African Power Pools: Institutions, Reforms, Issues and Challenges

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Abstract

In Africa, regional electricity markets are being developed through the establishment of five power pools that aim to promote electricity trade between countries in different regions. However, experiences from global regional electricity markets have shown that ineffective regional governance and flawed rules for regional trading and network cost allocation are the primary obstacles to realising the benefits of well-designed regional markets. This paper contributes new information on the challenges and issues unique to African power pools, which are shaped by the power sector's specific situation in African countries and the political economy of regional integration. Using a case study approach, the paper analyses the experiences of the three major African power pools - SAPP, WAPP, and EAPP - and their regional institutions. The analysis identifies key challenges and issues that must be addressed to successfully manage and advance each power pool. By addressing these challenges and issues, the paper suggests how to move forward to promote regional power trade for each power pool.

Keywords: *African Power Pools; Regional Electricity Market; Power Pool Reform; Regional Integration; Political Economy*

1. Introduction

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., The National Electricity Market (NEM) in Australia) power systems that are characterised by having a highly harmonised and coordinated organisation within a traditional or a market-oriented regulatory framework. A power pool is thus a higher hierarchical level of organisation of several systems to facilitate power exchange so that their original interactions become stronger and subject to well-defined commonly agreed rules [Olmos and Perez-Arriaga, 2013]. This paper only refers to power pools between several national power systems.

The degree of inter-utility coordination for power trade ranges from simple unspecific agreements on energy transactions to detailed arrangements for coordinated operation and planning. Hence, various arrangements can be implemented to govern regional power trade. The literature describes

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several trade arrangements that can be put in place to achieve efficient power trade [Pastor, 2008, Olmos and Perez-Arriaga, 2013]. These arrangements can be summarised and grouped into the following frameworks:

- **Operational Framework**: The transmission system operators of participating countries need to define minimal technical requirements for power trade to be safe and reliable. When interconnecting two or more power systems, the system operators need to synchronise and maintain the two systems under the operable frequency range.
- **Commercial Framework**: A commercial framework defines the commodity to be traded, how it can be traded and the financial settlements of trade transactions. Regional power trade does not only allow for importing power but also for providing services that are required for the system operation, so-called ancillary services. Thus, different platforms can be designated for different trading activities.
- **Infrastructure Planning Framework**: Interconnections between countries and corridors for transmitting power through transient countries are the backbone of regional trade and what form the regional grid. Thus, the regional grid requires optimal development for trade to be efficient. The planning framework should identify new generation, transmission and reinforcement projects with benefits exceeding their investment cost. Additionally, it should establish criteria for prioritising and approving these projects.
- **Regulatory Framework**: A regulatory framework that covers cross-border power trade must be established to ensure that the involved parties follow the necessary technical and operational standards, examine the proposed infrastructure plan, establish the rules for regulating the market and the infrastructure, as well as to manage any legal or financial issues that may arise.
- **Policy Framework**: A higher-level policy framework sets a clear direction and goals for regional power trade. It consists of energy policies, trade policies and environmental policies that support regional power trade and incentivise participating parties to make decisions for achieving the overall policy goals. By providing clear guidelines and incentives, the policy framework can facilitate the expansion of cross-border trade in electricity and contribute to the development of a more sustainable and reliable energy supply.

Once the essential frameworks for regional power trade are established, designated institutions can be established to implement them effectively. In general, five different types of institutions or organisations can be created to correspond with these frameworks. Beginning with the core component, a regional system operator is required to ensure the seamless operability of interconnected power systems. This organisation typically comprises all national system operators, and it plays a crucial role in coordinating the transmission of power among countries.

Another essential institution is a regional market operator that ensures compliance with the commercial framework. The regional market operator can be a separate entity or integrated within the regional system operator. It plays a vital role in monitoring and supervising power trading activities, ensuring that they comply with established policies, rules, and regulations.

