the Community Court of Justice, ECOWAS, has ordered WAPP to pay $280,000 as dismission compensation for the plaintiff

gies in WAPP seem to be curbing the progress.

The economic and political external factors have their toll on members' strategies. Due to frequently unpaid debts and political conflicts in bilateral agreements, member countries grew untrusting each other (Interview 3 and 5). Thus, all countries are pursuing national strategies for self-sufficiency and self-reliance. Additionally, perceiving the electricity sector as national sovereignty, members are said to be not genuinely interested in cooperating with WAPP (Interview 5). National utilities do participate in WAPP because whenever they are participating, they receive per diems, but the fact that they participate does not mean they are interested. For regional projects with WAPP, some utilities do not follow up consistently with the progress (Interview 5). To them, WAPP is useful to raise funds and conduct studies, but they do not fully coordinate or share data with WAPP. For instance, for developing communication protocol with SCADA systems, Nigeria's utility is not interested in sharing the protocol (Interview 5). Particularly, the big three utilities of Nigeria, Ghana, and Cote d'Ivoire have an ambiguous approach towards WAPP; as they do not want to be constrained and giving control by WAPP.

WAPP also does not have a strong dominant player. Nigeria has the largest resources to potentially fill this role but it is unable to meet its domestic demand due to suffering from acute internal infrastructure and unexploited potentials. Moreover, Nigeria is not well-positioned in WAPP and it would require huge transmission investments. Thus, it is unlikely that it will have a major role in the future. Most likely, Ghana will play a key role in regional trade due to its strategic position, stable political environment, and economic growth. But this would require cooperation with neighboring countries. The risk of neighboring countries failing in their commitment offset the efforts of other countries. For instance, Burkina Faso did not fulfill its side of the agreement on the interconnector with Ghana. In conclusion, the strategies and actions of WAPP members are not in favor of the development of WAPP nor regional trade, if not the opposite.

ECOWAS can be said to be the prime mover for the development of WAPP and energy integration. ECOWAS has succeeded in brokering significant upstream progress through institutional reforms such as the Energy Protocol, ERERA, ECREEE, and the investment company in WAPP. In view of the limited financial capacity of member countries, ECOWAS has consistently tried to involve the private sector and international financial institutions through WAPP. Owing to ECOWAS's sophisticated formal rules in the form of protocols, strategies, and institutional arrangements, ECOWAS Commission has an explicit role in carrying out regional integration agenda in a proactive manner. However, ECOWAS has little power for enforcing the regional integration directives and does not exercise supranational power on member countries (Interview 2). Member countries resist giving ECOWAS such power due to their various interest, political shifting, mutual mistrust, and deep-rooted nationalism ideology.

International institutions are prime movers of change behind the leading of ECOWAS. Financial institutions and donors are very active in the region. The huge energy potentials of the region attract donors and investors to exploit untapped resources. Regional institutions like WAPP provide opportunities to channel money for feasibility studies, trading, market reforms, operational codes, and standards. This reduces the transaction cost of going through national governments considering the corruptive nature of some governments. WAPP is such a case for the World Bank (Interview 5). Most of the transmission projects are financed by the World Bank. The investment in interconnection projects has been accelerating and all the short-term committed projects in table C.3 are in the final construction phase, some will be even energized later this year and the entire region will be connected in a year or two (Interview 3, 5 and 11). Besides donors and financial institutions, other international advisory institutions like Tony Blair Institute for Global Change (TBI) are also actively working with WAPP and national governments. TBI particularly works in enabling the political decision and changing governments' reluctance for regional trade by directly advising energy ministers on how to manage the risk of losing

national supremacy and security of supply through firm contracts. On the other hand, they provide technical assistance for WAPP and ERERA. Thus, directly influence endogenous factors and indirectly affect the pool design, including transmission tariff methodology, market rules, and grid code (Interview 3 and 5).

5.8 CONCLUSION

WAPP has exerted a lot of efforts to systematically establish the regional market. Against the eight power pool reforms (identified in chapter 3), WAPP implemented the following reform steps:

1. Establishing legal documents and agreements permitting trade, the WAPP Articles of Agreement
2. Establishing regional regulator for trade, ERERA.
3. Establishing commercial market rules for trade, the WAPP Market Rules and Procedures.
4. Admitting IPPs participation.
5. Establishing regional grid development, WAPP Special Purpose Company/Vehicle and Project Unit.

The following factors were important in the establishment and development of WAPP:

1. The establishment of the regional economic community ECOWAS.
2. The distribution of natural energy endowments in the region and limited size of some countries created interdependence and a need for trade between countries.
3. The presence of ECOWAS Commission as a regional institution for promoting regional integration, foreign investments, and cooperation in the energy sector.
4. The financial support received from international institutions.

Finally, although WAPP has not established a regional competitive market yet, it has strong institutions, i.e., regulations and formal rules. The regional dynamic is characterized by strong regional institutions and financial institutions' involvement against difficult political, economic, and physical conditions.

6 THE EASTERN AFRICAN POWER POOL – EAPP

"We have to be impatient in moving Africa forward"
Akinwumi Adesina (President African Development Bank)

In this chapter, we look into the situation in the Eastern African Power Pool (EAPP). Firstly, we present the historical development of EAPP. We start by looking into the regional institutions in section 6.1, the governance structure in section 6.2, the policies and regulation in section 6.3, the regional infrastructure in section 6.4, the national systems in section 6.5, and the regional market in section 6.6. Secondly, we apply our analytical framework, discussed in chapter 3, in section 6.7. We conclude the chapter with answering the second research question *"What were the factors and reform steps for establishing EAPP?"* in section 6.8.

The Eastern African Power Pool (EAPP) is the youngest power pool in Africa and the largest in terms of coverage area and inhabitants [ICA, 2016; IEA, 2019]. The pool includes eleven countries, as shown in figure 6.1, and covers a total area of 9,515,368 km^2 and a population of 542.7 million [Worldometer, 2020].

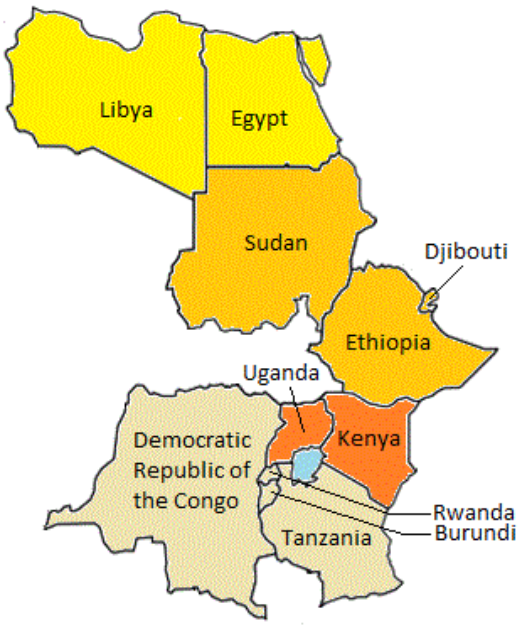


Figure 6.1: Geographic map of the countries of EAPP.

6.1 REGIONAL INSTITUTIONS

The collaboration in the Eastern region of Africa took many forms before its institutional crystallization. Between 1974 and 1984, severe drought and natural disasters were recurring in the Eastern Africa region. Attempting to tackle the issue regionally, the Inter-Governmental Authority on Drought and Development (IGADD) was established in 1986 between the six countries of the Horn of Africa: Djibouti, Ethiopia, Kenya, Somalia, Sudan, and Uganda. In 1996, the members of IGADD signed "Letter of Instrument to amend the IGADD Charter" to the revitalized regional organization under a new name, the IGAD [IGAD, 2016]. Both Eritrea and South Sudan joined the IGAD after attaining their independence. On the other hand, EAC was re-established [1] in 1999 between three partner states: Kenya, Tanzania and Uganda. EAC now includes Burundi, Rwanda, South Sudan [EAC, 2020]. But perhaps the biggest platform for collaboration that includes members from IGAD and EAC, is COMESA, established in 1994. COMESA was another reformulation of the Preferential Trade Area which had existed since 1981. It was especially pushed for by the United Nations Economic Commission for Africa, that aimed to promote economic cooperation and intra-regional trade [Verhaeghe and Woolfrey, 2017]. Consequently, the purpose of COMESA became to foster trading and economic prosperity through regional integration between its 21 member states: Burundi, Comoros, Djibouti, DRC, Egypt, Eritrea, Ethiopia, Eswatini, Kenya, Libya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Sudan, Somalia, Tunisia, Uganda, Zambia, Zimbabwe [COMESA, 2015].

COMESA's approach to regional economic integration follows the Balassa Model of integration, in which members move from trade agreements to a free trade area, to a customs union, to a common market, to a monetary union, and the to a full economic community [Balassa, 1967]. COMESA's highest authority for policymaking is the Heads of State and Government followed by the Council of Ministers. It also established COMESA Court of Justice to promote compliance with regional agreements but without an employed sanction mechanism. Member countries are given financial incentives through the Regional Integration Support Mechanism for supporting trade activities.

Initially, the Eastern Africa Power Pool (EAPP) was founded in 2005 between seven Eastern Africa countries, namely: Burundi, DRC, Egypt, Ethiopia, Kenya, Rwanda, and Sudan. The member countries signed an IGMOU with a prime aim to foster power system interconnectivity. In 2006, EAPP was adopted as a special institution of COMESA during its 11th summit in Djibouti. By 2012, EAPP included the seven founding members plus Djibouti, Tanzania, Libya, and Uganda (Tanzania being the only member of EAPP and not of COMESA) [EAPP, 2016a]. The signature of the IGMOU was followed by the signature of an IUMOU by the Chief Executive Officers/Managing Directors of the countries' eleven power utilities. The goals of EAPP are to optimize the usage of energy, reduce the cost of electricity, establishing a framework for efficient coordination of energy pooling and promotion of power exchange. As COMESA was primarily developed to facilitate trading, EAPP remained completely autonomous. The main role of COMESA is to provide a level of oversight and political clout. Additionally, COMESA acts as a financial intermediary between donors and EAPP [Verhaeghe and Woolfrey, 2017].

6.2 THE GOVERNANCE OF EAPP

The current organization of EAPP comprises fourteen utilities and seven national energy/electricity regulators from the eleven member countries. The organization structure is set based on the IGMOU and the IUMOU, which consists of the council of ministers at the top of the hierarchy

1 Prior to that, EAC had 3 names since its inception; the East African High Commission from 1948 to 1961, East African Common Services Organization from 1961 to 1967, and then from 1967 to 1977 the East African Community. However, in 1977 the EAC collapsed due to a stark disagreement about the decision-making seats

under which there are the steering committee, the coordination center and the Independent Regulatory Board (IRB), as shown in figure 6.2.

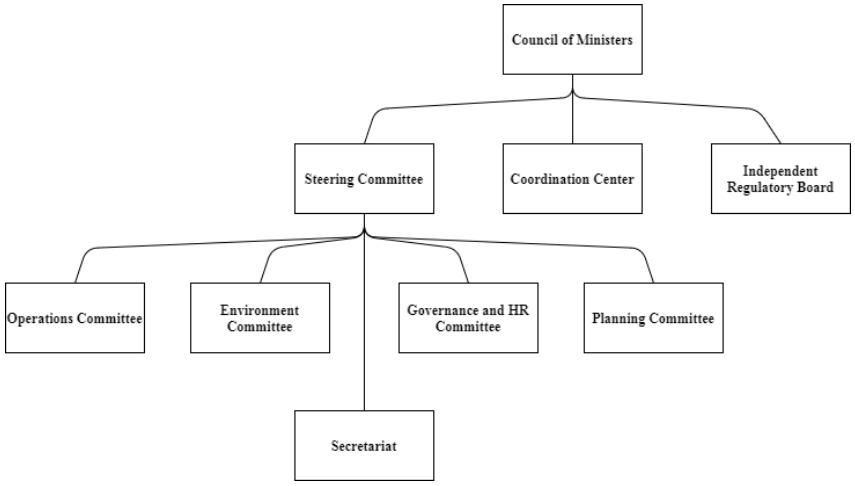


Figure 6.2: The governing structure of EAPP. Source: EAPP [2016a]

The council of ministers is the supreme governing body of EAPP that provides strategic guidance and oversight and responsible for approving membership applications and appointing the secretary general and the IRB members. The steering committee consists of the heads of member utilities and is the executive body responsible for policy formulation, monitoring of plans execution, and managing four organizational committees and the general secretariat located in Addis Ababa, Ethiopia. A representative of the COMESA Energy Programme always attends meetings of the steering committee and council of ministers. The general secretariat facilitates day-to-day activities, bilateral and multilateral issues to enable the development of the power pool. Each of the four organizational committees has a chairperson on a rotational basis who is elected from the steering committee. The four committees are:

- **The Planning Committee**: its activities are carried out by the committee's secretary, who is the system planning, programming and environment manager, and senior planning officers elected from member utilities. The committee is responsible for coordinating the master plans and development programs of member utilities.
- **The Operations Committee**: its members include a secretary who is the grid coordination manager and senior load dispatch center officers elected from member utilities. The committee is responsible for defining the operation and maintenance rules of power plants and networks involved in EAPP.
- **The Environment Committee**: its members are environment technocrats elected from members' utilities who are senior environment officers. The environment officer of EAPP is the secretary of the committee. The committee is responsible for the environmental impact assessment and mitigation measures on the electrical installations within EAPP.
- **The Governance and Human Resources Committee**: its members are senior HR officers elected from members' utilities and. The finance, human resources & administration manager of EAPP is the committee's secretary. The committee is responsible for collecting technical and commercial information necessary for the operation of the regional interconnection and power exchange; helps the steering committee with the recruitment process, serves as an administrative tribunal to hear appeals submitted by staff members against administrative decisions made by the secretary general, and advises the steering committee on all disciplinary measures to be taken against management staff.

A market committee is expected to be established and operate soon and meanwhile, a market working group has been established for the purpose of working on issues related to EAPP power market [EAPP, 2020b]. However, owing to the lack of funds, as well as the absence of adequate interconnection, and the early stage of the market establishment, EAPP was unable to set up and fully operationalize all sub-committees [EAPP, 2016a]. The plan for establishing a coordination center to function as the regional market operator was abolished (Interview 10), despite an early study performed by SNC Lavalin International Inc and Brinckerhoff Parsons [2011] that recommended Kenya for hosting the center. Currently, the general secretariat hosts the grid coordination unit, the marketing and energy trading unit, the system planning and programming unit, the social and environmental protection unit, the finance, human resources and administration unit (Interview 10).

Financially, EAPP has three financing sources: member fees for the operation, support received from the regional institute, and projects funding from financial institutions (Interview 1). However, these arrangements are not formally mentioned in the official documents and financial statements are not annexed to official reports.

6.3 REGULATION AND POLICIES

6.3.1 Institutions

In 2012, the meeting between the national regulators and energy ministries of EAPP members to address regulatory issues concluded with the necessity of establishing a regional regulator to oversee regional regulation. The Eastern Africa Power Pool Regulatory Forum was formed to lead and facilitate the establishment of the IRB. This recommendation was then approved by EAPP council of ministers and the IRB was founded during the same year to be based along with the permanent secretariat in Addis Ababa, Ethiopia. The board consists of nominees of national regulatory boards in the countries of the members, or ministries of Energy in countries with no regulatory body, and is responsible for making standards, procedures, specifications, settle disputes, foster investments, and organize power markets within EAPP. Additionally, the mandates of the IRB include issuing operating licenses to qualified participants, approving formulae for calculating EAPP regional transmission and wheeling tariffs, recommending changes to EAPP member country's domestic legislation to facilitate the development of EAPP regional power trade, settling any dispute between members, and imposing penalties and sanctions on non-compliance [EAPP, 2016b].

The IRB reports directly to the council of ministers and is composed of several working groups for technical regulation (grid code and domestic regulation), legal affairs, economic regulation (tariff, market rules and surveillance) and administration and finance. All are managed by the CEO of the IRB secretariat.

The IRB is affiliated only with EAPP and its council of ministers, while COMESA has another regional regulator that existed before the IRB. Since 2009, the Regional Association of Energy Regulators for Eastern and Southern Africa (RAERESA) has been working as COMESA special institute for promoting integration and investment in the energy sector as well as creating a harmonized regulatory environment. RAERESA has its legal framework from Articles 106 to 109 of the Treaty establishing COMESA and is composed of: the Plenary which is the highest decision-making body, the executive committee, the portfolio committees, and the Secretariat [COMESA, 2021]. The association has ten members of national regulators with full membership and four with an observer membership, as shown in table 6.1. Additionally, EAC has its own regulatory association, the Energy Regulators Association of East Africa (EREA), that cooperate with the IRB as well as a renewable energy center, the East African Centre for Renewable Energy and Energy Efficiency (EACREEE) (Interview 9).

	Full Membership	Abbreviation	Country
1.	Electric Utility and Consumer Protection Regulatory Agency	EgyptERA	Egypt
2.	Energy Regulatory Authority	EEA	Ethiopia
3.	Energy Regulatory Commission	ERC	Kenya
4.	Electricity Regulation Office	ORE	Madagascar
5.	Malawi Energy Regulatory Authority	MERA	Malawi
6.	Rwanda Utilities Regulatory Authority	RURA	Rwanda
7.	Seychelles Energy Commission	SEC	Seychelles
8.	Electricity Regulatory Authority	ERA	Sudan
9.	Electricity Regulatory Authority	ERA	Uganda
10.	Zimbabwe Energy Regulatory Authority	ZERA	Zimbabwe
	Observer Membership	**Abbreviation**	**Country**
11.	Agency for Regulation of Water, Electricity and Mining	AREEM	Burundi
12.	Energy Regulatory Authority	ESERA	Eswatini
13.	Utility Regulatory Authority	URA	Mauritius
14.	Energy Regulation Board	ERB	Zambia

Table 6.1: RAERESA Members. Source: COMESA [2021]

6.3.2 Regulatory and Policy Frameworks

The development of Eastern regulatory institutions has been very slow with little to no regulation output. To this end, the IRB of EAPP did not approve the drafts of the market rules, market procedures, and market guidelines which were delivered from a consultancy job in 2014 (see Appendix D). Additionally, with the absence of power exchanges between members, the IRB has no active role to play, other than preparing for its mandate. Thus, the IRB presently only has one staff member and is effectively not functioning (Interview 9 and [Norda and KPMG, 2019]).

Similarly, the RAERESA of COMESA still in the stage of building its foundation. Although the institution was formed in 2009, according to Elnasr [2017], establishing the secretariat remained a work to be done. Therefore, the association does not have a dedicated platform and no publication was found. Furthermore, it is only recently in 2019 that RAERESA signed a Memorandum of Understanding that establishes a three-year collaboration with the Council of European Energy Regulators for capacity building [CEER, 2019].

6.4 THE REGIONAL INFRASTRUCTURE

6.4.1 The Current Status

The regional infrastructure of EAPP is fragmented and covers all the members within three isolated blocks as shown in figure 6.3 [2]. The total capacity of the transmission network is 1,440 MW. Four countries have only one interconnection and the other seven countries each have two interconnections with the largest interconnection capacity of 371 MW between Ethiopia-Sudan. The total installed capacity of the eleven countries is 83,818.4 MW in with a peak demand of 48,570 MW.

Figure 6.4 shows the generation portfolio of EAPP, which consists of 79% fossil fuels (mostly natural gas), 16% hydro, 2% wind, 1% from each of geothermal, solar, and biomass and waste installed capacity. The lion's share goes to Egypt with 56.1 GW installed capacity which counts for 67% of the total regional capacity. The second-largest installed capacity is 32.11 GW found in Libya and makes 13% of the total. Then 10% of the capacity is installed equally between

2 Some rural electrification exists between some countries like Uganda-Rwanda and Kenya-Tanzania

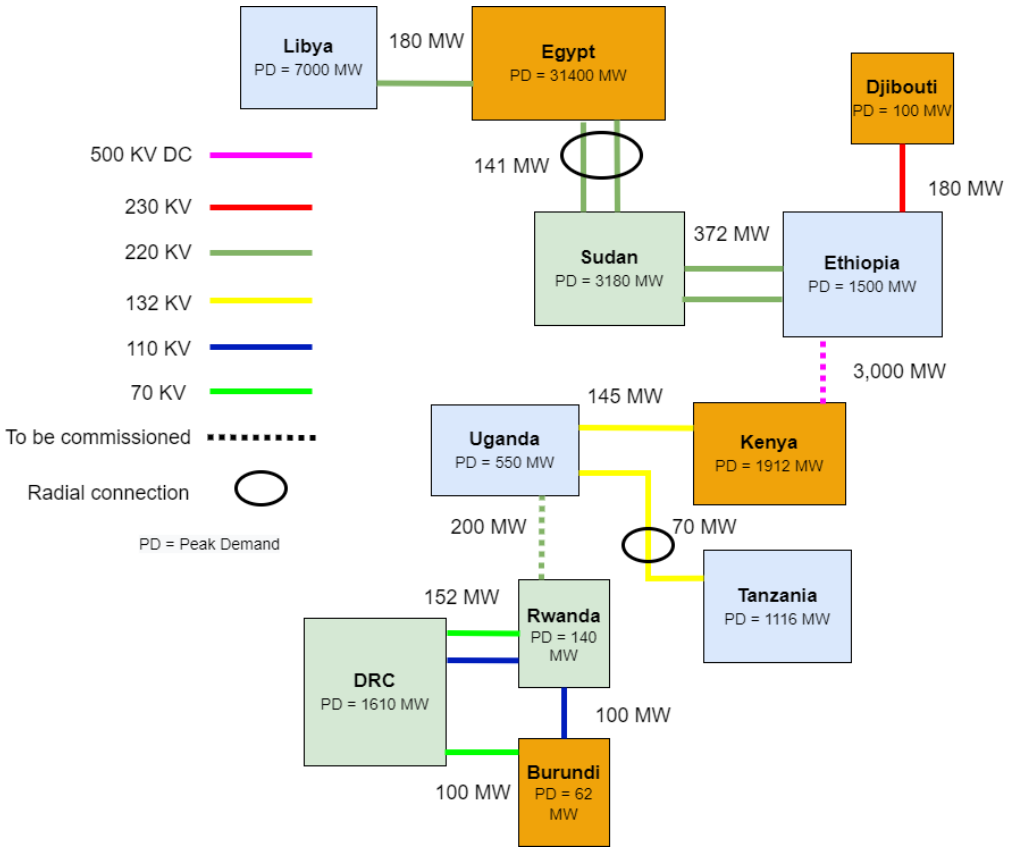
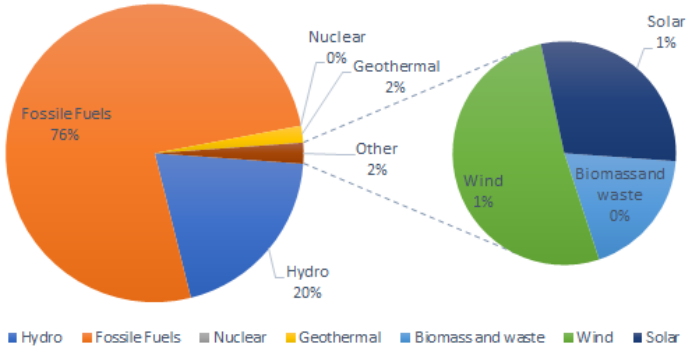


Figure 6.3: Peak demand and transmission capacity of EAPP regional power grid. Composed by the author from various secondary data sources: SNC Lavalin International Inc and Brinckerhoff Parsons [2011], EAPP [2014c], EAPP et al. [2014], private communication with the control center of Sudan, and projects documentations from the World Bank

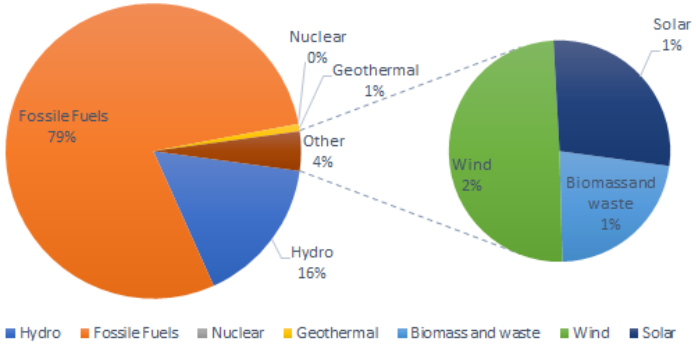
Ethiopia and Sudan. 279,987.2 GWh of electricity was generated in 2018, 66% of which came from Egypt that produced 78.8% of the total fossil fuel generation of EAPP. The second-largest producer is Libya with its entire generation capacity from fossil fuel contributing to 15% of its total.

EAPP is rich in hydropower generation, thanks to the Nile River, and is distributed amongst the countries in the three different sub-networks. The largest hydro producer is Ethiopia with a share of 23.1% followed by Egypt 22.9%, Sudan 17.1%, DRC 18.7%, and Uganda 6.4%. The only country with geothermal generation is Kenya with an installed capacity of 663 MW.

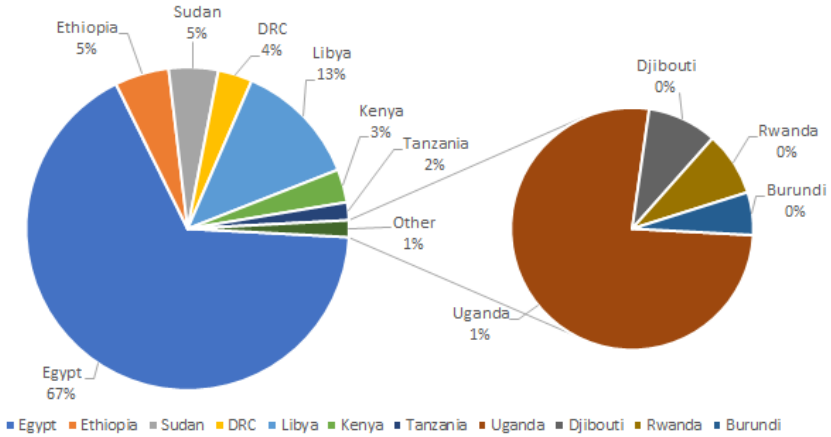
Figure 6.5 shows the energy trade in EAPP. Trading is scarce and the amount of annual trade was only 2,369 GWh. Due to the equable distribution of hydro, countries have a similar energy mix and only export when they have a surplus of electricity. The largest exporter in the region is Ethiopia with 62.1% of the total exported electricity in the region. Most of the countries' consumption is satisfied with local generation. Burundi and Sudan are the biggest import-dependents with 29.5% and 7.1% of their electricity consumption imported, respectively. The other two largest exporters are Egypt with 18.9% and Uganda with 14.2%. Interestingly, at first glance at the third isolate network between Burundi-Rwanda-DRC, all the three countries appear to be net importers in figure 6.5c, despite being isolated, this is because the three countries established a public company called SINELAC which operates two hydropower plants, Ruzizi I (29.8 MW) and Ruzizi II (43.8 MW), on the shared border of the Ruzizi River. Thus. the three countries import electricity from SINELAC.



(a) EAPP generated electricity by source in 2018.

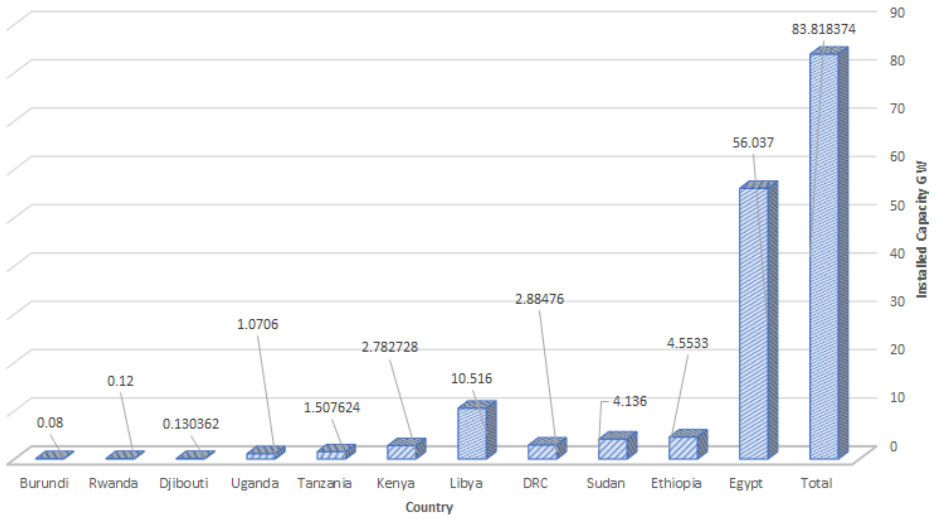


(b) EAPP installed generation capacity by source in 2018.

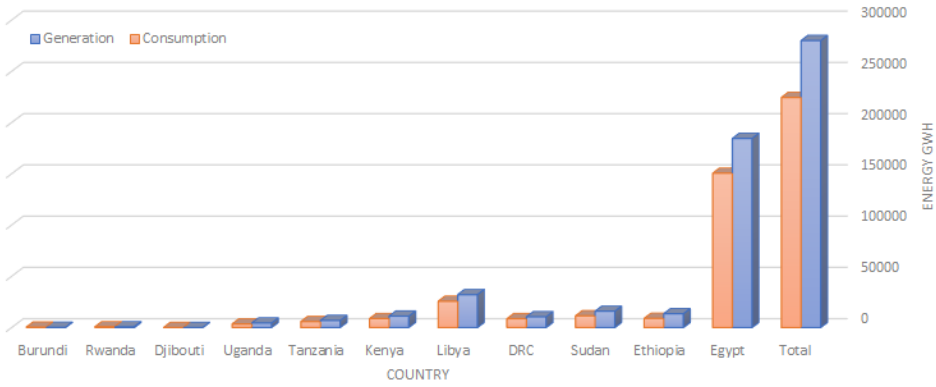


(c) EAPP countries' share of the installed generation capacity in 2018.

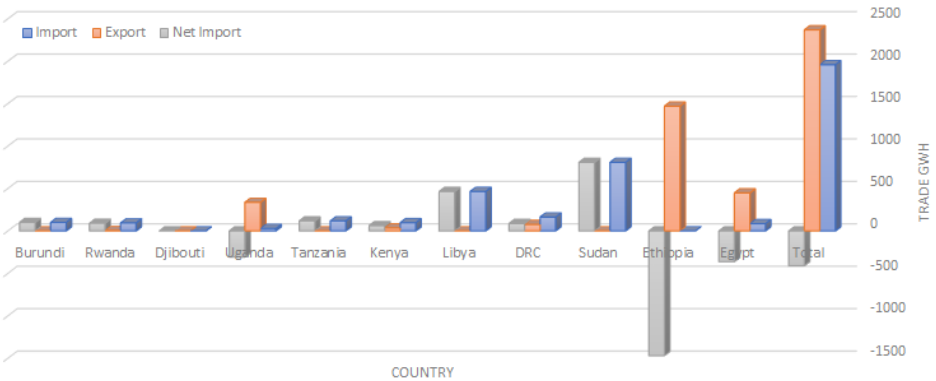
Figure 6.4: EAPP generation portfolio in 2018. Data source: EIA [2021]



(a) EAPP installed generation capacity per country in GW in 2018.



(b) EAPP countries' generation and consumption in GWh in 2018.



(c) EAPP countries' export and import of electricity in GWh in 2018.

Figure 6.5: EAPP energy trade in 2018. Data source: EIA [2021]

6.4.2 Planning and Investments

The first Regional Power System Master Plan and grid code studies were launched in 2009 and its final report was submitted in May 2011. The master plan took stock of various studies conducted in the region by other initiatives and sub-regional institutions (Eastern Nile Power Trade Investment Project, Opportunities for Power Trade in The Nile Basin Final Scoping Study, the Vision and Strategy Framework for Management and Development of Lake Victoria Basin, and the East Africa Power Master Plan Study) [ICA, 2011]. The master plan was updated in 2014 for a 10-year span and included South Sudan as a highly potential member. The plan uses a simplified Balmorel model that is based on least-cost dispatch planning and the development is divided into two periods from 2015 to 2020 and then to 2025. The new capacity to be installed is mainly split between hydro and natural gas (see in Appendix C). When excluding natural gas installed in Egypt, hydropower will form more than 50% of the new capacity. With the exception of Djibouti and Libya, all the countries are planning to install hydroelectric generation with Ethiopia taking the lion's share of almost half of the planned capacity.

Most of the transmission projects from the previous master plan were delayed and adopted in the new plan of 2014. These are also split between 2015-20 and 2020-25 (also see in Appendix C). The total estimated cost of these projects is US$1.58 billion.The plan point shortly to other interconnection with countries outside EAPP. Some of the existing connections are Libya-Tunisia (linking EAPP with COMELEC), Egypt-Jorden (linking EAPP with MENA), and DRC-Zambia (linking EAPP with SAPP); other planned projects are Egypt-Sudia Arabia, Libya-Greece, and Eastern DRC-Western DRC (to link EAPP with CAPP and WAPP). The 2014 master plan does not give technical details of the suggested projects that are mainly serving as recommendations to coordinate national plans. The study also does not delve into the financing aspects or the action plan for the implementation. The new EAPP's profile [EAPP, 2020b] states that a newly developed 10-year strategic plan was finalized for the period of 2018-2027 with a three-year Action Plan (2019 – 2021). These were harmonized with the 2014 plan and were approved by the council of ministers in February 2018.

6.5 MEMBER COUNTRIES

EAPP members have different economic and political situations. The horn region especially had witnessed a long political tension between member countries including civil wars (e.g., in Ethiopia, Sudan, Rwanda, and Libya) and cold wars (e.g., between neighboring countries and Ethiopia as a previous communist country supported by the Union of Soviet Socialist Republics (USSR), and between Sudan and Uganda). While countries like Egypt and Kenya had more stable internal conditions. With the exception of Egypt, Kenya and Libya, the rest of the nine members are classified in the low Human Development category [UNDP, 2020]. Energy potential in the region like hydropower has been largely a source of conflict instead of collaboration.

According to UNEP [2017], hydropower exists in all member countries except Libya and Djibouti. The biggest potential is found in DRC (the Congo River) with 774 TWh/year and Ethiopia (the Nile River) 260 TWh/year. Oil is found predominantly in Libya and in a relatively small volume in Egypt, Sudan, and Uganda while natural gas exists only in Egypt and Libya. The geothermal potential is significant in Kenya and comparably small in Ethiopia and Djibouti. Solar potential is equitably distributed over all the countries while wind potential is considerable in the upper countries of Libya, Egypt, and Sudan. Uranium in the region is only produced in DRC. The development of these resources was subject to the various conditions of the countries, the highest GDP in the region is Egypt with $303 Billion while the regional average is only $67.5 Billion. The GDP per capita takes a different shape, as shown in figure 6.6. The highest GDP per capita is by far Libya with $7,685 comparing to the regional average of $1,892.

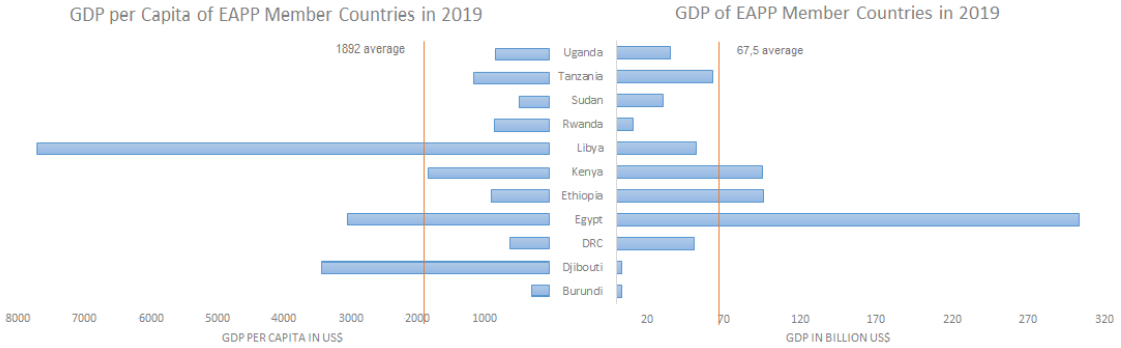


Figure 6.6: GDP of EAPP member countries in 2019. Source: World Bank [2021]

Country	Electricity Law/Act	Corporatization & Commercialization	Regulation	IPPs	Unbundling	Management /Concession Contracts	Privatization
Burundi	2005	1997	2014	2016	Pending	Pending	Pending
DRC	2006	2010	2014	2000	Pending	2014	Pending
Djibouti	Pending	Pending	2009	None	Pending	Pending	Pending
Egypt	1996	1997	1997	1998	Pending	2001	2001
Ethiopia	1997	1997	1997	1999	2013	2007	2001
Kenya	1997/2006	1995	1997	1997	1997	2006	2001
Libya	Pending	Pending	1997	2013	Pending	Pending	Pending
Rwanda	2008	2011	2011	2011	Pending	2012	2011
Sudan	2001	Pending	2011	None	2010	Pending	Pending
Tanzania	2002	2002	2006	2004	Pending	2002	Pending
Uganda	1999	1999	2000	2000	2001	2001	2001

Table 6.2: EAPP member countries implementation of the standard textbook model. Collected by the author from various secondary sources including Rana and Khanna [2020], Imam [2020], Nsabimana [2020], Nworie [2017], Eberhard and Catrina Godinho [2017], Eberhard et al. [2016], UNIDO [2006], and the World Bank projects documentations.

Considering the standard textbook model of electricity sector reforms, member countries various ostensibly in their sector organization. Three countries implement all the steps of the reforms: Uganda, Kenya, and Ethiopia (partially unbundled). Oppositely, both Djibouti and Libya have not formally started the reform process (no electricity act/law). Other countries are stalled in different steps as shown in table 6.2. The reforms delivery has been considered successful in Kenya (see Godinho and Eberhard [2019]) while questionable in other countries. The only two countries that provide universal access are Egypt and Libya while the regional average is 50%, as shown in figure 6.7.

6.6 THE REGIONAL MARKET

Members of EAPP are national utilities that are either transmission or generation companies (no IPPs yet). Currently, 14 utilities are registered members of EAPP; three companies are based in Kenya; one company, SINELAC, belongs to the Economic Community of the Great Lakes Countries Burundi, DRC, and Rwanda; and the rest are representative from each of the 10 remaining countries. All are shown in table 6.3.

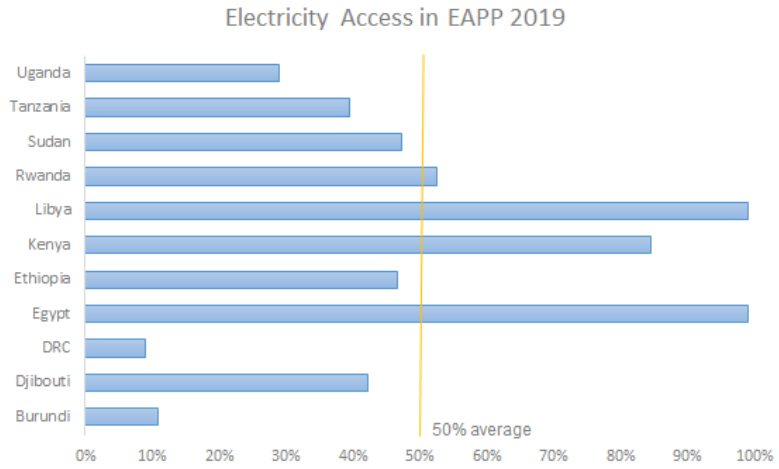


Figure 6.7: Electricity access in EAPP member countries in 2019. Source: IEA [2021]

	National Power Utilities	Abbreviation	Country
1.	Régie de Production et de Distribution de l'Eau et de l'Electricité	REGIDESO	Burundi
2.	Électricité de Djibouti	EDD	Djibouti
3.	Societe Nationale d'Electricite	SNEL	DRC
4.	Egyptian Electricity Holding Company	EEHC	Egypt
5.	Ethiopian Electric Power	EEP	Ethiopia
6.	General Electric Company of Libya	GECOL	Libya
7.	Kenya Electricity Generating Company	KenGen	Kenya
8.	Kenya Power and Lighting Company	KPLC	Kenya
9.	Kenya Electricity Transmission Company	KETRACO	Kenya
10.	Rwanda Energy Group	REG	Rwanda
11.	Sudanese Electricity Transmission Company	SETCO	Sudan
12.	Tanzania Electricity Supply Company Ltd	TANESCO	Tanzania
13.	Uganda Electricity Transmission Company Limited	UETCL	Uganda
14.	Société Internationale d'Electricité des pays des Grands Lacs	SINELAC	Burundi, DRC, Rwanda

Table 6.3: EAPP members as of September 2020. Source: EAPP [2020b]

6.6.1 Market Development

The first cross-border interconnection in Africa was the 132 kV transmission line linking Uganda and Kenya for bulk power supply to the capital of Kenya, Nairobi, since 1958 [Economic Commission for Africa, 2003]. The trading contract was signed in 1955 whereby the Uganda Electricity Board (UEB), the previously state-owned monopoly, is supposed to supply 30 MW of electricity to Kenya Power Company (KPC) for 5 years. In 1993, UEB also signed a supplying contract with TANESCO, by which it provides 9 MW of electric power to the city of Bukoba for 30 years [ECOWAS, 2006]. The trade between these countries was further promoted by the establishment of EAC and the development of a regional master plan supported by the World Bank. The exploitation of Uganda's hydroelectric potential was the main driving force. Partner States ratified the EAC Common Market Protocol on the establishment of a common market which came into force in 2010 [Mabea, 2020].

The same trend followed in the rest of the region. A tri-lateral partnership was formed between Burundi, DRC, and Rwanda for developing hydropower stations along the shared re-

sources of Ruzizi River. Jointly in 1958. the Ruzizi I hydroelectric dam was built within the territory of DRC and was followed by Ruzizi II in 1989. The early agreement enabled Rwanda to import 3.5 MW from Ruzizi I, while Burundi imports electricity from Ruzizi I based on its owed debts. On the other hand, the six countries had isolated electricity exchange on their borders through common medium voltage networks. Uganda supplied electricity to isolated centers in Tanzania and Rwanda, while Rwanda also supplied electricity to the isolated district of Kisoroin Uganda [Economic Commission for Africa, 2003].

In contrast to the lower part of the Nile basin (the Nile Equatorial Lakes region), the upper easter region (Egypt, Ethiopia, and Sudan) did not witness similar historical development. It was only in 1999 when the Nile Basin Initiative (NBI) was launched to foster regional partnership. With the support of the World Bank, the NBI conducted several studies and master plans for developing power trade which were used by EAPP.

Following the adoption of EAPP as an institution of COMESA in 2006, the general secretariat commenced planning for full implementation of a regional power market. An early plan was developed by Nexant under the USAID fund in 2010 consisted of four stages for developing adequate institutions and interconnections. The first stage is preparational for combining the national efforts into regional actions. The second stage is transitional for establishing trade between neighboring countries by 2013. The third stage is also transitional for establishing a spot market and linking every pair of countries by 2017. The final stage is transformational for a full trading environment and a liquid market by 2021 [EAPP, 2014c]. However, the execution did not follow the propounded timeline and was updated in 2014 to be finalized by 2025.

Two major studies were conducted for developing the regional market. The first study was performed by the Consortium of SNC Lavalin (Canada) and Parsons Brinckerchoff (UK) for developing a regional master plan and grid code. The study was concluded in 2011. The other study was carried out by Mercados for the regional market design and market rules. The deliverables included market guidelines, rules, and procedures along with An excel-based mini-application, named the African Day-Ahead Market (ADAM). A pilot project was performed with ENERGINET-DK (the Twinning consultant) for testing the ADAM through shadow trading in two locations Sudan-Ethiopia and Uganda-Kenya over a six-month period in 2014-15. The exercise yielded virtually a $20 million economic gain from the short-term trade, which is considerably high considering the limited transmission capacity. According to the Twinning consultant, the ADAM is fit for live trading and there is no need for a new market platform to start trading on existing interconnectors [Norda and KPMG, 2019]. However, trading went back to bilateral contracts upon finalizing the project and currently there is no market committee.

6.6.2 Market Progress

As we mentioned above, EAPP is currently operating on bilateral agreement between member countries and the market development is still ongoing. In August 2020, EAPP has published a request for consultancy service for developing a market design for EAPP based on the study of 2014. This comes as part of Tanzania-Zambia transmission interconnector project funded by the World Bank for linking SAPP and EAPP [EAPP, 2020a]. Figure 6.8 shows the net import trade volume for the recent four years and figure 6.9 shows the development timeline.

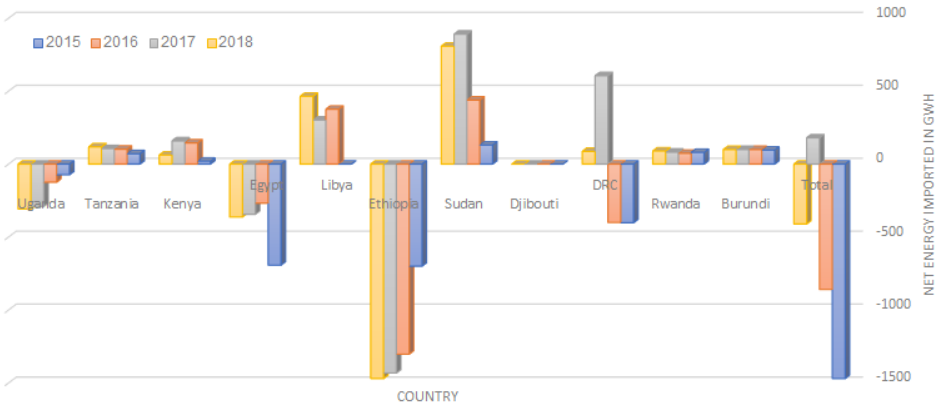


Figure 6.8: The net imported electricity (GWh) in EAPP between 2015-2018. Data source: EIA [2021]

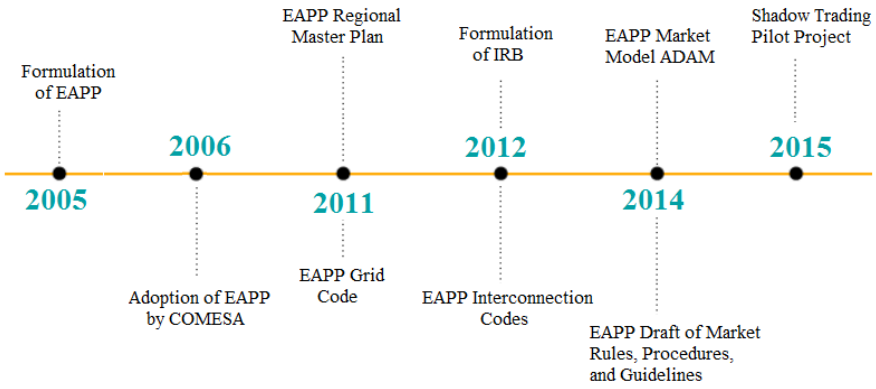


Figure 6.9: EAPP development timeline.

6.7 ANALYSIS

The development of EAPP has been stalled in terms of hard and soft infrastructures development, i.e., the physical interconnections and rules of operation. The progress has been obstructed by the exogenous factors, the lack of effective regional lead, and members' equivocal strategies. In this context, EAPP with the help of international institutions is trying laboriously to improve its internal factors and push for regional cooperation. In the following subsections, we elaborate on these factors and the process that shaped the market design following our framework of analysis.

6.7.1 The Objectives

EAPP was a stand-alone organization before being adopted by COMESA. The objectives of EAPP were set prior to COMESA adoption (Interview 10). According to EAPP profile, EAPP has the following objectives [EAPP, 2020b]:

1. "To secure power supply for the region's countries;
2. optimize the usage of energy resources available in the region by working out regional investment scheme in power generation, transmission and distribution taking into account the environment effects;

3. to increase power supply in the region in order to increase access rate of the population to electricity in Eastern Africa;

4. to reduce electricity production cost in the region by using power system interconnection and increase power exchange between countries;

5. to provide efficient coordination between various initiatives taken in the field of power production, transmission as well as exchange in the region;

6. to create in the framework of the new Economic Partnership for African development, a conducive environment for investment in order to facilitate integration of projects financing in the fields of power generation and transmission in the region;

7. facilitate in the long-term development of Electricity Market in the region."

The objectives of EAPP highlight the goals of availability and affordability clearly, and slightly the acceptability goal. The objectives are clear in the role of EAPP to be taken, except the first objective. Securing power supply for the region's countries is an abroad goal and could entail various responsibilities pertaining to the availability of supply. The investment role is then explicitly mentioned next in the second objective. According to this, EAPP is not only concerned with generation and transmission but distribution as well. Acceptability is also embedded in the second objective prudently by accounting for the environmental effects. In terms of Affordability, EAPP has a role in minimizing the cost through optimization of energy usage and power exchange. By such objectives, EAPP is set for even tight operations to the regional system, which is unrealistic given the current circumstances of the region (as we examine in the following subsection).

6.7.2 Development and Performance Factors

The conditions in the region of Eastern Africa are discouraging for the development of EAPP. All exogenous factors are divergent between member countries and overall problematic for the establishment of a unified regional power pool. Additionally, EAPP endogenous factors are ineffectual and worsening the process. Each is discussed in the following paragraphs.

Exogenous Factors

In the physical context, the transmission network for connecting member countries was initially absent and then developed to form three unconnected blocks, as if following the sub-regional communities in the region (EAC: Kenya, Uganda, and Tanzania, and Great Lakes countries: Burundi, DRC, and Rwanda). While some countries suffer from internal underdeveloped infrastructure (e.g., DRC has three isolated internal systems) and low electricity access, other countries have a well-interconnected grid and universal access to electricity. The energy resources are distributed unevenly. The North part of the region (Egypt and Libya) has predominantly thermal resources while hydro is dominant in the Southern part. However, countries do not exhibit interdependence on resources except for Sudan's continuous reliance on the excess generation from Egypt and Ethiopia. The three countries share the water resources of the Nile River which is currently a source of conflict between the three countries. The situation is opposite in the lower part of the Nile River where the Great Lakes countries together founded SINELAC for managing the shared resources. This dispersion in the physical infrastructure limits the trade to only between the sub-groups.

The economic factors are also dissimilar in the region. Countries with a stable economy like Egypt and Libya have saturated demand growth and financially capable of implementing large generation projects. On the other hand, countries like Burundi and Rwanda are too small for large cheap generation, hence, they require cooperation, while Sudan particularly is subject to

borrowing restrictions as Highly Indebted Poor Countries. These countries import electricity as demand growth outgrows the generation capacity. However, neighboring countries do not always have enough excess generation or enough financial capabilities to increase transmission capacity for regional trade. Hence, these economic conditions stagnate the level of trade.

The regional institutional context is dispersed. The region has several sub-institutions and sub-regional economic communities. COMESA includes all EAPP members except for Tanzania. However, the institution is relatively new comparing to the other regional economic communities and includes broad heterogeneous membership. With the various interests of its members, COMESA is not entrenched in the region and members only show interest when projects are aligned with national interests, like financing trade activities [Woolfrey, 2016]. Moreover, COMESA Secretariat suffers from very real capacity constraints, both in terms of financing and human capacity. The COMESA Court of Justice is functionally impractical as member countries do not utilize it, while there is also a lack of sanction mechanism [Woolfrey, 2016]. Hence, COMESA has no effective enforcement mechanism. Thus, the low quality of regional institution and rule of law, as well as institutional decentralization and heterogeneity, all make central power pool design options and adopting regulation and policy on the national level impossible. In the context of EAPP, Ethiopia has proved to be an influential stakeholder. Earlier, member countries were planning to decentralize EAPP organs by locating the IRB in Egypt and the market operator in Kenya. The plan was believed to be blocked by the domination of Ethiopia on EAPP secretariat which led to the leave of the formal general secretary who pursued this agenda [Woolfrey, 2016]. Thus, the interest of Ethiopia in being the dominant regional exporter influences the design of EAPP and creates a source of tension between EAPP member states.

The political context between member countries has been historically at unease. Besides the internal instability in countries like DRC and Sudan, the trilateral conflict between the largest players in EAPP Egypt-Sudan-Ethiopia prevents the development of resources. This could potentially affect the development of EAPP as the governments are directly involved through the council of ministers (Interview 1). Furthermore, member states' ideology of nationalism limits regional trade and cooperation as members seek national agenda of self-reliance. This also undermines the role and involvement of EAPP (Interview 1, Woolfrey [2016]).

Endogenous Factors

EAPP has not been doing well internally. The organs of EAPP are understaffed and not operational, this includes the IRB. EAPP also did not manage to establish dedicate market committee despite donors' recommendation [Norda and KPMG, 2019]. There is a need for EAPP to build its staff capacity to carry out its role effectively (Interview 1). All EAPP studies and activities, including the drafts of market documentation, are not carried out by external consulting companies. The governance structure of EAPP has also been a subject of revision a couple of times. The position of the regulator still internal to the pool and was first under the steering committee. The structure also does not provide fairness and inclusion to all stakeholders as it does not allow for IPPs' participation.

Perhaps the single internal factor impeding the performance of EAPP is its financial arrangements. EAPP is almost entirely dependent on donors for financial support for its activities and investments. In 2013, of the total budget, donors' contribution was 88% and only 12% from member utilities. During the same fiscal year, 4 member utilities had not paid their dues for at least two years [Woolfrey, 2016]. Sudan for instance did not pay its membership fees for at least five years (Interview 1). Hence, it is not surprising that without donor funding, critical EAPP meetings and activities are often canceled or not carried out [Norda and KPMG, 2019]. This financial limitation is one reason that the pool is not technically ready for hosting regional trade. Adding to this, the budgeting procedures of EAPP are considered not transparent and

previously created duplication of funding by donors for the same project. This had led donors to suspend their support to EAPP, for example, the USAID partial suspension of its supporting program Powering Progress Project [USAID, 2013]. Such a shortcoming affects EAPP's reputation and potentially jeopardizing future funds.

While EAPP is keen on engaging with member utilities by providing workshops and studies, its engagement with other regional organizations in the same field is limited. Strategic cooperation with regional organizations dealing with energy, such as the Nile Basin Initiative and the Nile Equatorial Lakes Subsidiary Action Program (NELSAP), would enhance the regional integration efforts and benefit EAPP. There is also a lack of hosting donors-related activities like conferences to improve investments. These reasons lead to the belief that there is a lack of leadership and strategic vision to EAPP [Norda and KPMG, 2019; Woolfrey, 2016].

Finally, EAPP does not have a formal procedure for dispute resolution between its members. This responsibility is assigned to the IRB that is currently unfunctional.

6.7.3 The Dynamics

The dynamics of EAPP show all factors are impeding the development of the pool and opposing the weak driving forces in the system.

The Design

The starting conditions at the onset of EAPP shaped its current design. EAPP was founded between seven members without regional institutional authority. The electricity sector in those member countries was dominated by state utilities. Although several countries had introduced IPPs at that time but as of today, their role remained insignificant and no pressure is exerted on EAPP to expand its membership for covering IPPs. The absence of a regional body makes it naturally difficult to grant autonomy to the pool. National governments show their ownership of EAPP by direct governing through the council of ministers. This compromises the independence of the IRB. Again, this is a consequence of the absence of a regional institution. Although EAPP came under the auspice of COMESA, the two institutions remain unconnected. This is evident considering that COMESA has its own regulator, RAERESA, with no recorded cooperation with EAPP's IRB.

Although EAPP has a wide set of objectives that include all the main goals of availability, affordability, and acceptability, EAPP's inadequate ability to manage its endogenous factors prevented taking certain design options for fulfilling its roles. Namely, an investment unit was not initiated to pursue EAPP's investment responsibilities because of financial inadequacy. Lacking the political unity between members of EAPP in combination to their nationalism ideology, disable other design options like having a mandatory or tight pool that would be necessary to effectively fulfill its broad objectives (e.g., optimization the usage of resources). Under such severe internal and external factors, the design of EAPP is just limited to the founding blocks.

Motors of Change

Against all the harsh factors of EAPP, the driving forces are very weak. In fact, members' strategies are negatively affecting the development of EAPP. And with such a fragile regional institution, the only force pushing the development of EAPP is of international institutions.

The members of EAPP show generally disinterest in cooperating with the pool, with the exception of Ethiopia that has strategic gain from regional trade. Given the position of Ethiopia and its plans for exploiting hydropower, the country has a strong interest to be involved in

EAPP. However, this interest is manifesting as a desire to control the power pool and influence its design. Particularly, Ethiopia is keen on the transmission tariff and wheeling pricing. As a future major exporter in the region, these design aspects directly affect its profits from regional trade. The desire to have such control over EAPP appears in its determination to centralize the functions and institutions in Addis Ababa including the IRB and pool operator [Woolfrey, 2016]. This creates tension with other members that were keen to host some of EAPP's bodies, like Kenya, Rwanda, and Egypt, and makes them not interested in EAPP.

Kenya for instance has three seats on the steering committee, however, none of the three utilities were showing interest recently in attending those meetings. This came after the departure of the former Kenyan secretary-general of EAPP upon his attempt for pushing for decentralization [Woolfrey, 2016]. A similar attitude is displayed by the Sudanese representative SETCO. Despite being a founding member, for a long period, Sudan was not interested in EAPP and had no representative in both council of ministers and the steering committee, which is still the case for the latter (Interview 1). The staff of SETCO shows interest only when invited for a meeting in Ethiopia because they receive per diems for traveling. Egypt with its huge thermal generation capacity that could complement hydro is also not interested in EAPP and prefers bilateral agreements (Interview 1). Additionally, the Grand Ethiopian Renaissance Dam (GERD) conflict with Sudan and Ethiopia aggravates the situation. Other members favor cooperation in their sub-group. EAC members have in the past supported the idea of establishing their own power pool, and Tanzania and Uganda were reluctant to join EAPP, while the Great Lakes countries feel marginalized in the context of EAPP participation and are exploring alternatives for regional trade [Woolfrey, 2016]. In such a situation, the development of EAPP becomes a conundrum.

COMESA did not play a notable role in the development of EAPP mainly due to its financial shortcomings, weak institutional arrangements, and lacking authority generally and especially over all members of EAPP, namely Tanzania. Overlaps between COMESA and other regional initiatives create difficulties in terms of coherence and regional leadership. The lack of authority with the diverse membership of COMESA makes pushing regional integration agenda a difficult task and depends on members' interests.

International institutions, especially the World Bank, have been behind the creation of EAPP and are attempting to make a similar scenario to WAPP (Interview 5, Rose [2017]). However, within this whole context and with the lack of a regional lead, their efforts have been limited. All of the World Bank, the USAID, the SIDA, the Norwegian Ministry of Foreign Affairs, and other European institutions provide financial and technical assistance to EAPP.

6.8 CONCLUSION

EAPP efforts for establishing a regional market were limited to its difficult conditions. Against the eight power pool reforms (identified in chapter 3), EAPP implemented only one reform step, establishing legal documents and agreements permitting trade, the IGMOU and the IUMOU. The only important factor in the establishment and development of EAPP is the support from international institutions. The regional dynamic is characterized by a lack of regional lead, members' engagement, and weak involvement of international institutions.

7 COMPARATIVE ANALYSIS

"Behind the formal structures of regional organisations is a messy world of regional power and politics"
The European Centre for Development Policy Management

In this chapter, we answer the third and the fourth research questions *"What are the differences between African Power pools?"* and *"How can the performance difference of African power pools be explained?"* through a comparative analysis of the three cases. We compare the three power pools on a two-level analysis. The first level is descriptive analysis in section 7.1 in which we identify similarities and differences based on our analytical framework and empirical findings. The second level is explanatory analysis in section 7.2 in which we explain why the development and the performance were different based on practical comparison and academic theories. Finally, in section 7.3 we observe lessons learned and practical issues and challenges of the development, all in light of the relevant theories.

7.1 SIMILARITIES AND DIFFERENCES

In this section, we provide contextual descriptions of the three cases based on the elements of our analytical framework. For each element in the framework, the differences and similarities between the three cases are highlighted.

7.1.1 Starting Conditions

Before establishing the power pools, trade took place in the three regions through bilateral agreements. It depended on the already existing infrastructure. SAPP had the advantage of having South Africa connected with five neighboring countries. Eskom had nine bilateral agreements with other utilities [Economic Commission for Africa, 2003]. Unlike SAPP, trade in WAPP was decentralized and five bilateral agreements existed between OMVS members, Côte d'Ivoire and Ghana, Nigeria and Niger, Ghana and Togo-Benin, and Côte d'Ivoire and Burkina Faso. Trade was limited in EAPP due to the lack of infrastructure. Only three bilateral agreements were in place between Uganda and Kenya, Uganda and Tanzania, and SINELAC members.

The national electricity sectors in the three cases were slightly different. In the case of SAPP, all the member countries had a vertically integrated sector and no IPPs at the beginning. Similarly, WAPP member countries were also vertically integrated. However, the important difference is the inclusion of the private sector. Seven of WAPP member countries had introduced IPPs by the time of WAPP's creation and major exporting countries like Ghana, Côte d'Ivoire, and Senegal had undergone the process of privatization. In the case of EAPP, both Uganda and Kenya were partially unbundled. Adding Ethiopia and Egypt, the four countries had introduced IPPs and attempted privatization.

The institutional settings of the three power pools in terms of objectives vary notably. SAPP objectives are centered around maintaining the grid and include the goals of availability and acceptability. On the other hand, WAPP is investment-focused and its objectives include the goals of availability and affordability. EAPP does not have a specific foci and its objectives include all three goals of availability, acceptability, and affordability.

7.1.2 Exogenous Factors

Comparing external factors between the power pools is difficult due to their broad contexts. We focus on the physical context as it directly impacts the possibilities of trade. For the other three contexts, we limit our comparison to the general indicators as it would require more in-depth investigation for an accurate comparison.

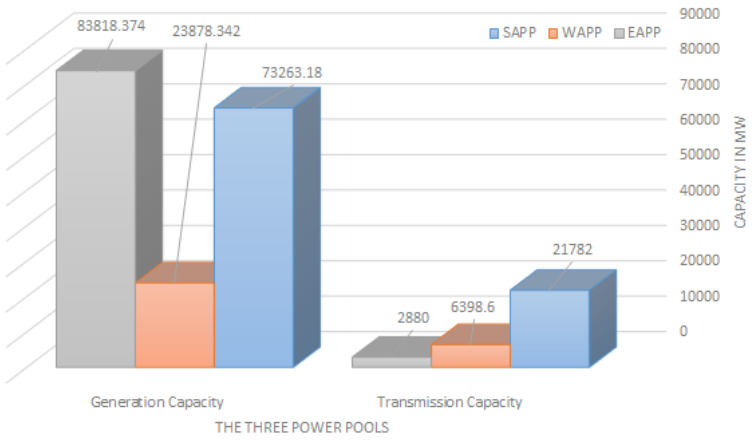
The general development of the regional infrastructure of the three power pools is different. The transmission network of the three power pools does not include all members. SAPP has three unconnected members, WAPP has five unconnected members, and EAPP members are connected in three isolated blocks. Table 7.1 shows the details of the infrastructure and trade for each country in the three power pools. In order to make a comparison, the unities were unified to MW. Data on annual average electricity consumption and trades (shown in figure 7.1b) were converted from GWh to MW by multiplying it with the constant 0.1142 (equals 1000/(24*365)) to be in the same unit as the transmission capacity. The largest transmission capacity and trade volume exists in SAPP and the lowest is of EAPP, even though EAPP has the largest installed capacity. The same order persists for the utilization of transmission capacity (percentage of trade to the capacity) and the percentage of consumption satisfied by trade, as shown in figure 7.1c. While the percentages suggest an underutilization of the transmission capacity in the three cases, it worth noting that transmission capacity usually facilitates peak demand and the consumption data used here is an annual average. It can be seen from the table that some countries rely heavily on exported electricity to satisfy their consumption (highlighted in bold red). The largest importers are the neighboring countries Benin and Togo in WAPP with Benin imports 100% of its consumption with an extra 8.85% distribution losses and Togo imports 86.03%. This percentage is significantly low in EAPP. The only country with a relatively high percentage is Burundi and the reason is that it imports electricity from the joint utility, SINELAC, on its due debt to the company.

The electricity access for the three cases is close on average. The highest average electricity access is 50% in EAPP. Both Egypt and Libya have universal access and followed by Kenya 85%. SAPP has 47% electricity access, the highest three countries are South Africa 94%, Eswatini 90%, and Botswana 57%. The lowest average access is 43% in WAPP, with 85% in Ghana, 76% in Côte d'Ivoire, and 71% in Senegal.

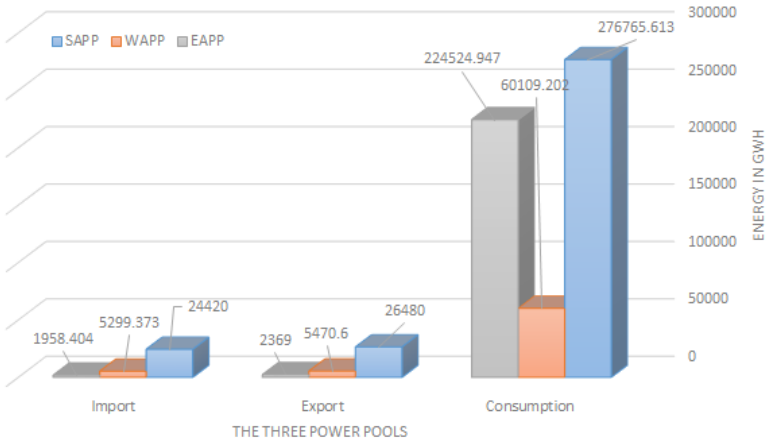
A shortcoming of the database of EIA [2021], is that it is country-based. Therefore, we did not account in these statistics the trade happening with other countries outside the regional power pool. For example, Libya trades with Tunisia, Egypt trades with Jordan, and Senegal trades with Mauritania. Also, DRC trades with its neighbors from three different power pools; Zambia from SAPP, Burundi and Rwanda from EAPP, and the Republic of the Congo from CAPP. DRC itself is split internally into two isolated power systems: the eastern part connected with EAPP, and the western-southern part connected with CAPP and SAPP [World Bank, 2020a]. Morefore, these statistics do not include joint utilities like SINELAC (EAPP) and SOGEM (WAPP) since they are independent and belong to more than one country which might give a slightly misleading representation of export and import. As it is difficult to obtain detailed data for these cases and considering that it does not comprise a large portion of total trade volume, these approximations do not undermine our general conclusion.

	Countries	Transmission Capacity (MW)	Installed Capacity (MW)	Electricity Consumption (MW)	Export (MW)	Import (MW)	Cross border Trade (MW)	Trade % of Transmission Capacity	Trade % of Consumption
				SAPP					
1	Angola	0	5396	1183.06	0	0	0	0	0
2	Botswana	840	755	376.8	0	95.89	95.89	11.42	12.7
3	DRC	600	2884.76	981.07	8.68	18.61	27.28	4.55	0.95
4	Eswatini	2981	282	192.05	0	116.44	116.44	3.91	41.29
5	Lesotho	230	80.4	102.96	0	45.66	45.66	19.85	**56.79**
6	Malawi	0	407	172.98	0	0	0	0	0
7	Mozambique	5320	2642	1528.55	1192.47	1130.02	2322.49	43.66	**87.91**
8	Namibia	970	586	477.66	13.01	393.72	406.74	41.93	**69.41**
9	South Africa	6171	53368.77	23575.6	1650.46	949.77	2600.23	42.14	4.87
10	Tanzania	0	1507.62	663.53	0	0	0	0	0
11	Zambia	2120	2943.02	1495.09	139.84	17.35	157.19	7.41	5.34
12	Zimbabwe	2550	2410.61	844.87	18.38	20.21	38.58	1.51	1.6
	Total	**21782**	**73263.18**	**31594.3**	**3022.83**	**2787.67**	**5810.5**	**26.68**	**18.39**
				WAPP					
1	Benin	1389	347.9	135.62	0	147.62	147.62	10.63	**108.85**
2	Burkina	427	387.9	200.86	0	75.34	75.34	17.64	37.51
3	Côte d'Ivoir	981	2203	763.27	131.96	11.64	143.61	14.64	18.81
4	Ghana	683	5131.69	1009.4	84.47	15.98	100.46	14.71	9.95
5	Guinea	0	654	226.35	0	0	0	0	0
6	Guinea Bissau	0	29.17	4.46	0	0	0	0	0
7	Liberia	0	192.58	39.71	0	0	0	0	0
8	Mali	610.3	618.56	347.06	65.18	49.89	115.07	18.85	33.15
9	Niger	190	318.04	181.06	0	143.04	143.04	75.28	**79**
10	Nigeria	967	12284.23	3311.81	342.88	0	342.88	0	10.35
11	Senegal	283.3	1235	438.58	0	38.61	38.61	0	8.8
12	Sierra Leone	0	175.27	27.6	0	0	0	0	0
13	The Gambia	0	105	33.24	0	0	0	0	0
14	Togo	868	196	142.77	0	122.83	122.83	14.15	**86.03**
	Total	**6398.6**	**23878.34**	**6861.78**	**624.5**	**604.95**	**1229.45**	**19.21**	**17.92**
				EAPP					
1	Burundi	200	80	38.68	0	11.42	11.42	5.71	29.51
2	Djibouti	180	130.36	4.35	0	0	0	0	0
3	DRC	252	2884.76	981.07	8.68	18.61	27.28	10.83	2.78
4	Egypt	321	56037	17189.4	51.14	9.74	60.88	18.97	0.35
5	Ethiopia	552	4553.3	1025.85	167.81	0	167.81	30.4	16.36
6	Kenya	145	2782.73	995.61	4	11.07	15.07	10.39	1.51
7	Libya	180	10516	2933.02	0	53.08	53.08	29.49	1.81
8	Rwanda	252	120	87.24	0.46	10.73	11.19	4.44	12.82
9	Sudan	513	4136	1308.52	0	92.25	92.25	17.98	7.05
10	Tanzania	70	1507.62	663.53	0	13.47	13.47	19.24	2.03
11	Uganda	215	1070.6	403.44	38.36	3.2	41.55	19.33	10.3
	Total	**2880**	**83818.37**	**25630.7**	**270.43**	**223.56**	**494**	**17.15**	**1.93**

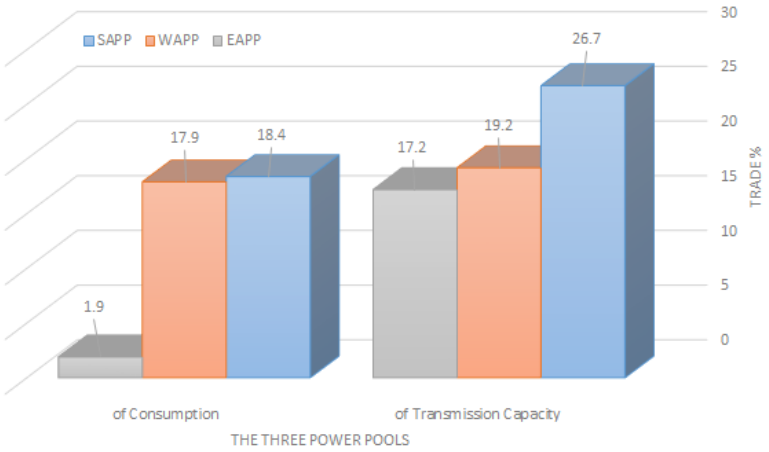
Table 7.1: The percentage of trade in electricity consumption and transmission capacity in all member countries of the three power pools. Data source: EIA [2021]



(a) The transmission interconnection and generation capacity of the three power pools in 2018.



(b) The energy consumed, exported and imported within the three power pools in 2018.



(c) The trade percentage of the consumption and the installed capacity of the three power pools in 2018.

Figure 7.1: The capacity, energy and trade % of the three power pools.

All the three power pools have a leading country with more than 50% of the generation capacity. These are South Africa in SAPP with 73%, Egypt in EAPP with 67%, and Nigeria in WAPP with 51%. The three countries are also the largest fossil fuel generators in the region. Both Egypt and Nigeria rely on thermal generation with gas, while South Africa relies on coal generation. Even without Nigeria, the combined generation capacity of Egypt and South Africa is 152.2% of the total capacity of all other countries including Nigeria. The two countries' CO_2 emission from fossil fuel generation is 2.5 times the total emission of the rest of all countries combined, including Nigeria as well. The generation mix of the three power pools is similar with significant hydroelectric generation distributed in the three regions. WAPP has a simple energy mix of hydro and fossil fuel while SAPP has nuclear and EAPP has geothermal.

For both SAPP and WAPP, member countries are interdependent in terms of generation. In SAPP, the utilities in the North depend on hydropower generation and complement with the thermal generation of South Africa and Botswana. In WAPP, small countries, like Benin and Togo, and landlocked countries, like Mali and Burkina Faso, depend on resource-rich countries Nigeria, Ghana, and Côte d'Ivoire. This interdependence is lacking in EAPP where countries share hydropower generation along the Nile River.

Pool	Largest Capacity %	Second-largest Capacity %	Third-Largest Capacity %
SAPP	Fossil Fuel 70%	Hydro 18%	Nuclear 3%
WAPP	Fossil Fuel 75%	Hydro 24%	Solar 1%
EAPP	Fossil Fuel 79%	Hydro 16%	Wind 2%

Table 7.2: The three largest installed capacity in the generation mix of the three power pools.

The economic context of the three regions is analogous in that all countries have a dual economy, urban and rural, and that the electricity demand is outpacing generation capacity (except for just Egypt and Libya). Similar to the generation capacity, the three leading countries also have the highest total GDP. Considering the population of each region, SAPP members have the highest distribution of GDP, followed by EAPP, and lastly WAPP. Most WAPP member countries have financial restrictions and have close GDP per capita. The economy of both SAPP and EAPP is different from one country to another with standard deviations of 2382 and 2082 of the GDP per capita, respectively. Table 7.3 shows the average figures of the GDP in the three regions.

	EAPP	SAPP	WAPP
Average GDP in Billion US dollar	67.5	54.9	48.9
Average GDO per capita in US dollar	1,892	2,678	1,134

Table 7.3: GDP and GDP per capita of the three cases.

The regional institutional context is different in each case. Strong regional institutions are found in WAPP. The ECOWAS Commission plays an active role in regional integration and harmonization. The commission has the authority to make legal demands from member countries to implement directives and regulations. ECOWAS special institution ERERA is responsible for regional regulation and has the legal authority for enforcing resolutions and interfering in member countries. ECOWAS energy protocol was ratified by national parliaments and became a regional law. It facilitates foreign investments and dispute resolutions. SAPP has less quality of regional institutions compared to WAPP. SADC is a secretariat that aims to increase regional cooperation. It has no authority for making legal demands from member countries. SADC agreements are not binding obligations to member countries and it has no regional court for appealing against member countries. The region has no regional regulator but rather an association, RERA, for helping national regulators. In both cases, SAPP and WAPP are institutions of SADC and ECOWAS respectively. However, the case of EAPP is even more different in that it is not formally

an institution of COMESA and does not report to it. EAPP member countries lack regional institutional unity and are rather scattered between three economic communities IGAD, EAC, and COMESA. Until now, the position and the authority of the IRB are not entirely clear and other communities have their own regulators, like EREA in EAC and RAERESA in COMESA. In all three cases, some countries are more influential than others. This is either due to their prominent position as exporters, like South Africa in SAPP and Ethiopia in EAPP, or due to their voting share, like Ghana and Nigeria in WAPP.

The political context is different for each case. SAPP has currently a stable geopolitical situation between member countries after ending the historical tension between South Africa and the other countries. The geopolitical tension is currently found in EAPP between Ethiopia, Sudan, and Egypt over the GERD conflict. Such a conflict could affect the regional trade and disable the exploitation of hydropower in the region. There is also a civil war in Ethiopia currently. The situation is tenser in WAPP with national political instabilities and civil wars. Additionally, mistrust is exhibited between member countries as well as hydro conflicts in the Niger Delta. In all three cases, the electricity sector is considered national sovereignty and the political agendas include self-sufficiency. However, the members of SAPP depend on regional trade for meeting their peak demand as well as during scheduling maintenance.

Figure 7.2 shows the ranking of the external factors between the three cases. Green is the highest rank and red is the lowest.

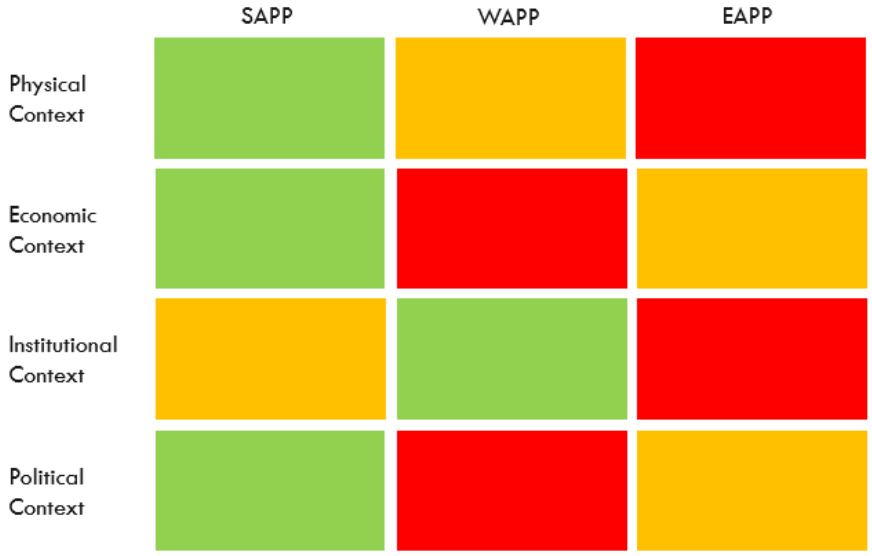


Figure 7.2: Comparing the exogenous factors between the three cases. Green is the best state of the three and red is the worst.

7.1.3 Endogenous Factors

The three power pools are different in their endogenous factors. These internal factors are coupled with the development stage of the power pools as RIOs.

The governance structure of each power pool is distinct and each has different decision-making authorities. The organizational or sub- committees of the power pools are similar in terms of functionalities. The committees cover the main aspects of the pool operations: investment and planning, operations, and environment. The organization of these committees varies.

In both WAPP and EAPP, there is a dedicated secretariat for coordinating the pool activities while in SAPP, this responsibility is given to the coordination center. Owing to its functioning market, SAPP has a dedicated market committee and market surveillance. The two other power pools are following the same track and in the various process of establishing a coordination center and market committee. In the case of SAPP, SADC monitors closely the executive board and its meetings, while WAPP only report officially to ECOWAS and EAPP does not report to COMESA.

When moving to the upper-level of the governance hierarchy, each of the three power pools has unique governance models. The highest decision-making of SAPP, the executive board, consists of vertically integrated utilities and is a simple single class board member. SAPP allows for IPPs to obtain membership but they are excluded from the executive board and the management committee. IPPs have limited voting rights for trading issues only. SAPP can make changes in the operational rules by itself but any change related to its policy or involving other outside entities must go through SADC ministers. EAPP on the other hand has a similar but more restrictive governance structure. The highest decision-making authority in EAPP is the council of ministers and all decisions must be approved by it. EAPP also does not include IPPs in its membership and its members are national utilities.

The governance model of WAPP is totally different from the other two pools. WAPP does not involve political entities and formally mandates its executive officers to be independent of market participants. WAPP gives IPPs the right to vote and include consumers as official members also with voting rights (there is still no such a member but it is legally possible). The highest decision-making body of WAPP involves all members with equal voting rights (except observer members). Hence, the governance model of WAPP can be said more democratic and inclusive. However, when looking into the members of WAPP, half of the votes belong to only two countries, Ghana and Nigeria. Which makes it possible to control and block decisions by these two stakeholders if they nationally orchestrate.

The three power pools have similar financing arrangements. Members' fees or contributions are used for covering the operation of the pool. While SAPP and EAPP have a fixed annual fee, WAPP members' contributions vary proportionally to the energy sold by the member. The power pools also receive grants from donors for executing projects. Both EAPP and WAPP rely on donors' grants for most of their activities. SAPP on the other hand has an extra source of revenue from the fees of operating the market. Also, both ECOWAS and COMESA facilitate funding for WAPP and EAPP, while SAPP remains financially independent of SADC.

SAPP has a full staff capacity and demonstrated its staff quality by successfully managing disputes through the coordination center. SAPP also reached a level of maturity whereby it can perform its regular activities by its own staff and only employee external consultants for newly introduced activities or market expansion. On the other hand, both EAPP and WAPP depend on external contracts for carrying out most of their activities. The committees of the two pools are fully staffed. WAPP is in the process of establishing its information and coordination center, while EAPP ceased its earlier effort of establishing a coordination center (Interview 10). The IRB of EAPP is also still not fully staffed. WAPP has formal procedures for dispute resolution that includes internal mediation and external appeal to the ECOWAS Court of Justice. EAPP entrusts dispute resolution to the IRB that is currently not operational and has no formal procedures.

SAPP is technically advanced compared to WAPP and EAPP. Their competitive markets have been running for more than a decade now and they are currently moving towards real-time operation by introducing a balancing market. WAPP is advancing in establishing its SCADA and communication systems for launching the regional market. Half of the work is already finished and it is expected to achieve technical readiness within a few years. EAPP is far from being technically ready. The current efforts are directed towards regional studies and advising

for interconnection. Efforts for installing the physical system did not start yet.

In terms of the relationship with stakeholders, each power pool maintains a degree of relationship with financial institutions. WAPP has a strong relationship with technical and financial institutions and has a special coordination committee for this purpose. Differently, SAPP has a strong relationship with technical organizations and market experts. Since the start of the competitive market, SAPP maintains a close relationship with the Nordpool representatives. While EAPP is currently seeking to strengthen its relationships with other institutions for technical and financial assistance, they have no special organ for this purpose and previous miscommunication led to support cancellation.

7.1.4 The Design

The design of the three power pools is different. Since only SAPP has a competitive market, we focus on the other design elements.

Regulation and Policies

The regulatory bodies of both SAPP and EAPP are incompetent and effectively nonfunctional. The two pools are currently self-regulated through internal agreements. While EAPP states clear roles for the IRB to be the regional regulator, SAPP does not give such a role to RERA that is rather an association for collaboration between national regulators. However, the role of RERA is currently under revision. The IRB was initially working under the steering committee as the rest of the organizational committees but following the recommendation of the World Bank, was decoupled to report to the council of ministers. Still, the IRB is located in EAPP secretariat.

Unlike the other two regional regulators, the regulator of WAPP, ERERA, is conferred both statutory and quasi-judiciary. ERERA issues regulations and decisions that are binding, directly applicable in the ECOWAS zone and their application is guaranteed by member states on their territory. The regulations and decisions of ERERA are subject to appeal before the ECOWAS court of justice which intervenes in the process as the jurisdiction of the appeal.

In terms of energy policy, both SADC and ECOWAS have institutions for energy policy, SACREEE and ECREEE. These are not directly linked with the power pools, but their policy might affect its operation. SACREEE is relatively young compared to ECREEE and only helps member countries with improving their national policies. While the renewable energy targets of ECREEE are taken into account in the master plan of WAPP and its policies are adopted by ECOWAS. On a different side, there is the EACREEE, which only belongs to EAC members and is not related to COMESA and, thus, does not affect EAPP.

Regional Planning

The planning and investment in infrastructure in SAPP and EAPP are similar in that no regional entity exists that has a mandate and authority to carry out regional projects. The three power pools are responsible for the coordination of national plans and providing recommendations. Each pool created a list of priority projects for both transmission and generation and relies on national utilities or countries to execute them.

The case of WAPP is different. WAPP has the mandate to implement regional projects in the adopted master plan by ECOWAS. Additionally, WAPP has a special investment company for executing projects under donors' funds like WAPP Solar Parks funded by the World Bank. On the other hand, SAPP has the PAU for project development. The unit facilitates projects

upon a request from member countries but does not implement them. Both WAPP and SAPP have the same methodology for wheeling tariff, the MW-km, which depends on identifying the beneficiaries of the projects. This method, however, does not guarantee cost recovery for all interconnections and was criticized for not being optimal (see [Rose, 2017]). WAPP is currently revising this methodology. On the other end of the spectrum, EAPP does not have a specialized unit to oversee project implementation nor formal tariff setting methodology. Comparing to WAPP master plan, EAPP does not provide enough details in its regional master plan.

Design Variables

Each power pool has distinct characteristics pertaining to its observable design variables. Table 7.4 shows the differences in the design variables of the three cases.

The three cases are similar in trading mechanism and are classified as loose or 'new style' pools, as labeled by the World Bank. Trading is voluntary in the three cases and is order-driven rather than quota-driven. However, WAPP and EAPP are different from SAPP in that they intend to unify bilateral agreements and mandate their approval by the pool and the regulator.

The three cases are different in their degree of autonomy and membership. The highest the degree of the pool autonomy, the more diverse its membership. At the highest end, WAPP has full autonomy for decision-making and is governed by its members. The membership of WAPP includes all entities involved in the electricity sector activities and they have equal voting rights. In the middle, SAPP has semi-autonomy for making internal decisions but requires SADC approval for external decisions. Its membership is open to IPPs but with limited voting rights. National utilities have full voting rights and higher weight for operational decisions. At the lowest end, EAPP has no autonomy in that all its decisions are subject to approval by the council of ministers. EAPP membership is closed to national utilities only.

7.1.5 The Dynamics

We compare the dynamics of the three power pools by comparing the motors of change in each case. We find that each case is unique in its dynamic and can be classified distinctly for its development.

Regional Institutions

The dynamics within the three RECs are different. Generally, in both ECOWAS and SADC there is a hegemonic power of the biggest countries Nigeria and South Africa, respectively. These countries have some degree of leverage due to their economic and/or military superiority in their respective regions to drive or block elements of their region's integration agenda. However, in COMESA, no single member state is able to wield this kind of influence across the multiple issue areas [Verhaeghe and Woolfrey, 2017].

The three RECs SADC, ECOWAS, and COMESA are different in their institutional arrangements and foundations. SADC is an inter-governmental institution and a secretariat for regional cooperation on specific sectors. It operates through regional protocols and agreements between member countries. ECOWAS institutional arrangements are at an advanced stage as ECOWAS executive secretariat was transformed to ECOWAS Commission in 2007. This gives ECOWAS more authority to issue legal demands in the form of directives and regulations. COMESA is also different as its foundation was more technical and its treaty is based on the Preferential Trade Area that explicitly focused on promoting regional integration through the removal of trade barriers. The other two treaties of ECOWAS and SADC differ in the way they treat economic issues. The ECOWAS Treaty is explicit on each of these issues, while the SADC treaty only addresses them

Design variable	SAPP	WAPP	EAPP
Autonomy	Semi Semi-autonomy: internal decision-making while external decision-making is subject to SADC approval	Complete autonomy	No autonomy: all decisions are subject to the approval of the council of ministers
Loose or tight pool	Loose	Loose	Loose
Voluntary or mandatory pool	Voluntary pool, only monitoring bilateral agreements	Voluntary pool, unified bilateral model, and mandatory approval of bilateral agreements by WAPP	Voluntary pool (currently working on unifying Power Purchase Agreements)
Membership	Vertically integrated utilities (full voting rights) and IPPs (limited voting rights)	Transmission Owner/Operator (TSO and System Operators), Transmission User (Generators and distribution/retail companies), and others	Vertically integrated utilities
Trading platform	DAM , IDM, FPM-W/M, and planned balancing market	Planned DAM and ancillary services	Planned ADAM
Transmission tariff methodology	MW-km load flow-based tariff	MW-km load flow-based tariff (currently under revision)	None
Congestion management	Unknown	Unknown	None
Balancing mechanism	Is left for the different system operators. A balancing market is currently under trail	None	None
Ancillary Services	None	None	None
Capacity mechanism	None	None	None
Investment unit (functionality)	Project Advisory Unit: does not execute project	WAPP donors' coordination committee and WAPP project unit: execute projects	None
Position of the regulator	No regional regulator, self-regulation	Regional regulator, ERERA, is external to the pool	Regional regulator, IRB, is internal to the pool

Table 7.4: The design variables of the three power pools.

indirectly with broad principles and objectives.