A regional planning entity is also required to develop a coordinated and integrated plan for the region's power sector. This entity would be responsible for identifying potential investment opportunities, ensuring optimal resource utilization, and developing strategies for meeting future power demand. This planning activity is essential for transmission – most frequently the regional system operator is the only entity technically qualified to make this plan – and it may be accompanied by an indicative generation expansion plan from a regional perspective.

Additionally, a regional regulatory institution must be established to oversee the activities of all involved parties and ensure compliance with relevant regulatory requirements. This institution would oversee the implementation of technical and commercial frameworks, issue licenses and permits, and ensure adherence to safety and environmental standards.

Lastly, a regional political body can be established to issue policies and guidelines to support regional power trade, align national interests, and promote regional cooperation. Such a body would provide a platform for regional coordination, negotiations, and dispute resolution. Figure 1 shows the five frameworks with their corresponding institutions.

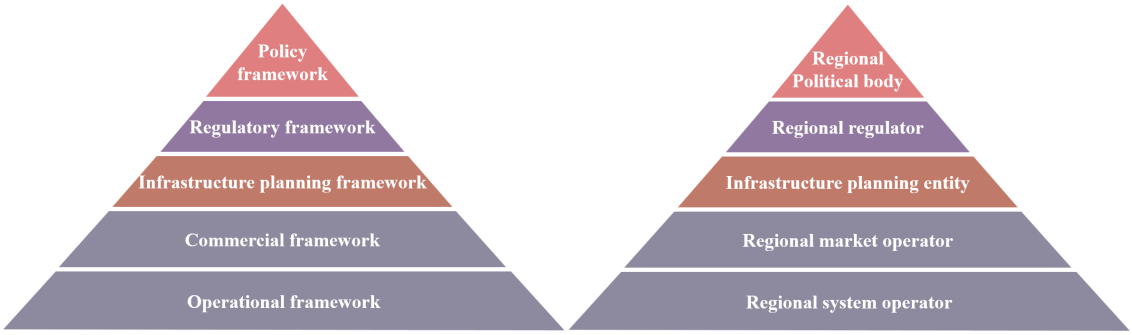

Figure 1. Mapping regional trade Frameworks, on the left, to regional institutions, on the right.

The establishment of regional power trade poses numerous challenges, identified in the literature, related to institutions and governance [Barker et al., 1997, Economic Consulting Associates, 2010, Oseni and Pollitt, 2014], regional infrastructure [Byer et al., 2009, Olmos and Perez-Arriaga, 2013], and market operations [Rose, 2017]. Firstly, a successful market requires effective regional institutions and regulations to oversee operations. Secondly, regional regulators must incentivise investments in infrastructure projects, such as cross-border transmission, to facilitate the exchange of power. Finally, market rules must be aligned with national concerns about ensuring a secure and reliable supply of power.

Nevertheless, the situation in African power pools suggests a different important set of issues and challenges to be considered for establishing a regional electricity market in the context of developing countries. Five regional power pools are under development to promote power trade at a supranational scale. They are at different development stages and have different trade arrangements. This paper discusses the unique issues and challenges of African power pools by analysing the situation and arrangements of the three prominent power pools in the South, West, and East (SAPP, WAPP, and EAPP). The following section provides the broader context of power pools in Africa and the particular context of the three selected power pools. From their context, common issues and challenges are described in section 3. section 4 discusses how to improve the situation in each of the three cases and how to address the common issues and challenges. section 5 concludes the findings of the paper.

2. The context of African power pools

Power pools in Africa are established to foster cooperation between countries in power sectors. These power pools are founded by the regional economic communities (RECs) of the African Union. The RECs are institutions of African states that aim to facilitate regional economic integration between members of the individual regions under the auspices of the African Economic Community. The African Union recognizes eight RECs: the Arab Maghreb Union (UMA) in the North; the Common Market for Eastern and Southern Africa (COMESA) in the South East; the Community of Sahel–Saharan States (CEN-SAD) in the North; the East African Community (EAC) in the East; the Economic Community of Central African States (ECCAS) in the centre; 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. Figure 2 shows the REC membership map. These RECs serve as the foundation for the establishment of five power pools in Africa, namely the Maghreb Electricity Committee (COMELEC), the Southern African Power Pool (SAPP), the Western African Power Pool (WAPP), the Central African Power Pool (CAPP), and the Eastern African Power Pool (EAPP), in the order of their establishment. Figure 3 displays the geographic location of the five power pools.