Because of these regional institutional differences, the involvement of each of the REC with its power pool is different. ECOWAS has a strong influence on WAPP and manages it through its special regional institutions like ERERA. ECOWAS also adopts the master plans of WAPP and helps the market creation through adopting policies and regulations on the national level. In contrast, COMESA is primarily a trading platform for collaborations between Eastern and Southern countries and does not include all EAPP members. Therefore, EAPP is loosely tied to COMESA and operates autonomously without reporting to COMESA. SAPP is positioned in the middle of the two. While it is directly linked to SADC, the latter does not interfere with its operation and gives it a degree of autonomy in deciding internal matters. In the three cases, the regional body has no power or mechanism for enforcing decisions on member countries. Although ECOWAS legally has the power to make binding decisions, it lacks the effective supranational power for enforcement.

Members' Strategies

For the three cases, the majority of member countries have vertically integrated utilities and national strategies for self-sufficiency. In each case, small countries that cannot afford large-scale generation projects rely to some extent on imported electricity to satisfy their demand. In the case of EAPP, Burundi imports electricity from the joint utility SINELAC. In WAPP, both Togo and Benin rely on imports from Ghana and Nigeria. And in SAPP, Lesotho relies on imported electricity from South Africa. In both the cases of WAPP and EAPP, some member countries have their own sub-cooperation particularly for using shared resources of hydro. In EAPP, the economic community of the Great Lakes Countries Burundi, DRC, and Rwanda have established the joint utility SINELAC for hydropower projects. In WAPP, the OMVS brings together the four riverside countries of River Senegal Guinea, Mali, Mauritania and Senegal and established the joint utility SOGEM for the rational control and exploitation of the resources of the river and its valley.

The cooperation between member countries in each case is different. In the case of SAPP, member countries initially cooperated against relying on South Africa but following the creation of SADC, member countries cooperate through SAPP with South Africa and are adopting strategies to rely on trade in scheduling maintenance and satisfying peak demands. Hence, trust is built between member countries through SAPP. Oppositely, member countries of WAPP do not trust each other due to having frequently unpaid debts. The bilateral agreements are also not firm in ensuring the reliability of supply and are politically compromised. In the case of EAPP, on one hand, there is rather a conflict on hydro resources between the group of Egypt, Sudan, and Ethiopia and on the other hand, there is cooperation on hydro resources between the group of Burundi, DRC, and Rwanda. In both the cases of WAPP and EAPP, there is a general disinterest from some of the utilities to cooperate with the power pool. The big three utilities of Nigeria, Ghana, and Cote d'Ivoire have an ambiguous approach towards WAPP; as they do not want to be constrained and giving control to WAPP. While the domination of Ethiopia on EAPP pushes away other countries like Kenya and Rwanda.

International Institutions

In all three cases, the international institutions played a role in the development of the power pool. The same international institutions are supporting the three power pools financially, these are the World Bank, the AfDB, the USAID, the SIDA, the NORAD, and the EU. These institutions also facilitate technical support with other parties. In the cases of SAPP and WAPP, they also receive financial support from their regional development banks of ECOWAS and South Africa. The degree of support is different in each case. SAPP receives more technical support from

the Swedish and Norwegian governments as well as the U.S. Energy Association and Nordpool. WAPP receives more financial support from the World Bank directly or through trust funds with other donors. Almost all WAPP interconnections are financed by donors.

Besides donors and financial institutions, other international advisory institutions like TBI are actively working with national governments of both WAPP and EAPP. Additionally, in the case of WAPP, they are directly involved in providing technical assistance for WAPP and ERERA.

Figure 7.2 shows the strength ranking of the motors of change among the three cases. Green is the highest rank and red is the lowest. The picture shows that each case has its unique forces for development. SAPP is the case where the development is Members lead. In the case of WAPP, the regional institution and international institutions are both strong but without the regional institutional quality and frameworks, like the energy protocol that enables foreign investments, international institutions' involvement would have been compromised especially considering the political instability in the region. Therefore, WAPP is the case where the development is Regional lead. The three driving forces were all weak in the case of EAPP. The involvement of COMESA is less tangible and EAPP is not anchored in COMESA. With the exception of Ethiopia, the engagement of member countries was not strong in the past and there was a period when some countries have no representatives in EAPP. Thus, Financing institutions had relatively the biggest role in the development of EAPP. The World Bank has specially a strong interest in EAPP and it is believed that it was behind the creation of EAPP (Interview 7 and [Rose, 2017]). Therefore, EAPP is the case where the development is Donors lead.

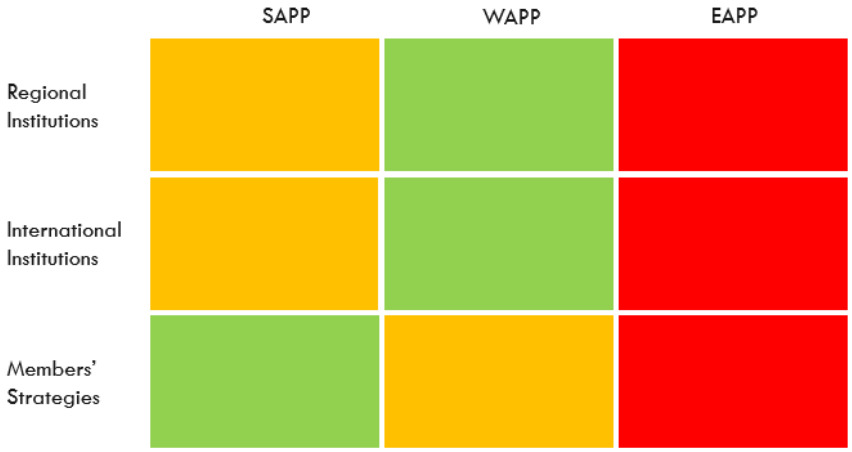


Figure 7.3: Comparing the dynamics between the three cases in terms of the strength of each motor of change. Green is the highest rank and red is the lowest.

7.2 EXPLAINING THE DIFFERENCES

In this section, we expound on the reasons for the different development and performance of the three power pools. We highlight the critical differences and theoretical explanations to the differential development, internal performance, and design. Each of these is described in a separate section in which we attempt to establish causal relations with the known and unknown factors.

7.2.1 Regional Development

Each power pool developed differently within its regional context. The development of the regional infrastructure and market were different because of the different external factors and driving forces as described in section 7.1. In the following two subsections, we explain the critical differences and relations that led to the performance in each case as well as how it can be viewed from a theoretical perspective.

Regional Infrastructure

For the regional infrastructure, it is difficult to trace back how each power pool performed throughout the time from its establishment due to the lack of historical data. Therefore, we base the performance in the regional infrastructure around to what extent was each power pool able to connect all member countries and achieve enough generation capacity.

Developing regional infrastructure can be either centralized or decentralized depending on the regional institutions/integration and the mandate of the power pool.

In both the case of SAPP and EAPP, the infrastructure is decentralized and left for member countries. The theory of regional integration (neofunctionalist) argues that the integration is a path-dependent process [Pierson, 1996]. The institutions of regional integration are affected by past events. This can be observed in the case of SADC. Historically, SADC actions have been crisis-driven and its foundation was on the tension and crisis of the apartheid in South Africa. The institutional arrangements of SADC do not give it the power to enforce the master plan or mandate SAPP to take an investment role (Interview 8). In the same way, SAPP is also crisis-driven. An example is the establishment of the PAU as a response to capacity crisis episodes in the region during the first two decades of 2000. This expansion of the functionality of the power pool is predictable under the theory of regional integration. The process of regional integration creates the so-called 'Spillover' which is a demand-generating process. Functional spillover is what Haas [1968] defines as the expansion to previously unintended steps due to the negative externalities of non-integrated policy that prevent governments from reaping the full benefits of integration, hence, creating incentives to undertake additional function or step. On the other hand, EAPP lacks the regional integration environment that can push for regional development. COMESA does not include all members of EAPP and is not institutionally linked with it. The region has other economic communities like IGAD, EAC and the great lakes region which makes the development start in separate blocks. Integrating these blocks then follows economic incentives as EAPP does not play a role in facilitating investments. In the two cases, perhaps such an outcome was a result of the good economic conditions in the region and that each country should be able to carry out its respective projects. In contrast, WAPP's authority for implementing regional projects is due to the institutional arrangements of ECOWAS. ECOWAS transformed from an executive secretariat to a commission in 2007. During this period, WAPP progress was slow and only the Articles of Agreement was signed. Once became a commission, ECOWAS has the power to make legal demands from member countries which is why WAPP master plan and market policies are been pushed regionally. One reason for ECOWAS to consign WAPP with centralized infrastructure development is the unfavorable economic conditions in the region. The majority of member countries have limited resources and financing options. These conditions necessitate the involvement of international institutions as the main source of financing interconnections. This is what is known by geographical spillover that is having investment from non-member states as a result of a larger market [Haas, 1968].

A centralized approach leads to fast performance and is more likely to connect all members but it depends on the interests of the financing partners/institutions.

The development of infrastructure in WAPP was initially slow but progressed rapidly in connecting all member countries. The initially slow progress could be attributed to project preparations that include a number of stakeholders (Interview 11) and the time it took to transform

the institutional arrangements of ECOWAS. WAPP is responsible for all regional projects in its master plan that includes more than 100 projects, preparation and resource mobilization for this number of projects takes time. Once resources are mobilized, implementation takes place parallelly. This centralized nature of regional development makes the progress homogeneous across the region. In two years' time, all members are expected to be connected (Interview 11). The degree of regional integration (increasing geographical spillover) and the constant engagement with these institutions in the financial and technical partners committee accelerates resource mobilization and WAPP direct supervision of interconnection projects facilitates the implementation. Regarding the generation capacity, WAPP's role has been limited in the past to solar park projects and it is countries' responsibility to implement generation projects identified in the regional master plan. Nigeria with the largest capacity in the region and potential resources suffers from corruption and internal power grid issues. Nigeria is also not positioned in the center to drive regional trade. Thus, the generation capacity in the region has been lagging compared to the interconnections. Another factor is that WAPP is an independent institution with no direct political involvement. This gives WAPP a level of transparency and autonomy for decision-making which potentially accelerates investments from international institutions that seek to reduce transaction cost by avoiding corruption (Interview 5). Indeed, in corruption transactions (the exchange of money or favor for a benefit disbursed by a government official) involving high asset specificity (asset for certain tasks like transmission network), a transparent organization's hierarchy and frequent transaction reduce the risk of corruption [Husted, 1994]. Hence, WAPP provides a way to avoid corruption transactions.

A decentralized approach leads to slow performance and difficulties in connecting all members, depending on member countries' interests and economic conditions.

The absence of regional institutions and frameworks for protecting foreign investments makes it difficult to mobilize investment resources outside member states (a lower degree of integration reduces the geographical spillover). In a decentralized approach, it is also difficult to allocate all beneficiaries of interconnection projects which then reduces their feasibility between the two directly connected countries. The projects are then dependent on financing capabilities and economic conditions of two parties per project. In SAPP, countries with good economic conditions, like South Africa, implemented projects faster than countries that have unfavorable economic conditions, like Malawi. One reason that SAPP did not play an early role in regional infrastructure is due to the favorable physical conditions in the region at its inception as well as economic conditions. Similarly, EAPP does not play a role in facilitating investments in regional projects. Members' interests and capabilities determine the implementation of interconnections. Countries benefit from connecting to neighboring countries with potential excess capacity. The economic conditions of Sudan and its generation deficit stimulated its connections with neighboring countries. Similarly, Burundi, DRC, and Rwanda cooperated to exploit shared hydropower and are connected through their joint utility SINELAC. Kenya's connection with Uganda is on its interest in the cheap hydro of the latter. Hence, the regional infrastructure developed into three isolated blocks.

In a decentralized approach, the generation projects are usually inhibited by political decisions. The largest producer in SAPP is South Africa that is well-positioned with multiple interconnections and provided the necessary wires to establish the market. However, the generation capacity in South Africa had a prominent impact on regional trade. During the late 1990s, there were signs that the region is heading towards generation capacity shortage and SAPP coordination center notified the council of ministers. Despite this, investments did not happen until the crisis transpired. As there was no shortage in finance, the political involvement in making investment decisions was attributed to delaying generation investments. In EAPP, Egypt has the largest generation capacity that could drive regional trade but the country is not well-positioned to have several interconnections. Ethiopia has the potential for leading trade with its geographic position and hydro potential. However, the political situation in the region hinders the development of hydropower generation. The conflict between Egypt-Sudan-Ethiopia over

the Grand Renaissance dam could disable large generation capacity and, consequently, jeopardize some interconnection projects like the HVDC between Ethiopia-Kenya and Ethiopia-Sudan.

There are other potential causes for the difference in the performance of infrastructure development. These could be the methodology for allocating the cost of transmission interconnections, the geographical size of the power pool, and length of transmission lines to be installed. However, these are unknown casual relations. While WAPP is geographically smaller, both SAPP and EAPP have close size. WAPP and SAPP also have the same transmission tariff methodology. Therefore, these could be correlations to the performance but not causation.

Regional Market

The performance of establishing a regional market for each power pool was predicated on the physical context and a function of member strategies, internal factors, and the involvement of international institutions. The differences between the three cases in these aspects begot the performance difference.

Regional trade is stimulated by the variance of natural energy endowments between countries, which is a sufficient condition for establishing a regional market in a situation of generation capacity shortage. However, having enough interconnection capacity is a necessary condition.

The theory of regional integration gives two conditions for regional demand to integration, interdependence between member states and their preferences [Schimmelfennig, 2018]. From a power sector point of view, we observe this interdependence in the natural energy endowments. In both SAPP and WAPP, the natural energy endowments are distributed unequally between members which creates interdependence and reliance on trade (as statistically shown in table 7.1). This was strong in SAPP due to cycles of drought in hydro which were critical for cross-border power exchanges to happen even before establishing the regional market. With interconnections in place between most countries, the regional market was established within just six years of SAPP creation. In WAPP, the natural energy endowments were concentrated in a few countries while the majority have limited resources and geographical size. However, regional infrastructures were the hard constraints for preventing trade. Countries did not have enough interconnection capacity for cross-border exchange. The internal transmission network also suffers from technical issues and is not always interconnected internally. Additionally, the generation capacity is limited in the region and countries export their excess hydro generation without another complimentary resource. EAPP exhibits a lesser degree of interdependence as hydro exist in all countries except Libya. Consequently, interconnections projects were not a priority for countries. Due to the lack of interconnection capacity in WAPP and EAPP, the performance of establishing a regional market was slow and limited to promoting interconnections.

A regional market can be established on an ad hoc basis or systematic basis based on the interdependence between countries and regional preferences.

The other condition, states' preferences, explains how the market is created. From our observations, these preferences are reflected in the way of approaching regional integration and depend on the necessity (interdependence) of member states. In the case of SAPP, the regional market was ad hoc due to the strong interdependence between member countries. Additionally, because SADC does not have a regional regulator but rather a regulatory association, there was no strict need to follow a systematic approach of establishing regulation for trade. Although establishing a regional regulator is, in theory, a reform step that is usually emphasized in the literature [Olmos and Perez-Arriaga, 2013; Oseni and Pollitt, 2014; Rose, 2017], SAPP shows that the internal mode of governance could indeed replace regulations, as Barker et al. [1997] suggests. Indeed, it is simpler to establish a regional market between vertically integrated power systems than liberalized power systems. Both WAPP and EAPP follow a systematic approach

for market establishment by working on regional regulations and market development. In the case of WAPP, regional regulations have to be developed by ERERA for establishing the market as mandated by regional institutions of ECOWAS. Hence, despite currently having enough interconnection capacity to gradually start the regional market, the plan is to stick to bilateral agreements until all members are connected and regulations are approved. In the case of EAPP, the interdependence between countries is not strong enough to follow an ad hoc approach and the pool chose to develop regional regulations internally with its IRB based on members' preference and aligned with the theory.

The performance of establishing a regional market becomes fast when having a dominant player pushing for regional trade with enough excess capacity.

In SAPP, the strategy of the major player in the region, South Africa, accelerated the creation of the market. South Africa with its multiple bilateral agreements was keen on creating a regional market and benefit from cheap hydro in the northern countries. This catalyst (hegemonic player) is lacking in both WAPP and EAPP. Both Nigeria and Egypt do not have enough interconnections for playing this role while Nigeria also suffers from generation issues. Alternatively in EAPP, Ethiopia could play this role in the future with its hydropower projects and strategic position in the region. This empirical observation is in line with regional integration in that regional demand is derived by 'the commercial interests of powerful economic producers' [Moravcsik, 1998]

The performance of establishing a regional market depends on how well the power pool can manage its internal factors and relationship with international partners/institutions.

Organizations' ability to achieve their goal is affected by their organizational capacity to build their structures, systems, people and skills [Cairns et al., 2005]. Establishing a regional market is a goal for the three power pools and how they built their capacity provides an explanation to the performance difference. International institutions like Nordpool were early interested in supporting SAPP as the first regional market in Africa. Developing the regional market was then a function of SAPP internal factors, members' strategies, and the physical constraint of the generation capacity. The shortage of generation capacity during the first years, especially in South Africa, led to effectively halting the STEM in 2006. South Africa was again keen to reopen the market in preparation for FIFA World Cup 2010. Then the DAM was introduced to provide more flexibility than the STEM. After five years of operating the DAM , the staff capacity of SAPP was developed and they were able to establish their own market platform and adding the IDM. SAPP gained the trust of member countries who changed their strategy to rely on trade for their need and now a balancing market is in the preparation phase. For both WAPP and EAPP, the first objective is to overcome the physical limitations. WAPP performance in doing so has been satisfactory and almost according to the schedule. The main factors for this performance are WAPP's internal factors like its strong relationship with partners and efficient financing arrangements. In EAPP, international institutions were keen on establishing a regional market but the performance is hindered by EAPP's internal factors. EAPP suffers from inefficient financing arrangements and staff capacity. This is further exacerbated with member countries showing disinterest in pushing for EAPP to take a more proactive role.

One potential cause for the difference in the systematic approach of WAPP and EAPP could be the development of regional regulations. Considering this, EAPP would still need time before establishing a regional market even while having sufficient interconnections between the three blocks in the upcoming years. In theory, the price difference between countries is a factor for establishing a regional market [Olmos and Perez-Arriaga, 2013]. However, due to the vertical integration structure of member countries, strong government involvement (protectionism), and shortage of generation, this factor did not play a role in the three cases and only comes into play when there is surplus capacity.

7.2.2 Internal Performance

The internal performance of the power pool can be measured against its objectives. The objectives of the three power pools are diverse, which makes it hard to compare their performance. In essence, the internal performance is different because of the different objectives and conditions that each pool have to deal with. Therefore, in the following paragraphs, we explain the important factors and their consequences on the internal performance of each power pool.

Leadership is crucial for the successful coordination and gaining members' trust.

SAPP objectives stress the role of coordinating and harmonizing relationships between member utilities. On several occasions, SAPP demonstrated good leadership quality in solving issues between members and assisting them. SAPP coordination center successfully resolved trading-related disputes between utilities and other pool participants, such as the dispute over reactive power between MOTRACO and Eskom. The center was also appointed for consulting negotiations on a power purchase agreement with Escom in Malawi and also for coordinating the ZIZABONA interconnector. The center gained from its experience with Nordpool and developed its own trading platform. It also maintains a good relationship with technical partners and utilities through holding regular events and training. All these occasions made SAPP coordination center a prominent body that drives the internal performance of SAPP.

Clear and comprehensive regional institutions encourage foreign investments in interconnections.

WAPP objectives stress the role of investments and formalizing the rules of regional trade. The utilities of WAPP have financial liabilities and limited financial resources to spare for regional investments. WAPP managed to overcome these shortcomings by relying on foreign investments. The crucial element for pulling investment is the institutions of ECOWAS. The Energy Protocol provides a comprehensive framework for the protection of foreign investments and long-term cooperation. WAPP successfully built on this and managed to establish a tight relationship with donors through its partners coordination committee. The autonomy of WAPP also decoupled the political involvement and potential corruption that exists in countries. Having a strong focus on investment activities based on the regional institutions, the internal performance of WAPP is satisfactory in achieving its objectives.

The lack of members' engagement with the power pool hampers its performance in the absence of regional support.

EAPP objectives are broad in that they include coordination between members, investments, and optimization of resources. However, due to the lack of a regional institution through which EAPP can exercise authority, members' engagement with EAPP becomes the only way for it to make tangible actions. Such an engagement is lacking for EAPP to progress internally. Some member utilities are liable and do not pay their fees which contributes to EAPP's inefficient financing arrangements. The lack of clear protection of foreign investments and regional institutions limits the financing from donors. EAPP staff is still in the capacity-building phase and depends on external consultancy for its main activities. Additionally, no leadership is observed for driving the coordination between members. All these make the internal performance of EAPP insufficient in achieving its objectives. But perhaps that is because EAPP is relatively young compared to the other two power pools and might still need time to reach the same level of maturity.

7.2.3 Design Variance

Since it is only SAPP that has an operating competitive market, it is difficult to compare and deduce the effect of the design variance between the three power pools on the overall performance and the market operation (since it is only one case). One structural design variable is

the choice of investment unit which we discussed its effect in the previous subsection about the regional infrastructure. For the other structural variables, having multi-classes membership and autonomy for decision-making improve the performance of the power pool as in the best case of WAPP followed by SAPP and then EAPP. This is because multi-class membership increases participants and contributes to making inclusive development, and autonomy of decision-making speeds the process and reduces political interference [Barker et al., 1997]. In the following paragraphs, we rather focus on explaining why the variables were different among the cases.

The institutional qualities of the regional body and its authority determine the degree of autonomy given to the power pool.

The institutional foundations of the power pool are set by the fathering institution or REC and consequently, its characteristics are propagated to the power pool. The overall preference of member states to pursue regional integration through the RECs is directly transferred to the power pools. This can be seen in the three cases. In the case of WAPP, ECOWAS commission has a regional authority and institutional approach for regional integration and cooperation. Hence, WAPP autonomy for decision-making and regional authority is derived from ECOWAS as an institution within it. For SAPP, SADC secretariat has no legal power and authority for making regional demands. Regional integration is pursued through intergovernmental agreements that rely on the role of the states. Thus, SAPP has no regional authority and was initially directly governed by the council of ministers, but as the pool progressed, it was given a degree of internal decision-making. For EAPP, its foundations were not ushered by any regional body and later it was not institutionally anchored in COMESA. Therefore, it has no regional authority and no autonomy for making decisions.

The extent of implementing power sector reforms in member countries affects the regulation and the membership of the regional power pool.

Lucas and Boudreaux [2019] theory of hierarchical institutional interdependence states that national institutional rules and regulations are contingent on the regional institutions and regulations. This can be observed when looking at how the regulation and membership of the power pool were developed. At the outset of establishing the power pool, the structure of national systems determines how countries manage the regional system. The national regulations determine how the pool is regulated. In the case of SAPP, there was no independent national regulator until 1997. Therefore, it is not surprising that SAPP has no regional regulator. In the two other cases, countries had national regulators at the inception of the power pools. Upon the signing of WAPP Articles of Agreement, there were eight national regulators. In EAPP, there were six regulators in 2006. Another aspect is the private sector involvement in national systems which determine the membership of the power pool. In 1995, there was no private sector involvement in SAPP as privatization and IPPs were not implemented. Therefore, SAPP membership only included national utilities at that time. The case was different in WAPP. By 2006, countries like Ghana, Côte d'Ivoire, Mali, and Senegal had already privatized their utilities and the numbers of IPPs were significant like in Nigeria. The membership of WAPP was then open to all enterprises. In EAPP situation was different. Privatization was attempted in several countries but without divesting national utilities (except in Uganda). IPPs were also introduced but were obligated to sell to state utilities. Therefore, in the case of EAPP, the reforms were limited to a few steps in a few countries and did not beget strong private sector involvement to push for membership in the power pool.

As the reforms progress in member countries, the structural design variables of the power pool also change. This was observed in SAPP as with member countries introducing more IPPs, the pressure increased for admitting them to the pool. But as national utilities are reluctant to recede their position, IPPs were admitted but with limited voting rights. Here, we also observe the relation between the pool autonomy and its membership. Both SAPP and EAPP are governed by a political body, the council of ministers, with an interest in securing the position of their utilities. Therefore, although opening the membership has clear advantages like increas-

ing trade and financial incomes (through fees), political involvement with protectionist policies prevents such a decision. Currently, as regulation progresses in the members of SAPP, there are intentions of transforming RERA into a regional regulator. We can also expect the membership of EAPP to be expanded once IPPs attain a notable presence in the market.

The choice of having an investment unit in the power pool relies on members' interest in infrastructure development.

In the case of WAPP, there was a strong need for investing in infrastructure, both transmission network and generation capacity, and member countries were limited in financing resources. This is why WAPP mandate emphasizes its investment role and gives it authority for project implementation. In the case of SAPP, owing to the shortage of capacity in the region, SAPP has adopted an investment role for facilitating generation projects. Investment need was absent in the case of EAPP. Although such a role could have accelerated interconnecting the members, members were not interested to give EAPP such a role. Members execute such projects through sub-regional organizations belonging to the different groups in the region, e.g., the NELSAP of the NBI. The theory of regional integration gives a similar explanation. It foretells that the outcomes of regional integration reflect the regional preference of actors [Schimmelfennig, 2018].

The choice of some market design variables is influenced by the interest of dominant members. Members with large capacity or who are net exporters could exert leverage to block or push certain design options. South Africa and Ethiopia are examples of such actors. As they benefit the most from regional trade, they have a strong interest in the choice of transmission tariff methodology and compensation. These actors could also exercise market power in the competitive market. Therefore, these have to be considered in the design of the power pool.

7.2.4 Synthesis of Theoretical Explanation

The African power pools are established in a complex and layered system and have different facets of development. In creating our analytical framework in chapter 3, we combined different theories with a market design framework. Following the above mix of empirical and theoretical explanations, we summarized the cluster of theories used, what do they explain, and how they apply to the context of African power pools, as follows:

1. **The Theory of Regional Integration**: explains the establishment and development of RIOs in general by addressing the conditions for regional integration, how the regional demand is created, the transfer of political authority to regional organizations, how regional organizations expand their tasks, competencies, and members, and what impact they have on states and societies in their regions [Schimmelfennig, 2018].

2. **The Theory of Power Sector Reforms**: explains how the issues of power sector organization, the inefficiencies within the different organization modes, the conditions and steps for market creation, and the reasons behind undertaking certain reforms.

3. **The Theory of Market Design**: explains what the rules of the market should be, the different exogenous factors affecting the market design, and the evolution of different hybrid markets.

4. **The Literature of Power Pool Reforms**: only explains the necessary steps for creating a regional market.

5. **The Theory of Capacity Building**: explains the different internal and external factors affecting the performance of organizations and how organizations develop the capacity to perform their tasks through adopting different strategies and practices.

6. **The Literature of Transition Management (from Evolution)**: explains the evolution of small firms (niche), the processes of development in a multi-actor system, the forces of change within the system, and the different development trajectories.

Inspecting African power pools through power sector reforms, market design, and power pool reforms does not explain their development and why the performance is different. Additionally, these theories alone do not provide enough explanation as to why the power pools were established in a situation of underdeveloped national systems and why they have different authority and structures. The theory of regional integration explains the foundational implications of African power pools. It gives a higher understanding of their establishment and authorization from the perspective of RIOs and the situation of regional integration. The theory also provides a general explanation of the necessary conditions for the integration and some issues in the process. The necessary conditions can be translated through the exogenous factors of market design theory while the issues of the integration process can be translated through the theories of power sector reforms. Hence, they explain the establishment of regional markets in Africa. To understand the development and performance differences, a deeper analysis beneath the regional development is required. The theory of capacity building explains the operational performance of the power pools and the adequacy of their organizational capacity as RIOs. Then, the transition management literature explains the development of this capacity by identifying the driving forces in the system. Therefore, there are different layers of the theoretical understanding of African power pools. Figure 7.4 is an attempt to depict these layers and the corresponding actors.

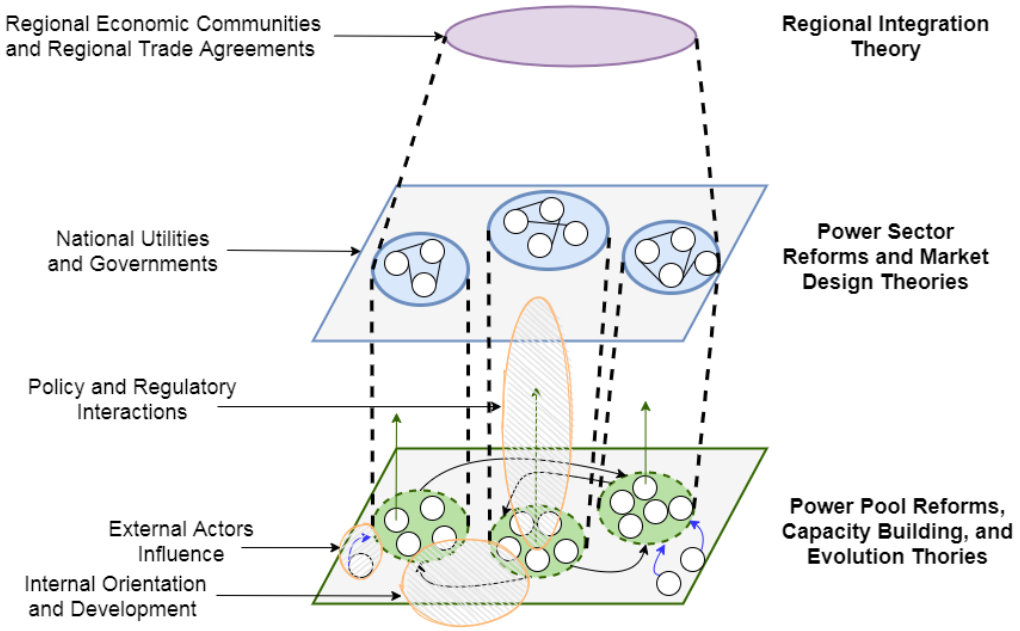


Figure 7.4: The theoretical levels of understanding African power pools, a conceptual framework.

Each layer has its own issues and can be studied severally. The first (top) layer has the fundamental issues of the foundation, authority, and the approach for regional development. The second layer deals with more technical issues of market creation, infrastructure investments, and the benefits of regional trade. The (bottom) third layer addresses the issues of operations and performance like staff quality, financing, organizational development, and governance structure. There is an interaction between the second and the third layers due to the link between the theories of power sector reforms and power pool reforms (national sub-systems with the regional system).

7.3 OBSERVING THE DEVELOPMENT

From our observation and comparison of the three cases, we highlight in this section lessons learned from the development of the three power pools and also some notable issues and challenges.

7.3.1 Lessons Learned

The following are the main lessons from the three cases:

1. **Regional power pools in Africa are forms of economic integration.** The power pools were founded to allow cooperation in the energy sector and sharing resources between countries. This fundamental makes the power pool more than a design exercise for establishing a regional market. These power pools are concerned with various integration aspects other than the technical design of the market. This includes predominantly assisting national utilities and promoting regional infrastructure by either engaging with the political authority or with donors. Additionally, the whole context of regional integration affects the performance of these power pools. The theory of regional integration takes different paths into how regional integration can move forwards or be explained. The view of Intergovernmentalism is that governments use regional integration to maximize their national security and economic interests. The regional integration results from intergovernmental bargaining and reflects the regional preference and power constellations [Schimmelfennig, 2018]. As an integration agenda, the higher the degree of integration, harmonization, and cooperation in the region, the easier the establishment and development of power pools, and the opposite is true.

2. **A strong political commitment is essential for establishing and developing a regional power pool.** Regional trade involves moving a commodity outside the country and electricity is a basic commodity for the development. Without a political consensus from the governments, regional trade cannot happen. The basic building blocks of establishing a power pool are the signing of an IGMOU and IUMOU for granting permission to transport electricity outside countries and defining the obligations and rights of each part. The political commitment is then needed for pushing the regional agenda for the development of the power pool.

3. **A regional power pool can be established by a bottom-up or top-down approach. A bottom-up approach requires members' engagement and a top-down approach requires a regional authority.** The bottom-up approach for regional power pool means that it starts gradually between a group of countries with internal agreements between utilities and then expands organically to include other countries. Countries join the power pool for their own interests and benefits, the power pool then provides services according to the needs of member countries and adapts to the national systems. SAPP is a case of a bottom-up established power pool. Oppositely, the top-down approach means that the power pool starts with a predefined scope and missions covering a known number of countries. In this approach, national systems adapt to the requirements of the power pool by implementing necessary regulations and policies. For this to happen, a regional authority that has member countries' authorization is required. WAPP is a case of a top-down established power pool. The two approaches coincide with two theoretical views debating regional integration, these are intergovernmentalism and neofunctionalism. The bottom-up approach is in line with intergovernmentalism that views the regional integration process starting from members negotiating their interests and building bargains on it. The top-down approach is aligned with neofunctionalism that views the regional integration process as an outcome of supranational institutions and does away with state-centrism for transnational interdependence [Schimmelfennig, 2018].

4. **The regional institutions or the RECs determine the characteristics and the authority of the power pool.** The power pools in Africa are incubated by RECs and the relationship with the REC shapes their characteristics. A power pool that is a formal institution of a REC directly inherits its mandate and authority from it. How member states pursue regional integration in the REC (intergovernmental or transnational) explains how the power pool approaches market creation. In this view, RECs are the policymakers of the power pools that set their legal framework. In the absence of a REC, the formal agreements between member countries set the playing field of the power pools.

5. **The physical context determines the development of regional trade.** Sufficient interconnection capacity between countries is needed for regional trade to start. In a normal scenario, these interconnections are stimulated by countries depending on their neighbors for importing electricity which happens in the case of countries' chronic generation shortage or excess generation capacity of the neighbors. The natural energy endowments of countries play an important role in creating interdependence between countries and shaping the development of trade. Indeed, regional integration theory argues that interdependence creates the demand for regional integration [Schimmelfennig, 2018]. Hydropower resources have a prominent effect on driving regional trade because of their usually cheap price and also seasonal dependence. Additionally, the physical characteristics of national systems like how well the network is interconnected and the demand distribution limit the amount of trade each country can have.

6. **A regional market and competition can arise between vertically integrated power systems.** Power sector reforms are necessary for creating a competitive market at the national level. On the regional level, a competitive market can be established between vertically integrated utilities without the need for power sector reforms at the national level. The sufficient condition for creating a competitive market is to have multiple competing players. Seasonal surplus of generation can provide for competition at the regional level and vertically integrated utilities can share their resources on the regional market. To establish a regional market or a regional power pool, power pool reforms need to be taken to coordinate trade activities (as we indicated in chapter 2).

7. **The performance of the power pool in achieving its objectives is a function of its internal factors and members' strategies.** As an organization, the power pool has different facets to manage (organizational capacity) for achieving its objectives. How well the pool can orient its activities and its internal structure is critical for making performance progress (as we saw from the theory of organization in chapter 2). As targeted stakeholders, members' strategies can be a limiting factor for the power pool when national agendas prevent regional cooperation. In contrast, having members pursuing regional agendas helps the power pool in its tasks. What remains crucial, is how the power pool can mitigate members' strategies (like protectionist) and incentivize the shifting of agendas. WAPP provides an example of how the pool can orient its activities (e.g., investments facilitation) to members' interests to shift their strategies to pro-regional. Defining regional projects in a way that includes internal transmission lines makes countries interested in regional activities.

8. **Aligning power pool design to its members' needs is important to achieve effective outcomes.** The organizational structure of the pool is more effective when is based on its members' need. A power pool that adopts a certain focus by having an investment functionality or a dedicated technical organ depending on what is needed by members can earn their trust and support. The market design of the pool should similarly be according to the necessities of utilities and simplified to their technical capabilities to ensure their participation. Indeed, attending to actors' interests increases their participation [De Bruijn et al., 2010].

9. **International institutions can play an important role in overcoming physical and economic limitations in the region by providing financial grants as well as supporting the power pool technically.** Having member countries with limited resources makes it hard to build the necessary infrastructure for operating a regional market. In such a case, international financial institutions can provide the resources for enabling the market. The absence of market competition in African countries makes the power pools inexperienced in establishing a market as usually the staff is chosen from national utilities. Therefore, support from technical institutions is indispensable at the outset and continues to be important for the progress of the pool to become operationally sustainable [Brown and Moore, 2001; Brown and Kalegaonkar, 2002].

10. **A centralized approach for developing regional infrastructures accelerates interconnecting all members and ensures homogeneous development.** A regional body that has the direct responsibility of overseeing regional projects helps in mobilizing resources and tracking the implementations. Such a body could be vital to ensure connecting all member countries when the economic conditions are poor in some countries. By clearly defining property rights for regional interconnections and ensuring the enforceability of contracts, a regional body helps to stimulate investments [Besley, 1995].

7.3.2 Practical Issues and Challenges

In this last subsection, we conclude the chapter with common issues related to structure of national systems and members' engagement as well as a set of general challenges.

Issues with Vertically Integrated Structure

Although competition can indeed happen between vertically integrated power systems, there are issues with the structure as it is naturally not conducive to competition. The following are some of these potential issues:

- In most countries, electricity prices are determined by state-owned monopolies and are usually not cost-reflective. This reduces the prospects for deriving efficiency gains from power pooling, as such gains are maximized where the prices of electricity exchanged through a pool reflect the dynamics of a cost-reflective competition between countries. The transaction cost theory explains that vertical integration is an inferior organizational mode in obtaining, processing and using external information about prices, costs, quality, and technological change in the long run compared to the hierarchy of the market [Williamson, 1998]. In trade theory, this is considered a departure from the assumptions of the basic Heckscher-Ohlin model of free trade. Indeed, Markusen [1981] shows that if markets were initially monopolized, opening up to trade and competition between monopolists might lead to a loss of welfare. Additionally, if one country is selling electricity at below cost and another at its true (higher cost), the result of the joining of the two would worsen the impact of the initial price distortion in the country with prices below cost as well as the overall welfare compared to no interconnection [De Villemeur and Pineau, 2012].

- The vertically integrated structure does not give consumers the choice of supply. In this structure, most of the IPPs are obliged to sell the monopolistic utility (except for large private IPPs dedicated to power mining companies for example). This creates barriers to market entry enjoyed by national utilities which gives rise to monopolistic profits [Helpman and Krugman, 1985]. Consequently, under this imperfect competition, the economic efficiency is limited in African power pool.

- Because of the vertically integrated structure, market power is more prominent in the power pools with countries having more than 50% of total generation. Price manipulation and predatory pricing can be exercised in the regional market by big utilities, especially

when the market players are few in numbers (oligopolies). This was observed with Eskom in SAPP [Oseni and Pollitt, 2014; ECOWAS, 2006].

Issues with Members' Engagement

One of the main issues with the development of African power pools is the genuine engagement of members. This can be seen in the light of regional integration theory. In theory, regional trade agreements should begin to liberalize trade between the signatory countries and the projected benefits should then begin to flow. However, most of the time there is the protectionist issue that monopolistic firms have vested interest to withhold their position in the market. These firms tend to influence the political decisions to inhibit liberalization (crony capitalists) [Kimbugwe et al., 2012]. The theory also describes the problem with uneven distribution of integration benefits between members which is a function of asymmetric interdependence and outside options between members. Members who are less dependent on regional integration because they are less affected, tend to join as a defensive necessity against possible exclusion from markets (what is known as Baldwin's domino effect). In the context of power pools, these issues manifest themselves in the same way. Prominent monopolistic utilities, especially state-owned, seek to keep their position in the market under the argument of protecting national interests. These utilities are also reluctant to concede their sovereignty to a higher authority. Finally, utilities that do not see huge benefits from regional integration and have alternative options for the development, tend to join as a defensive necessity with no genuine interest to engage with the power pools and could even block decisions for deeper integration. Additionally, from our empirical findings, utilities with a strong interest in regional integration could push others away if they seek to dominate the decision-making process.

Challenges

The following represents a number of challenges in the three cases:

- Without liberalizing the national market, there is a challenge for countries to balance their dependence on imports of electricity to not affect domestic production facilities. This could expose an importing country to a hold-up problem if the other country refuses to export. This security risk is two-sided, as the exporting country might become equally dependent on the export revenue from electricity sales [Oseni and Pollitt, 2014].
- Investments in transmission infrastructure continue to be a challenge in all three power pools. This is true for regional interconnections and internal lines. Even in SAPP, congestion and disturbances remain obstacles for regional trade (89 disturbances transpired in 2019 that interrupted the scheduled trade). Similarly, most countries have inadequate investments in generation capacity and suffer from unavailable capacity. All these impede the power pools from reaching the desired capacity of trade.
- As indicated in the reports of the power pools, it is challenging to attract and retain qualified staff for developing expertise in African power pools. All power pools continue to rely on external experts for developing their projects and activities. This is acceptable to a certain degree but is not sustainable in the long term. This also true for relying on foreign investments excessively, which could create a lack of local ownership (as in the case of WAPP).

In the following chapter, we discuss how these issues and challenges could be overcome.

Part III

AFRICAN POWER POOLS: LOOKING AHEAD

8 RETHINKING AFRICAN POWER POOLS

"Market design is like fractals, whenever you zoom in to certain topics, you still encounter the same complexity"
Laurens de Vries

In this chapter, we address the fifth research question *"What are the reforms and design options for improving the performance of African power pools and renewable energy integration?"*. In section 8.1, we highlight how the three African power pools can be reformed to ameliorate their development, what are the blockages for this to happen, and how to manage the issues and challenges identified in the previous chapter. Then, using our empirical investigations, our analytical framework from chapter 3, and our conceptual framework of theoretical understanding from chapter 7 we develop a pragmatic generalization on how to approach the development of regional power pools in section 8.2. Lastly, we give special attention to how the power pools can improve renewable energy integration through their market design. We first give an overview of the progress of renewable energy policies in the three regions and argue for the need to modify the market design in section 8.3. Then we discuss how certain market design elements can help renewable energy participation in the short-term competitive market in section 8.4.

8.1 PROSPECTS OF REFORMS AND DEVELOPMENT

The development of the three power pools took different trajectories as to how the power pools were established, bottom-up or top-down, the reform steps, and how the infrastructure is being developed, centralized or decentralized. In each of the following subsections, we explain how each case can be improved and what are the issues or blockages for this to happen.

8.1.1 SAPP

SAPP has developed bottom-up based on its members' needs. Such an approach is practical for starting the market with interested members and thus, took a decentralized approach for infrastructure development. As a consequence, not all the members are connected to the regional network despite that the market has been running for two decades. Effectively functioning power pools require further investments in underlying infrastructure (sufficient transmission and critical mass of generation capacity) but also a shift in thinking from short-term oriented objectives towards long-term gains. A centralized approach would accelerate connecting all member countries and following up with the generation capacity in the region. This would ensure smooth development rather than ad hoc or upon request project development (how the PAU operates). At this point, a centralized approach for infrastructure would benefit the development of SAPP. The practical issue is that SAPP currently does not have the mandate to perform this role (Interview 8). However, this is likely to change as there have been calls for changing this within SADC (Interview 6). The theory of regional integration also anticipates

that integration tends to incentivize additional integration steps (functional spillover) and that this happens as interdependent sectors are regulated at the same level [Schimmelfennig, 2018]. This exactly what is happening with SADC moving from electricity to energy regulation and the intention to give RERA more power and authority for decision-making [Political Analysis, 2019; COMESA, 2019]. With SAPP gaining member countries' trust, such a change can be brokered. By transforming RERA to a regional regulatory authority, the market would benefit from regulations in several ways, like managing inherited issues of vertical integration (as we discuss in subsection 8.1.4), and thereby completing the reform steps.

8.1.2 WAPP

WAPP has developed top-down based on the directives and regulations of ECOWAS and took a centralized approach for infrastructure. This has helped to accelerate investments in the transmission network. However, there are issues with following this approach to establish the market. Currently, WAPP market design is complicated (Interview 5). Rules are being made for issues that are not there and unsuitable for the size of the market. This is one reason that sometimes utilities are not interested in WAPP market design projects as nobody feels a real need for all of this. Implementing these rules by national utilities will then be an issue when running the competitive market and connecting all members. Therefore, the market should be built step-wise and bottom-up to allow utilities to easily integrate. Similar to the development of Nordpool, regulations should start with defining the principles rather than detailed rules [Mundaca et al., 2013]. The issue is that WAPP currently relies on funds from the World Bank that is keen on securing its investments and having a complete market design prepared by experts. WAPP itself cannot design the market because of its staff's inexperience, but the market design should be simplified to the utilities' interests and easy adaptation.

The theory of regional integration (postfunctionalism) anticipates a backlash problem with increasing the degree of integration. As regional integration progresses and undermines national sovereignty and community, it creates economic and cultural losers as well as some integration-sceptic parties [Schimmelfennig, 2018; Dixit and Norman, 1986]. This explains some of the reluctance from utilities and foresees creating some issues from increasing foreign investments (loser domestic investors). WAPP could complement regional programs supported by international institutions with initiatives to develop national energy markets to provide private and public sector actors incentives to go regional; and foster competition. Such incentives could take the form of compensation mechanisms where WAPP creates losers (whether these belong to the public or private sectors). With its current regional development, if the market design of WAPP goes the right way in integrating national utilities, WAPP can possibly transform into a tight pool that optimizes the generation across the region, similar to the ISO model in the U.S.. This is because WAPP is currently planned to be both the market and system operator. However, this full integration and completing the reform steps could happen in the distant future and would require all the utilities to be on board.

8.1.3 EAPP

The reforms in EAPP have been limited to just one step. Similarly, the development has been narrowed to conducting studies, workshops, and attempting to develop market-related documents and regulations. There is no clear approach to how EAPP is developing. Although the attempts to establish a regional regulator and market documents can be seen as a top-down approach, EAPP lacks the regional body through which it can exercise regional authority. However, judging from the experience of SAPP, this is not a problem as EAPP would benefit more from a bottom-up approach for market design that would attend to the utilities' interests. For adopting this approach, EAPP has a practical issue on how decisions are made. With the council

of ministers, EAPP is a more political organization. Political support is very much needed due to the lack of a REC that encompasses all members to provide political support. However, there is no merit in leaving all decisions to the ministers, especially the technical issues that could be decided among the utilities. Including technical and operational matters in the meeting of the council of ministers is considered as a dysfunction [Norda and KPMG, 2019]. The same could be said for regulation matters like approving the Power Purchase Agreement model (Interview 10). Changing the governance structure to completely de-politicize EAPP would not yield the desired results. Rather, emphasis should be placed on protocols of decision-making and giving the pool a degree of autonomy to decide on these matters internally.

EAPP would also benefit from a centralized approach to infrastructure development and has the mandate (objectives) for it. The issue then remains with the staff capacity and the orientation of EAPP activities. Additionally, the financing arrangements need to be improved but perhaps the major obstacle for taking an investment role is the lack of necessary institutions and frameworks for protecting foreign investments like the Energy Protocol of ECOWAS. Providing that member countries support such a role, EAPP could tackle this by attending to the property rights of regional projects, starting with member countries and adopt initiatives to coordinate with donors and other regional organizations working on infrastructure development, e.g., the NELSAP. For this to happen, proper capacity building programs are needed to strengthen EAPP's legal and financial competence. EAPP's competitive market could start organically between interconnected members and expand to include other countries. The region of EAC is suitable for starting the market as countries have been pushing for harmonization (through their own regional regulatory association EREA and policy center EACREEE) and ratified the EAC Common Market Protocol. Additionally, most of the bilateral agreements in the region are between EAC members and they will soon be interconnected (Interview 9 and 10). Then via Ethiopia, the rest of the countries can be connected. A hurdle for this course of development is the strong interest of Ethiopia to centralize EAPP institutions in Addis Ababa. This could lead to starting a separate market between EAC countries and later integrate it with EAPP. Thus, without attending to other members' requests and interests, EAPP would run the risk of further increasing members' disinterest. Based on this, we suggest the following reform steps for EAPP:

1. Establish an investment unit (functionality) to regional projects investments.
2. Develop technical and commercial market rules while regional interconnects are being materialized.
3. Start the competitive market organically between interconnected members.
4. Establish a regional market operator where the market starts.
5. Allow IPPs participation by adopting a proper framework suitable to the structure of national systems.
6. Develop regional regulation gradually with market expansion.

8.1.4 Managing Vertically Integrated Structure

Although the vertically integrated structure has several issues, it is justified under several conditions. The transaction cost theory explains the advantages of the structure in reducing opportunistic behavior, the cost of coordination and planning, and removing internal information asymmetries [Joskow, 2004b]. The issues can be managed with a couple of regulatory options:

- To avoid welfare loss, regulation of the regional market can set a minimum trading price to reflect average cost-reflection (as in the theory of monopoly regulation [Gómez, 2013]). Alternatively, in the presence of complex national subsidies, the regional regulator might

oblige market participants to use cost-reflective prices in trading their surplus on the regional market. This however requires a regional regulator with enforcement authority.

- In case of the absence of a regional regulator, harmonizing national regulation (for example via a regulatory association) so that the price-setting mechanism in countries is the same would ensure that regional trade does not worsen the welfare and the initial distortions in the markets.

- Admitting IPPs to the regional market improves the imperfect competition of vertically integrated utilities. As a reform step, IPPs could provide benchmarks for performance and may increase their influence over time [Correljé and De Vries, 2008]. In light of the regional market, regulation of IPPs could allow flexibility for trading in the regional market without compromising the national agreements. This does not require the removal of the monopoly and is beneficial in the long run for national systems as well. The new power sector regulation of Namibia provides a good example to this (see the Modified Single Buyer (MSB) model Government of Namibia [2019]).

- Monopoly regulation also provides options for preventing market power. The ideal solution is to make the market contestable and reduce market concentration. This happens when there is a large number of market participants with comparable market shares. This again gives importance to admitting IPPs and reduce entrant barriers in general. Although market power depends on the structure of the market and not the rule in a competitive market [Gómez, 2013], several regulatory rules were attempted to dilute market power but were also debatable in their effect (e.g., price cap or different contracts). In the context of a regional market, perhaps the practical solution is to establish market surveillance and develop ex-ante identification for market power from practical experiences (see the review of Adrian et al. [2018]).

8.1.5 Managing Practical Issues and Challenges

The issue of members' engagement with the power pool has different causes that can be managed internally. Members join the pool for having interest, gains, or not missing an opportunity. The secretariat of the power pool or the coordination center should ensure the alignment of the pool activities to member interest and prevent any possible conflict of interest. This entails fair consideration of the interests and requests from all members. In the case of uneven distribution of benefits, the implementation of compensatory and corrective policies could be necessary for disadvantaged members [McCarthy, 1996; Asante, 1997]. We also observed a reluctance from some utilities to implement complex design schemes for the regional market which should be mitigated by adopting the market design to the capabilities of the utilities and the size of the market (Interview 5).

The challenges of fear of non-supply and balancing the dependence on regional trade can be managed by regulating trade and making market and bilateral contracts firm and subject to penalty for non-delivery (Interview 5). Member states should adopt national plans to the regional plan and either devise strategic plans or regulations to ensure national security of supply without prohibiting imports when it is economically more feasible. Gradual liberation/opening of the power sector and proper market design also improve the adequacy of supply.

The challenge of infrastructure investments can be mitigated through the power pools. The geographical spillover effect from regional integration increases the likelihood of attracting more investments from non-member countries [Haas, 1968]. However, to stimulate investments, it is necessary to enact investment frameworks for protecting foreign and domestic investments in regional projects. Property rights should be clearly identified for these projects. Additionally, traditional feasibility studies should include identifying all beneficiaries of regional projects for

fair cost allocations [Olmos and Perez-Arriaga, 2013]. The power pool can play a crucial role in mobilizing substantial financial resources by actively involving international financial institutions as well as member countries in preparing regional projects (as in the case of WAPP). Finally, following up on the implementation of these projects provides assurance for investors (increase accountability) and increases the chances of reinvesting in other projects.

As a development organization (RIOs), the power pools have the challenge of developing their own organizational capacity. This is an accumulative process that starts with support from international institutions on both technical and financial aspects. This challenge can be managed by improving the corporate governance of the power pool through evaluating and assessing the pool's ability to perform its tasks. And instead of relying on foreign investments only, the pool could complement regional programs with initiatives to develop national energy markets to provide private and public sector actors incentives to go regional and increases the sense of local ownership.

8.2 DEVELOPING REGIONAL POWER POOLS

Our perspective on African power pools is multilayered and encompasses the different aspects of development. The analytical framework we devised in chapter 3 can also be taken as a high-level design framework. In order to give a general theory on regional power pool development, we combine the framework with the theoretical levels described in chapter 7. The result is shown in figure 8.1. Each layer has different development dynamics and the layers influence each other. In the following subsections, we expound on the development of each layer, the conditions, and the sequence of steps. Then we discuss the alignments between the different elements to influence the progress and development.

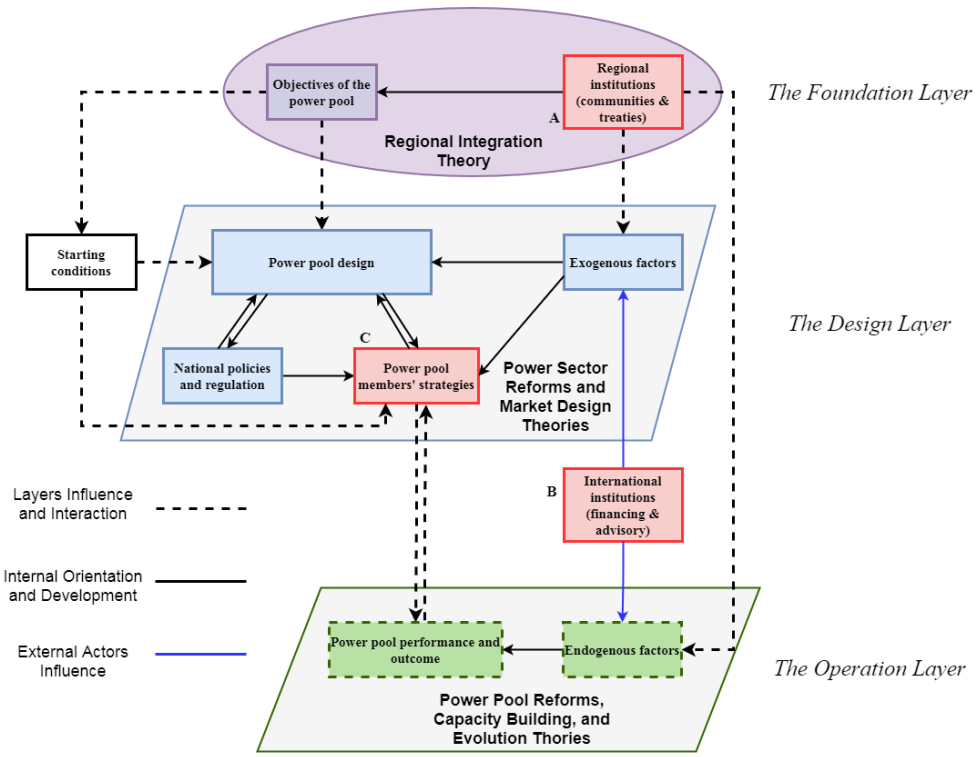


Figure 8.1: Regional power pool development framework.

8.2.1 The Foundation Layer

The first layer is what we call the foundation layer. In this layer, the institutions, objectives, authority, and development approach are established by member countries. To understand these foundations, it is necessary to look into how member countries cooperate. The cooperation between member countries could be either limited or broad. The cooperation is limited when it only takes place in this particular field of the power sector. In this case, the regional power pool only facilitates power exchange between member countries and could serve to optimize the regional dispatch (as in the case of MER, the regional market in Central America). In such a context, the power pool usually does not have a development role beyond advising for transmission planning (which is necessary for the pool to perform [Olmos and Perez-Arriaga, 2013]) and member countries retain their autonomy. The second case is when cooperation is broad and takes place under regional integration. In this case, the way member countries approach regional integration directly determines how the power pool functions. In a 'low politics' integration (as described by Hoffmann [1966]), member states with their different power are the key actors in the integration process and maintain their autonomy. In this context, the power pool would enjoy a lesser or no authority in the region and its development role (and objectives) reflects the regional preference and power constellation. This level of integration takes the form of a coordination/common platform like a regional executive secretariat. A deeper level of integration is the 'high politics' integration that touches the core power of the state. This level of integration takes the form of transnational organizations with a degree of supranational power. In this context, the power pool tends to have more authority in the region and its development role (and the objectives) reflects the regional need.

The establishment of the power pool is different in each background. In limited cooperation, an agreement between the utilities is necessary. This could be in the form of IUMOU. In a low level of integration, an extra agreement is usually made between the political powers to authorize the trade. This could be in the form of IGMOU or a regional trade agreement. In a deep level of integration, the establishment of the power pool is institutionalized within the transnational authority. This could be in the form of legal articles embedded within the regional law/constitution.

The establishment of regional power pools usually starts with conducting feasibility studies about regional interconnections. It is important, however, to assess the interdependence between member countries in terms of resource complementation. These studies should also communicate the different potential beneficiaries for fair cost allocations. Having a major producer in the region to provide the 'club goods' can be an important factor for creating the power pool. Also, theoretically, as the regional integration progresses and deepens between countries, it is expected to benefit the development of the power pool and expand its functionality, role, and authority to reap more regional benefits (spillover).

8.2.2 The Design Layer

The second layer is the design layer. This is the most dynamic and relevant layer in the development of the power pool. The design of the power pool is predicated on this dynamic and evolve with it. To understand the design of the power pool, it is necessary to look into the organizations of national systems, the external factors surrounding the power pool, and members' strategies. The power pool inherits two things from national systems. First, when national systems have a vertically integrated structure, the power pool membership will be exclusive to national utilities. When these national utilities are state-owned, the power pool is usually governed by countries' ministers as the highest decision authority which leaves no autonomy for decision-making. If the private sector has a strong presence in many countries and reforms started to introduce IPPs, the membership will be expanded. Similarly, if the national market

allows for consumer participation, it is also expected to be allowed in the regional market but it could be otherwise if national policies protect the domestic market and only allows for trade as a supplement. Second, the regulation of national systems is contingent on regional regulation. In the case of countries operating under monopolies with self-regulation, the regional market will not have an independent regulator. As regulations in member countries progress in establishing regulators, a regional regulator is more likely to be founded. When member countries have liberalized national markets, the way the regional market operates depends on members' preference. National markets could be kept autonomous as in MER or they could be coupled as in the internal electricity market of the EU [Olmos and Perez-Arriaga, 2013].

In the case of having liberalized national markets, the remaining design choices require harmonization efforts to ensure the compatibility of the different designs in the light of a possible greater gain from the integration. In the case of vertically integrated structure, the choices require assessments (scientifically) of their benefits in view of the market size. At first, it is necessary to establish a transmission tariff methodology and congestion management method. For these, it is important to consider that major exporting members with strategic interest in regional trade could attempt to influence the choice of these variables to their advantage. Then, providing that there are enough interconnections between member countries, the development of the regional market should start with a competitive market with a forward time horizon (like month-ahead, week-ahead, or day-ahead) and move closer to real-time operation (intra-day). A shorter trading platform like the IDM provides flexibility to supplement peak hours or unexpected demand. Based on this, a balancing market can be introduced when significant imbalances are frequently observed after the closure of the last competitive market. On an advanced level, the market could provide ancillary services when there are differential capabilities between the utilities and demand from less capable utilities. However, this would also require sophisticated infrastructure and system operation (physical conditions). Investments can be stimulated by the power pool by two variables, either by establishing an investment unit or introducing a regional capacity market. These choices are beneficial to overcome limitations in physical conditions (infrastructure) and when some countries have poor economic conditions. The type of investment functionality of the unit depends on the authority of the power pool. A pool with no regional authority can only facilitate the bankability of projects while with regional authority it could oversee and implement projects. In the latter case, the pool should develop the ability to mobilize financial resources and it becomes crucial to have frameworks for protecting investments (institutional context).

8.2.3 The Operation Layer

The third layer is the operational layer. This is the most crucial layer in building, operationalizing, and expanding the power pool. In this layer, the internal structure of the power pool and its ability to perform the tasks are determined. When national systems are liberalized, the development role of the power pool is limited to establishing the regional market and advising transmission planning. In such a case, the staff is expected to be experienced with market design and operation. Then the important aspect is the governance structure of the pool. This structure is initially set at the foundation layer, however, as the pool evolves and interacts with different actors, the structure is subject to change to accommodate new demands and requirements. When the national systems are vertically integrated, the pool is expected to have no experience in market design and operation. Among the eight power pool reforms (identified in chapter 3), five steps are necessary to establish the regional market:

1. Establishing legal documents and agreements permitting trade (prepared at the foundation layer).
2. Establishing commercial market rules for trade (prepared by the pool member utilities).

3. Establishing operation rules and a regional market operator (operationalized by the pool independent staff).
4. Establishing a wholesale energy market platform (operated by the market operator).
5. Planning for the regional grid (either performed jointly by member utilities or by an independent organ in the pool).

To perform these steps, the pool has to gain substantial expertise. This is reflected in developing staff capacity, technical readiness, and financial arrangements. The learning process of the pool depends on the technical and financial support it receives from the external actors and stakeholders. The pool's ability to maintain good relationships with these actors and stakeholders is crucial for its internal development. These actors help in improving the organizational structure of the pool and also influence the market design. External actors could be international financial institutions, technical institutions, and peer power pools. To maintain a good relationship with regional stakeholders and member utilities, the pool needs to perform the following activities:

1. Conduct regional studies and analysis for cross-border projects.
2. Develop regional plans for grid.
3. Provide training for member utilities.
4. Help in resolving disputes over regional trade.
5. Help in advising business plans and investments.

As the performance of the power pool in delivering its tasks improves, members' trust increases which leads to shifting their strategies. This leads to expanding the role and functionalities of the power pool to reap more benefits from the regional integration (spillover effect). As a consequence of members' trust, the pool would gain autonomy in decision-making and further reforms could be implemented like establishing a regional system operator and regulator.

8.2.4 Alignments

The regional power pool encounters different challenges and barriers in its development facets in each layer. The overall development hinges on aligning the various aspects of the internal factors and the design options to the external factors and members' interests. The following points discuss critical alignments between the layers for the development of the power pool:

- The first barrier to establishing a regional market is the lack of sufficient interconnections between member countries. The power pool has an essential role to enable regional interconnections. At this stage, the pool should focus its activities on conducting studies to show the benefits of trade and then promote investments by involving stakeholders and investors. The investments that private parties are willing to finance and build tend to be less than socially optimal as revenues from the commercial exploitation tend to be much smaller than the social value of these lines [Perez-Arriaga et al., 1995]. Thus, central planned transmission investments by the pool can improve investments besides others proposed by private parties (like competition). If member countries have limited financial capabilities and poor economic conditions, the pool can go further and oversees regional projects' preparations and implementations directly. This requires the pool to improve its internal structure by increasing financial and institutional transparency and establishing a dedicated body able to perform all necessary steps (tendering, procurements, etc.) and obligations (guarantees, protection, property rights, etc.).

- The second major barrier to the development of the power pool is the disinterest and lack of engagement of members. The cause of this issue should be carefully approached by the pool. Providing basic support to member utilities is a necessary first step to gain members' interest in the pool. Among the five main activities identified in the previous subsection, the pool should focus more on what the situation requires. Additionally, the causes of the issue could be in the way the market design or the reforms are approached. Member utilities could pursue a protectionist strategy to their national sovereignty or simply unwilling to incur the cost of implement what they do not recognize a benefit from. It is important here to adopt a pragmatic approach to the development and not what is usually deemed as best practices. While some theoretical steps are required for the maximum benefit of the regional market, they, however, could be not feasible given the blockages of implementation. Therefore, steps should be introduced as the market evolves. The market design should be adapted to the utilities' capabilities and the present needs. On the other hand, the five reform steps mentioned in the previous subsection are necessary, but the remaining three could be gradually adapted to the situation of national systems (that usually reflects utilities' strategies).
- The other barrier to the development is the lack of organizational abilities to perform the tasks and objectives. The support from external actors and the regional institutions should be aligned to the needs of the power pool. A power pool that attempts to overcome the first barrier of infrastructure investments needs to be supported regionally to perform the task by providing the necessary institutions and framework to enable regional investments. Differently, a power pool that attempts to mitigate members' engagement needs to develop its staff capacity and leadership to bring together the different interests.
- The main challenge to fully benefit from regional trade is having imperfect competition in the market. However, it is necessary to align the regional market to the structure of national systems. Imperfect competition is still beneficial for utilities interacting with the market as well as for stimulating cooperation on public projects [Venables, 2003]. The alignment between the three layers (in terms of foundational objects, system structure, and pool capabilities) is necessary to drive a deep integration. As the integration is deepening, the market opening degree increases with the removal of barriers and increasing competition.

8.3 RENEWABLE ENERGY

Renewable Energy Sources (RES) are key for shifting the energy mix from the currently fossil-fuel dominant mix to clean energy. The energy transition is shaped by economic development, technological innovation, and policy changes [Cherp et al., 2018]. In Africa, RES are gaining more attention at both the national level and the regional level. At the national level, policies have been introduced for supporting RES in the majority of African countries (Interview 12). Table 8.1 shows renewable energy policies in member countries of the three power pools. With the exception of Burundi, all member countries have renewable energy targets in their national plans. The supporting regulatory or fiscal policies differ between countries depending largely on the economic development. Member countries of SAPP have the highest average of policies, while it is only Nigeria that implemented all the six selected policies. The most popular policy between all countries is the reductions in sales, energy, CO_2, VAT, or other taxes and the least popular is the electric utility quota obligation.

At the regional level, efforts have been directed to establish centers for renewable energy and energy efficiency policies. Most of the RECs have their own regional center. SADC has SACREEE, ECOWAS has ECREEE, and EAC has EACREEE. These centers help in establishing a regional policy framework, regional energy programs, promoting climate change mitigation, facilitating

Countries	Renewable energy targets	Feed-in tariffs / premium	Net metering	Tendering	Electric utility quota obligation	Reductions in sales, energy, CO_2 , VAT or other taxes
SAPP						
Angola	✓	✓	✓	✓		✓
Botswana	✓	✓		✓		✓
DRC	✓					
Eswatini	✓			✓		
Lesotho	✓	✓	✓	✓		
Malawi	✓	✓		✓		✓
Mozambique	✓			✓		✓
Namibia	✓	✓	✓	✓		
South Africa	✓		✓	✓	✓	✓
Tanzania	✓	✓				✓
Zambia	✓	✓		✓		✓
Zimbabwe	✓	✓	✓	✓		✓
WAPP						
Benin	✓					✓
Burkina Faso	✓			✓		✓
Côte d'Ivoir	✓			✓		✓
Ghana	✓	✓	✓		✓	✓
Guinea	✓					✓
Guinea Bissau	✓					✓
Liberia	✓					✓
Mali	✓					✓
Niger	✓					✓
Nigeria	✓	✓	✓	✓	✓	✓
Senegal	✓			✓	✓	✓
Sierra Leone	✓					✓
The Gambia	✓					✓
Togo	✓					✓
EAPP						
Burundi						✓
Djibouti	✓					
DRC	✓					
Egypt	✓		✓	✓		✓
Ethiopia	✓					✓
Kenya	✓	✓	✓	✓		✓
Libya	✓					✓
Rwanda	✓	✓		✓		✓
Sudan	✓					✓
Tanzania	✓	✓				✓
Uganda	✓	✓		✓		✓

Table 8.1: Renewable energy support policies in member countries of the three power pools. Collected by the author from various secondary sources including Mabea [2020], Kazimierczuk [2019], SACREEE [2018b], and ECREEE [2014].

funding, enhancing capacity-building activities, and providing useful platforms for information dissemination and networking. Additionally, the three power pools also promote RES by integrating them into their master plans that identify potential projects according to regional targets and the required connecting infrastructure. Several studies have been conducted to come up with scenarios and optimal energy mix for these power pools [IRENA, 2018, 2015]. Furthermore, both WAPP and EAPP are currently conducting renewable energy projects under funds from the World Bank while SAPP lacks the mandate for taking this role. When power pools (and markets in general) started, little emphasis emerged on the market role in increasing renewable energy participation. However, as the need for energy transition into low carbon economies is accentuated and many countries are scaling up RES, it becomes apparent that the new focus needed to be on how to increase the penetration of renewables into the market. The power pools have significant potential to increase RES share owing to the broad geographic size for optimizing the dispatch for mitigating intermittency and improving system reliability.

From our interviews, the three power pools are interested or already working on ways to increase RES in the competitive market. Therefore, in this research, we identify best practices to accommodate RES in the competitive market (day-ahead and intra-day) by tuning some design variables, in the following section.

8.4 DESIGNING THE SHORT-TERM COMPETITIVE MARKET

The electricity market designs are different today from one country to another. Market designs are gradual adaptations to the characteristics of power sectors and countries' conditions. Thus, no two market designs are alike. Similarly, regional markets are different depending on the degree of integration and harmonization between the different jurisdictions. The simple form of a regional market starts with bilateral trade to a fully integrated market with unified real-time operations. Figure 8.2 displays a hierarchy of integration of regional markets, showing examples of regional markets at different stages of the hierarchy.

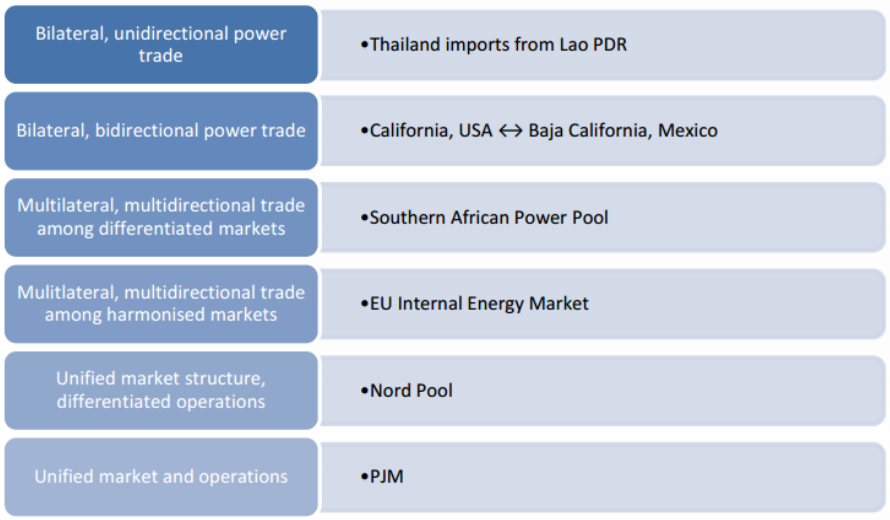


Figure 8.2: A hierarchy of integration of regional markets from a low to a complete degree of integration. Source: IRENA [2019]

The market design question is about what the rules should be but a more pragmatic view is how the rule can be implemented and enforced. Electricity markets are where commercial aspects happen for trading energy and other complementary products like ancillary services and reliability products. Each of which has its own market and design questions. Energy is the most basic product traded on electricity markets. In the short term, energy is trade in the DAM and the IDM. The two markets are the building blocks and serve as references for other markets. In the DAM, trading takes place one day before the delivery of electricity. Market participants submit their bids and offers, and a clearing algorithm determines the market price for each settlement period (e.g., for each hour) of the following day and the accepted quantities. After the day-ahead, and before real-time delivery of electricity, market participants can reschedule their transactions in the IDM up to a short period before the market closes. Many reasons could necessitate this rescheduling, including updating the forecast of RES.

The practices for design the short-term market are generally two ways [Batlle, 2013]: the U.S. ISO approach (centralized market) and the Target Model of the European electricity market (de-centralized market). The main difference between the two is related to the roles of the market operator and system operator. The U.S. ISO approach integrates the physical constraints in the clearing process of the market and involves the ISO in the markets. The EU model decouples the system operator's responsibilities from the market functioning and attempts to isolate trading from the complexities of the network physical constraints.

Among the different design elements of the short-term market, we focus on the time frame of markets, bidding formats, and the locational granularity of prices and schedules. These are considered pivotal elements for renewable energy integration [IRENA, 2017]. We discuss these

design elements based on the two approaches of the U.S. and the EU while looking into how the current implementations in SAPP is.

8.4.1 Time Frame of the Market

The short-term market is composed of the DAM in both the U.S. and the EU models. Following the DAM, the ISO takes control of the system operations in the U.S. model while in the EU model the IDM takes place between market participants and then the system operators take actions (also through other market mechanisms). In the two models, the DAM is an hourly auction that takes place 24 hours prior to the delivery time and covers all 24 hours of the delivery day. There are three fundamental design decisions related to the time frame of markets:

- The time threshold within which bids have to be presented as final and beyond that, only the system operator can take action/dispatch resources (the so-called gate closure),
- the timeline and format of the IDM (run by the market operator in the EU and by the ISO in the U.S.),
- and the settlement period.

The Gate Closure

The gate closure is the final time until which market participants are allowed to balance their account and correct any deviation from the initial declared amount without any actions from the system operator. As RES become more prevalent in the market, uncertainty becomes part of the market as most of RES are weather dependent. Making the gate closure as close as possible to the time of delivery gives RES a better chance to accurately declare their generation capacity and avoid imbalances (the difference between the actual energy delivered and the submitted amount). This, however, poses some challenges for the system operator to estimate the amount of reliable reserve for real-time operations.

In the U.S., the gate closure is the time at which the DAM is cleared. However, under certain circumstances, market participants can readjust their bids until a few hours or minutes before the delivery [IRENA, 2017]. In Europe, the gate closure is within the delivery day, the IDM, and happens h hour before the delivery. This time varies from one country to another, the Nordpool uses 1 hour while Germany uses 0.25 hour (15 minutes). Currently, the gate closure in SAPP IDM is 1 hour.

In deciding the gate closure time, the market operator should carefully consider and compare the benefits gained by participants, in terms of flexibility and certainty for RES, and costs incurred by the system operator.

The IDM Timeline and Format

The IDM in Europe provides opportunities for generators to adjust their schedule and recover the balance between demand and supply if the forecasted conditions change. The price produced by the IDM is used to settle these changes before any imbalance settlement (that requires actions from the system operator). The intra-day adjustments are performed by the ISO in the U.S. and no price or bids are received. The market participant then pays the real-time price of these adjustments calculated every 5 minutes by the ISO. This is particularly relevant for renewable energy generators as the costs can be lower if the deviations are known in advance for other resources to fill the gap. Thus, the European IDM capture the different value in times deviations.

The IDM in Europe is either continuous or discrete. In the continuous IDM, bids are submitted continuously and matched at any time before the gate closure (e.g., Nordpool). In the discrete IDM, auctions are held at predefined times (e.g., in Italy). Auction-based IDM provides less flexibility for market participants but if it runs frequently, it can be less of an issue. On the other hand, Discrete auctions provide higher liquidity since it concentrates transactions and reflects

all the accumulated events since the last session. Continuous IDM provides more flexibility but less liquidity. The choice also has other effects like on pricing cross-border capacity. Some countries, like Germany, adopted a hybrid IDM to combine the advantages of the two choices. Currently, SAPP runs a continuous and hourly IDM.

The Settlement and Dispatch Period

In real-time operations, the generation must always equal the demand (electrical load). However, the demand, as well as RES, fluctuates continuously during the day and the system operator must dispatch its reserve generation to keep the balance and the system stable. The bids on the market reflect the average amount of energy to be consumed or generated on a predefined period called the settlement period (or trading period). The system operator balances the market on its own sub-periods and charges the average price during the settlement period. In the U.S. the ISO balances the system and calculates the real-time price every 5 minutes but charges the average hourly prices to settle the deviations. This simplifies the metering and the process but is considered inefficient [Federal Energy Regulatory Commission, 2016].

Increasing RES leads to more volatility which will increase the imbalance when the settlement period for calculating the average is long. In Europe, the settlement period in the IDM is usually aligned with the balancing period performed by the TSO. This varies from 15 minutes (Germany and the Netherland) to one hour (Poland and Spain) [Neuhoff et al., 2015]. The European Commission proposed a regulation explicitly requiring market operators to allow trading energy in intervals as short as the imbalance settlement periods which is at 15 minutes intervals in all member states [European Commission, 2016].

Reducing the settlement period in the DAM also improves the scheduling of variable energy sources but is more costly and could require excessive computational complexity than in the IDM [IRENA, 2017]. Currently, SAPP has an hourly settlement period. During the real-time operation, a marginal price for balancing the system is calculated reflecting the real cost for the involved TSO(s) and Control Area(s) in fixing the imbalances. The period of calculating these prices differ between TSOs and market participants that are out of balance will pay the imbalance price on an hourly basis.

8.4.2 Bidding Formats

The bidding formats differ from a market to another; this could be by having different trading intervals used, if portfolio bidding is allowed or not, if is there a limited number of bids for each portfolio or unit per time interval, if price caps are implemented, if negative prices are allowed, etc [Baillo et al., 2006]. Generally, bidding formats can be a simple price-quantity hourly bid or a complex declaration of technical and economic constraints.

In the U.S., the ISO requires sellers to submit multipart offers to represent the detailed operational costs and also the technical constraints of their generating units. These details are used to determine the optimal dispatch during real-time operations (so-called security-constrained economic dispatch). In Europe, as markets were designed to reduce interventions of the system operator, the bidding format is a simple price-quantity bid. Thus, generators have to anticipate (based on conjectures) the dispatch so as they properly internalize all costs in the hourly price component. The increasing penetration of RES have increased uncertainty in the dispatch, making accurate predictions more difficult. New bidding formats allow for flexibility, true costs reflection, and the physical constraints of their generation units on the energy market. Participants can represent some operational constraints and economic conditions using block orders or complex conditions. Block orders entail an all-or-nothing constraint, representing the willingness of an agent to sell/buy some amount of electricity at a given price, but only if this amount can be sold/bought fully. Additionally, several block orders can be combined to create more complex products. This gives both buyer/seller the ability to hedge against price risk and

wrong estimation of market conditions.

Increasing the complexity of bidding formats, however, might not be practical if the complexity of the market-clearing algorithm cannot handle large amounts of complex bids since hedging against all potential outcomes may require an extremely large number of block orders. Thus, an in-between format should be adopted considering the pricing and clearing rules. In SAPP, market participants can only submit simple hourly bids with a minimum volume of 1.0 MW.

8.4.3 Locational Granularity of Prices and Schedules

The increase of RES penetration is expected to lead to more internal congestion in transmission lines. RES, especially wind, can be geographically clustered around certain locations where the potential is high. Expanding the transmission network takes more time than building RES generation. Therefore, shifting towards a more detailed spatial resolution in the wholesale market would be more useful for scheduling projects and identifying bottlenecks in the transmission network. This would require increasing the spatial resolution in zonal pricing or using nodal pricing as a regulatory approach for pricing transmission congestion. Additionally, nodal pricing is argued to reduce the chances of market participants taking advantage of network constraints [Wolak et al., 2020]. Currently, SAPP follows the European way of applying a uniform price on all accepted transactions (no discriminatory pricing) and uses a simplified zonal representation of the network. There is also no penalty for nondelivery, all contracts from the market trades are firm contracts and any deviations after the markets are handled through the imbalance process for any imbalance that does not fall under the Emergency Situations.

RES support by national systems will eventually increase penetration in the power pools. The market design should follow with necessary adjustments to facilitate RES integration. Currently, market design in the three power pools is influenced by the technical support received from European partners. This is evident, for instance, from the market design of SAPP which is originally inherited from Nordpool. Having the market platforms owned by the TSOs also potentially influences the design options to be more in favor of system operations. Therefore, the three power pools could benefit from external regulations and taking into account alternative design options suggest above in facilitating RES and deal with limited transmission capacity. Some of these alternatives like reducing the settlement time, introducing more flexible bidding formats, and delaying the gate closure are easier to implement in the three power pools as the number of market participants is not large for the computation to be time-consuming. The three power pools also face limited transmission capacity and have limited opportunities for active demand-side participation. Thus, implementing nodal pricing, or even a cost-based short-term market that uses LMP, would help developing transmission lines and make optimal use of the limited resources.

9 CONCLUSION & RECOMMENDATIONS

"Knowledge is an unending adventure at the edge of uncertainty"
Jacob Bronowski

In the preceding chapters, we investigated three African power pools to understand their development, design, and how to improve them. This chapter concludes the research by answering the research questions in section 9.1, giving policy recommendations in section 9.2, reflecting on the methodology of this study in section 9.3, and recommending further research in section 9.4.

9.1 ANSWERS TO THE RESEARCH QUESTIONS

This research aims to provide contextual information on African power pools, give a thorough understanding of their functioning, analyze the factors that led to their different development and performance, and propose design improvements. In this section, each sub-question identified and helped reaching this goal is answered. Answers to sub-questions lead to providing ideas for the main research question.

SQ1: *How can regional power pools be studied in the institutional context of Africa?*

The various literature studies on African power pools are limited and mainly focus on technical modeling as a technical exercise for designing a regional market and social science studies do not provide a formal way to study African power pools or regional power pools in general. The foundation of African power pools has implications for their development and performance. African power pools are institutionalized as non-profit development organizations within African regional economic communities, hence, they can be viewed as RIOs . In an attempt to provide a comprehensive understanding of African power pools, we integrate the different theories and facets of development to provide an analytical framework for studying African power pools. Our framework commences from the general understanding of the power pool as a market design exercise. From our empirical investigation of African power pools, we observe the similarities between them and hybrid markets. From there we use the analytical framework of Correljé and De Vries [2008] as a theoretical base. Utilizing both our empirical and theoretical knowledge of organizations' capacity building and regional integration, we identify different factors of development, three motors of change in the system, and the power pool design dynamics. Our framework gives a more comprehensive understanding of African power pools as regional organizations for establishing regional markets. Incorporating capacity building and regional integration theories was crucial in expanding the aspects of development.

SQ2: *What were the factors and reform steps for establishing the African power pools?*

Our investigation on the three African power pools SAPP, WAPP, and EAPP, reveals several factors and reform steps that lead to their establishment. Each of the three cases implemented certain reform steps and had different factors.

SAPP has implemented six reform steps: establishing legal documents and agreements permitting trade, the IGMOU and the IUMOU; establishing commercial market rules for trade, the Agreement Between Operating Members and Market Book of Rule; establishing Wholesale energy market, the DAM, the FPM-W/M. and the IDM; admitting IPPs participation; establishing regional market operator, the coordination center; and establishing regional grid development unit, the PAU. The important factors that led to the establishment of SAPP are: the establishment of the regional economic community SADC; the presence of sufficient regional infrastructure in the region (interconnections and generation); the distribution of natural energy endowments in the region which created interdependence and a need for trade between countries; the presence of South Africa as a regional champion for pushing regional trade agendas in SADC; the successful establishment of the coordination center; and the technical support received from international institutions. Owing to all these factors and reforms, SAPP has successfully established and run competitive markets for about two decades time.

WAPP has implemented five reform steps: establishing legal documents and agreements permitting trade, the WAPP Articles of Agreement; establishing regional regulator for trade, ERERA; establishing commercial market rules for trade, the WAPP Market Rules and Procedures; admitting IPPs participation; establishing regional grid development, WAPP Special Purpose Company/Vehicle and Project Unit. The important factors that led to the establishment of WAPP are: the presence of ECOWAS Commission as a regional institution for promoting regional integration, foreign investments, and cooperation in the energy sector; the distribution of natural energy endowments in the region and limited size of some countries which created interdependence and a need for trade between countries; and the financial support received from international institutions.

EAPP's efforts for establishing a regional market were limited due to difficult regional conditions. EAPP has implemented only one reform step, establishing legal documents and agreements permitting trade, the IGMOU and the IUMOU. The only important factor in the establishment and development of EAPP is the support from international institutions.

SQ3: *What are the differences between African Power pools?*

Our investigation reveals numerous differences between the three cases in all the external factors affecting the market establishment (physical, economic, institutional, and political) and the internal factors affecting the organization performance (governance structure, staff capacity, technical readiness, financing arrangements, dispute resolution, and stakeholder relationship). In comparing the three cases, SAPP has the best physical, economic, and political conditions while WAPP has the best institutional conditions. The governance structure, financing arrangements, and dispute resolution were the best in WAPP while staff capacity and technical readiness were the best in SAPP. All power pools have good stakeholder relationships and SAPP has the best relationship with its members. We found general similarities in the general structure of national systems (the majority are vertically integrated), generation mix of all countries, the involvement of regional economic countries (with different degrees), and the presence of a dominant country with more than 50% of the generation capacity in each region.

SQ4: *How can the performance difference of African power pools be explained?*

Each power pool has a different set of objectives and because of the vast differences in the development factors, the regional dynamic was different and, consequently, the performance was different. Both infrastructure development and market establishment were approached differently. SAPP and EAPP have a decentralized approach for regional infrastructure that leaves project execution for member countries. WAPP adopted a centralized approach for regional infrastructure that puts the responsibility of regional projects on WAPP. The market establishment in SAPP followed a bottom-up approach based on utilities' interest and without regional regulation. WAPP followed a top-down approach for market creation based on the directives and

regulations (through ERERA) of ECOWAS. EAPP is trying to systematically develop the market by establishing a regional regulator, the IRB, internal to the pool structure. Each case has its unique forces for development. The three identified motors of change members' strategies, regional institutions, and international institutions were different. SAPP has the strongest positive force of members' strategies. WAPP has the strongest forces of regional institutions and international institutions. Therefore, the development of each case can be classified differently. SAPP is the case where the development is ***Members Lead***, WAPP is the case where the development is ***Regional Lead***, and EAPP is the case where the development is ***Donors Lead***.

SQ5: *What are the reforms and design options for improving the performance of African power pools and renewable energy integration?*

Based on our comparative analysis, both SAPP and EAPP would improve their performance in integration member countries by adapting a supervisory role to regional infrastructure. On the other hand, WAPP would improve utilities' engagement by simplifying the market design and local initiatives to empower domestic investments. Because EAPP's reforms were limited to one step, we recommend taking the following steps to establish the regional market:

1. Establish an investment unit for regional grid development/investments and accelerating interconnections.
2. Develop technical/operational and commercial market rules while regional interconnects are being materialized.
3. Start the competitive market organically between interconnected members.
4. Establish a regional market operator where the market starts.
5. Allow IPPs participation by adopting a proper framework suitable to the structure of national systems.
6. Develop regional regulation gradually with market expansion.

Additionally, technical decisions in EAPP should be decoupled from the council of ministers and left for the pool members. In terms of improving renewable energy integration, the three power pools already play a role in incorporating renewable energy in their regional master plans. Both WAPP and EAPP conduct renewable energy projects funded by the World Bank. Considering the support of member countries to RES, the design of the short-term competitive market of the three power pools can facilitate RES integration by reducing the settlement time, introducing flexible bidding formats, delaying the gate closure, and implement nodal pricing.