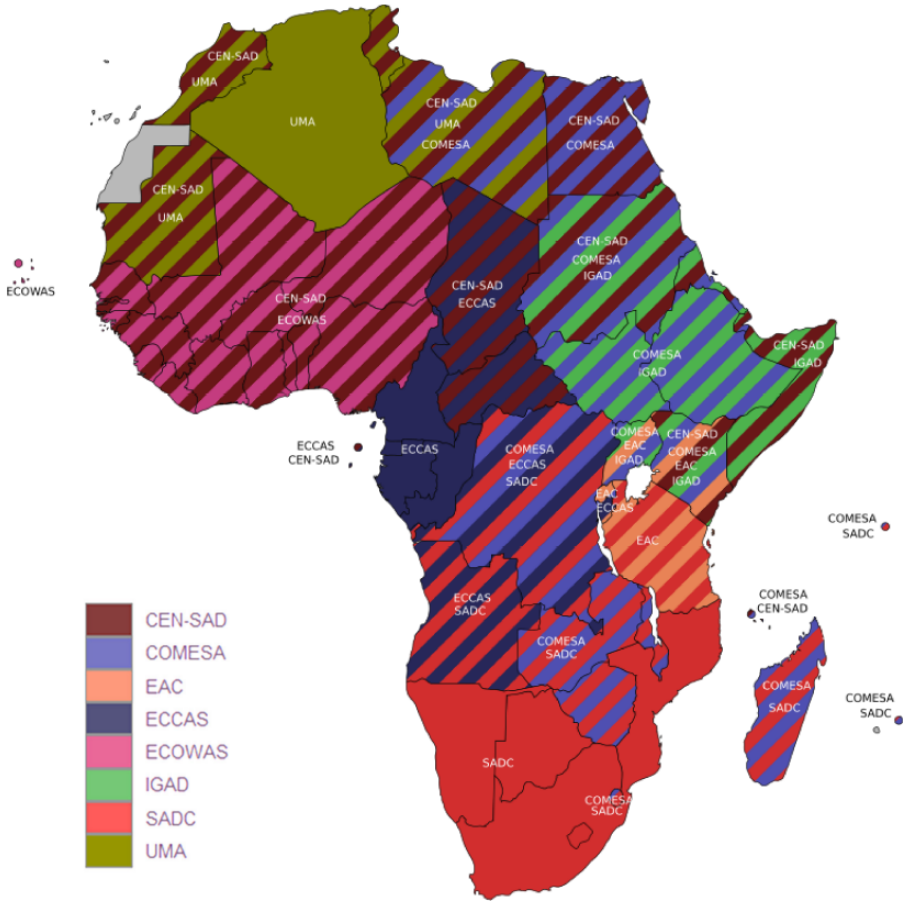

Figure 2. The geographical map of the membership of eight regional economic communities in Africa. Source: [Kyriakarakos, 2022]

It is important to note that the African RECs have varying institutional characteristics in terms of rules and authority, and they set the policy framework for the power pools. As a result, the power pools display different regulations, governance, and institutions [IEA, 2019]. However, a common feature among all the power pools is their mandate to perform the activities of the regional market operator and regional infrastructure planner [WAPP, 2019a, SAPP, 2019, EAPP, 2020]. While some power pools, such as WAPP, are designed to carry out the activities of the regional system operator, others, such as SAPP, delegate these responsibilities to control area transmission system operators and only facilitate the coordination between them. Table 1 shows the membership of the three selected power pools and their respective foundation year.