MQ: *"How can the design of regional power pools in Africa be adapted to facilitate the sustainable energy transition, improve service quality and economic efficiency?"*

Finally, the research shows that there are three layers to the functioning of African power pools, each has several drivers as well as barriers to how the development and the design can be improved. It is important to align the different aspects between the layers to ensure moving forward with the development. The operation layer is where the development can be steered by the pool staff to stimulate members' engagements. Such stimulation can be attained by considering the factors and members' strategies at the design layer. The design layer also gives an understanding of the high-level design of the pool according to the objectives and institutionalization set at the foundation layer. The foundation layer explains the pool foundations in light of the context of regional integration and members' way of cooperation. Improving the power pool can happen internally by the pool staff affecting members' strategies to change the design either internally or propagate it to the regional institutions at the upper layer. Improvement can also be pushed externally through the influence of international institutions that engage with the pool staff and member countries. African power pools can facilitate the sustainable energy

transition through increasing renewable energy integration by regional planning, executing RES projects, and adapting the design of the competitive market. Member countries can have better service quality from the power pool by giving it more authority for developing regional infrastructure to connect all members and developing the regional generation capacity. Economic efficiency can be fostered through increasing regional competition by allowing IPPs participation and gradually developing adequate regulations and opening national markets.

9.2 POLICY RECOMMENDATIONS

Many of the more popular arguments for regional power pools rest largely on the possibilities of deriving substantial economies of scale and cost reduction with respect to activities typically associated with the expansion of trade, coordination of energy resources, and enabling investments in large projects. However, the evidence from empirical studies of African power pools [Eberhard et al., 2008; Oseni and Pollitt, 2014; ICA, 2018; IEA, 2019; Medinilla et al., 2019] and our research suggest that the anticipated gains have not been fully realized. Our findings show that actors at the different layers need to adapt their policies to realize the full potential of the power pools. In the following subsections, we provide policy recommendations for the actors in the system.

9.2.1 Enabling Regional Power Pools - Regional Economic Communities

Regional power pools are RIOs that are enabled by the policies of the RECs. These policies should enable the maximum benefit from the power pools and allow its operation in the different jurisdictions. We recommend policies that give the power pool a fair degree of autonomy and authority in making decisions and performing projects to deepen the integration in the energy sector. Such policies are crucial for enabling the power pool to develop regional infrastructure. The essence of regional integration is to contribute to the progress and development of the entire region. The policy objectives should ensure the inclusion of the development and the benefit to all members. African countries are in very different stages of development and it is essential to adopt a central approach to infrastructure development to even it out. Through the power pool, investments in infrastructure can be improved significantly by pooling external and internal resources together for optimal social value [Perez-Arriaga et al., 1995]. The REC has another critical role to play in enabling this. Regional institutions should be developed to promote and protect foreign investments as well as multilateral investments by countries. Thus, the REC should establish regional frameworks for investments activities and cooperation in the energy field. It is also important to ensure the enforcement of these legal institutions in all countries.

9.2.2 Empowering Regional Power Pools - International Institutions

African power pools are in different stages of development and they face different issues. External support from international institutions is indispensable for bringing the power pool to the developed level. So far, international institutions have been providing financial support to conduct studies and technical support for market design (tariff methodology, market rules, power purchase agreements, etc.). While these supporting programs are important, the development of the power pool requires a careful orientation to these programs towards sustainable pool operations. Most of the time financial support is paid for consultants to perform studies and adds little to the staff capacity. Additionally, the pool might be facing more pressing issues like managing stakeholders'/utilities' engagement or pooling resources and investments. Therefore, policies for supporting programs should include non-technical support like capacity building programs, especially in leadership and financing. International institutions are recommended

to first identify the issues and determinants of the progress, then decide on suitable supports that yield the best results [Norda and KPMG, 2019]. Furthermore, international institutions like advisory institutions have a role in empowering the power pool by working with national governments to manage regional trade and market opening. These advisory institutions have expertise in dealing with stakeholders and could help the power pools in their engagement with the utilities. We recommend these institutions to coordinate with the power pool to make all stakeholders on board for regional integration and power pooling.

9.2.3 Steering Regional Power Pools' Development - The Pool Staff

Although the development of the power pool is constrained by the regional context (foundation layer) and the exogenous factors of market design (design layer), the pool itself can play a steering role to enable the development on the different fronts. The pool performance in the operational layer influences development on the national level (design layer) and the regional level (foundational layer). We recommend the pool to devise a strategic plan to tackle the different barriers to its development and improving its organizational capacity. In doing so, the pool should focus and orient its activities to tackle notable issues and needs from members in a proactive manner. The alignment of these activities incentivizes members' engagement and would lead in the long run to expand the role and authority of the pool. With this expansion, more benefits are expected to be achieved. It is recommended for the pool to have policies for its own performance and evaluation to increase transparency and track its capacity building. Additionally, the market design prepared by the pool should consider the technical abilities of member utilities and allow easy implementation.

9.2.4 Unlocking the Potential of Regional Power Pools - Member Countries

Theoretically, the case for power pools is strong. However, the practical implementations limit their benefits. There are many issues with the power system in Africa that makes power pooling challenging and takes the development characteristic. Member states have a significant role to play in creating an enabling environment in which regional benefit is maximized. This does not necessarily mean greater state intervention but the use of pragmatic policies and actions aimed at addressing sector failure and socio-economic imbalances. It is not feasible to fully liberalize national sectors to allow more efficient trade on the regional level. There are those (e.g., Besant-Jones [2006]; Jamasb et al. [2015]) who have argued for a gradual approach of incremental reforms based on strategic goals. In the regional context, governments should avoid protectionist policies that inhibit regional trade. While the risk of capacity leaking is justified, policies should be introduced to allow certain IPPs (or under certain conditions) to participate in the regional market to increase competition. Harmonization of pricing and adopting cost-reflective tariff are strongly recommended to prevent worsening the overall welfare [De Villemeur and Pineau, 2012]. While regional trade is less predictable, it provides more flexibility in accommodating national demands. Member countries are recommended to introduce policies to rely on trade to fulfill peak demand and scheduling maintenance. Such policies increase the overall reliability and trust in regional trade. The power pool can play an important role in pooling financial resources for investments and implementing regional projects. In the long term, regional projects can move closer to projects on the national level to facilitate power wheeling. Member countries are recommended to support the pool in taking such a role (through national legislation and regulations) and coordinate together in the planning and execution of infrastructure projects. This also includes coordinating between existing sub-regional cooperation between some members and the power pool on the long-term planning.

9.3 REFLECTION

In this section, we take a step back and reflect on the methodology selected to answer the research questions and the implication of the outcomes. We reflect on the research approach, the analytical framework, data collection methods, the theories applied, and finally the author personal learning in alignment with the master's program.

9.3.1 Research Approach

To start with, this research was not a straightforward process. The first phase of the research was equivocal. We wanted to investigate market design in Africa but the focus was not yet on the regional market. We spent the first phase of the literature review studying power sector development and how a market is created. This was mostly about the national market and little about the regional market. As we were following a pragmatic approach, we looked at the theory and practices. We touched on the situation of Africa on both levels (national and regional) as a premise to follow on the next step. Because of this, most of the context in chapter 2 was not necessary to answer the research questions (their final version). However, the knowledge about the context in Africa and national markets was very useful in seeing its implications on regional markets and understanding the development characteristic of African power pools.

After deciding on the regional level, we followed an institutional approach (NIE) to the analysis without initially having a framework. Thus, we looked into the various aspects of institutional settings, governance, regulations, physical infrastructure, and national systems. Again, we collected more information than necessary but because of that, we started to see the bigger picture. Therefore, we gradually formulated an analytical framework based on a market design framework as it was our first intention. At this stage, it was the empirical development that enabled the analysis of the individual cases to be more compact. When conducting the comparative analysis for the three cases, we gradually embedded the theories that explain our empirical observation and give the theoretical basis to our empirically developed framework. We identified different theories and literature that helped in generalizing the framework despite having different cases [Eisenhardt, 1989]. Eventually, without realizing it, we followed [Yin, 2003a, p. 72] framework for the case study method, as shown in figure 9.1, that indeed allows generalization for multiple cases and gives more robust understanding [Herriott and Firestone, 1983; Yin, 2003b].

In its own unique way, our research has path-dependency effects. Owing to the unfocused start, the sheer amount of collected data and information was unnecessary for answering the research questions but it was part of the original intentions to provide research material and it enabled us to perceive the broad perspective. The path we took influenced the type of insights we observed. We uncovered different development aspects more than market design aspects. Therefore, a better formulation for the main research question might be something like *"How can the development of regional power pools be improved"*. Additionally, because we started with an institutional approach, we were able to see more factors and foundational implications than the dynamics in the system. Thus, little attention was given to the processes within the system and analyzing the actors. While we analyzed the impact of having powerful actors in the market and their general strategies, which helped us in explaining certain drivers and barriers, but we missed the classic stakeholder analysis to show the power dynamics and formal relationships between the actors (power grid and formal chart). Such an analysis would have given more insights into the issues and dilemmas. Therefore, some sub-questions could have been different and explicitly focus on the actors.

Finally, we followed a qualitative analysis to make the argument more accessible to people without a technical background. Scientifically, this means that verification of the results is open

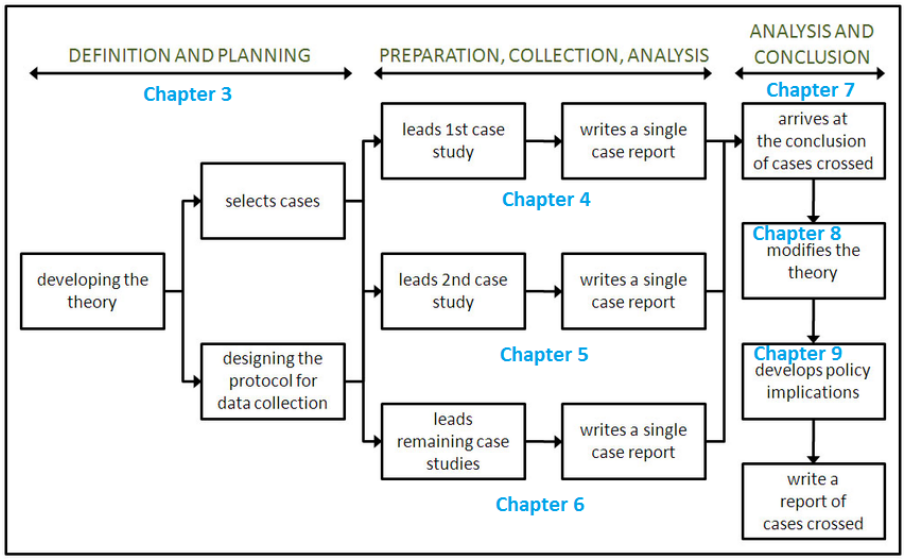


Figure 9.1: A framework for case study method adapted to show the corresponding chapter in this thesis. Source: Yin [2003a]

to more people than in the case of quantitative analysis. Additionally, the accessibility of the argumentation is important for the social relevance of the study, as the final aim is to provide policy advice.

9.3.2 The Analytical Framework

The applied theories on regional power pools have been limited to market design and regulation. We started by following the same path of institutional analysis and looking at these various issues. However, the more we study African power pools, the more we realize the different theoretical facets of their development. Our empirical investigation indicates several implications to the foundational and structural factors. Thus, it was necessary to expand our theoretical spectrum of analysis and follow a more interdisciplinary approach. We integrated organization, capacity building, and regional integration theories to give a full view of the development. However, as we are not experts in these fields (and some of the theories are limited), we followed an ad hoc development of the analytical framework of Correljé and De Vries [2008] based on our empirical investigation and embedding theoretical variables to be compatible with the framework as to not undermine its theoretical base. Our analytical framework can be considered heuristic at this stage as we did not define a formal way to operationalize it and specific indicators to measure the added variables. We, therefore, sometimes use general indicators (e.g., GDP) that could be debatable in their measure. And as we are investigating the regional context, sometimes we settle on the general trends in the region (like the political situation) and sometimes we describe specific events that we think make a notable difference in the dynamics. Therefore, this should not be viewed as inconsistency, but rather for realistic reasons as it is impossible to cover everything in detail. Yet, we are sure that our framework helps in giving more understanding and a broader view of African power pools.

9.3.3 Data Collection Methods

There is a general lack of data about Africa. Data about the power systems are usually found from surveys commissioned by international institutions, especially financial institutions like the World Bank and African Development bank. Data collection and access were the main challenges in this research (besides founding the theoretical basis to the analysis). Not all the

relevant documents about African power pools are open access and some are restricted. We collected quantitative and qualitative data about 36 countries in Africa. We relied on desk research and interviews. Interviews were particularly important to gain in-depth insights into the situation on the ground. However, reaching to right interviewees was extremely difficult with the limited network of the author and the university as it is based in Europe. Scheduling and transcribing interviews were time-consuming considering that we had to cover and tap into three different regions in Africa. Unfortunately, we were not able to conduct some interviews due to the time limit and we could not also reach out to all different actors in the three regions. Initially, the author was planning to send online surveys to member utilities of the power pool to understand their perspectives and strategies, but this was not feasible in the scope of this research. Such surveys would enhance the analysis and give more insights into the drivers and issues of the actors. Similarly, we could not reach out to international institutions and the RECs. Thus, data in this research remain limited.

9.3.4 Theoretical Reflection

Power Sector Reforms in Africa

In this research, we took off with the standard textbook model to investigate power sector reforms in African countries. The model was useful to understand certain aspects of power pool reforms related to national systems (e.g., regulations and membership). Nevertheless, it has been proven that implementing the reform steps does not guarantee the proclaimed results of improvements (Foster and Rana [2019] and Interview 4). There are several issues with implementing the model in Africa related to the theoretical assumptions and simplification of the neoclassic theory. We can reflect on this by comparing the situation in Africa and in the place of origin, the UK:

- A well-functioning market is premised on the presence of investors looking for opportunities in the market which assumes a well-established financial market where capital is available. This was the case in the UK with investors investing in gas and nuclear generation. This condition is not satisfied in African countries where the economy is not developed and remains unequal between the urban and rural sides (dual economy). A large portion of the population (more than 50%) does not have access to electricity to generate sufficient income or capital to invest in electricity. The governmental economy is usually inflicted by high interest rates, inflation, and restricted access to foreign loans. In the best case, the economy is dependent on world oil prices and other raw exports.
- The model stresses the role of regulation in improving the performance of utilities, increasing private sector participation, and protect the public interest. However, this is also premised on the existence of a well-functioning legal system that would allow regulatory reform, which was the case in the UK. In Africa, many countries have no functional legal systems, either due to corruption or lack of enforcement. Thus, even while national regulators are established, they have no power (Interviews 4, 5, 9).
- Unlike other markets, the electricity market (and gas market) requires sufficient infrastructure to be in place, both network and generation capacity, for competition to happen. The UK had universal access to electricity guaranteed with surplus generation capacity and well-connected transmission and distribution networks. In Africa, network coverage is very limited and suffers high losses. The generation capacity falls significantly behind the demand and considerable installed capacity is not available (e.g., around 30% in West Africa [Medinilla et al., 2019]). Under these conditions, any attempt of establishing competition would always yield high prices that are not accepted socially.
- The standard textbook model is premised on the separation of ownership and clear assignments of property rights and investments. The assumption here is that "electricity

systems around the world are physically and operationally very similar" and "the technical complexity exists everywhere there is electricity" and, hence, the same ownership reform and restructuring can be implemented everywhere [Hunt, 2002, pp. 11-12]. According to the theory of NIE [Williamson, 1998], this is not true when you have different informal institutions, customs, traditions, norms, and religions. The UK and Africa share almost no similarity in these contexts. The UK had a strong neoliberal ideology that was intellectually accepted, which is not the case in Africa.

All these failed premises and others (e.g., the political system and political economy) precipitate the failure of the standard textbook model and power system reforms in Africa. Additionally, when looking at the essence of the model argument is that "the unrestrained interaction of competitive forces will yield the best allocation of our economic resources, the lowest prices, the highest quality and the greatest material progress" [Hunt, 2002, p. 4], it is clear that this does not match the development agenda in African countries, especially when the short-term benefits of the reforms are likely to be small or non-existent, and the long-run benefits, while compellingly supported in theory, may be very difficult to track in practice [Borenstein and Bushnell, 2000].

Regional Power Pools Development

While we started this research with the standard textbook model, our investigation of African power pools revealed the need for more insights from different theories. Within the scope of this research, we managed to layer the theories according to the development perspectives. In the following points, we document the usefulness and shortcoming of the theories based on our application:

1. **The Theory of Regional Integration**: was useful in explaining the foundation of the power pool and how the approach to regional integration correlates to the approach of the power pools. It also gives a prospect of expansion in view of regional integration. However, caution should be emphasized on these interpretations because the theory is based on the regional trade of normal commodities and the view of electricity as a commodity is slightly different. Additionally, there are sectorial differences to the theoretical generalization. For instance, the different structures of the economy in African countries are seen as a barrier for regional integration [Goldstein and Ndung'u, 2001, p. 22], however, this is not the case for power systems integration. It is also perceived that regional integration in Africa is development integration which is more difficult to implement trade integration in theory [Bhagwati and Panagariya, 1996].

2. **The Theory of Market Design**: was useful in explaining the different factors (exogenous) for establishing the regional market but it does not explain how regional markets evolve. The shortcoming is that the theory view market design as a function of members' strategies, which is the same for regional market except that for African power pools members are countries and not firms as the theory assumes. This is because of the vertically integrated structure in Africa and the government involvement (state-owned utilities). Therefore, the theoretical explanation of a market that is determined by profit-maximizing firms does not help. It is more likely that the theory of political economy can be more useful in this context.

3. **The Theory of Capacity Building**: was useful in explaining the different factors (endogenous) affecting the functioning and performance of the power pools as RIOs, which gives agenda for partners' support. However, organizational development could be viewed differently (e.g., theory of change) and theories will fare differently depending on contextual factors [Kogut, 1988]. The term capacity building itself is viewed differently in the literature [Cairns et al., 2005]. Our analysis was thus limited as we used insights from a single

study and the only one viewing African power pools as organizations, [Norda and KPMG, 2019].

4. **The Literature of Transition Management (from Evolution Theory)**: was useful in picturing the dynamic of change using the concept of motors of change. However, the literature draws extensively on the processes in the innovation system that cannot be extended elsewhere. Still, the analysis in the literature is generally useful in understanding actors' interactions. Thus, to gain more insights, performing stakeholder analysis would have been required. In our analysis, we only identified three forces and used the geopolitical dynamics in the region to understand the development trajectories.

9.3.5 Research Value

The added value of the research can be summarized in the following three points:

- **Data and Information**: new empirical data have been collected in this research both about power sector reforms in African countries and the power pools. These data were organized from the conducted interviews. In addition to the new data, we collected and organized information from the literature and authentic reports. This includes, inter alia, reform steps, renewable energy policies, regional market design, institutions of the power pools, involved actors, and development barriers. The value of the data and information is in helping further research on promising areas. Additionally, it helps future technical modeling with institutional underpinning to what choices are applicable.
- **Theoretical Insights**: our investigation on power sector reforms in Africa reveals theoretical issues aligned with the scientific literature. It gives theoretical insights into why the reforms fail in Africa. This has value in enriching the theory. Looking into the functioning of the power pools, we have identified the theories that explain best our empirical observations. This variety of theories have not been pointed out by previous research and is valuable in giving different perspectives. We have organized the theories in correspondence to the elements in the system. The value of this is in helping future research to further explore and assess the different topics in-depth and on a theoretical ground.
- **Development Framework**: we have constructed a framework to understand the development of the power pools. This is the first attempt to formalize the analysis in the literature. The value of the framework appears in showing the interaction between the different elements and how the development happens. Interviews were important to give insights into this dynamic. The other value of the framework appears when used as a generalization to how regional power pools develop. The multilayered theoretical perspective gives insights into how the layers develop and what are the steps at each layer. It also shows the importance of the alignments between the layers to overcome the different barriers. Finally, the framework provides a method for future research to how to design regional power pools.

9.3.6 Personal Learning

This report represents eight continuous months of full-time work. Unmeasurable efforts were exerted in exploring different theoretical knowledge and collecting a challenging and enormous amount of data about African countries in order to provide materials and insights for researchers and be able to suggest improvements. However, this report was equally a quest to satisfy a genuine curiosity in market design and power sector reforms. As an electrical engineer who is keen on the power system, the social and economic aspects were very interesting to me and their regulation and market design implications. Moving into these fields was not easy. As a hardcore engineer, analysis has been always in terms of modeling and quantitative methods. Shifting to socio-economic research and qualitative methods posed a challenge in itself. One

has to be extra critical about reading into data and its interpretation. Especially when the data is almost always partially available and could be subjective. Because of this, writing convincing and factual paragraphs was never harder. It was equally challenging to determine where to stop in gathering information and providing sufficient analysis. This is because the socio-economical aspects of the power system are very broad and complex. Narrowing the focus and setting scope questions was in itself mentally laborious. Undergoing these experiences was indeed transformative to one's skills and abilities.

This thesis project was carried out for the completion of the master's program Sustainable Energy Technology (SET). The study program is about the field of sustainable energy and system integration for the energy transition. In addition to the technological side, the program puts an emphasis on the social and economic aspects of the energy system. This research fits well with SET as it explores the African power pools as regional system integrators and their role in facilitating the energy transition. When I embarked on this research, I had no idea about the situation of market design in Africa. The academic knowledge received during the master was European based. I wanted to know more about it and do something about it. Then we discovered the African power pools that are apparently unbeknown to many scholars in the field. Investigating the three power pools covers two-thirds of African countries. Not only we came to know about the sector organization, but also about their economic, political, and even geographical information. Intellectually, this was tremendously satisfying on its own. Answering the research question could have been done with less data, but the efforts were worthy for the learning experience if not for providing materials. The learning curve during writing this thesis was exceptional.

The context in African countries does not permit liberalizing the power sector and establishing a national competitive market. This is because of the various political, economic, and institutional conditionalities that if they are to be satisfied, it almost means making African developing countries developed countries. However, the case of a regional market is different. The African power pools are a way for a top-down development for national systems under the regional market organization. That is why there was a success and will be down the road.

9.4 FURTHER RESEARCH

From this research limitations and insights, we suggest that the following research undertakings would be beneficial:

- Improving and validating our analytical framework, both theoretically and empirically, and applying it to other cases to test its usefulness. This would require a more in-depth understanding of organizations, capacity building, and regional integration theory to identify more accurate factors, indicators, and development process/interactions between actors. This is particularly important to give more accurate recommendations to improve the power pools' support programs and development.
- Investigating the situation of regional power pools in other developing countries using our development framework to attest for the alignment between the three layers and compare it with African power pools to enlarge the lessons learned and expanding/elaborating on the pool development and reform steps that we identified. Additionally, investigating the alignments should reveal more barriers to regional development, especially by identifying policies and regulations at the national level that are contradictory. We pointed to protectionist policies, but what are the contradictory regulations? Conducting a single case study would allow to delve into these details.

- Applying stakeholder analysis on the actors of African power pools and conduct surveys to gain more insights into the power dynamics and their implications. We were able to give insights into the motors on change in the system but what is the exact measure of these forces? and how is interplay process between the actors? Also, applying political economy on the regional level to understand how the design of African power pools is influenced.
- Studying the price or quality of service impact of the power pools on national electricity price levels or volatility, power shortages, etc. In regional trade theory, trade between monopolists might lead to a loss of welfare if the price is not cost-reflective. It would be interesting to test this in the electricity trade in African power pools (e.g., SAPP). It would give a more compelling argument for regional regulation as the welfare is an important goal of regional integration. One could also look at the impact of the move from bilateral trading to the competitive markets in SAPP.
- Conducting classic cost-benefit analysis of the actual performance outcome of African power pools to see if the potential initially identified is being realized.
- Conducting formal design to African power pools to identify potential design options and mechanisms for improving the market performance, given the structure of national systems. There is a need for such studies especially concerning design choices that affect investment in infrastructure, like transmission tariff methodology for the grid and capacity mechanism for the generation.

REFERENCES

Act, C. C. (2008). Elizabeth ii. chapter 27. *London, UK*.

Adams, W. (2015). *Conducting Semi-Structured Interviews In: Kathryn E. Newcomer, Harry P. Hatry, Wholey Joseph, S. Handbook of Practical Program Evaluation*. Routledge. San Francisco: Jossey-Bass.

Adeoye, O. and Spataru, C. (2020). Quantifying the integration of renewable energy sources in west africa's interconnected electricity network. *Renewable and Sustainable Energy Reviews*, 120:109647.

Adiar, S. K. and Litz, F. T. (2017). Understanding the Interaction between Regional Electricity Markets and State Policies. NI Primer 17-01. Durham, NC: Duke University, http://nicholasinstitute.duke.edu/publications.

Adrian, K., Sam, F., and Dylan, F. (2018). International review of market power mitigation measures in electricity markets. Available: [Online]. Retrieved June 10, 2021 from https://www.accc.gov.au/system/files/Appendix%209%20-%20HoustonKemp%20-%20International%20review%20of%20market%20power%20mitigati....pdf.

African Development Bank (2020). *African Economic Outlook 2020: Developing Africa's workforce for the future*. African Development Bank, Côte d'Ivoire.

Akoutou, A. B., Sohn, R., Vogl, M., and Yeboah, D. (2014). *Understanding Regional Integration in West Africa: A Multi-thematic and Comparative Analysis*. ZEI, Center for European Integration Studies.

Alleyne, M. T. S. C. and Hussain, M. M. (2013). *Energy subsidy reform in Sub-Saharan Africa: Experiences and lessons*. International Monetary Fund.

Amundsen, E. S. and Bergman, L. (2006). Why has the nordic electricity market worked so well? *Utilities Policy*, 14(3):148 – 157.

Arowolo, W. and Perez, Y. (2020). Market reform in the nigeria power sector: A review of the issues and potential solutions. *Energy Policy*, 144:111580.

Asante, S. K. (1997). *Regionalism and Africa's development: expectations, reality and challenges*. Basingstoke: Macmillan.

Association of Power Utilities of Africa (2019). *Revisiting Reforms in the Power Sector in Africa*. African Development Bank, Côte d'Ivoire.

Attia, B. (2019). Big solar bankability & utility performance can benefit from power pools. Available: [Online]. Retrieved January 24, 2021 from https://www.energyforgrowth.org/memo/big-solar-bankability-utility-performance-can-benefit-from-power-pools/.

Bacon, R., McPherson, C., Nadifi, N., and Labella, P. (1999). Global energy sector reform in developing countries: a scorecard. Joint report with UNDP, World Bank.

Baillo, A., Cerisola, S., Fernández-López, J. M., and Bellido, R. (2006). Strategic bidding in electricity spot markets under uncertainty: a roadmap. In *2006 IEEE Power Engineering Society General Meeting*, pages 8–pp. IEEE.

Bakken, I. and Rustad, S. (2018). Conflict trends in africa, 1989–2017. *Conflict Trends*, (6).

Balassa, B. (1967). Trade creation and trade diversion in the european common market. *The Economic Journal*, 77(305):1–21.

Baldwin, R., Cave, M., and Lodge, M. (2012). *Understanding regulation: theory, strategy, and practice*. Oxford University Press on Demand.

Barker, J. J., Tenenbaum, B., and Woolf, F. (1997). *Governance and regulation of power pools and system operators: An international comparison*. World Bank.

Batlle, C. (2013). Electricity generation and wholesale markets. In *Regulation of the Power Sector*, pages 341–395. Springer.

Besant-Jones, J. E. (2006). *Reforming power markets in developing countries: what have we learned?* World Bank Washington, DC.

Besley, T. (1995). Property rights and investment incentives: Theory and evidence from ghana. *Journal of Political Economy*, 103(5):903–937.

Beyer, C. (2007). Non-governmental organizations as motors of change. *Government and opposition*, 42(4):513–535.

Bhagwati, J. and Panagariya, A. (1996). Preferential Trading Areas and Multilateralism - Strangers, Friends, or Foes. *The Economics of Preferential Trade Agreements*.

Bissiri, M., Moura, P., Figueiredo, N., and Silva, P. (2020). Towards a renewables-based future for west african states: A review of power systems planning approaches. *Renewable and Sustainable Energy Reviews*, 134:110019.

Blumenthal, B. (2001). Improving the impact of nonprofit consulting. *Journal of Nonprofit Management*, 5(1):1–17.

Borenstein, S. and Bushnell, J. (2000). Electricity restructuring: deregulation or reregulation. *Regulation*, 23:46.

Bossuyt, J. (2016). The Political Economy of Regional Integration in Africa: The Economic Community of West African States (ECOWAS). Available: [Online]. Retrieved April 28, 2021 from https://ecdpm.org/publications/political-economy-regional-integration-africa-ecowas/.

Bowen, B. H., Sparrow, F., and Yu, Z. (1999). Modeling electricity trade policy for the twelve nations of the southern african power pool (sapp). *Utilities Policy*, 8(3):183–197.

Brown, L. and Kalegaonkar, A. (2002). Support organizations and the evolution of the ngo sector. *Nonprofit and Voluntary Sector Quarterly - NONPROFIT VOLUNT SECT Q*, 31:231–258.

Brown, L. and Moore, M. (2001). Accountability, strategy, and international nongovernmental organizations. *Nonprofit and Voluntary Sector Quarterly - NONPROFIT VOLUNT SECT Q*, 30:569–587.

Brunekreeft, G. and Twelemann, S. (2005). Regulation, competition and investment in the german electricity market: Regtp or regtp. *The Energy Journal*, 26(Special Issue).

Bushnell, J. (2004). California's electricity crisis: a market apart? *Energy policy*, 32(9):1045–1052.

Byer, T., Crousillat, E., and Dussan, M. (2009). Latin america and the caribbean region energy sector: retrospective review and challenges. Technical paper 123/09.

Cairns, B., Harris, M., and Young, P. (2005). Building the capacity of the voluntary nonprofit sector: Challenges of theory and practice. *Intl Journal of Public Administration*, 28(9-10):869–885.

CEER (2019). Press Release - European energy regulators sign MOU with Eastern and Southern Africa energy regulators. Available: [Online]. Retrieved March 5, 2021 from https://www.ceer.eu/european-energy-regulators-sign-mou-with-eastern-and-southern-africa-energy-regulators#.

Chen, W.-M., Kim, H., and Yamaguchi, H. (2014). Renewable energy in eastern asia: Renewable energy policy review and comparative swot analysis for promoting renewable energy in japan, south korea, and taiwan. *Energy Policy*, 74:319–329.

Cherp, A., Vinichenko, V., Jewell, J., Brutschin, E., and Sovacool, B. (2018). Integrating techno-economic, socio-technical and political perspectives on national energy transitions: A meta-theoretical framework. *Energy Research & Social Science*, 37:175–190.

COMESA (2015). What is COMESA. Available: [Online]. Retrieved February 24, 2021 from https://www.comesa.int/what-is-comesa/.

COMESA (2019). Esrem supports creation of energy regulator for southern africa. Available: [Online]. Retrieved March 6, 2021 from https://www.comesa.int/esrem-supports-creation-of-energy-regulator-for-southern-africa/.

COMESA (2021). Regional Associations of Energy Regulators for Eastern and Southern Africa (RAERESA. Available: [Online]. Retrieved March 5, 2021 from https://www.comesa.int/regional-association-of-energy-regulators-for-eastern-and-southern-africa/#:~:text=Executive%20summary,creating%20a%20harmonised%20regulatory%20environment.

Correljé, A. and De Vries, L. (2008). Hybrid electricity markets: The problem of explaining different patterns of restructuring. In *Competitive Electricity Markets*, pages 65–93. Elsevier.

De Bruijn, H., Ten Heuvelhof, E., et al. (2010). *Process management: why project management fails in complex decision making processes*. Springer Science & Business Media.

De Villemeur, E. B. and Pineau, P.-O. (2012). Regulation and electricity market integration: When trade introduces inefficiencies. *Energy Economics*, 34(2):529–535.

Den Hertog, J. A. (2010). Review of economic theories of regulation. *Discussion Paper Series/Tjalling C. Koopmans Research Institute*, 10(18).

DESA, U. (2006). Multi dimensional issues in international electric power grid interconnections. *New York: United Nations*.

DFID (2019). Opportunities to support and increase regional power trading in southern africa. *Infrastructure and Cities for Economic Development*. Presentation. Available: [Online]. Retrieved April 14, 2021 from http://icedfacility.org/wp-content/uploads/2019/07/ICED_SouthernAfricaPowerTrading.pdf.

Dixit, A. and Norman, V. (1986). Gains from trade without lump-sum compensation. *Journal of International Economics*, 21(1-2):111–122.

Dornan, M. (2018). When international 'best practice'is not: Power sector reform in small island states. *Handbook of Small States: Economic, Social and Environmental Issues; Routledge: London, UK*.

Duri, J. (2020). Overview of corruption and anticorruption in sub-saharan africa. *U4 Helpdesk Answer*.

Dyck, I. and Di Tella, R. (2002). Cost reductions, cost padding and stock market prices: The chilean experience with price cap regulation. *Journal of LACEA Economia*.

EAC (2020). Overview of EACs. Available: [Online]. Retrieved February 24, 2021 from https://www.eac.int/overview-of-eac.

EAPP (2014a). Daily Procedures for Capacity Allocation, Market Operations and Cross border Nominations- DPCMC . EAAP Twinning.

EAPP (2014b). DAY-AHEAD TRADING RULES. EAAP Twinning.

EAPP (2014c). Development of Regional Power Trade in East Africa. Unpublished Presentation. Private Communication.

EAPP (2014d). Market Guidelines. EAAP Twinning.

EAPP (2016a). The Eastern Africa Power Pool (EAPP). Available: [Online]. Retrieved February 25, 2021 from http://eappool.org/about-eapp/.

EAPP (2016b). The Eastern Africa Power Pool Independent Regulatory Board (EAPP-IRB) Establishment. Available: [Online]. Retrieved March 4, 2021 from http://eappool.org/independent-regulatory-board/.

EAPP (2020a). Technical Assistance to the EAPP Grant Number: D350 - Consultancy Services for the Design of the EAPP Power Market. REF. NO.: ET-EAPP-186205-CS-CQS.

EAPP (2020b). The Eastern Africa Power Pool Profile. Unpublished. Private Communication.

EAPP, Ea Energy Analyses, and Energinet (2014). EAPP Regional Power System Master Plan Volume I: Main Report. Unpublished. Private Communication.

Eberhard, A. (2007). Infrastructure regulation in developing countries: an exploration of hybrid and transitional models. In *African Forum of Utilities Regulators 3 rd Annual Conference*.

Eberhard, A. and Catrina Godinho, C. (2017). A review and exploration of the status, context and political economy of power sector reforms in sub-saharan africa, south asia and latin america. Oxford Policy Management.

Eberhard, A., Foster, V., Briceño-Garmendia, C., Ouedraogo, F., Camos, D., and Shkaratan, M. (2008). Underpowered: the state of the power sector in sub-saharan africa. Background Paper 6, 48214, World Bank.

Eberhard, A., Gratwick, K., Morella, E., and Antmann, P. (2016). *Independent power projects in Sub-Saharan Africa: Lessons from five key countries*. World Bank.

Eberhardt, A., Clark, A., Wamukonya, N., and Gratwick, K. (2005). Power sector reform in africa: assessing impact on poor people. *University of Cape Town Graduate School of Business/ESMAP*.

Economic Commission for Africa, U. (2003). Assessment of power pooling arrangements in africa. UN. ECA Ad Hoc Expert Group on Assessment of Power Pooling Arrangements in Africa Meeting (2003, Jun. 24 - 26: Addis Ababa, Ethiopia.). Addis Ababa.

Economic Consulting Associates (2009). The Potential for Regional Power Sector Integration. South African Power Pool (SAPP) Transmission & Trading Case Study. ESMAP.

Economic Consulting Associates (2010). The potential of regional power sector integration - literature review. ESMAP Briefing Note 004/10.

ECOWAS (1999). Final communique. Twenty-second Session of the Authority of Heads of State and Government Lome, 9 -10 December 1999. Available: [Online]. Retrieved February 25, 2021 from https://www.ecowas.int/wp-content/uploads/2015/02/22nd-ECOWAS-Summit-Lome-9-10-Dec-1999.pdf.

ECOWAS (2003). ECOWAS Energy Protocol A/P4/1/03. Available: [Online]. Retrieved February 26, 2021 from https://www.ecowapp.org/sites/default/files/eprotocol.pdf.

ECOWAS (2006). Power Sector Regional Regulation Mechanisms. Available: [Online]. Retrieved March 20, 2021 from https://erera.arrec.org/wp-content/uploads/2016/08/Power-Sector-Regional-Regulation-Mechanisms.pdf.

ECOWAS (2007). Regulation C/REG.27/12/07 on the composition, organisation, functions and operation of the ECOWAS Regional Electricity Regulatory Authority (ERERA). Available: [Online]. Retrieved March 3, 2021 from https://erera.arrec.org/wp-content/uploads/2016/08/ERERA-s-Operations-Act.pdf.

ECOWAS (2008). Supplementary ACT A/SA.2/1/08 Establishing the ECOWAS Regional Electricity Regulatory Authority. Available: [Online]. Retrieved March 3, 2021 from https://erera.arrec.org/wp-content/uploads/2016/08/ERERA-s-Establishment-Act.pdf.

ECOWAS (2013). DIRECTIVE C/DIR.1/06/13 – Directive on the Organisation of the Regional Electricity Market. Available: [Online]. Retrieved March 4, 2021 from https://erera.arrec.org/wp-content/uploads/2016/08/Directive-on-the-Organisation-of-the-Regional-Electricity-Market-June-2013-ENG.pdf.

ECOWAS (2020). Basic information. Available: [Online]. Retrieved February 24, 2021 from https://www.ecowas.int/about-ecowas/basic-information/.

ECOWAS (2021). ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE). Available: [Online]. Retrieved March 4, 2021 from https://www.ecowas.int/specialized-agencies/ecowas-centre-for-renewable-energy-and-energy-efficiencyecreee/.

ECREEE (2013a). ECOWAS Energy Efficiency Policy. Available: [Online]. Retrieved March 4, 2021 from http://www.ecreee.org/sites/default/files/documents/ecowas_energy_efficiency_policy.pdf.

ECREEE (2013b). ECOWAS renewable energy Policy. Available: [Online]. Retrieved March 4, 2021 from http://www.ecreee.org/sites/default/files/documents/ecowas_renewable_energy_policy.pdf.

ECREEE (2014). ECOWAS Renwable Energy and Energy Efficiency Status Report. Available: [Online]. Retrieved June 2, 2021 from http://se4all.ecreee.org/sites/default/files/ecowas_status_report_en.pdf.

EIA (2021). Electricity data. Data Retrieved March 12, 2021 from U.S. Energy Information Administration, https://www.eia.gov/international/data/world.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of management review*, 14(4):532–550.

Elnasr, M. (2017). RAERESA's Activities and Priority Areas 5th High-level Meeting of Regional Associations of Emerging Markets. Presentation. Available: [Online]. Retrieved March 5, 2021 from https://www.saarcenergy.org/wp-content/uploads/2019/02/5.-RAERESA-Activities-5th-High-Level-Meeting.pdf.

Erdogdu, E. (2013). *Essays on electricity market reforms: A cross-country applied approach*. PhD thesis, University of Cambridge.

ERERA (2015a). RESOLUTION No. 005/ERERA/15 – Approval of the Regional Market Rules of the WAPP. Available: [Online]. Retrieved March 4, 2021 from https://erera.arrec.org/wp-content/uploads/2016/08/Resolution-No005-ERERA-15-Approval-of-the-Regional-Market-Rules-of-the-WAPP.pdf.

ERERA (2015b). RESOLUTION No. 007/ERERA/15 – Adoption of Operation Manual of the West African Power Pool. Available: [Online]. Retrieved March 4, 2021 from https://erera.arrec.org/wp-content/uploads/2016/08/WAPP-OPERATION-MANUAL-EN_signed.pdf.

ERERA (2015c). RESOLUTION No006/ERERA/15 – Tariff Methodology for Regional Transmission Cost and Tariff. Available: [Online]. Retrieved March 4, 2021 from https://erera.arrec.org/wp-content/uploads/2016/08/Resolution-No005-ERERA-15-Approval-of-the-Regional-Market-Rules-of-the-WAPP.pdf.

ERERA (2016). ERERA'S Strategic Plan and Activity Programme 2016 - 2020. Available: [Online]. Retrieved March 4, 2021 from http://www.erera.arrec.org/wp-content/uploads/2016/08/ERERA-s-Strategic-Plan-and-Activity-Program-2016-2020.pdf.

ERERA (2017a). RESOLUTION No. 009/ERERA/17 – Model Bilateral Contracts. Available: [Online]. Retrieved March 4, 2021 from https://erera.arrec.org/wp-content/uploads/2018/01/Resolution-009-Model-Bilateral-Contracts.pdf.

ERERA (2017b). RESOLUTION No. 010/ERERA/17 - Regional Electricity Market Procedures for WAPP. Available: [Online]. Retrieved March 4, 2021 from https://erera.arrec.org/wp-content/uploads/2018/07/Resolution-No-010-ERERA-17_Reg.-Elec.-Market-Procedures-for-WAPP.pdf.

ERERA (2019a). Comparative analysis of electricity tariffs in ECOWAS member countries. Available: [Online]. Retrieved April 29, 2021 from https://africa-energy-portal.org/sites/default/files/2019-12/Electricity%20Tariffs%20Study%202019.pdf.

ERERA (2019b). RESOLUTION No. 014/ERERA/19 - Approval of the West African Power Pool Transmission Service Access and Use Procedures (WTSAUP). Available: [Online]. Retrieved March 4, 2021 from https://erera.arrec.org/wp-content/uploads/2020/07/Resolution-No-014-ERERA-19_Approval-of-WTSAUP.pdf.

ERERA (2020). WAPP Procurement Code. Available: [Online]. Retrieved March 4, 2021 from https://www.ecowapp.org/sites/default/files/wapp_eeeoa_procurement_code_version_anglaise1.pdf.

European Commission (2016). Proposal for a regulation of the european parliament and of the council on the internal market for electricity.

Federal Energy Regulatory Commission (2016). Settlement intervals and shortage pricing in markets operated by regional transmission organizations and independent system operators.

Finon, D. (2003). Introducing Competition in the French Electricity Supply Industry: Erosion of the Public Hierarchy by the European Institutional Integration. In *Competition in European Electricity Markets*, Chapters, chapter 11. Edward Elgar Publishing.

Fischer, R., Serra, P., Joskow, P. L., and Hogan, W. W. (2000). Regulating the electricity sector in latin america [with comments]. *Economia*, 1(1):155–218.

Fiszbein, A. (1997). The emergence of local capacity: Lessons from colombia. *World Development*, 25(7):1029–1043.

Foster, V. and Rana, A. (2019). *Rethinking power sector reform in the developing world*. World Bank Publications.

Glachant, J.-M. and Finon, D. (2000). Why do the European Union's electricity industries continue to differ? A new institutional analysis. In *Institutions, Contracts and Organizations*, Chapters, chapter 21. Edward Elgar Publishing.

Gnansounou, E., Bayem, H., Bednyagin, D., and Dong, J. (2007a). Strategies for regional integration of electricity supply in west africa. *Energy policy*, 35(8):4142–4153.

Gnansounou, E., Bayem, H., Bednyagin, D., and Dong, J. (2007b). Strategies for regional integration of electricity supply in west africa. *Energy Policy*, 35(8):4142–4153.

Godinho, C. and Eberhard, A. (2019). Learning from power sector reform experiences: The case of kenya. *World Bank: Energy and Extractives Global Practice*, (8819).

Goldstein, A. and Ndung'u, N. S. (2001). Regional Integration Experience in the Eastern African Region. OECD Development Center Working Papers 171, OECD Publishing.

Gómez, T. (2013). Monopoly regulation. In *Regulation of the Power Sector*, pages 151–198. Springer.

Government of Namibia (2019). Detailed Market Design. Available: [Online]. Retrieved June 1, 2021 from https://www.ecb.org.na/images/docs/Rules_and_Regulations/MSB/MSB_Detailed_Design_Report.pdf.

Gratwick, K. N. and Eberhard, A. (2008). Demise of the standard model for power sector reform and the emergence of hybrid power markets. *Energy Policy*, 36(10):3948–3960.

Grover, V. (2015). Research approach: An overview. *Golden Reserach Thoughts*, 4:1–8.

Guba, E. G. (1990). The paradigm dialog. newbury park. *Cal.: Sage Publications*.

Haas, E. B. (1968). *Uniting Of Europe: Political, Social, and Economic Forces, 1950-1957*. University of Notre Dame Press.

Hall, D. and Nguyen, T. A. (2017). Electricity liberalisation in developing countries. *Progress in Development Studies*, 17(2):99–115.

Hantke-Domas, M. (2003). The public interest theory of regulation: non-existence or misinterpretation? *European journal of law and economics*, 15(2):165–194.

Hekkert, M., Suurs, R., Negro, S., Kuhlmann, S., and Smits, R. (2007). Functions of innovation systems: A new approach for analysing technological change. *Technological Forecasting and Social Change*, 74(4):413–432.

Helpman, E. and Krugman, P. R. (1985). *Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy*. MIT press.

Herriott, R. E. and Firestone, W. A. (1983). Multisite qualitative policy research: Optimizing description and generalizability. *Educational researcher*, 12(2):14–19.

Hodgson, G. (2007). Evolutionary and institutional economics as the new mainstream? *Econ. Rev*, 4:7–25.

Hoffmann, S. (1966). Obstinate or obsolete? the fate of the nation-state and the case of western europe. *Daedalus*, pages 862–915.

Hunt, S. (2002). *Making competition work in electricity*, volume 146. New York: John Wiley & Sons.

Hunt, S. and Shuttleworth, G. (1996). *Competition and choice in electricity*, volume 2. John Wiley & Sons Chichester.

Husted, B. W. (1994). Honor among thieves: A transaction-cost interpretation of corruption in third world countries. *Business Ethics Quarterly*, 4(1):17–27.

IAEA (2016). *Sustainable Electricity Supply Scenarios for West Africa*. Number 1793 in TECDOC Series. International Atomic Energy Agency, Vienna.

ICA (2011). Regional Power Status in African Power Pools. Technical report, Infrastructure Consortium for Africa.

ICA (2016). Updated Regional Power Status in Africa Power Pools. Technical report, Infrastructure Consortium for Africa.

ICA (2018). Infrastructure Financing Trends in Africa—2018. Joint report with African Development Band, The Infrastructure Consortium for Africa.

IEA (2019). *World Energy Outlook 2019*. IEA, Paris.

IEA (2021). Sdg7: Data and projections.

IGAD (2016). About us. Available: [Online]. Retrieved February 24, 2021 from https://igad.int/about-us.

Imam, M. (2020). *Essays on Energy Reforms, Regulation and Institutions*. PhD thesis.

Imam, M., Jamasb, T., and Llorca, M. (2019). Political Economy of Reform and Regulation in the Electricity Sector of Sub-Saharan Africa. Cambridge Working Papers in Economics 1949, Faculty of Economics, University of Cambridge.

IMF (2020). World economic outlook database. International Monetary Fund.

IRENA (2015). Analysis of Infrastructure for Renewable Power in Eastern and Southern Africa . *International Energy Agency*. Available: [Online]. Retrieved June 2, 2021 from https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA_Africa_CEC_infrastructure_2015.pdf.

IRENA (2017). Adapting market design to high shares of variable renewable energy. *International Energy Agency*. Available: [Online]. Retrieved June 2, 2021 from https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/May/IRENA_Adapting_Market_Design_VRE_2017.pdf.

IRENA (2018). Planning and prospects for renewable power: West Africa. *International Energy Agency*. Available: [Online]. Retrieved June 2, 2021 from https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Nov/IRENA_Planning_West_Africa_2018.pdf.

IRENA (2019). Integrating Power Systems across Borders. *International Energy Agency*. Available: [Online]. Retrieved April 25, 2021 from https://www.iea.org/reports/integrating-power-systems-across-borders.

Jaag, C. and Trinkner, U. (2009). A General Framework for Regulation and Liberalization in Network Industries. Working Papers 0016, Swiss Economics.

Jacob, S. A. and Furgerson, S. P. (2012). Writing interview protocols and conducting interviews: tips for students new to the field of qualitative research. *Qualitative Report*, 17:6.

Jamasb, T. (2006). Between the state and market: Electricity sector reform in developing countries. *Utilities Policy*, 14(1):14–30.

Jamasb, T., Mota, R., Newbery, D., and Pollitt, M. (2004). *Electricity sector reform in developing countries: a survey of empirical evidence on determinants and performance*. World Bank.

Jamasb, T., Nepal, R., and Timilsina, G. R. (2015). *A quarter century effort yet to come of age: A survey of power sector reforms in developing countries*. Number 7730. World Bank.

Jamasb, T. and Pollitt, M. (2005). Electricity market reform in the european union: review of progress toward liberalization & integration. *The Energy Journal*, 26(Special Issue).

Jaunky, V. C. (2013). Divergence in technical efficiency of electric utilities: Evidence from the sapp. *Energy Policy*, 62:419–430.

Joskow, P. L. (1998). Electricity Sectors in Transition. *The Energy Journal*, 0(Number 2):25–52.

Joskow, P. L. (2000). Deregulating and regulatory reform in the us electric power sector. MIT Center for Energy and Environmental Policy Research.

Joskow, P. L. (2003). The difficult transition to competitive electricity markets in the us. MIT Center for Energy and Environmental Policy Research.

Joskow, P. L. (2004a). New institutional economics: a report card. *ISNIE Presidential Address*.

Joskow, P. L. (2004b). Vertical Integration. *Handbook on New Institutional Economics*, pages 319–348.

Joskow, P. L. (2006). Introduction to electricity sector liberalization: lessons learned from cross-country studies. *Electricity market reform: an international perspective*, 1:1–32.

Joskow, P. L., Schmalensee, R., et al. (1988). Markets for power: an analysis of electrical utility deregulation. *MIT Press Books*, 1.

Karaki, K. (2017). Understanding ECOWAS Energy Policy. European Centre for Development Policy Management, Netherlands, The Political Economy Dynamics of Regional Organisations (PEDRO).

Kazimierczuk, A. H. (2019). Wind energy in kenya: A status and policy framework review. *Renewable and Sustainable Energy Reviews*, 107:434–445.

Keay, M. (2016). Electricity markets are broken–can they be fixed? Oxford Institute for Energy Studies.

Kessides, I. (2004). *Reforming infrastructure: Privatization, regulation, and competition*. Number 28985. World Bank.

Kessides, I. N. (2012a). Electricity reforms: what some countries did right and others can do better. Technical report, World Bank.

Kessides, I. N. (2012b). The impacts of electricity sector reforms in developing countries. *The Electricity Journal*, 25(6):79–88.

Kimbugwe, K., Perkidis, N., Yeung, M., Kerr, W., and Perdikis, N. (2012). *Economic Development Through Regional Trade: A Role for the New East African Community?* Springer.

Kogut, B. (1988). Joint ventures: Theoretical and empirical perspectives. *Strategic Management Journal*, 9(4):319–332.

Kruger, W., Alao, O., and Eberhard, A. (2019). Namibia country report. Available: [Online]. Retrieved April 14, 2021 from https://energyeconomicgrowth.org/sites/eeg.opml.co.uk/files/2020-03/Namibia%20Country%20Report.pdf.

Littlechild, S. (2004). Competition and regulation in the uk electricity market. *Institute d'Économie Publique, IDEP*, 14(1):3–14.

Lucas, D. S. and Boudreaux, C. J. (2019). The Interdependence of Hierarchical Institutions: Federal Regulation, Job Creation, and the Moderating Effect of State Economic Freedom. Papers 1903.02924, arXiv.org.

Mabea, G. (2020). Electricity market coupling and investment in renewable energy: East africa community power markets. *International Journal of Sustainable Energy*, 39:1–14.

Markets, D. T. T. E. (2004). Sustainable power sector reform in emerging markets–financial issues and options. *Joint World Bank/USAID Policy Paper (June 2004)*.

Markusen, J. R. (1981). Trade and the gains from trade with imperfect competition. *Journal of international economics*, 11(4):531–551.

McCarthy, C. (1996). *Regional integration: part of the solution or part of the problem?* Africa Now: People, Policies and Institutions, London: Heinemann.

Medinilla, A., Byiers, B., and Karaki, K. (2019). African power pools: Regional energy, national power. Available: [Online]. Retrieved January 24, 2021 from https://ecdpm.org/publications/african.

Miketa, A. and Merven, B. (2013a). Southern african power pool: Planning and prospects for renewable energy. abu dhabi, irena. *Abu Dhabi: International Renewable Energy Agency. www. irena. org/SAPP*.

Miketa, A. and Merven, B. (2013b). West african power pool: Planning and prospects for renewable energy.

Millán, J. et al. (2011). Market or state?: Three decades of reform in the latin american electric power industry. *IDB Publications (Books)*.

MOFFITT, M. (1977). Chicago economics in chile. *Challenge*, 20(4):34–43.

Moravcsik, A. (1998). *The Choice for Europe: Social Purpose and State Power from Messina to Maastricht*. Ithaca, NY: Cornell University Press.

Muller-Jentsch, D. (2001). *The Development of Electricity Markets in the Euro-Mediterranean Area: Trends and Prospects for Liberalization and Regional Intergration*. World Bank.

Mundaca, L., Dalhammar, C., and Harnesk, D. (2013). The integrated nordic power market and the deployment of renewable energy technologies: Key lessons and potential implications for the future asean integrated power market. *Energy market integration in East Asia: Renewable energy and its deployment into the power system*, pages 25–97.

Musau, M. P. (2018). Analysis of the east africa power pool (eapp) with renewable energy penetration and proposed asynchronous tie lines. In *2018 IEEE PES/IAS PowerAfrica*, pages 336–341.

Narayan, P. K. and Prasad, A. (2008). Electricity consumption–real gdp causality nexus: Evidence from a bootstrapped causality test for 30 oecd countries. *Energy policy*, 36(2):910–918.

NEGASH, E. (2009). Nigeria Economic and Power Sector Reform Program (EPSERP). appraisal report, African Development Bank Group.

Neuhoff, K., Batlle, C., Brunekreeft, G., Konstantinidis, C., Nabe, C., Oggioni, G., Rodilla, P., Schwenen, S., Siewierski, T., and Strbac, G. (2015). Flexible short-term power trading: Gathering experience in eu countries.

Newbery, D. (1999). The uk experience: privatization with market power. *A European Market for Electricity*, 2:89–115.

Newbery, D. (2013). Evolution of the british electricity market and the role of policy for the low-carbon future. In *Evolution of Global Electricity Markets*, pages 3–29. Elsevier.

Newbery, D. M. (2005). Electricity liberalization in britain: the quest for a satisfactory wholesale market design. *The Energy Journal*, 26(Special Issue).

Norda and KPMG (2019). Joint Review of Swedish/Norwegian Support to the Southern African Power Pool and the Eastern African Power Pool . Norad collected reviews, Norwegian Agency for Development Cooperation.

Nordpool (2019). Annual Report 2019: Embracing New Challenges . Annual report, Nord Pool.

NordREG (2014). Nordic Market Report 2014. Annual report, Copenhagen: Nordic Energy Regulators.

NordREG (2015). Nordic market report: Main developments and trends. Data Retrieved December 23, 2020 from Nordic Energy Regulators, https://www.nordicenergyregulators.org/publications/publications-2015/.

NordREG (2019). Work Program 2019. Annual report, Copenhagen: Nordic Energy Regulators.

North, D. C. (1990). *Institutions, Institutional Change and Economic Performance*. Political Economy of Institutions and Decisions. Cambridge University Press.

North, D. C. (1991). Institutions, ideology, and economic performance. *Cato J.*, 11:477.

Nsabimana, R. (2020). Electricity sector organization and performance in burundi. *Proceedings*, 58(1).

Nworie, I. (2017). *The Economics of Electricity Market Reforms in Developing Countries: An African Experience and Lessons*. PhD thesis, University of Portsmouth.

Ogunleye, E. K. (2017). Political economy of nigerian power sector reform. *The Political Economy of Clean Energy Transitions*, page 391.

Ogus, A. I. (2004). *Regulation: Legal form and economic theory*. Bloomsbury Publishing.

Oladosu, G. (2016). Electricity market reform in sub-saharan africa and the power africa initiative: The nigerian case.

Olmos, L. and Perez-Arriaga, I. (2013). Regulation of the power sector, chapter 10: Regional markets. volume 61, chapter 10, pages 501–536. Springer, London.

Oseni, M. O. and Pollitt, M. G. (2014). Institutional arrangements for the promotion of regional integration of electricity markets : international experience. Policy Research Working Paper Series 6947, World Bank.

Ouriachi, A. and Spataru, C. (2015). Integrating regional electricity markets towards a single european market. In *2015 12th International Conference on the European Energy Market (EEM)*, pages 1–5. IEEE.

Oyewo, A. S., Aghahosseini, A., Ram, M., and Breyer, C. (2020). Transition towards decarbonised power systems and its socio-economic impacts in west africa. *Renewable Energy*, 154:1092–1112.

Pandey, R. (2002). Energy policy modelling: agenda for developing countries. *Energy Policy*, 30(2):97–106.

Pastor, R. F. (2008). Building regional power pools: a toolkit. *World Bank, Washington, DC*, (44679).

Perez-Arriaga, I., Rubio, F., Puerta, J., Arceluz, J., and Marin, J. (1995). Marginal pricing of transmission services: an analysis of cost recovery. *IEEE Transactions on Power Systems*, 10(1):546–553.

Pierson, P. (1996). The path to european integration: A historical institutionalist analysis. *Comparative Political Studies*, 29(2):123–163.

Pineau, P.-O. (2008a). Electricity sector integration in west africa. *Energy Policy*, 36(1):210–223.

Pineau, P.-O. (2008b). Electricity sector integration in west africa. *Energy Policy*, 36(1):210–223.

Political Analysis (2019). SADC pushes for completion of transformation study for RERA. Available: [Online]. Retrieved March 6, 2021 from https://www.politicalanalysis.co.za/sadc-pushes-for-completion-of-transformation-study-for-rera/.

Pollitt, M. (2004). Electricity reform in chile. lessons for developing countries. *Journal of Network Industries*, (3-4):221–262.

Pollitt, M. (2008). Electricity reform in argentina: Lessons for developing countries. *Energy economics*, 30(4):1536–1567.

Pollitt, M. G. (2009). Electricity Liberalisation in the European Union: A Progress Report. Cambridge Working Papers in Economics 0953, Faculty of Economics, University of Cambridge.

Pollitt, M. G. and Haney, A. B. (2013). Dismantling a competitive electricity sector: The uk's electricity market reform. *The Electricity Journal*, 26(10):8–15.

Pou, P. (2000). Argentina's structural reforms of the 1990s. International Monetary Fund.

Rana, A. and Khanna, A. (2020). *Learning from Power Sector Reform: The Case of the Arab Republic of Egypt*. The World Bank.

Reitan, E. A. (2003). *The Thatcher Revolution: Margaret Thatcher, John Major, Tony Blair, and the Transformation of Modern Britain, 1979-2001*. Rowman & Littlefield.

Remy, T. and Chattopadhyay, D. (2020). Promoting better economics, renewables and co2 reduction through trade: A case study for the eastern africa power pool. *Energy for Sustainable Development*, 57:81–97.

Resource Planning Associates, I. (1980). Power Pooling: Issues and Approaches. Technical report, D.O.E./ERA/6385, Cambridge.

Roques, F. and Finon, D. (2017). Adapting electricity markets to decarbonisation and security of supply objectives: Toward a hybrid regime? *Energy Policy*, 105:584–596.

Rose, A. M. (2017). *Improving the performance of regional electricity markets in developing countries: the case of the Southern African power*. PhD thesis, Massachusetts Institute of Technology.

Rosnes, O. and Vennemo, H. (2009). *Powering up: costing power infrastructure spending needs in Sub-Saharan Africa*. World Bank.

Rudnick, H. and Velasquez, C. (2018). Taking stock of wholesale power markets in developing countries: A literature review. *World Bank Policy Research Working Paper*, (8519).

SACREEE (2018a). Energy Efficiency Key to the SADC Industrialisation Agenda - Energy Policy Brief No. 16. Presentation. Available: [Online]. Retrieved March 7, 2021 from https://www.sacreee.org/sites/default/files/documents/files/policy%20brief.pdf.

SACREEE (2018b). SADC Renwable Energy and Energy Efficiency Status Report. Presentation. Available: [Online]. Retrieved March 7, 2021 from https://www.sacreee.org/sites/default/files/documents/files/SADC_EN_%28web%29.pdf.

SADC (1996). Protocol on Energy. Available: [Online]. Retrieved February 25, 2021 from https://www.sadc.int/documents-publications/show/Protocol%20on%20Energy%20(1996)#:~:text=The%20SADC%20Protocol%20on%20Energy,energy%20throughout%20the%20SADC%20Region.

SADC (2010). Summary of the Regional Indicative Strategic Development Plan. Available: [Online]. Retrieved March 7, 2021 from https://www.sadc.int/files/5113/6785/2592/SADC_RISDP_Summary_en.pdf.

SADC (2012). History and Treaty. Available: [Online]. Retrieved February 24, 2021 from https://www.sadc.int/about-sadc/overview/history-and-treaty/.

SADC (2016). SADC Energy Monitor 2016: Baseline Study of the SADC Energy Sector. *Southern African Development Community and Southern African Research and Documentation Centre, Gaborone and Harare*. Available: [Online]. Retrieved March 6, 2021 from https://www.aler-renovaveis.org/contents/lerpublication/sadc_2016_sep_sadc-energy-monitor-2016.pdf.

SADC (2020). SADC Regional Indicative Strategic Development Plan (RISDP) 2020–2030. Available: [Online]. Retrieved March 7, 2021 from https://reliefweb.int/sites/reliefweb.int/files/resources/RISDP_2020-2030_F.pdf.

SAPP (1997). SAPP Annual Report 1995-1997. Annual report, Zimbabwe: Southern African Power Pool Coordination Centre.

SAPP (2006). Signing of a Host Country Agreement between the Southern African Power Pool (SAPP) and the Government of Zimbabwe. Press Release. Available: [Online]. Retrieved March 1, 2021 from http://www.sapp.co.zw/sites/default/files/Press%20Release%20-13%20MARCH%202006.pdf.

SAPP (2015). Day-Ahead Market (DAM). Available: [Online]. Retrieved March 19, 2021 from http://www.sappmarket.com/Home/Market_DAM.

SAPP (2017a). SAPP Annual Report 2017. Annual report, Zimbabwe: Southern African Power Pool Coordination Centre.

SAPP (2017b). SAPP Pool Plan 2017. Available: [Online]. Retrieved March 16, 2021 from http://www.sapp.co.zw/sites/default/files/SAPP%20Pool%20Plan%202017%20Main%20Volume.pdf.

SAPP (2018). SAPP Annual Report 2018. Annual report, Zimbabwe: Southern African Power Pool Coordination Centre.

SAPP (2019). SAPP Annual Report 2019. Annual report, Zimbabwe: Southern African Power Pool Coordination Centre.

SAPP (2021a). About SAPP. Available: [Online]. Retrieved February 25, 2021 from http://www.sapp.co.zw/about-sapp.

SAPP (2021b). Environmental Sub-Committee. Available: [Online]. Retrieved March 1, 2021 from http://www.sapp.co.zw/coordination-centre/environmental-sub-committee.

Scarf, H. (1994). The allocation of resources in the presence of indivisibilities. *Journal of Economic Perspectives*, 8(4):111–128.

Schimmelfennig, F. (2018). Regional integration theory. In *Oxford Research Encyclopedia of Politics*.

Schmidt-Hebbel, K. (2006). Chile's economic growth. *Cuadernos de economía*, 43(127):5–48.

Sekaran, U. and Bougie, R. (2016). *Research methods for business: A skill building approach*. John Wiley & Sons.

Sen, A., Nepal, R., and Jamasb, T. (2016). Reforming electricity reforms? empirical evidence from asian economies. *OIES Paper EL 18, February, The Oxford Institute for Energy Studies (OIES), University of Oxford*.

Sithole, N. and Sichone, E. C. (2012). Restructuring of the Electricity Industry: Experience of Southern Africa. Presentation. Available: [Online]. Retrieved March 6, 2021 from https://erera.arrec.org/wp-content/uploads/2016/11/Session-2-3rd-paper-RERA.pdf.

SNC Lavalin International Inc and Brinckerhoff Parsons (2011). Regional Power System Master Plan and Grid Code Study. Final master plan report, chapter volume i., Eastern Africa Power Pool (EAPP) and East African Community (EAC).

Spalding-Fecher, R., Senatla, M., Yamba, F., Lukwesa, B., Himunzowa, G., Heaps, C., Chapman, A., Mahumane, G., Tembo, B., and Nyambe, I. (2017). Electricity supply and demand scenarios for the southern african power pool. *Energy Policy*, 101:403–414.

Statnett (2019). Nordic Grid Development Plan 2019. Annual report.

Stigler, G. J. (1971). The theory of economic regulation. *The Bell journal of economics and management science*, pages 3–21.

Streimikiene, D., Bruneckiene, J., and Cibinskiene, A. (2013). The review of electricity market liberalization impacts on electricity prices. *Transformations in Business & Economics*, 12(3):40–60.

Thomas, S. (2004). Evaluating the british model of electricity deregulation. *Annals of Public and Cooperative Economics*, 75(3):367–398.

Treichel, V. (2010). *Putting Nigeria to work: A strategy for employment and growth*. World Bank.

UK DECC (2012). Energy sector indicators 2012. *URN 12D/193*. Available: [Online]. Retrieved January 24, 2021 from https://www.gov.uk/government/statistics/uk-energy-sector-indicators-2012.

UNDP (2020). Human development report 2020. *United Nations Development Programme: New York, USA*.

UNEP (2017). Atlas of Africa Energy Resources. United Nations Environment Programme: Nairobi, Kenya.

UNIDO (2006). The reform of the power sector in Africa. Available: [Online]. Retrieved April 14, 2021 from https://www.unido.org/sites/default/files/2009-02/Module4_0.pdf.

Union, E. (2018). Directive (eu) 2018/2001 of the european parliament and of the council of 11 december 2018 on the promotion of the use of energy from renewable sources. *Official Journal of the European Union*, 5:82–209.

Urban, F., Benders, R., and Moll, H. (2007). Modelling energy systems for developing countries. *Energy Policy*, 35(6):3473–3482.

USAID (2009). Electricity sector reform - training and field support kit. Presentation. Available: [Online]. Retrieved March 14, 2021 from http://www.energytoolbox.org/esr/esr.pdf.

USAID (2013). Powering progress project: End of project performance evaluation report. Presentation. Available: [Online]. Retrieved April 14, 2021 from https://pdf.usaid.gov/pdf_docs/PDACW314.pdf.

Vajeth, O. (2016). Introduction to the SAPP Project Advisory Unit. Presentation. Available: [Online]. Retrieved March 16, 2021 from https://d1jbg4la8qhw2x.cloudfront.net/wp-content/uploads/2016/05/Omar-Vajeth.pdf.

Van Thiel, S. (2014). *Research methods in public administration and public management: An introduction*. Routledge.

Vanheukelom, J. (2017). Understanding the southern african development community. Available: [Online]. Retrieved April 28, 2021 from https://ecdpm.org/wp-content/uploads/SADC-Background-Paper-PEDRO-Political-Economy-Dynamics-Regional-Organisations-Africa-ECDPM-2017.pdf.

Vanheukelom, J. and Bertelsmann-Scott, T. (2016). The Political Economy of Regional Integration in Africa: The Southern African Development Community (SADC). Available: [Online]. Retrieved April 28, 2021 from https://ecdpm.org/wp-content/uploads/ECDPM-2016-Political-Economy-Regional-Integration-Africa-SADC-Report.pdf.

Venables, A. J. (2003). Winners and losers from regional integration agreements. *The Economic Journal*, 113(490):747–761.

Ventosa, M., Linares, P., and Pérez-Arriaga, I. J. (2013). *Power system economics*. Springer.

Verhaeghe, E. and Woolfrey, S. (2017). Understanding COMESA and the East African Power Pool. *European Centre for Development Policy Management, Netherlands, The Political Economy Dynamics of Regional Organisations (PEDRO)*.

Wandersman, A., Duffy, J., Flaspohler, P., Noonan, R., Lubell, K., Stillman, L., Blachman, M., Dunville, R., and Saul, J. (2008). Bridging the gap between prevention research and practice: the interactive systems framework for dissemination and implementation. *American journal of community psychology*, 41(3-4):171–181.

WAPP (2018a). Creation of the WAPP. Available: [Online]. Retrieved February 25, 2021 from https://www.ecowapp.org/en/content/creation-wapp.

WAPP (2018b). Update of the ECOWAS revised master plan for the development of power generation and transmission of electrical energy - Volume 1: Executive Summary. Technical report, West African Powr Pool.

WAPP (2018c). Update of the ECOWAS revised master plan for the development of power generation and transmission of electrical energy - Volume 2: State of play of the current situation of the electricity system and perspectives. Technical report, West African Powr Pool.

WAPP (2018d). Update of the ECOWAS revised master plan for the development of power generation and transmission of electrical energy - Volume 4: Generation and Transmission Master Plan. Technical report, West African Powr Pool.

WAPP (2018e). Update of the ECOWAS revised master plan for the development of power generation and transmission of electrical energy - Volume 5: Priority Investment Program and Implementation Strategy. Technical report, West African Powr Pool.

WAPP (2019a). Annual Report 2019. Annual report, West African Powr Pool.

WAPP (2019b). Governing structures. Available: [Online]. Retrieved February 25, 2021 from https://www.ecowapp.org/en/content/governing-structures.

WAPP (2020a). 2020 – 2023 WAPP Business Plan. Available: [Online]. Retrieved March 4, 2021 from https://www.ecowapp.org/sites/default/files/wapp_2020-2023_business_plan_0.pdf.

WAPP (2020b). Articles of Agreement for WAPP organization and functions. Available: [Online]. Retrieved February 26, 2021 from https://www.ecowapp.org/sites/default/files/eng_wapp_articles_of_agreement.pdf.

Ward, V. L., House, A. O., and Hamer, S. (2009). Knowledge brokering: exploring the process of transferring knowledge into action. *BMC health services research*, 9(1):1–6.

WEC (2013). World energy resources 2013 survey. *World Energy Council: London, UK*.

Weigt, H. (2009). A review of liberalization and modeling of electricity markets. *Available at SSRN 1483228*.

Williamson, O. E. (1998). Transaction cost economics: how it works; where it is headed. *De economist*, 146(1):23–58.

Wolak, F. A., Glanchant, J., Joskow, P., and Pollitt, M. (2020). Wholesale electricity market design.

Woolfrey, S. (2016). The Political Economy of Regional Integration in Africa: The Common Market for Eastern and Southern Africa (COMESA). Available: [Online]. Retrieved April 28, 2021 from https://ecdpm.org/publications/political-economy-regional-integration-africa-comesa/.

World Bank (1993). The world bank's role in electric power sector. World Bank Policy Report 11676.

World Bank (2019a). *CPIA Africa: Strengthening Debt Management Capacity*. World Bank.

World Bank (2019b). Proposed Additional Grant from the Advancing Regional Energy Projects in Southern and Eastern Africa Multi-Donor Trust Fund. Project Paper PAD2462, World Bank.

World Bank (2019c). World bank enterprise surveys. Available: [Online]. Retrieved January 24, 2021 from https://www.enterprisesurveys.org/.

World Bank (2020a). Increasing access to electricity in the democratic republic of congo: Opportunities and challenges. Available: [Online]. Retrieved March 18, 2021 from http://documents1.worldbank.org/curated/en/743721586836810203/pdf/Increasing-Access-to-Electricity-in-the-Democratic-Republic-of-Congo-Opportunities-and-Challenges.pdf.

World Bank (2020b). Open data.

World Bank (2020c). The world bank in africa. Available: [Online]. Retrieved January 24, 2021 from https://www.worldbank.org/en/region/afr/overview.

World Bank (2021). World development indicators.

World Energy Council (2015). The world is getting ever more connected. *World Energy Focus*, 15.

Worldometer (2020). African countries by population (2021). Worldometer Database.

Wright, J. and Van Coller, J. (2017). A review of sapp markets and a proposal for a novel market structure to incentivise generation investment in southern africa.

Yi-chong, X. (2006). The myth of the single solution: electricity reforms and the world bank. *Energy*, 31(6-7):802–814.

Yin, R. K. (2003a). *Case Study Research and Applications*. COSMOS Corporation.

Yin, R. K. (2003b). Design and methods. *Case study research*, 3.

Zhang, Y., Parker, D., and Kirkpatrick, C. (2005). Competition, regulation and privatisation of electricity generation in developing countries: does the sequencing of the reforms matter? *The Quarterly Review of Economics and Finance*, 45(2):358–379. The Regulation of Development and the Development of Regulation.

Zhang, Y.-F., Parker, D., and Kirkpatrick, C. (2008). Electricity sector reform in developing countries: an econometric assessment of the effects of privatization, competition and regulation. *Journal of Regulatory Economics*, 33(2):159–178.

Part IV

APPENDICES

A THE STANDARD TEXTBOOK MODEL IMPLEMENTATIONS

We provide two cases for implementing the standard textbook model for power sector reforms. First is the successful case of Argentina in section A.1. Second is the failure cases of Nigeria in section A.2.

A.1 THE CASE OF ARGENTINA

Following the footsteps of Chile, Argentina was the second country in Latin America to embark on comprehensive reforms in its electricity sector. The sector witnessed a rapid and full implementation of the standard textbook model. By 1993, the Argentinian electricity sector was fully liberalized [Jamasb, 2006].

A.1.1 Country's Context

In 1989, a populist government came to power in Argentina with a social reform agenda. However, coming from a debt crisis during the 1980s and hyperinflation, the government had large fiscal deficits that led to starting a large-scale privatization program of 154 state companies in energy, telecommunications, railways, banking and other sectors. Privatization was part of larger structural reforms included financial system reforms, liberalization of trade and the capital account, and far-reaching public sector reforms [Pou, 2000]. Among influential stakeholders in the reform was the traditional constituency of the Peronist Party who imposed limits to the reform agenda and sequence. Besides, international organizations, like the World Bank, and overseas investors played an important role in the privatization program that proved to be very successful.

Although the economy of Argentina was in the top ten in 1913 with a higher per capita income than France, Germany and the Netherlands [Pollitt, 2008], the following period witnessed severe political instability and the economy deteriorated notably. In 1989, the losses of state-owned companies accounted for 3% of the GDP and Argentina was set back in the developing countries track. Before the military governing in 1930, Argentina was one of the most stable and conservative countries with decades of civilian constitutional government and well-established institutions.

As per 1992, the generation mix of Argentina had a significant hydro component of 35% and the rest is composed of 14% nuclear and thermal generation. Nearly half of the electricity demand, as well as the GDP ($2700 per head), was centered around the Greater Buenos Aires area with demand growth of 3.3% per annum and energy consumption of 1,303 kWh per capita. [Pollitt, 2008; World Bank, 2021].

A.1.2 The Sequence of the Reforms

Upon the election of the new government, the first attempt to address the losses of the state-owned companies in the electricity sector was the adoption of the Federal Electricity Pact and corporatizing the business, 1989. However, nothing much had changed. With technical assistance from the World Bank, the ministry of energy commenced the process of designing a new electricity industry between 1990-91. In 1992, the new design was substantiated with the enact-

ment of the Electricity Law (24,065). Law 24,605 provided the legal framework for: the break-up and sale of the existing state-owned companies; the creation of a wholesale energy market; the creation of an independent national electricity regulator ENRE; and the definition of the powers of the Secretary of Energy in the new system. The Federal Energy Council was also established to advise the Secretary of Energy and the Congress and to administer the National Fund of Electricity for regional subsidies [Pollitt, 2008].

With such a comprehensive framework, almost all the steps took place in the year 1992. Argentina was remarkably able to implement a decade of the Chilean progress in just a couple of years and even overcame the insufficient unbundling and limitations on the competition.

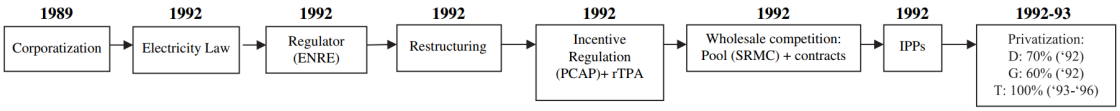


Figure A.1: Argentina's sequence of reforms. Source: Jamasb [2006].

A.1.3 Restructuring the Sector

The electricity sector was broken into virtually three regions. The main region covers most of the country and 93% of the electricity demand. The region was under the MEM wholesale market. The second region in the south covers 6% of the demand and operate under the MEMSP market. The two markets were connected later in 2005 under one system. The remaining 1% of the demand was supplied by small isolated systems [Pollitt, 2008]. The wholesale followed the Chilean market principle of a cost-based bidding system for scheduling power plants with an independent system operator for dispatching (CAMMESA). However, to subdue the market power experienced in Chile, the maximum size of the generators was limited to 10% of the market [Jamasb, 2006].

On the generation side, the largest state-owned company Servicios Electricos del Gran Buenos Aires (SEGBA) was broken into 5 generation firms and 3 distribution companies. Privatization encompassed more than 70% of the generation, all of the transmission and 60% of the distribution. The remaining public ownership in the generation was limited to the state-owned nuclear power generating company and two hydropower plants. Private investment was stimulated by the one to one convertibility between the Argentine Peso and the US. Generators had a nondiscriminatory right of access to all transmission lines and pay for delivering the power to consumers. The wholesale generation competition was very strong in Argentina and prices were driven low but the spot market revenues were supplemented by revenues from a capacity payment mechanism.

The transmission and the distribution segments were regulated third party access, in contrast to Chile, and were both operated under concessions. Argentina uses two different schemes for financing transmission expansions. The first scheme consists of an agreement between the transmission firm and the users who finance the expansion, in which the users retain the rights to congestion rents during the investment period. The second new approach is the so-called 'Public Contest' mechanism. Transmission expansion could be determined by an innovative voting arrangement combined with an allocation of costs of the expansion calculated by the operator. Users benefiting from the new connections vote for or against the project (>30% for rejection). The project is approved in a public hearing and the regulator calls for a public auction of the construction, maintenance, and operation contract. Bidders compete on the basis of the annual levy to be paid by beneficiaries. This second mechanism is sought to reduce free-riders [Fischer et al., 2000].

The distribution concession contract was for ninety-five years and broken into nine periods of ten years. The ENRE sets the tariffs before the contract and calls for a competitive auction. During a management period, regulated tariffs could be reviewed after five years and the regu-

lator can grant the desired tariff increase after conducting a public hearing and contracting an independent cost study [Fischer et al., 2000]. Regulated tariffs were pegged to the US dollar under the parity with the peso. However, in 2002 when the peso was allowed to float freely all prices within the sector were delinked from the US currency and fixed in nominal pesos. Consequently, firms suffered from losses as they could not pass-through price increases to customers. The government pursued a policy of price controls, subsidies and demand-side management measures. The politicization of the tariffs setting resulted in a level at which cost recovery was not feasible [Pollitt, 2008].

The 2002 crisis of the Argentine peso severely affected the performance of the electricity sector and showed that governments could exhibit opportunistic behavior towards the private electricity industry (see Millán et al. [2011]). Prior to the crisis, the reforms were extremely successful in increasing the installed generation capacity and operating performance in terms of plant availability and labor productivity [Jamasb et al., 2004]. The average energy spot price dropped steadily from around US$45 per MWh in 1992 to US$25 per MWh by 1998 under intense competition among the privatized generators [Besant-Jones, 2006] and the public finance for commercial activity fell from 11.7% of public expenditure in 1991 to 5.4% in 2000 due to reduced support for the electricity and gas sectors [Pollitt, 2008].

A.2 THE CASE OF NIGERIA

Nigeria was cited by Imam et al. [2019] as the only African country that implemented all the feature of the reform model. The Nigerian experience reflects many of the challenges facing African developing countries in reforming their electricity sector.

A.2.1 Country's Context

Nigeria has a strong position within West Africa; the country has by far the largest population in Africa, the biggest oil exporter and has the largest natural gas reserves on the continent. Until 2007, Nigeria was governed by the former militant Olusegun Obasanjo who was a member of the Democratic Party and held a Nigerian nationalist ideology. During this period, corruption was pervasive in the country [Treichel, 2010]. Since 2011, war broke between the government and the identified terrorist group of Boko Haram in the northern states. Losses were incurred as the group targetted oil companies and state-owned pipelines.

During the early 2000s, the economy was growing rapidly with a rate of 6.3%, driven by the non-oil sector (9.7%) like the service sector, and the GDP per capita peaked at $3,098 in 2014. Between 2004-08, the country's economy was undergoing economic reforms, particularly in governance, public finance management (PFM) and the financial sector [NEGASH, 2009]. Yet, the macroeconomic is susceptible to the oil prices (example the recession of 2015-2016) and 46 percent of the citizens live below the poverty line and less than 50 percent have access to electricity. The demand for electricity exceeds available capacity, which is less than 5 gigawatts (GW) for a population of about 170 million. The generation mix consisted of 21% hydropower generation and the rest was generated with thermal power plants (steam, OCGT and CCGT). [Eberhard et al., 2016].

Like the majority of African developing countries, Nigeria had an inherent structural weakness in its institutional framework. There were obvious gaps, overlaps, confusion, and conflicts in the mandates and interactive relationships among the existed institutions as provided for in their enabling laws [Ogunleye, 2017]. An Important stakeholder in the electricity sector is the Power Africa Initiative of the United States government that initiated the program "Power Africa" under President Obama in 2013, which involves the World Bank, African Development Bank (ADB) and other governments. The program was intended to foster private investment in six focusing countries including Nigeria [Oladosu, 2016].

A.2.2 The Sequence of the Reform

The reform was first conceived in 2001 when The National Electric Power Policy was accorded and called for full liberalization of the electricity market through the promotion of competitive sector engagements. In 2005, the Electric Power Sector Reform Act (EPSRA) was enacted as the legal basis and regulatory framework for the reform of the industry. Horizontal and vertical unbundling directly followed the Act enactment. However, it was not until 2010 the Nigerian Electricity Regulatory Commission (NERC) was established as an independent regulator and the transmission holding company was unbundled at the same time. One attempt for privatization in 2007 was failed due to unresolved labor issues, the lack of a credible power purchase agreement (PPA) and pricing settings [Eberhard et al., 2016]. An incident that led to the government announcement of the Power Sector Reform Roadmap in 2010 and the establishment of two governmental bodies: Presidential Action Committee on Power (PACP) and A Presidential Task Force on Power (PTFP) to address these issues and follow the implementation of the roadmap.

By 2013, privatization of five of the generation companies and 10 of the distribution companies was carried out. An interesting aspect of the reform sequence in Nigeria is that IPPs were introduced way earlier in 1999 under the National Integrated Power Projects (NIPPs) and corporatization & commercialization took place in 1988 [Nworie, 2017]. Following the government privatization program, NIPPs were also earmarked for divestiture. The roadmap set four phases for introducing the competitive electricity market: pre-transition, transition, medium-term, and long-term. After several delays, the Transitional Electricity Market (TEM) was finally declared in 2015 with the Nigerian Bulk Electricity Trading Plc (NBET) acts as a bulk trader, credible off-taker and aggregator to guarantee liquidity in the market, i.e. serves as the "principal buyer".

A.2.3 Restructuring the Sector

Following the enactment of the EPSRA, the state-owned National Electric Power Authority (NEPA) was unbundled, vertically and horizontally, into 6 generation companies, 11 distribution companies, and a single transmission company (Transmission Company of Nigeria, TCN) under the Power Holding Company of Nigeria (PHCN) holding company until its assets are transferred to are an independent commercial operation. Privatization took 80% of the generation, 100% of the distribution and TCN was eventually operated under a concession management contract won by the Canadian company Monitola Hydro International.

Despite going through all the standard steps, the electricity sector in Nigeria remains highly subsidized and regulatory efforts are constantly failing due to political intervention. The regulator announced a Multi-Year Tariff Order (MYTO) to raise tariffs gradually over four years starting in July 2009 with the aim of reaching cost-reflective tariffs in 2011. However, the targets were never delivered, as a result of widespread outrage, lawsuits and protest by consumers, and the government is still providing subsidies, managed by the NBET, to cover the difference between costs and revenues [Oladosu, 2016]. Many of the problems remained in the sector after the reforms. Corruption, patronage, poor collection and other fiscal leakages seem to have led the sector into a 'Stable low-level equilibrium' under a perpetual cycle between politicization, low tariff and Bad quality and corruption, which was identified by Arowolo and Perez [2020]. Such fundamental problems need to be addressed before an effective power market can be envisaged [Rudnick and Velasquez, 2018].

B STUDIES ON AFRICAN POWER POOLS

The following table shows a number of studies that investigate African power pools.

No.	Approach	Author [year]	Power pool
1		Bowen et al. [1999]	SAPP
2		Gnansounou et al. [2007b]	WAPP
3		Pineau [2008b]	WAPP
4		Rosnes and Vennemo [2009]	SAPP, WAPP. EAPP
5		SNC Lavalin International Inc and Brinckerhoff Parsons [2011]	EAPP
6		Jaunky [2013]	SAPP
7		Miketa and Merven [2013a]	SAPP
8	**Technical**	Miketa and Merven [2013b]	WAPP
9	**Modeling**	IRENA [2015]	EAPP
10		Wright and Van Coller [2017]	SAPP
11		Spalding-Fecher et al. [2017]	SAPP
12		IRENA [2018]	WAPP
13		Musau [2018]	EAPP
14		Remy and Chattopadhyay [2020]	EAPP
15		Adeoye and Spataru [2020]	WAPP
16		Oyewo et al. [2020]	WAPP
17		Economic Consulting Associates [2009]	SAPP, WAPP. EAPP
18		ICA [2011]	SAPP, WAPP. EAPP
19	**Social**	Oseni and Pollitt [2014]	SAPP, WAPP
20	**Science**	Norda and KPMG [2019]	SAPP, EAPP
19	**Methods**	Medinilla et al. [2019]	SAPP, WAPP, EAPP
21		Bissiri et al. [2020]	WAPP
22	**Hybrid**	Rose [2017]	SAPP
23	**Studies**	DFID [2019]	SAPP

Table B.1: The literature on African power pools categorized by the approach.

C INFRASTRUCTURE PLANNING

C.1 SAPP

Table C.1 shows committed generation capacity in SAPP from 2019 to 2023.

Country	2019	2020	2021	2022	2023	Total	Share %
Angola	1,043	65	-	2,100	-	**3,208**	**13.9**
Botswana	-	410	-	-	-	410	1.78
DRC	153.4	360	-	-	-	513.4	2.22
Eswatini	-	10	-	-	-	10	0.04
Lesotho	-	-	20	-	-	20	0.09
Malawi	136	60	278	-	258	732	3.17
Mozambique	30	30	-	550	-	610	2.64
Namibia	10	220	44	-	-	274	1.19
South Africa	3,234	1,219	2,342	1,525	805	**9,125**	**39.53**
Tanzania	-	27	1500	3430	600	**5,557**	**24.07**
Zambia	-	765	120	200	101	1,186	5.14
Zimbabwe	240	600	600	-	-	1,440	6.24
Total	**4,846.4**	**3,766**	**4,904**	**7,805**	**1,764**	**23,085.4**	**100**
Planned Decommission			**75**	**1,870**	**2,280**	**4,225**	**18.3**

Table C.1: SAPP's committed generation capacity from 2019 to 2023 in MW. Source: SAPP [2019]

Table C.2 shows the committed transmssion projects. The transmission projects have three categories: category A includes projects to interconnect unconnected members of SAPP, category B includes projects to relieve transmission congestion, and category C includes projects to move power from new generating stations to load centers.

Category A	Category A & B
Angola - Namibia	South Africa - Botswana
Angola - DRC	South Africa - Namibia
Malawi - Mozambique	South Africa - Lesotho
Tanzania -Zambia	South Africa - Mozambique
	South Africa - DRC
	Zambia - DRC
	Zambia - Mozambique
	Zambia - Zimbabwe
	South Africa - Zimbabwe
	Zimbabwe - Mozambique
	Zimbabwe - Botswana

Table C.2: SAPP's main transmission corridors planned between 2020 and 2025. Source: [SAPP, 2017b]

C.2 WAPP

Table C.3 shows transmission projects of WAPP. Some projects are already committed from the previous master plan and are expected to be commissioned within the short term. The final regional infrastructure will cover all member countries with almost all countries having three interconnections, as shown in figure C.1.

Short-term	**Medium-term**	**Long-term**
North Core: Burkina Faso - Niger - Nigeria - Benin (**committed**)	Median Backbone: Nigeria - Côte d'Ivoire (through Ghana, Togo and Benin)	Senegal - Guinea - Mali Burkina Faso - Côte d'ivoire
CLSG: Côte d'Ivoire - Liberia - Sierra Leone - Guinea(**committed**)	Guinea - Mali	Nigeria - Niger
OMVG: Senegal-The Gambia-Guinea Bissau-Guinea (**committed**)	Guinea-Côte d'Ivoire	
Guinea-Malia (**committed**)	Liberia-Côte d'Ivoire	
Ghana-Burkina Faso-Mali		

Table C.3: WAPP's main transmission corridors planned between until 2033. Source: [WAPP, 2018b]

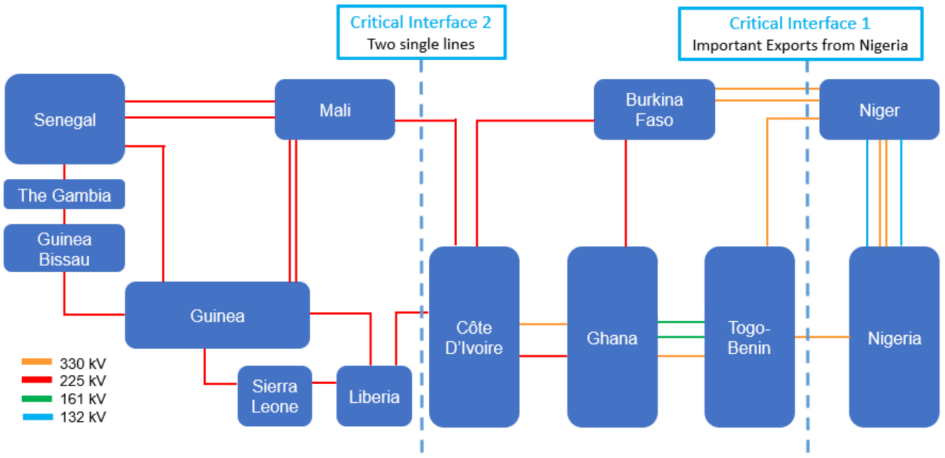


Figure C.1: WAPP's future transmission grid with critical interfaces. Sources: WAPP [2018b]

C.3 EAPP

Table C.4 shows future planned capacity per country in EAPP.

	2020	2025	Total added capacity	Share %
Burundi	108	33	141	**0.16**
Djibouti	7	17	24	**0.03**
DRC	4,596	4,028	8,624	**10.06**
Egypt	21,286	13,987	35,273	**41.14**
Ethiopia	9,494	4,559	14,053	**16.39**
Kenya	5,623	3,452	9,075	**10.58**
Libya	2,761	2,031	4,792	**5.59**
Rwanda	300	0	300	**0.35**
South Sudan	355	1,895	2,250	**2.62**
Sudan	2,115	1,479	3,594	**4.19**
Tanzania	3,974	1,720	5,694	**6.64**
Uganda	1,918	0	1,918	**2.24**
Total	**52,537**	**33,201**	**85,738**	**100**

Table C.4: EAPP master plan for new installed generation capacity in MW between 2015-2020 and 2020-2025, including South Sudan. Source: [EAPP et al., 2014]

Table C.5 shows future transmission interconnections between countries in EAPP.

	2020 Capacity (MW)	2025 Capacity (MW)	Total length (km)
Sudan-Ethiopia	1,600	-	550
Egypt-Sudan	500	1,000	775
Rwanda-Tanzania	200	1,000	115
Rwanda-DRC	-	300	46
Uganda-South Sudan	600	-	200
Libya-Egypt	200	-	163
Kenya-Uganda	300	600	254
DRC-Uganda	-	500	352
Sudan-South Sudan	-	300	400
Total	**3,400**	**3,700**	**2,855**

Table C.5: EAPP master plan for new interconnection projects between 2015-2020 and 2020-2025, including South Sudan. Source: [EAPP et al., 2014]

D MARKET RULES AND PROCEDURES

D.1 SAPP

The legacy of trading in the region still overshadowing the performance of SAPP. The bilateral contracts count for more than 65% of trade volume. Dispatch rules give priority network access to long-term contracts which could limit trade and efficient use of infrastructure. These contracts are treated as physical obligations and dispatched even if a lower-cost alternative exists in the competitive market [Rose, 2017]. The importance of these contracts, however, is that they ensure security of supply and provide certainty to project developers. Contracts can be either firm contracts that have attached reliability premium with penalties for non-delivery or non-firm contracts that are interruptible with notice and if notice is given, no penalties.

The market operator (coordination center) is responsible for collecting all trading information from bilateral and scheduling power exchanges between control areas. Bilateral contracts declare their trades and wheeling paths first and the system operators combine use it to calculate the remaining transmission capacity available for the competitive market. Based on this, the DAM then takes place. This one of the primary reasons that the majority of matched offers and bids are not physically traded, for instance in 2016/17, 63% of the energy that was matched in the competitive market could not be traded due to transmission constraints [SAPP, 2017a].

The DAM closes at noon the previous day, hence the term "day ahead", and the market operator publishes the results including trade volume, power "ask", and the clearing prices for each hour. The remaining unmatched requests and transmission capacity available are also published for IDM which opens immediately after concluding DAM. Besides DAM, the FPM is open for market participants for trades a month or week ahead. The market is based on physical delivery of the traded power volume following an auction-trading model just as the DAM.

On the other hand, IDM is a continuous trading platform, 24/7, where participants can submit their bids up to an hour before the delivery time. The IDM supplements DAM and helps participants to secure their balance between supply and demand on an hourly basis. The orders can be of type Bid (sales order) or Ask (purchase order). The orders are either matched automatically by the system on price or a buyer/seller can accept and "hit" an order in the market. The market contracts are settled at the matched price and trading is based on a first-come, first-served. IDM is fully transparent and participants' orders are seen by the power exchange and the submitting participant (as well as monitored by the relevant authorities). The coordination center charges 1% levied for its market operations service.

In order to be admitted to the competitive market, a participant must [SAPP, 2015]:

- Have been licensed or given permission by a host member country to undertake cross-border trading.
- Be accepted as a market participant by SAPP Executive Committee.
- Be a part of a TSO connected to one of SAPP control areas and have arrangements for balance responsibility.
- Sign the Book of Rules and Governing Agreements.

- Open of the requisite accounts for trading purposes and having the requisite security for trading purposes.
- Have at least two trained traders.

The system operator of each control area monitors and corrects the imbalances and the coordination center handles the settlement according to procedures described in the SAPP Operating Guidelines [1]. Imbalance is classified to either Inadvertent Energy, declared emergency energy, or other energy imbalance A tolerance of ±5 MWh (initially was 25 MW) is implemented for the classification of inadvertent energy to be paid in kind by the system operators of the three control areas and imbalance energy to be settled financially [SAPP, 2018]. Utility emergency energy rates will be used to compensate the supplier unless otherwise specified in bilateral agreements. Utility emergency energy rates are to be declared on a monthly basis by each operating member and verified by the coordination center. The rate of other energy imbalance is determined by the highest generation cost. Participants are required to provide a security deposit to the coordination center to ensure that in case the participant fails to pay, the amount will be deducted from the security deposit and paid to the seller on behalf of the defaulting party.

As for the transmission pricing, originally, the SAPP used the Postage Stamp method that charges all users a flat rate of 7.5% of the total amount of energy injected or withdrawn from the network but this was abandoned in 2003 (initially, it was not unanimously accepted by all utilities) in favor of a MW-km method [2] after it was recommended by the wheeling rates study commissioned to the consultant power planning associates LTD of the UK [Economic Commission for Africa, 2003]. The method applies only to bilateral contract transactions and lines used for wheeling. Transmission charges for DAM and IDM trades are based on the average transmission charge obtained from the MW-km method and shared evenly between buyers and sellers [Rose, 2017].

A major revision was performed when SAPP-MTP was launched in 2015. This included revising the Book of Rules and adding rules for the three introduced markets; the allocation of transmission capacity was changed to prioritize firm contracts over non-firm contracts for both bilateral and competitive markets; revision for imbalance charges which became linear between the clearing price and double the clearing price for maximum frequency deviation of 49.85 Hz (the acceptable range is between 49.95-50.05 Hz). Losses arising from wheeling bilateral trades were charged based on system average costs. On the other hand, losses arising from wheeling competitive market trades are charged based on the DAM market clearing prices (MCP) capped to a maximum of the daily average MCP.

Below in table D.1 is a summary of the timelines on key trading activities on SAPP competitive markets (Interview 6).

D.2 WAPP

The market rules set the relationship, responsibilities, and obligations of market participants and the System and Market Operator (SMO), the ICC, in relation to the market activities (see ERERA [2015a]). The SMO is responsible for balancing activities, operational planning of the interconnectors, allocation of transmission capacity, metering, and coordination of pooling schedule with domestic TSOs and control areas operators. The operator of a control area ensures the flows inter-area are maintained while the domestic TSOs in each area ensure the flows agreed at the regional-level are maintained in the interconnectors under their responsibility. The three parties maintain communication together for this purpose. The SMO reports to ERERA and

1 Not found online, needs further research

2 The method allocates costs based on the impact that individual transactions have on network usage after the system operator simulates network flows in a base case with all transactions included and then removed each at a time

Activity	FPM-M	FPM-W	DAM	IDM
Trading Day	Last Wednesday and at least 5 Days Before Delivery Month Start	Every Thursday a Week before Delivery Week	A day before Delivery day	Continuous for the following delivery Day
TTC Nominations on Trading Day	10:30	10:30	9:30	Ad Hoc
BC Nominations on Trading Day	10:30	10:30	9:30	Ad Hoc
Future market reservation (MR)	10:30	10:30	9:30	Ad Hoc
Price calculation	14:30	14:30	12:00	Continuous
Results ready	16:00	16:00	14:30	Continuous
Settlement Data	Delivery Day + 1 Day			
Payment of Invoices by participants	Delivery Month + 10 Days			
Settlement Bank Transactions	End of Month + 11 Days			
Final Bilateral Nominations	Delivery Day + 1 Day at 15:00			
Metered values	Delivery Day + 1 Week at 15:00			
Frequency	Delivery Day + 1 Day at 15:00			

Table D.1: Timelines for the key trading activities on SAPP competitive markets. Source: Interview 6

WAPP executive board. The SMO is authorized to make modifications to the market rules and the operation manual.

Every day by 16:00, the control area operator informs the SMO for the following day of the power flow schedule and the serving unities along with the reserve margin. Trading is based on the model contract and is conducted freely between the parties. Upon contract agreement, each contract is then approved by ERERA and registered with the SMO. These agreements take priority over all of the nodes required to facilitate delivery. The minimum exchange programming period is 1 hour and the programming time frame is 1 hour. Short-term contracts are limited to adjacent countries during Phase 1 and do not pay for losses and transmission charges. Transmission capacity is allocated on a first-come, first-served basis and imbalances are settled in kind. The SMO calculates the imbalances of the previous day and informs each TSO of the imbalances in order to be confirmed, the SMO then pays the TSO their allocated transmission tariff and losses revenue. The frequency deviation allowed between 48.5 Hz and 51 Hz beyond which load shedding occurs. The regional transmission tariff methodology adopted is a point-to-point MW-km load flow-based tariff methodology that is calculated for all bilateral contracts.

The market procedures set the protocols for information exchange, financial settlements, dispute resolution, market scheduling and fees (see ERERA [2017b]). Each day by 10.30, each market participant submits data for the subsequent day concerning each transaction scheduled hourly. The SMO set a preliminary schedule of all transactions for each hour at 13.30 and will be final by 15.30 providing no change was made by any participant. The SMO set a credit limit for each participant, which is an amount in US Dollar not to be exceeded over any 45 days. This amount will be withheld by the SMO and the participant receives the accumulated interest at the end of each calendar month. The credit limit is taken as a prudential procedure for trading activities.

The minimum criteria for admission of a market participant are:

- Be resident in any of WAPP countries.
- Be issued with a relevant license.
- Being capable of being sued and not being immune.
- Have an acceptable credit rating, to be approved by the SMO.
- Sign all market-relevant documents.

Participants pay market operation fees, system operation fees, regulatory fees, and market participation application fees. Additional, a participant could be subject to balancing or ancillary services fees. Participants are required to give a one-year notice if they want to cease participating in the market, providing that they fulfilled their obligation.

D.3 EAPP

EAPP's consultant study of 2014 [EAPP, 2014c] suggested a combination of a single-buyer model and a centralized market. EAPP shall perform the function of the market operator, and national TSOs shall buy, sell, and provide balancing services. The market guidelines set the inception of a day-ahead market, with anonymous hourly contracts between matched offers and bids by the market operator, the coordination center (yet to be established). The document also mentions third-party access to transmission capacity for all participants upon fulfilling the rules to be developed by EAPP (see EAPP [2014d] for more details).

The draft of the market procedures sketches a simple scenario for the day-ahead. The operations start by receiving the available transmission capacity from the national TSOs at 09:30, then the market operator starts receiving the bids and offers for the next day from 10:30 until noon. The market operator then calculates the results and sends the net exchange to the respective TSOs and receives their confirmation by 13:30 upon which the schedule for the next day is published at 14:00 and the TSOs receive the nominations from successful bidders of their intended trades by maximumly 16:00. Until the next day, settlements and post-market activities are performed (see EAPP [2014a] for more details).

The draft of the market rules suggests common operating rules for the day-ahead market to be followed by both market participants and the market operator. The DAM is limited to a price range set by the operator. The bid formats are submitted on a set of hourly blocks ordered ascendingly for offering and descendingly for buying including the bidding area. The operator must determine the clearing prices before 20:00 on the day prior to the delivery day or the trade will be fully suspended. The rules also define market manipulation activities to be monitored by IRB and upon which a participant shall be sanctioned. All participants are required to make a security account with an amount equals to the net purchase of the last 13 days of trading (see EAPP [2014b] for more details).

E | INTERVIEWS

E.1 INTERVIEW PROTOCOL

Interview protocol consists of three main sections: introductory explanation before the interview begins which includes collection of informed consent for the use of interview data and audio recording (if the interview was recorded), a general list of interview questions, and concluding remarks. Each is described in the following subsections.

E.1.1 Introduction

Hello Mr/Ms. **Interviewee's Name**, Thank you very much for agreeing to my interview request, I genuinely appreciate your time. Before we start I am obliged to mention some interview's formalities, could you please bear with me: The purpose of the interview is to gain insights into the development of SAPP/WAPP/EAPP from you Mr.Ms. **Interviewee's Name** as an expert, and it will be used for research purpose only. Please feel comfortable during the interview and if there is any question you do not like to answer, just tell me and it is totally fine. In terms of confidentiality, If you allow me, I would like to use your name in my thesis, otherwise, I can make it completely anonymous, so can I check with you if it's fine to use your name? Also, I would like to ask your permission to record the interview just for me to go back to it and transcribe it and it will not be shared with anyone, is that okay? Our interview will be about 45 mins and will follow the structure of the questions I sent you in the email. Okay, do you have any questions for me before we start?

A short introduction about me first, my name is Mohamed Elabbas, I am a master student at Delft university of technology, I am studying Sustainable Energy Technology master program, and as you know my master thesis is about the African power pools, I have three case studies, the SAPP, the EAPP, and the WAPP. My research aims to provide a thorough understanding of these power pools and how they can be improved and facilitate renewable energy integration. That's all from my side. Would you like to make any comments before we start officially with the questions?

E.1.2 Questions

A different set of questions is asked to each interviewee depending on their role within their organization and expertise. Below is a general list of questions used as a guideline. The questions and their orders were changed in some of the interviews, sometimes on the spot, according to the flow of conversation and interviewee's experience.

General

- Could you please introduce yourself, your role in your organization and your experience?
- Could you describe the role of your organization in regional integration and trade?
- Could you briefly explain what your organization does for promoting renewable energy and previous endeavors?

- Could you please mention any relevant engagements with African power pools?

Validation

- Could you comment on/confirm the development timeline of the power pool depicted in the picture below?
- Could you confirm/comment on the interconnections and peak demand of the power pool depicted in the figure below?
- Are the following reforms (based on the standard textbook model), shown in the table below, are correct?
- Does the following regional trade patterns of 2018, shown in the picture below, look correct?

Regional Institutions

- Could you describe the nature of the regional economic community?
- Could you describe the role of the regional economic community in the development of the power pool?
- Could you describe the formal relation between the power pool and other regional institutions?
- Could you describe how the situation and the relation between countries affect the regional communities and/or the power pools?

Factors

- What could be internal/endogenous factors that affect the performance of the power pool? (these are factors internal to the power pool and can be influenced directly by it)
- What could be external/exogenous factors that affect the performance of the power pool? (these are factors external to the power pool and can not be influenced directly by it)
- Could you mention the important factors delaying the establishment of the regional market?

Governance

- Could you describe the nature of the decision-making process in the power pool between members?
- The general assembly is the highest decision body of WAPP and currently consists of 36 members with voting rights, half of the voting is split between Nigeria and Ghana, each has 9 members: How does this affect the decision-making process?
- Do you observe any conflicts between member countries of the power pool?
- In the context of the three power pools, who are the important stakeholders?
- What could be the advantages and disadvantages of having the supreme governing body coupled with national governments/politics (the council of ministers)?
- Could you comment on the geopolitical situation in the region and who are the important actors/countries? Which countries are pro domestic generation (national political agenda) and which are pro regional trade?

Development

- How is the current progress of establishing the coordination center?
- How is the current progress with connecting all members of the power pool with the regional transmission network?
- What is the role of international partners in the performance of the power pool? (technical and financial assistance)
- What do you think are current or future challenges facing the progress of the power pool?
- Does the power pool have a mechanism for allocating the cost and investment of transmission interconnection projects? And How do the existing processes for regional transmission planning and cost allocation influence investment decisions?
- How do you think the development of the power pool can be accelerated?
- How is the current development of regional regulations?

Market

- When do you expect to operate the short-term competitive market?
- How members countries can benefit from the short-term trade in opposition to the current bilateral agreements? And which are expected to be important exporters and importers?
- How is the current situation with formulating and approving market documents?
- How does the sector structure of member countries affect the regional market? And what characteristics about the sector structure are important for short-term trade?
- What is the effect of having one country with more than 50% of the installed generation capacity on the market?

Renewable Energy

- Could you describe the potential of renewable energy in the region?
- How is currently the investment in renewable energy in the region?
- What are the challenges for increasing renewable energy shares in member countries (technical and non-technical)?
- Do you consider renewable energy integration in the competitive market design?
- How can the regional market promote renewable energy integration? What are the design options and the requirements/obstacles for implementing them?
- which renewable energy supporting mechanism can be implemented in the regional market?
- How do you see the integration of renewable energy affecting the competitive markets like Day-Ahead and Intra-Day market (DAM, IDM)?
- What are some important design variables/options that can be changed in DAM & IDM to support renewables integration in the market?
- Could you comment on how the market rules, bids format, pricing, and time frame of the market affect renewables' participation in the market?

E.1.3 Conclusion

This concludes the list of questions I prepared for this interview. Is there is anything that you want to share or that you find relevant that I have not asked you about? Could you recommend other experts or documentation that could contribute to this research? Thank you very much for your time and for providing such valuable information. Would it be okay if I get back to you during the data analysis process for more questions? I will also be transcribing our interview and send it to you for approval. Thank you once again and I wish you a nice day.

E.2 SAPP INTERVIEWS SUMMARY

E.2.1 Interview 6: SAPP Staff

Date of Contact: 05/04/2021
Date of Conduction: 26/04/2021

Background

Stephen Dihwa is the current executive director of SAPP Coordination Center. His responsibilities include looking into the coordination of planning, operations, the environmental aspects, and the trading aspects of SAPP. Elisha Mutambudzi is the Acting Chief Engineer Markets. The coordination center provides secretarial services to the power pool and carry out day-to-day activities including running the competitive electricity market.

SAPP

In my opinion, the factors that helped the development of SAPP had to do with the resource variances between the members. The fact that the utilities in the North have predominantly hydro sources of electricity, while in the South, particularly South Africa, they have a thermal generation, mainly coal-fired generation. Historically, the region has cycles of drought take place and when that happens the North has a deficiency in electricity while in the South it is available. Then it was observed that there was an opportunity for electricity trading by improving connectivity between the utilities in the North and those in the South. In my view, that led to the greater acceleration of SAPP.

The main role of SADC in the development of SAPP is to foster cooperation and political support in the electricity sector within the region. The cooperation covers project preparation and development. In SAPP, the master plan is developed by SAPP, then presented to SADC's ministries responsible for energy and they endorse it as guidance for member states but not as something that can be enforced. SAPP's rules, e.g. operational rules, are changeable by SAPP without going to SADC's ministries, but any rules that affect the policies of SAPP, the changing goes through SADC, particularly if there is any cooperation requiring an entity outside the SADC region.

Among the international institutions that helped the development of SAPP are first funding institutions, especially international development financing institutions like the World Bank, European Union, Norad, Sida, the Development Bank of South Africa, the African Development Bank, and others. Then SAPP also received assistance and cooperation from other institutions, particularly Nordpool, the United States Energy Association, and currently cooperating with ENTSO-E as well as other power pools in Africa and elsewhere.

A couple of members have trusted their electricity supply to rely on other SAPP members. Both Botswana and Namibia rely a lot on the import of electricity when having a deficit in their internal generation and demand. The possibility of relying on trade is considered in the planning of their power sectors. Other countries like Zimbabwe also have the policy to allow this consideration even when balancing supply and demand, and that import can always be put into supplement from an economic point of view. The rest of the countries as well have the confidence that they can supplement with imports from their neighbors. The clear decision of member countries that they need to cooperate in sharing their resources created confidence in trade, also the fact that the coordination center was established to oversee that cooperation and coordination also provide confidence that issues will be looked at by the special committees in place and that can address any issues that could arise. It is true that from a political point of

view, countries will always have this inherent requirement of self-sufficiency, but because of the limitation of resources to be able to implement all the generation projects they want to implement, they then end up with a default way that they have a shortage of generation, and when that happens, they are then aware that they can rely on import from their neighbors without any problems, and that is what is happening in the Southern Africa region.

South Africa was keen on the establishment of SAPP and some of the new interconnections that led to SAPP being operationalized, including the connection from South Africa to Botswana and Zimbabwe (then linked up with Zambia). The key role that South Africa plays is mainly being a seller of electricity, which is a bit challenging as they also import from Mozambique. The other key role they play is providing transmission wheeling path for countries like Namibia and Botswana as well as Lesotho and Eswatini. Thus, the grid of South Africa is key to supporting the moving of electricity transmission.

The region has national regulators and then a regional association of these regulators, which is similar to the situation in Europe. The question of the necessity of having a central regional regulator is then debatable. SAPP applies what we call self-regulation, in another way, when it comes to aspects like transmission pricing, SAPP has been able to come up with a methodology and how to coordinate that pricing within itself without having to have that approved by a separate authoritative regulator. The same applies to how SAPP looks at transmission capacity allocation, managing imbalances, and managing congestion in the network. When a competitive market is properly established, then there is no need for price regulation as pricing comes out of the competitive process. What SAPP then needs is to ensure that there is monitoring on the market and surveillance. Thus, the collaboration and agreements between member countries led to the needless of a regional regulator.

SAPP does not supervise any bilateral agreements but only is aware of them and their volumes, especially firm contracts as they take precedent to the market trade when allocating transmission capacity. The other role that SAPP plays is to determine any wheeling charges associated with bilaterals and the losses that need to be compensated. In the competitive market, SAPP does not have a ceiling price per se but in the platform itself, there is a figure just to make sure that nobody will make a mistake of putting an unreasonably high figure.

SAPP's relation with RERA and SACREEE takes a collaboration nature on common areas and not as formal obligations. The collaboration with SACREEE happens when SAPP is taking renewable energy projects, energy efficiency initiatives, and carrying out studies on the impact of renewables on SAPP's grid. Following an early debate between member countries, SAPP signed a memorandum of understanding with RERA to cooperate and define the areas that RERA has a key role to play and where SAPP can play independently. Right now, part of the cooperation is coming up with the harmonization of grid codes in the region. SAPP has been consulted in the process of transforming RERA into an authoritative regional regulator bsed on study recommendation. SADC has however not yet agreed to this. SAPP encourages the use of renewable energy and this comes in the development of the master plan. However, countries are signatories of the Paris Agreement and are making their own efforts to increase renewables share. There have been efforts to try and give SAPP powers to be involved in regional project implementation as currently these are carried out by member states for components in their own countries. What SAPP is busy with is ensuring the efficiency of grid operations with the impact of renewable energy integration. The next step is to look into how to make it easier for renewable energy to participate in the market as there is more pressure from IPPs now. So SAPP will be looking into how to redesign the market to enable such participation even while these IPPs have power purchase agreements with the utilities. Currently, IPPs have a voting right in SAPP but depends on what issues are being discussed. What you will notice, is that when it comes to operational aspects, the issues become not only about IPPs, but that national

utilities are given a higher weighting in decision-making than non-national utilities. So they are involved but the weighting becomes different. This is obviously because SAPP was formed by the governments and then they want their public-owned entities to have a bigger voice in certain aspects. But issues to do with trading, they all have equal voting in decision-making.

Concerning the effect of the structure of national sectors on regional trade, there is nothing observable at the moment that seems to be affected by the structure of the utilities. Power utilities purchase themselves electricity when necessary. But one could do a comparison with countries like Zambia where you have independent players, like the Copper Belt Energy Corporation, which creates other opportunities as far as trading is concerned but it does not limit trading happening on the competitive market. There might be some issues in the future whether it is needed to open up the market within each country to increase the level of trade but not at the moment. For now, the level of trade is increasing even under the current arrangements.

Trade between members increases when generation is deficient in one of the members while there is excess in other members. Sometimes trade increases due to maintenance, as SAPP provides flexibility for utilities to supplement their generation during the maintenance period. Electricity access to a certain degree could affect regional trade as it affects the demand in a particular country, but one of the challenges is whether each country managed to balance each supply and demand and if not, how it deals with that. SAPP foresees that there could be an improvement in trading by allowing some of the large customers to be able to purchase electricity on their own and we are seeing this happening in certain countries like in the new modified model in Namibia and other countries indicating that it is possible for large consumers like mines. This would potentially increase electricity trading. For SAPP, the new membership categories allow such an opportunity.

Issues with connecting non-operational members are related to getting financial closure on the required interconnectors. Malawi for example has just reached the closure state after years of discussion. For Angola, the challenge is not to just connect to SAPP but for them as a country to be fully interconnected internally. Right now, they are working on connecting their three separate systems while looking into interconnections with DRC and Namibia. For Tanzania, one of the challenges is that it is in the middle between SAPP and EAPP. SAPP plays a role in facilitating investment through its Project Advisory Unit, created under funding from the World Bank, that coordinates preparatory studies for transmission projects, like the interconnection between Malawi and Mozambique, connecting Angola with both DRC and Namibia, and what would be required institutionally and technically for SAPP to be connected with EAPP.

Currently, SAPP balancing market is under trial and is expected to be launched in the second half of this year, 2021. It will create an opportunity to move towards real-time trading. Currently, the shortest time period is an hour in the intra-day market, but after its closure, there is still an imbalance in some countries that could be filled with trading. This is the opportunity that the balancing market will provide for transmission system operators. A futuristic step would also be to include ancillary services, but currently, it is only for energy balance. One eminent challenge for SAPP right now is the connection with EAPP as well as with the Central African Power Pool (CAPP) in the future.

SAPP competitive market rules are confidential and only available to participants. The bidding formats are simple hourly bids and offers with varied volumes and prices for the different hours of the day. the minimum bid is 1.0 MW and these contracts shall endure for any 1 hour on the delivery day. In the Balancing Market, a marginal price for balancing is calculated reflecting the real cost for the involved TSO(s) and Control Area(s) in fixing the imbalance(s). For the imbalance price calculation, the marginal price for the system state will be decisive for the imbalance price. Each of the market participants that are out of balance (either long or short) will pay the imbalance price. Pricing is done on an hourly basis. Congestion in SAPP is mainly

a sign of system constraints in the grid. No participants will get a sale or buy at a price outside their bids due to congestion hence there is no intended disadvantage to participants that may warrant compensation. Participants who are out of balance or foresee that they will be out of balance shall utilize the balancing market to correct the imbalances. All contracts from the market trades are firm contracts and will be settled according to the market traded schedules and prices. Any deviations after the markets have been concluded will be handled through the imbalance process for any imbalance that does not fall under the Emergency Situations.

E.2.2 Interview 8: Eugenia Masvikeni

Date of Contact: 22/04/2021
Date of Conduction: 07/05/2021

Background

Eugenia is the renewable energy expert for the SADC Center for Renewable Energy and Energy Efficiency (SACREEE) and currently coordinates the World Bank program on Accelerating Regional Energy (Transformational) Projects (AREP) which is managed by the Southern Africa Power Pool (SAPP). The project seeks to promote renewable energy projects through support for national capacity building (for planning and decision-making)policy development, knowledge management and financing through investment promotion.

SACREEE

SACREEE was established in 2015 by energy ministers as a subsidiary of SADC for increasing access to modern energy services and improve energy security in the region. The center promotes universal access and concerns with addressing climate change challenges. In 2017, SADC ministers mandated SACREEE to support monitoring the implementation of the regional renewable energy and energy efficiency strategy and action plans. Thus, the center's programs are also linked to national development plans. The center does not develop projects but facilitates them through programs like the Renewable Energy Entrepreneurship Support Facility in collaboration with the International Renewable Energy Agency (IRENA) to unlock the potential of the private sector and medium enterprises as well as easing financing with various development finance institutions (DFIs). The center works through national focal institutions that are primarily the energy ministry or the department of energy in the country.

SACREEE relationships with SAPP and RERA are key for large-scale renewable energy projects. Some of these projects are large enough that they need grid access. The network needs to accommodate the intermittency of renewables. Therefore, it requires cooperation with RERA and SAPP. SAPP's role is particularly important to ensure sufficient transmission network. However, SAPP's mandate does not include implementing regional mechanisms for supporting renewable energy like Feed-in-Tariff or others. It is up to member countries to decide on their national supporting mechanism for renewable energy and SAPP needs to enforce the grid to ensure these mechanisms can be adopted infrastructure-wise. SAPP's role is to promote regional energy trade but not quite renewable energy beyond their grid planning. SACREEE as well cannot implement regional policies and only support member countries on their national policies.

Renewable Energy in SADC

In terms of potential, the highest is solar energy and it is abundant in most countries. This is followed by wind potential which is especially strong in coastal areas . Then there is hydro in some countries like Angola, DRC and Zambia. Due to the various challenges in the region and especially with the COVID-19 situation, most of the renewable targets of 2020 were not achieved in member countries and the status quo is not different from that reported in 2018 (yet

to be updated with the help of a consultant). Countries in the region at different stages of implementing renewable energy policies but have all started with national targets. Most countries implement tendering procurement processes announced by the governments for the private sector to submit bids. The funding of these projects is provided by DFIs and the capital market. South Africa, especially has a developed financial sector for mobilizing resources. Looking into the renewable energy sector in countries, there is the development component, for example, South Africa requires the community to be part of the projects, therefore, DFIs play a more key role than international financial institutions in that regard. South Africa is particularly ahead of all other countries but in Zambia, similar projects for solar are also funded by the World Bank. There is also the Swedish International Development Agency (SIDA) and Beyond the Grid program. Namibia and Botswana have high radiation and are doing mega solar projects financed by Power Africa, USAID.

The tendering procedure in South Africa takes two stages, the first is the pre-qualifying exercise that looks into the eligibility of applying developers against the standards of the required renewable energy technology, then if they are qualified, they submit a bid to be considered in terms of technicalities and finance. The tariff is usually the key to determining the winning bid. The tendering happens through bid windows. Currently, they reached window 5, where the government announces the capacity quota and the technologies to be procured. The process of licensing and permitting take place much earlier in the project development process and often start ahead of the bidding process as it takes time for approval. Initially, Feed-in-Tariff was introduced but then moved to the tender process as a more competitive and transparent mechanism. South Africa has a big market and the process is relatively complex and involves legal and technical advisories. Other countries are following South Africa's procurement model, however, at a more simplified and less costly scale.

In Southern Africa, there are many challenges in the field of renewable energy. To begin with, we have a dual economy in which there is urban access and rural access. So first, you would like the rural access to catch up with urban access and then also deploy renewable energy with productive use in order to create incomes for people to access energy in a more sustainable manner. This brings us to the issue of financing that is still challenging. In terms of capacity, we do have adequate skills to implement these projects but we still need to improve domestic policy environment. One of the key bottlenecks is the institutional arrangements. Procurement process, outside from South Africa's dedicated office for procurement, in many countries is lagging and lack of standardized and systematic approach for arranging the legal contracts and the power purchase agreements. Issues also include land rights, permitting, and consent processes all tend to be protracted and not always clear. Some countries are also promoting fossil fuels that compete with renewables and there is a lack of policy commitment in view of what happening on the ground.

E.3 WAPP INTERVIEWS SUMMARY

E.3.1 Interview 2: Elias Zigah

Date of Contact: 16/04/2021
Date of Conduction: 20/04/2021

Background

Currently, Elias is a researcher researching energy transition in Sub-Saharan Africa with a focus on market designs. Research expertise in Africa energy systems, regional integration, and energy transition.

Regional Integration

ECOWAS went through a smooth transition over the period from an organization, to a commission, to now having a president and chairman of the body but it has not reached the point of having the supranational institution that can really have the power to ensure decisions and policies are been implemented by member countries (in comparison to what we find in the European Union). There is a resistance to give institutional power to ECOWAS by member countries. Thus, the lack of supranational power makes it difficult to adopt a unified approach to the energy transition. One reason for this is that members' institutions are not well involved in the decision-making process which is part of why the supranational power that can ensure equal representational of member bodies is absent.

Major challenges for ECOWAS:

- The lack of supranational power to enforce decisions as there is no binding power or mechanism to oblige member countries to the implementation.
- The fear of losing national supremacy that member countries are afraid of if delegating authority to ECOWAS. This is particularly concerning the national resources in the region.
- The lack of commitment from member countries to adhere to regional policies, especially renewable energy policy.
- The financing capabilities of ECOWAS are still primitive which contributes negatively to policy implementation and the inadequacy of the regional transmission network connecting member countries.

As much as there are challenges, ECOWAS is doing well in terms of facilitating trade among neighboring countries, the West African Gas Pipeline from Nigeria to the coastal countries is an example of ECOWAS trade facilitation and promotion for a market energy system, another example is their embarkment on some regional infrastructure transmission line projects. With this support, WAPP will eventually overcome the current challenges and achieve a regional market. In terms of policies for energy transition and energy efficiency as well as standards for appliances, ECOWAS is performing well at the moment and there is no lack of ideas and initiatives. Here, the European Union is a strong influencer to ECOWAS and usually helps in intensifying policies through agreements for facilitating trade and adoption of energy transition policies. Yet, the issue remains with the enforcement mechanism and the political decision, so ECOWAS can still do more.

This is clear if you look at the past five years, nothing has significantly changed in terms of energy consumption and capacity despite having sound policies and initiatives that can easily

facilitate the energy transitions, so why they are not translated to actionable projects? that is the main issue in the region, the lack of implementation and commitment. Of course, there are other factors like the economic situation of the countries; the low GDP of these countries, and the low turnover and revenues to drive these policies home. But even for policies that do not require much finance to implement, the enforcement mechanism is not in place. An example of this would be Ghana that wanted to implement 10% renewable by 2020 (the master plan of 2015), but by 2020 Ghana added around just 1% to the generation capacity while during this period the capacity has doubled. Thus, there is no lack of finance but commitment. Additionally, the needs of the country at a given time play a role in setting the priority of the government through a different appraisal system, which was indeed a challenge for Ghana at that period. So in the face of challenges, countries do not commit to renewable policies and energy transition. These are some of the conflicting interests within member countries that easily undermine the overall regional policies with the lack of regional enforcement.

The markets in the region are not well-developed, even in some countries that followed the standard textbook model for liberalized market creation, like Nigeria and Ghana, these are not fully liberalized and the state still controls the market, influences the electricity price and their state-owned companies which have market powers. Hence, the competition is compromised in these countries that are considered best-case scenarios, so the situation is worse in other countries that are still operating in a vertically integrated structure. This is a significant setback to driving a common power pool that would facilitate renewable energy. Additionally, the regulatory body of most of the countries is not independent to make decisions irrespective of the political interest. For instance, Ghana Energy Commission (the regulator) is not fully independent according to the framework of the World Bank because of the appointment from the president and taking authority from the minister and so on. Thus, there is much influence in the activities of the regulator. Consequently, the regional regulator is not fully independent by this chain of dependence on the national regulators.

The case of ECOWAS is not special, in the entire continent of Africa, there is a lack of a regional approach for the energy transition. There are many collaborations in the different regions, like the South and the East, but the only way to ensure the enforcement is the share of commitment among member countries and produce tangible actions. Member countries ought to understand that implementing these policies is for the greater good of the entire region. For West Africa, WAPP has a role to facilitate the energy transition in the region by operating as a common front for regulating energy issues and the adoption of renewable energy. The strength of the regional body, ECOWAS, impacts the decision of member countries and WAPP.

E.3.2 Interview 3: Sergio Portatadino

Date of Contact: 06/04/2021
Date of Conduction: 21/04/2021

Background and TBI

Currently, Sergio is the technical lead and deputy chief of party of the Senior Advisors Group (SAG) at Tony Blair Institution for Global Change (TBI) and he's based in Abidjan, Cote d'Ivoire. SAG is the energy program that TBI runs in partnership with Power Africa, the US program to support the electrification of Africa. It is important to note that TBI is a nonprofit organization which support world's political and economic leaders building more open and inclusive societies. SAG is focused on sub-Saharan countries and the program entails sending embedded advisors in Ministries of Energy to support local authorities implementing their strategies to develop the energy markets. TBI does not invest directly in infrastructure but provides policy research and advisory support on the ground. SAG is currently working with the Governments

of Senegal, Nigeria, Burkina Faso, DRC, Kenya and Mozambique and with regional institutions, such as the West Africa Energy Regulator (ERERA).

TBI has been working for many years in West Africa to help advancing the national markets towards a single integrated one. In 2019, TBI published the West Africa Power Trade Outlook that shows the benefit of trade and the conditions for achieving it, which could amount to $32 Billion in 10 years. The trade is also expected to have a positive impact to reduce carbon emission significantly by 2030 and save about 23 million tons of fuel oil. Following this, the institute worked with the regional entities (such as ERERA) to create the favorable conditions for trade to happen. Hence, they work on improving regulation that concerns the transmission of power through two ways: the first is a top-down approach by working with ERERA, the regional regulator, to help implement a trade-enabling regional transmission tariff (e.g. through the organization of workshops in partnership with leading academic experts); the second is a bottom-up approach targeting specific transactions between countries to ensure they follow best practices and the regional regulation (e.g. OMVG deal between Guinea as a power exporter and Guinea-Bissau, the Gambia, and Senegal as importers). They work shoulder-to-shoulder with the governments of these countries as the real power remains in the hand of the national governments.

WAPP

The integration of national energy markets implies having an overall strong political context but at the same time also losing some sovereignty over the national market, and sometimes politicians and national companies are not that keen to lose the power of control over the evolution of their sector. The development is there, maybe it is slow compared to outside regions of Africa but it is going in the right direction and everybody has something to gain, especially considering the government subsidies to the utilities and final users tariffs (all below cost recovery) in these countries, so there is a lot to save from the public budget that can be used for other essential services. Despite having some countries exporting and importing, all of the WAPP member countries are worried about the security of supplies and trust between each other needs to be strengthened, which is the critical constraint in West Africa. TBI is working on making these countries reconcile the technical and economic analysis with the political decision and how to manage the risk of losing national supremacy and security of supply by making firm contracts and be compensated for unreliable supplies.

One contributing factor to this, some bilateral contracts between neighboring countries are not firm. The exporter commits to selling as much as possible and the importer buys as much as it can. However, when the exporter shut down a line for technical reason, it cascades a blackout to the importer which then becomes problematic as the quality of supply becomes no longer reliable. As a result, the importer starts to feel endangered and work to be independent even if that could be more expensive. In this process, the benefit of trade is lost in return for the security of supply. Thus, there is a political role here. Also. the mistrust is mutual as many times the exporters are not paid and they do not consider the importers reliable as well. This is one of the sides that TBI works on by looking into the operational side and the political one. WAPP and ERERA can play a role in solving this, but they are still not totally empowered. However, generally there is an issue with enforcement in the region, ECOWAS is still weak and lacks sufficient power. As an example, two years ago, Nigeria decided to unilaterally close its border even though it was not allowed to do it, but nothing happened when they did it. So the political-institutional context is that it is much weaker and the rules of law are not exactly implemented everywhere in these countries. In this context, the regulation of WAPP and ERERA still needs to be enforced. But the process is still not concluded, the regional grid code is yet to be approved (later this year), there is also no approved regional transmission pricing model

(with its current inadequate version), and there is still the proposal of having five control zones that however might be dropped. Thus, there is still more to do at the operational level before focusing on the implementation issues, but it is not far.

There are five key dimensions for enabling cross-border trade: institutional readiness, regulatory readiness, operational readiness, commercial readiness, and infrastructural readiness. All of them are in the developing phase. Infrastructure-wise, the development is proceeding well in constructing several lines. International financing institutes and donors play an important role in financing almost all of these projects, examples are the African Development Bank with Desert to Power Initiative, the World Bank, the French Development Agency, the European Investment Bank, the German Cooperation GIZ, and the Islamic Development Bank. But it will take time naturally and also due to the bad security situation in some countries. From a commercial point of view, the situation is more complicated because every country needs to be solvable and none of the public utilities are at the moment. The efforts are still ongoing to convince governments to use cost-reflective tariffs that are not very popular politically in these countries and cause struggles. This is one factor that can accelerate the implementation of best practices to create markets, which the World Bank is working on. Even in advanced sector-organized countries like Nigeria and Ghana, the governments still decide the price in these unbundled markets that does not recover the cost.

For the deployment of renewable energy, the region does not need target policies, the real need is coming up with bankable projects, especially solar and hydro are already the cheapest generation in the area and do not require incentives. There is also the technical issue of intermittency of solar generation that needs to be dealt with for these projects. However, renewables will develop naturally for their economic intrinsic incentives (having reached the grid parity already) but other generations like gas will also be needed, and maybe in the future batteries when they become cheaper but the best option now is gas generation to complement renewables. At a certain point, WAPP needs to decide which role it is going to have, is it just coordination of national system operators, or would it be a regional system operator itself, the latter is possible but not in the near future.

E.3.3 Interview 4: Anonymous

Date of Contact: 16/04/2021
Date of Conduction: 20/04/2021

An expert on the Nigerian electricity market.

Nigeria and WAPP

The population of Nigeria is about 200 million people, if we want to use the international rule of thumb that says 1 kW per person, Nigeria should have at least 50,000 MW to 100,000 MW of electricity supply to electrify the country. Electricity access in Nigeria is a very big issue. As of the second quarter of last year, 2020, the installed generation capacity is about 13,000 MW but the available capacity was only 6,300 MW average generation and just 3,700 MW reached the final users. There are a lot of technical and operational constraints including huge losses in transmission, distribution, and collection. The distribution network itself is limited and suffers from commercially induced low-load-take-off. The eleven distribution companies in Nigeria are rejecting load and incoming power. This is obviously because they have technical issues in the distribution network, but also because they are saying that consumers are not paying and cannot pay for the load. So, these companies have problems with being financially viable.

Nigeria indeed sells power to neighboring countries like Benin, Togo, and Niger. But here is the issue and the deep socio-political debate. When people and companies have no power in Nigeria, why are you selling power to other people? According to the regulator, in the second quarter of last year, 2020, the dues of these neighboring countries were about 13 million U.S. dollars. Among the three companies NIGELEC of Niger, CEET of Togo, and SBEE of Benin, only CEET paid about 4.9 million dollars to the market operator in Nigeria. So why even selling to them when they are not even paying timely? This is what is happening in Nigeria.

In my view, Nigeria should focus on itself before engaging with WAPP, because if you look into the situation in Europe, regional trade happened after countries overcame their internal issues, and then it becomes a matter of optimizing production and improve efficiency. Doing power pool does not make much sense in a situation where you have basic issues like electricity access, lack of cost-reflective tariff, lack of metering (only 40% of the connected people have metering and the rest is just estimating billing), and every quarter there are over 200,000 complaints from people in Nigeria to the regulator and distribution companies.

The reforms in Nigeria basically failed, the amount of power that reached people last year was the same ten years ago, so what did the reforms do? nothing much. Sector viability, electricity access, efficiency, and all that are still the same after the reforms, thus, result-wise the reforms failed. The main reason was the copy-paste implementation of the standard prescription without considering the different situation and starting conditions in Nigeria. Currently, the situation in Nigeria is in between, where you have a single buyer, Nigeria Bulk Electricity Trading company, instead of having a functional wholesale market. Thus, Nigeria is not much different from other developing countries that tried to implement the reforms. Only that now there is more competence in the sector and you have more professionals as privatized companies hire competent hands to try to make profits. But to the normal citizen on the street, no improvement in power supply.

The first thing about WAPP is that it is a lot "on paper" than what exists in reality. Several issues exist today on the ground that need to be solved prior to the establishment of a regional power pool. There are some interconnections indeed and also the West African Gas Pipelines that goes from Nigeria to Ghana for supplying gas for power plants, but the pool is not yet functioning and Nigeria has much to do internally before it can take any leading role in WAPP. Considering that Nigeria is the biggest in the region, the same can be said about many countries in the region. These preconditions and issues have to be solved first, otherwise, you are putting the cart before the horse and again copy-pasting the concept of the power pool.

E.3.4 Interview 5: Federico Bruno Pontoni

Date of Contact: 06/04/2021
Date of Conduction: 23/04/2021

Background

Federico is an energy economist who worked in Africa as a consultant for different companies. He has been working for more than two years now with WAPP and the regional regulator, ERERA. First with CESI (an Italian engineering company) and currently with Tony Bliar Institute (TBI) as an external consultant on regional power transactions in the Senior Advisors Group program. He is working with WAPP on the transmission tariff to define and revise the model based on the high-level resolution agreed upon last year, to be passed eventually to ERERA. On the other side, he is working with ERERA on the market rules as well as CESI on drafting the grid code. The full grid code is needed as the current operational rules are not enough. The World Bank finances the project with CESI. TBI works in partnership with Power Africa and re-

lay on their fund or other philanthropy. The institute provides advisory services and sometimes embedded advisory into African governments without them have to pay the institute.

WAPP

Effectively, WAPP is the collector of all donors' money as they find it easier to channel money through WAPP for feasibility studies, trading, market reforms, operational codes, and standards so that WAPP can gain technical expertise and operate the market. At the moment, they are very active on this. The international institutions are also trying to make EAPP similar to WAPP, but at the moment they cannot. In the end, WAPP is a way for the World Bank to channel money for investments in regional interconnections. EAPP at the moment cannot do that as they are very weak institutionally. The interconnections in the region are bilateral or trilateral agreements between countries, EAPP is invited but does not play a role. But basically, WAPP is in the hands of the World Bank and it is a way for the World Bank to finance the development of the electricity sector in West Africa, reducing the transaction cost instead of going around different countries, even though they have national offices in most of those countries, it is easier for many activities to just finance WAPP. So you do the West Africa master plan, financing the grid code, the operational code, the trading, and ask for feasibility studies for different power lines. So it is a way of trying to reduce transaction cost on the one hand and empowering WAPP on the other hand and also trying to put together the different actors and stakeholders of the sector.

WAPP is stronger than ERERA (weak institution) technically and has a level polity, but it is not particularly powerful when it comes to enforcement or market day-to-day operations. Because everybody wants to participate in the power pool in principle, but in reality, the electricity sector is something that is considered full sovereignty and nobody wants to share responsibilities. Many countries are scared of relying on others for power supply, they talk about trade but the actions they take are not for trade but self-sufficiency and self-reliance. That is why in the end you see few countries that rely on trade and these are small countries, like Togo, Benin, and Burkina Faso. The World Bank is now financing most of the interconnections and it will be on stream by the end of this year or next year because of COVID, but these are minor delays, so in two years the whole of West Africa will be interconnected and then it will be a game-changer because it will become one power system and the power will flow irrespective to trade or not. If you are not able to coordinate fourteen countries, then it is going to be a mess. What you want to avoid is opening the line without knowing the technical rules or whether they are enforced or not on the national level.

Based on my experience, national utilities are always involved and participating but at the same time it is because whenever they are participating they receive per diems, which are fundamental to raise participants. But the fact that they participate does not mean they know what WAPP is talking about. For example, whenever you do a project and have like ten meetings, sometimes you get ten different people showing up representing the same utility which means nobody is really following the project, irrespective of the fact that it is a regional project. So the project is advancing and WAPP can adopt a new rule, but nobody in the utilities is fully aware of what is happening. This is of course not true for all utilities but for some. The utilities on the one hand see WAPP as something important because through WAPP you can get money and things done, But it is clear on the other hand that they have a national strategy or national approach, they do not feel that they have to coordinate or share data with WAPP. For example, WAPP developed a protocol with SCADA systems, but it is clear for instance that Nigeria's utility is not interested in sharing the protocol. Particularly, the utilities of the three biggest countries Nigeria, Ghana, and Cote d'Ivoire have an ambiguous approach towards WAPP; on the one hand, they can see it useful as they can export excess power, on the other, they do not like the idea that they will be constrained and giving control by WAPP. If you read all the rules and regulation, there is always an ambiguity between national systems and the regional system.

In reality, these two are not separate and if say WAPP is responsible for the regional system, it means it will give commands to national utilities and this what they do not like, that is why you will never find in any WAPP document a clear statement of the hierarchy of decision but they will always talk about coordination and harmonization. On the political level, relying too much on others is not acceptable. Countries with excess capacity say they will export but it is a matter of justifying why they invested in too much generation, while countries that import even if it is convenient for them, their national plans are not aligned with regional plan and they seek to be self-sufficient in five or ten years. One reason could be that on the political level it is easier to show investment on generation and not transmission line, as they are hard to see while generation could be claimed as a success.

In my opinion, the World Bank must find a way to protect its investments and be paid back. Investments carried out in WAPP are in a way protected contractually and financially. This gives priority to international investments in interconnections with respect to the development of the internal network. The push for a supranational power pool is also a way of protecting regional investments and establishing protecting rules. In my experience of WAPP, it is not even a good idea. Because the structure that has been put is too complex compare to the volume and the base we have. That is why it is just on paper but nothing is applied. We are supposed to be done with market phase 1 now, but if you look into the codes and market rules of phase 1 comparing to what is happening, we are not in market phase 1 but before that, because companies are not using the bilateral agreement model nor the tariff, there is no capacity allocation mechanism, WAPP ICC does not calculate the net transfer capacity and so on. It is believed that the structure will be enough when all major projects are operational but I do not think it will be the case. The way in which the World Bank is influencing these processes is that they think it is easier to have a supranational body that favors harmonization and interconnections. The interconnections are being built, but the harmonization and regulation are just on paper with nobody applying it. Say by 2023, this problem will arise in all its magnitude because then West Africa will be entirely connected and it is highly unlikely that they will be able to synchronize. Many lines will, therefore, be open. In my experience, there is a mismatch between the World Bank in West Africa, the Competent Territorial Offices, and the World Bank in Washington. The power experts in Washington see the rules on papers as an excellent market organization while those on the ground are only following construction and reporting back the progress but not the application of those rules that are on papers.

You can try to build the market top-down as in the case of all power pools, except for SAPP that I think is different (which is not the best practice but it is working), but in reality, regional integration comes out of necessity. Right now, they are building something complicated in an attempt to mimic something similar to ENTSO-E but nobody really feels the need for all of this. In reality, most countries are somehow exchanging electricity even without having a grid code, operating vertically integrated, have no system of ancillary services, and in probably six countries there is no primary reserve or secondary. Four countries, Guinea Bissau, the Gambia, Liberia, and Sierra Leone are technically operating on low voltage and have no transmission network. Therefore, the alternative way is a bottom-up and rapidly increase the technical and operational capabilities of the utilities. First, common rules for operation and then on top of it you add market rules and other complicated systems. Because as you integrate, you need more sophisticated things which was the European process: first it was engineering and technical development for synchronizing grids, then markets were liberalized and rules were developed moving from state-bilateral agreements to regional integration which only then you need rules for things like transmission allocation and so on. With WAPP, solutions are created without having problems. It is a regional market design and rules and the market is simply not there.

WAPP is something between ENTSO-E and a regional market operator, even though currently they are not doing anything. Donors give money to WAPP to do studies and manage the in-

vestments. Then it is the body that elaborates on the technical rules that become resolutions of ERERA, which are in fact are elaborated by consultants paid by WAPP. So WAPP receives all the money but not ERERA. Another way the World Bank influence WAPP is when looking into the system operations. WAPP ICC is the system market operator and is responsible for the five control areas that do dispatching. The World Bank is financing all the equipment that will be installed on the network of all utilities but that will be owned by WAPP to allow the dispatch centers to carry out the system operation. This means instead of helping countries to have their own dispatch centers, they are imposing some countries, like Guinea Bissau, to give up the function of system operator in their network in return for having free equipment. That is why WAPP has power and some countries cannot disagree but do not implement what WAPP says. ERERA, on the other hand, did not have a headquarter until recently and are only invited at the very latest stage of drafting the documents by WAPP, then it takes them as resolutions. This is not surprising as no single national regulator has real power but mainly functions as a checklist. This is true even for excellent regulators like in Senegal where they calculate the cost-reflective tariff that should be applied but then the government applies another tariff. It is interesting because when you look into the balance sheet of SENELEC you see the amount of profit to be gain when applying the regulator tariff but what they get in reality is different when applying the minister tariff, and instead of profit they have a loss which is a subsidy the government has to give. This subsidy is not even paid at the end, which makes SENELEC in financial distress. It is the same story with ERERA, you have some rules for dispute resolutions but there is no real procedure nor a way for ERERA to enforce the regulation.

ERERA is composed of representatives from different countries who are appointed by ECOWAS executive board and are independent of national utilities but could be related to national regulators. In theory, national regulators should regulate the market at the national level and ERERA regulates all the aspects related to cross-border transactions. In reality, neither of which is happening and the distinction between national and regional markets is not clear. In terms of rules and market, in general, national utilities have very low technical skills. It is understandable as there is no regional trade. On the side of ERERA, there are more engineering skills than regulatory market skills. In WAPP, there are not many engineering experts and in terms of market perspective, nobody knows anything.

There are many positive things from the current development in WAPP, but it is necessary to be aware of the false hyper-positive narrative coming from the World Bank and other donors because they like the papers they finance. Many things are claimed but they are not there. It is not the fault of WAPP or ERERA, they are doing their best in providing information, training, informal cooperation, networking, forums for discussing problems, and so on. These are all the basis for integration but a decent market might not appear before 2040 and it is fine. The false narrative of integrating the market by 2025 as PJM is a donors' problem because they have two- or three-year budget and they have to overshoot and over-claim. In the reality of an over-complicated world, politics, resource and financial constraints, WAPP is efficient in doing something important and has been delivering. If you look at it, it does not make sense to let WAPP responsible for installing big solar parks in Burkina Faso, Mali, and the Gambia but it is because it was asked to by the World Bank. WAPP is responsible for the feasibility study, tender, and procurement but it is interesting because it is unknown who will sign the PPA. In my opinion, it is unlikely that WAPP will do that.

E.3.5 Interview 11: WAPP Staff

Date of Contact: 05/04/2021
Date of Conduction: 20/05/2021

Background

Viviane Ahossi is a legal assistant at WAPP, Kam Sie is a market expert at WAPP Information and Coordination Center (ICC), and Ibrahim Soumana is a project coordinator at WAPP secretariat.

WAPP

WAPP regional projects include many stakeholders, for each country we have at least one utility and the energy ministry. Coordinating between stakeholders is challenging and sometimes can be a source of delay. While including many stakeholders could advance projects parties have different interests and it might take some time to have them on board. Another delaying factor is financing. Usually, the infrastructure is financed by the technical and financial partners (TFPs) while the Resettlement Actions Plans (RAP) and the Environmental and Social Management Plan (ESMP) are financed by the countries/utilities. Given the limited resources of the countries, the financing of the RAPs and the ESMPs constitute a source of delay in the implementation of the projects. WAPP mobilizes TFPs, the resources are limited and financing for project environmental compensation is countries' responsibility which is even more challenging for countries as it is usually not included in the money received by the partners (the World Bank is trying to help with that). Organizing private investors forums to complete the financing offer can be considered to complement the current strategy. Depending on the project structure, in some cases, countries take loans from the partners and then direct them to WAPP implementation unit. However, compared to other power pools, WAPP structure is efficient in mobilizing finance for projects and conducts at least two meetings with partners per year. So far all resources were mobilized successfully but delays happen. The five isolated countries will be connected through two main projects:

- **Interconnection Lines of CLSG Project** : Expected first quarter of 2021-2022, this project will connect Liberia, Sierra Leone, Guinea to the whole network.
- **Interconnection Lines of OMVG Project** : Expected in 2021-2022, this project will connect Guinea, The Gambia, Guinea-Bissau to the whole network.

WAPP master plan is validated by ECOWAS and endorsed by all member states. Therefore, it eases the implementations and getting national approvals. Some projects are directly implemented by countries even being classified as regional projects and included in the master plan. In such cases, WAPP does not have control over the timeline and implementation. For the next master plan, we will look into the bottlenecks inside the countries. Even while having enough interconnection capacity, internal capacity restricts regional trade. Thus, the definition of a regional project could be extended to internal lines that impact regional trade. This will be looked at later when WAPP has a functioning market to identify important corridors. But WAPP is in charge of all the projects in WAPP master plan either directly or indirectly by closely follows up with national utilities. Depending on the project structure, projects that are classified as a 'special purpose vehicle' will have a specially created company to implement the project and operate the infrastructure after commissioning. Other projects are implemented by countries through loans (concessional loans can also be coupled with grants) from the partners with WAPP project implementation unit. Other projects can follow a PPP framework like the solar parks in Burkin Faso and Mali (later maybe in the Gambia, and Niger). Preparations are currently being made by the transaction advisor for auctioning these two projects and the private party will operate them (until now WAPP does not invest). Having national projects under WAPP master plan eases financing and donors are usually interested in regional projects. The construction of WAPP ICC is at 77% and will be fully functioning in December 2021.The equipment of the building is at 64%; The equipment and test are expected to be completed by March 2022. Projects were generally delayed due to the COVID-19 pandemic, but the commission will

be sequential by the end of this year.

The number of WAPP members is always changing every year and last year was 28. WAPP market is currently in phase 1 and competition is through bilateral agreements, since there are enough transmission capacity and options to buy from different parties. The competitive market, the day-ahead market, will be in phase 2, 2023 and the spot (intra-day) market will be in phase 3. In the current phase, bilateral agreements are made by countries and WAPP charges the transmission tariff and provides the capacity. The bilateral agreements will continue to be there and the other market platforms will be complementary to it. WAPP will supervise what the countries are doing to ensure the plan is in accordance with the stability of the entire network and coordinate the dispatch of the countries according to the schedule. The market as of today does not contemplate the type of energy and there is no special consideration for renewable energy but we are targeting special operations for renewable energy in phase 2. Right now, the rules for dispatch and the market does not give advantages for renewables. There is currently a huge program in West Africa to integrate renewables, especially solar energy. In the future, challenges will be to reinforce the corridors to expand the trade and through the market, WAPP can determine these lines. Maybe in the future WAPP could own some of the infrastructures that can be financed by the market when countries are not interested in these corridors as they could be for wheeling the power.

E.4 EAPP INTERVIEWS SUMMARY

E.4.1 Interview 1: Saliem Mohamed Mahgoub Saliem

Date of Contact: 19/04/2021
Date of Conduction: 20/04/2021

Background

Currently, Saliem is a partner and managing director of NAVITAS engineering and contracting, former acting general manager of Sudanese Electricity Transmission Co.Ltd (SETCO) from October 2019 to February 2020. Expertise in the business of the electrical transmission network and grid projects; a former manager at Siemens and General Electric; and worked with the transmission utilities in Sudan and the United Arab Emirates.

During his work with General Electric, he devised a strategic plan for electricity in Sudan. Afterward, he was contracted by SETCO to execute the first duration of the plan, the emergency phase. His plan included the role of EAPP and how can Sudan benefit from regional trade. Thus, during his tenure as an acting general manager of SETCO, he was actively involved with EAPP to discuss the membership of Sudan through SETCO among other topics. Sudan can benefit from EAPP very much and quickly, providing that it is driven in the right way, which is unfortunately still not happening but it is moving in the right direction generally.

Sudan

His current company provides projects aligned with the IPP (Independent Power Producer) and PPP (Private Power Provider) principles. Factors that negatively affect the deployment of IPPs and renewable energy in Sudan:

- The lack of awareness and mentality for large-scale diffusion and exploitation. This is both on the governmental and citizen levels, particularly, the mentality of the decision-maker and senior staff is problematic and technology resistant.
- The price is unaffordable for small-scale projects and the lack of support from the government for large-scale affordable projects.
- The inadequate quality of equipment and engineering in Sudan, the quality gap is especially exacerbated by having incompetent utilities to lead the development.

EAPP

EAPP provided studies, analysis, and business plans for member countries, especially when it comes to interconnections and cross-check studies between neighboring countries for power trade, they can also supervise these projects. EAPP is very keen for Sudan to be an active member and committed to provide support, the issue is with the disinterest of Sudan. There was a period when Sudan was not a member of the steering committee nor has a representative in the council of ministers, despite being a founding member. The Sudanese staff becomes interested just once they are invited for a meeting in Ethiopia and only for the per diems they receive when traveling.

EAPP has three financing sources: member fees for the operation, support received from the regional institute, and projects funding from financing institutions (like the European Union that funded Sudan renewable future 2025). Sudan did not pay the member fee for five years, among the work was the discussion with the general secretary about the amount to be paid

(requesting a discount and arranging installments). EAPP does not exclude its members for solvency issues, they can still attend but they are not given support. EAPP members retain their membership as long as they are members of the regional institute. Hence, EAPP has a sort of flexibility in dealing with its members.

At that time, the Independent Regulator Board (IRB) was conceived and deemed necessary for regulating the trade agreements between countries, especially when it comes to the penalties in case of system failures. Thus, the idea was to have a member from each country and who would be independent of the members. One of the issues is that some member countries, like Sudan, do not effectively have a national regulatory body to nominate its staff for the IRB. Consequently, the absence of the IRB is the main factor for delaying market development.

The current instability in the geopolitical situation, especially between Ethiopia-Sudan-Egypt, has a negative effect on the decision-making of EAPP. However, providing that the IRB exists and there are well-established regulations, this effect can be decoupled and the political disagreements will not affect the trade as long as the economic incentives are present (win-win situation). The conflict of the Grand Renaissance Dam depends on the negotiating parties, if following the economic principles, this should not affect the energy trading from Ethiopia to Sudan.

The bilateral agreements between neighboring countries can be done despite the political differences. The political situation can affect these agreements but usually does not stop it when the economic benefits are attainable. Sudan had an agreement with Egypt for exchanging 70 MW without agreeing on the price. EAPP should have a leading role in facilitating these agreements. It is already agreed that all the bilateral agreements will be communicated to EAPP to advise the countries on improving (concerning the amount, penalty, and price) them and bridge the gap between countries but without having the authority to change them. Yet, EAPP needs to build up its staff and qualifications to adequately fulfill its regional role.

The electricity is considered as national security for Sudan and Sudan should have sufficient capacity to cover its demand. The trade is seen as a way to make use of the excess generation from neighboring countries. Thus, Sudan does not see the benefit of the short-term trading of electricity while the government should be pushing more for EAPP. In contrast, the situation in Egypt is better and there is satisfaction about the performance of the national utilities. This makes Egypt not keen to push for short-term trade but rather for bilateral agreements. EAPP should understand the position of each country and their interest in order to incentivize their participation.

E.4.2 Interview 9: Geoffrey Mabea

Date of Contact: 05/05/2021
Date of Conduction: 07/05/2021

Background

Geoffrey is the executive secretary of the Energy Regulators Association of East Africa (EREA) based in Tanzania. EREA supports national regulatory associations through harmonization of energy policies, capacity building in the region, sharing of information, and supporting the establishment of EAPP. Initially, there was a direction back in 2011 to establish an East African Community (EAC) power pool to cover the six countries. However, it was agreed by the council of ministers to work with EAPP for achieving better economies of scale. Thus, EAC signed an MoU with EAPP to cover the whole region. EREA is establishing a center of excellence on energy regulation to support the entire region with capacity building including EAPP members.

EAC and EAPP

EAC member countries are at various stages of liberalization. Kenya and Uganda are the most advanced in this regard. Both liberalized the generation while the distribution is still under one supplier, a monopsony. Kenya is slightly advanced in that they have policies allowing the generators to sell directly to large consumers, a sort of quasi-liberalization in the distribution sector. In Tanzania, multiple generators are also selling to the single buyer TANESCO. Rwanda is at an early stage of liberalization with multiple generators and a distribution company. Both South Sudan and Burundi are working on a vertically integrated structure. All countries have an independent regulator except South Sudan. In Tanzania, there is an additional independent regulator for the region of Zanzibar. In all countries, prices and power purchase agreements are regulated. Renewable energy policies are found in multiple countries. Feed-in-Tariff is found in Kenya, Tanzania, and Uganda. There is also renewable energy auction and obligation.

The harmonization efforts in the region are to do with finding methodologies of arriving at tariff and not a single price (due to countries' specific factors like inflation and risk index). EREA develops tools and frameworks for this harmonization between member countries. This also includes encouraging open access to the network and developing standards for grid code to enable regional trade. Bilateral agreements are found between member countries like Kenya-Tanzania and Burundi-Rwanda. There is also the first trilateral agreement between Kenya-Uganda-Rwanda. The regulation of these agreements is up to the involved parties and their national regulators. Initially, a power agreement was signed between Rwanda and Kenya and then the wheeling agreement between the three countries.

EAC members have the political willingness to participate in EAPP, despite the protraction of its establishment due to funding and capacity issues. We had a number of ministerial meetings with EAPP and the IRB in the past which were successful in my view. Of course, there are some issues like the case of Ethiopia and Egypt on the dam, but on the bigger picture, the political will is there. EAPP does not need to start with all member countries at once, but with the existing interconnections and then extending. EAPP shadow trade was computer-based and before it can be manifested to physical trade, we need to have the physical infrastructure in place. Currently, the transmission line between Kenya and Ethiopia is under construction as well as one section of the transmission line between Kenya and Uganda. Before actualizing the market, there needs to be a regional regulator. We have the IRB but one person is running it right now and its strategic plan will be approved in the upcoming months once the ministers meet. Then we need all the relevant documents of market rules, grid code, and a model for purchase agreements. There are also the technical aspects as to what is the percentage of energy to be traded in the market (opposing to the one running on bilateral) and what kind of market platform to be adopted. Once we have the infrastructure and the SCADA system in place, we could start with a market between Ethiopia-Kenya-Uganda but beyond that, it is not possible.

EREA is a strategic partner to IRB in that it provides capacity building. The IRB is composed of the director-generals of the national regulatory authorities of the countries. But only one person is coordinating the IRB secretariat and hence it needs to expand to include other departments. Some members of IRB are also members of the executive council of EREA. The members of EAPP are currently the national transmission and generation companies.

EAPP is not anchored in COMESA but it is a specialised institution within the COMESA region. In the spirit of regional integration, COMESA signed an MoU with EAC and IGAD to cover member countries of EAPP. As a matter of fact, EAPP is not an official institution of COMESA but it is owned by the three economic communities EAC, IGAD, and COMESA. COMESA serves as an umbrella but without the MoU with EAC, Tanzania would be left out. The agreement with IGAD also includes Somalia that is currently not a member of EAPP. Bring-

ing these three economic blocks together is a challenge itself but it is something that cannot be avoided. As for COMESA, they participate in some of the activities in regional harmonization but they do not interfere with the operation and objectives of EAPP. EAPP does not report to COMESA but to the council of ministers of member countries.

One of the agendas of EAPP is indeed to facilitate renewable energy integration and it will play a key role in ensuring stability for large-scale integration. EAPP's role is also important as they will develop the grid code that has the specific elements through which renewables can be integrated into the network. Therefore, it is essential to consider renewable energy in the process. Otherwise, the system may not support the integration. The past grid code developed by EAPP is again under review and the market rules are yet to be developed from some existing drafts. But this might not take long as EAPP can make use of SAPP or WAPP experience. And there are already plans for coupling EAPP and SAPP through Tanzania.

E.4.3 Interview 10: EAPP Staff

Date of Contact: 06/04/2021
Date of Conduction: 17/05/2021

Background

Hieromini Ireneus Shirima is a Power Economist; working with EAPP. He has worked with EAPP for more than four years now and previously he worked with the national utility of Tanzania, TANESCO. Haitham Ahmed Hashim is a power system expert, working with EAPP in the grid coordination unit and previously worked with the Sudanese Electricity Transmission Company (SETCO).

EAPP

EAPP employs its staff on a competitive basis and most of the time the staff come from the national utilities as they are more experienced, more aware of the power sector situation and more equipped to advance EAPP's objectives. Most of the time the qualification requirements include previous experience with the utilities that is why very few of the General Secretariat staff are not previous employees of the utilities. The employed staff of the EAPP General Secretariat do not represent their utilities but work for the General Secretariat. The member utilities' representatives are members of different EAPP Technical Committees.

The main factor that contributed to the establishment of EAPP is the economic benefits of pooling the resources together in a large electricity market where countries complement each other, that is what the ministers responsible for energy had in mind when they decided to establish EAPP. EAPP was established in 2005 and its objectives were set by the Council of Ministers and in 2006 it was adopted by COMESA and is now serving as its special organ for energy issues. However, it should be noted that not all of EAPP are members of COMESA. That is why EAPP also has MoU with EAC to include Tanzania which is not a member of COMESA. EAPP also has MoU with SAPP. The EAPP currently has eleven (11) member countries who signed the Intergovernmental Memorandum of Understanding (IGMOU), and fifteen utilities who signed the inter Utility Memorandum of Understanding (IUMOU).

EAPP does not report to COMESA but COMESA sometimes facilitates grants and financing with its development partners for EAPP activities. The international institutions have been playing a critical role in facilitating EAPP activities. For instance, recently, the World Bank has granted EAPP about $10 million as technical support. Most of the supports for EAPP are received in the form of grants but not loans. EAPP does feasibility studies for transmission lines

between countries and it is also involved in the technical issues of interconnection projects. Currently, EAPP is participating in the technical team of the feasibility study of the interconnection between Tanzania and Uganda which is funded by the World Bank but through EAPP. Other interconnections between Ethiopia and Kenya and also between Uganda and Rwanda are all being constructed and soon will be commissioned. Delays in the implementation of interconnections projects as earmarked in the regional master plan study may be due to organizing for finance but not during the construction phase.

EAPP monitors the performance of interconnectors in the region to ensure compliance of high availability and reliability and in the course of monitoring; the EAPP always prepares quarterly interconnectors performance reports by using inputs from member countries. Bilateral agreements are now left for member countries but EAPP is currently developing a short-term model PPA to enable countries to trade easily. The model PPA is not currently used but at an advanced stage to make countries use it. It will ease trade between member countries during generation shortages in some countries and reduce the paper works required before the actual trade is done. The draft model PPA was presented to the steering committee and the council of ministers but yet to be approved as the legal department of the national utilities and the national regulators are required to review the draft.

The regional regulator, IRB, is involved in approving wheeling agreements between countries. The regional master plan of EAPP is made from inputs from national master plans of member countries. The master plan advises on projects that contribute to regional trade and have more benefits for countries. Initially, the agreement between the ministers was to allow national utilities to participate in the regional power market, however, in the future, it might change to include IPPs. That is why currently the structure of the national power systems will not affect the power trade in EAPP market and also because IPPs have to sell to national utilities then the national utilities trade regionally. The EAPP's objectives are to be advanced by the utilities themselves, not the general secretariat. Most of the utilities do not have a department for trade because the market is yet to start. EAPP runs training programs for its member utilities. The structure of EAPP is now under review and it might include a market committee. The general secretariat has a market unit but only for coordination, the technical committees are the ones who make decisions on technical issues. The plans for establishing a coordination center were abolished and the functions will be taken by the general secretariat under the grid coordination unit and it will be the market operator.

The shadow trading operations in 2015 were limited to only two interconnections, now EAPP is about to carry out do shadow trading operations on all the existing interconnections. The shadow operation itself is not sufficient to start physical trade; there is a need for grid code, market rules, wheeling agreements, and other preconditions. All these are now being developed in parallel through consultants along with the EAPP market design. In the future, such activities are to be performed by EAPP technical committees just like what is happening with the power balance statement. EAPP prepared and published the first Power Balance with assistance from a consultant but future power balance statements will be prepared by EAPP Technical Committee for Planning. Right now, EAPP is reviewing the previous market design with a help of a consultant by assessing five market models which are deemed applicable for EAPP and see what can be adapted by EAPP. The market models are European style self-dispatch market, SAPP style "national control with regional cooperation" market, Namibian style "Modified Single Buyer" market, PJM central dispatch market and Regional Electrical Interconnected System for Central America (SIEPAC).

There is direct cooperation with SAPP to couple the two markets through Tanzania but it is tricky to define on which borders the two markets are connected because Tanzania is part of the two power pools. A study was already conducted to assess the impact of connecting the

two power pools and EAPP and SAPP jointly visited TANESCO for identifying what is needed legally, commercially, and technically to connect the two power pools. EAPP currently does not have a SCADA system for running the market. It is currently in the preparatory phase for the design, engage consultancy service and finalize the design. The procurement will start by the end of 2022. Through the SCADA system, the performance of all the EAPP region interconnectors will be monitored.

The meetings of the council of ministers of EAPP are always attended by more than two-thirds of the ministers and have never failed to reach an agreement. Since there are no disagreements between the ministers, there is political will from member countries for regional trade. For Sudan, although SETCO is a member of EAPP the decision-maker in the country is the holding company. Therefore, a representative should be on the steering committee but we did not receive a response from them until now. Regional trade in EAPP includes moving electricity, just as any other commodity, out of the country and hence governments have to be involved, especially considering that the traders are national utilities. Therefore, the council of ministers has to be involved. EAPP also cooperates with the Nile Basin Initiative and has been invited for commissioning the transmission line between Rwanda and Uganda that is under the NELSAP project.

The regional market has its rule in integrating renewable energy. EAPP is currently designing the market and needs to consider how to integrate renewable energy. The most important thing is the power trading platform to incorporate how to receive and scheduling the bids from renewable energy generators. This is one of the criteria for EAPP market design. Limiting the market to only day-ahead might not be accommodating renewable well. The intra-day market is more suited for renewables. EAPP also plays a role in supporting renewable energy activities in its member countries. EAPP received a grant from the World Bank through ESMAP to support carrying out renewable energy resource assessment and mapping. The initial focus is on solar mapping with an intention to cover up to seven countries. The project is implemented in phases with the first phase covering three countries, Kenya, Tanzania and Uganda. The focus of the project is to get high-quality bankable irradiance measurements, supporting meteorological measurements and promoting the awareness of the resource potential of solar energy. Currently, the project is being implemented by Vendor from South Africa and data have already been collected for almost one and a half years and will be collected for two years and will be made available for free to prospective public and private investors. In the future, the project will be extended to other EAPP member countries and might include building solar parks. The main objective of the project is to help in reducing the resource risk to developers and removing the need for each developer to commission their own solar measurement station.

E.5 OTHER EXPERT INTERVIEWS

E.5.1 Interview 7: Bruce Byiers and Alfonso Medinilla

Date of Contact: 20/04/2021
Date of Conduction: 06/05/2021

Background

Bruce is the head of the African Institutions and Regional Dynamics Programme of the Economic and Agricultural Transformation programme at the European Center for Development Policy Management (ECDPM). Alfonso is a Policy Officer in ECDPM's Economic and Agricultural Transformation and European External Affairs programmes and the Institutional Relations team. They conducted studies about African Regional Economic Communities (RECs) and their power pools. They investigated the regional cooperation and integration from a political economy point of view. The program aim was to bring a reality check to how European donors understand and engage with African institutions to improve the programs supporting regional cooperation and development. ECDPM is an independent think tank looking at EU-Africa relations. It receives requests usually from European organizations but in the past received a request from SADC via donors. ECDPM plays a bridging role as a neutral organization but has not been in direct contact with African power pools. The studies on the power pools were carried out for the German government as part of a wider project. Often, regional organizations like power pools are looked at from a technical point of view in terms of policies and agreements but the reality that the frustration with implementation is to do with politics. Hence, there is value in explaining the relevance between countries' politics, domestic politics, and how it shapes regional engagements.

Regional Economic Communities

The three RECs SADC, ECOWAS, and COMESA are considered uniform building blocks of the African Union economic community and are very different from each other. Starting with the foundation factors, the fact that SADC was a setup by the frontline states against apartheid makes it much more of a cooperation forum against something which is trying to minimize dependency on South Africa's economy. Even after the apartheid, South Africa remains the massive dominant economy and the other countries are still in a way trying to work out how to balance this dominance and use it to drive regional integration. The decisions in SADC are heads of state-driven and in a way, the heads of state are all of the liberation era (more than COMESA) and there is an unwillingness for one government to criticize another. This can be seen currently in the reluctance to propose or ask for intervention in Mozambique. Thus, it is a framework for collaboration but certainly not for supranational authority or handing any level of sovereignty. COMESA is more diverse and its foundation was more of a treaty for a free trade area. So the basis of COMESA is more of a technical organization around trade and then expanded its agenda to other topics. It is less coherent as a regional group with various national economic approaches. But COMESA has managed to do interesting things around trade. From our studies, it was almost bad for COMESA to expand into other areas. ECOWAS is seen as more functional than the other two and play multiple roles, especially in peace and security. The big issue in ECOWAS if you talk about legitimacy is like SADC they got Nigeria as the dominant economy which creates a bit of mistrust. There is also an overlap with WAEMU, the francophone group, which is more integrated and has its own common currency and external tariff before ECOWAS. Lots of ECOWAS measures are built on the WAEMU ones but somewhat reluctantly and there is almost a competition between the two to who has the loyalty of member states. All three are heads of state-driven in decision-making and control, despite having heavy institutional arrangements of tribunals and courts. On the surface, it looks like very much regional projects but in reality, it is hanging on member states' interest, especially on

energy cooperation and power pools. These interests are crucial when looking into dynamics around regional power cooperation and markets. Hence, the power to drive the development of these power pools and make them functional is very much at the member states level and the role that utilities' authority plays in the way these things are run.

The RECs provide housing for the power pools but the players and their actions although connected to the RECs but they are separate as they represent sectoral national interests. This is also adding to the fact that the membership of the pools is different than of the RECs. Then the cooperation is different in this narrow sectoral logic from what you have in the broad comprehensive cooperation of the RECs. Sometimes this can be a benefit as it is a more business-like way of doing things, but it can also be a drawback as progress tends to be slow as with the RECs. This is also particularly affected by the capacity and interest of national utilities to achieve this regional aspirational goal of establishing power pools. So it is not just as simple as you have a REC which at the institutional level decides on having a power pool. Usually, everyone agrees on the principle but in reality, the setup of the power pool is not a top-down measure coming from the REC. However, contrasting to SADC, which is a secretariat, ECOWAS is a commission, and in theory, since the treaty of 1994, ECOWAS does have more autonomy and authority. So on paper, ECOWAS can lay down these sorts of legal demands on regional cooperation but in reality, that does not drive what is happening. Essentially, the RECs provide forums for multilateral engagements like power pools as futuristic aspirations and so they are the political entry point to these power pools. The political endorsement and high-level support help brokering some of the deals but then it is a matter of investments in regional interconnections and capacity. The regional dynamics would also shift as national systems evolve, supposedly one country managed to build huge capacity, then the power dynamic would change and it might be able to drag other countries along for regional energy market. One example in the future could be Ethiopia, although currently it seems to be a blocking factor. In this situation where EAPP is minimally connected to COMESA, the national interests are what shape the development. It is very few countries in Africa that can play the role of a regional hegemon and muster the critical capacity, like South Africa in the past, to drive regional trade. There are several steps before reaching a regional market with real-time trading and the start is usually bilateral trade that is more secure in a sense. Therefore, establishing a power pool will always end up with overlaps between some existing mechanisms and sub-regional initiatives for developing interconnections, for example, the Nile Basin Initiative in East Africa and the OMVS in West Africa, which are quite older than power pools. These sort of organizations influence the power pools especially if they are well established and integrated, then member countries would weigh the benefit of expanding their initiatives to these power pools. Also, some of the technical aspects, like tariffs, are retrofitted into the power pool like in the case of OMVS and WAPP. Thus, their influence could sometimes be more than the RECs and so again it depends on member states' interest. For member states, the regional power pool helps in raising money and investment for things that are hard to fund (e.g. interconnections). The RECs then help in coordinating between different countries to provide this investment that is necessary for the power pool but it might lead to more bilateral agreements instead.

The geopolitical situation between member countries could impede the development of some projects. A few years ago, when there was a shortage of power in South Africa, Botswana proposed to create a thermal power station using Botswana's coal and then export electricity to South Africa but they refused to agree on a future contract to buy the energy and instead they preferred to have a railway bringing coal from Botswana to South Africa. It is clear that South Africa does not want to have any energy dependency on others but since they are now having a chronic shortage, their interest might be shifting. Another example is the situation between Egypt-Sudan-Ethiopia, where Sudan was first aligned with Egypt against Ethiopia's Grand Renaissance Dam but then in the middle, they shifted to support Ethiopia recognizing the agricultural benefits of the dam. Now it seems like they went back to the Egyptian side. Thus,

the geopolitics of the horn brings water and irrigation into this energy deal of hydroelectric power and the geopolitical situation becomes a fundamental factor in the regional integration. This is also true for West Africa where Nigeria was until recently opposing any infrastructure development of hydropower upstream and there are still struggling positions around dams' development on the Niger River. Other discoveries like natural gas in West Africa can shift countries' interest in how they deal with their neighbors on energy and could potentially affect the development of large green projects like solar and wind.

The Achilles heel for these power pools' development is the acceleration of installed capacity. However, there is a benefit of even power pooling quite early on before having the installed capacity in place. In Europe, national systems are still isolated despite having the required capacity. But then power pools should be built on bilateral agreements between countries and not as an opposing mechanism.

E.5.2 Interview 12: Mohamed Alhaj

Date of Contact: 27/05/2021
Date of Conduction: 15/06/2021

Background

Mohamed is an expert in renewable energy in Africa and the founder and director of Clean Energy 4 Africa. Clean Energy 4 Africa is a think tank for promoting renewable energy in Africa through market studies, training, and capacity building. They work in different African countries and recently active in Sudan in conducting studies about the first solar power plant.

Renewable Energy in Africa

There is a high demand for energy in Africa with the rapid urbanization and industrialization which is twice as fast as the global average and expected to sustain in the following decades. This is why the transition to renewable energy has been an objective in Africa. Almost all countries have some kind of national target to increase renewable energy share. The capacity of renewable energy has been increasing from 28 GW in 2010 to 50 GW in 2018 with hydro being the largest source. Success cases like the Benban in Egypt (1.6 GW) show that the renewable energy market in Africa is growing although there is still a lot to be done. There are still a lot of barriers to increasing renewable energy integration in Africa, some of these are:

1. The political will and long-term commitment from governments to shift toward clean energy and low carbon technologies. This needs to be reflected in national strategies and laws to attract investments.
2. The lack of policy instruments to provide confidence for investors, especially for large utility-scale projects.
3. The electricity grid in most countries requires major reinforcement in both transmission and distribution to be resilient enough to handle the integration of renewables at a large scale.
4. The lack of sustainable financing for large projects in view of the poor economic conditions and risks of currency and inflation.
5. Human capacity in Africa still needs to be developed to cope with the technologies.

To increase renewable energy integration in Africa, we need to look into it from a holistic view. The energy transition is a broader concept that includes renewable energy but not just in

the electricity sector but in other energy usages like heating, cooling, water desalination, transport, and so on. These are important because they take a large portion of the demand in Africa and need to be tackled to increase energy access for the transition to happen. The electricity sector is important because if you want to reach 100% renewable energy it is technologically possible if you electrify most of the end-user usages and services. The enabler here is to provide economic incentives for investments to take place on large utility-scale projects, mini and micro-grid projects, and small household-scale projects. Additionally, innovation in business models is needed to stimulate market growth. In my view, the political will can be tackled by engaging with decision-makers and give a well-informed view on the potential of renewable energy as well as by spreading awareness and raising the voice of the civil society. Another way is to partner with the private sector and lobby for renewable energy at the government level.

In Africa, we still have to rely on governments to lead and enable the energy transition. Many countries need to develop their legislation, regulations, and institutions generally to make renewable energy attractive for the private sector. The society and research entities also have a role to advocate and push for the energy transition. International organization (e.g. GIZ) has a huge role in bringing about finance and technical expertise, especially in capacity building. Thus, strong partnerships are needed and co-creation and adaptation for the African context. Neighboring countries and external organizations can have a peer-pressure effect on countries to adopt policies and at least commitment.

The power pools in Africa play a big role in the energy transition as they facilitate the integration of utility-scale plants and mitigate the variability of renewable energy sources. Regional integration has an impact on the bankability of projects and cash flows as well as increasing the overall reserve. The power pools also touch on the aspects of grid code and the dispatch priority. There need to be standards, criteria, and harmonization among the different systems, especially when considering the effect of renewable energy on the grid. These aspects impact the development of interconnections between countries and the integration of renewable energy. For instance, the interconnection between Egypt and Sudan is currently stalling because of these issues and is now only a radial connection that feeds the north area of Sudan. The structure and organization of national systems have an effect on the power pools and the integration of renewable energy. An important aspect in this is designing the national tariff to reflect the cost and allow for sustainable utility operations.

تم بحمد الله


TUDelft