In the subsequent sections, a concise overview of the foundation of each power pool, including the institutional characteristics of their RECs, key factors that led to their establishment and their regional institutions, will be presented.

2.1. SAPP

The Southern African Development Community (SADC), the REC of SAPP, is an intergovernmental institution and a secretariat for regional cooperation in specific sectors. It operates through regional protocols and agreements between member countries that are not binding. SAPP is an institute of SADC, but the latter does not interfere with its operation and gives it a degree of autonomy in deciding internal affairs. However, any change related to its policy or involving other external entities must go through the ministers of SADC. Historically, South Africa had leverage in the region due to its economy and military superiority [Vanheukelom, 2017]. Due to its interest in regional trade, it played an important role in pushing the power sector integration agenda in SADC.

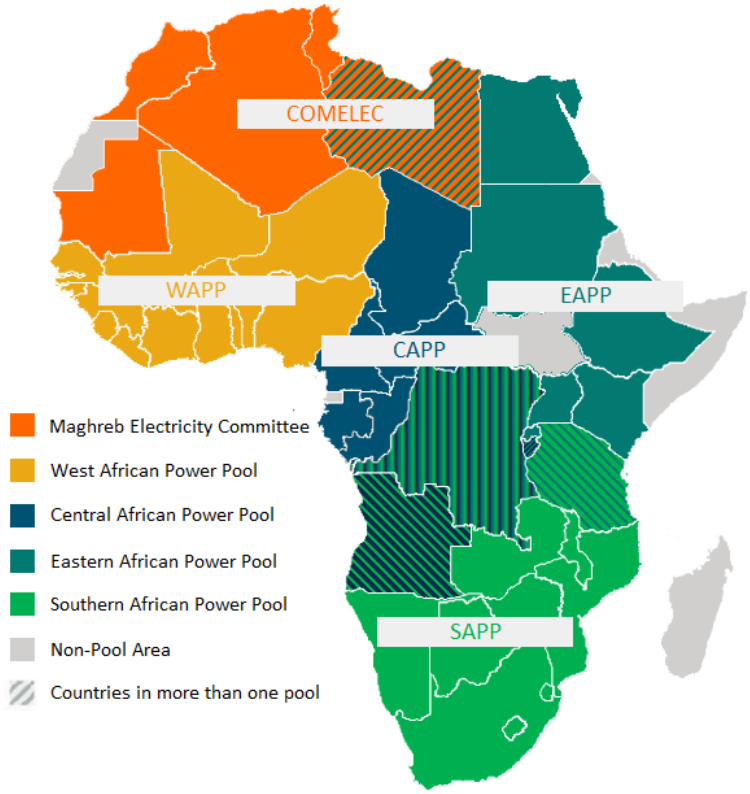

Figure 3. African countries according to their power pool membership.

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

1. The establishment of the 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 (thermal generation in South Africa and hydropower in the northern 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 centre.
6. The technical support received from international institutions.

The highest decision-making level of SAPP, the executive board, is a simple single-class board with national utilities as its board members. The twelve member countries of SAPP are represented by their respective national utilities. SAPP allows IPPs to obtain membership but excludes them from the executive board and the management committee. Additionally, IPPs have limited voting rights on specific topics. Hence, national utilities have a favourable position in deciding SAPP's internal rules of the market and operation.

The following steps were implemented to enable regional trade through SAPP:

1. Establishing legal documents and trade agreements, the Inter-Governmental Memorandum of Understanding and the Inter-Utility Memorandum of Understanding.
2. Establishing commercial market rules for trade, the Market Book of Rules.

Table 1. The foundation year and membership of the three power pools. Sources: [SAPP, 2019, WAPP, 2021, EAPP, 2020]

Power Pool	Year	The REC	Member countries	Market participants
SAPP	1995	Established by SADC	Angola, Botswana, DRC, Lesotho, Malawi, Mozambique, Namibia, South Africa, Eswatini, Tanzania, Zambia, Zimbabwe	17 electricity enterprises (12 national utilities and 5 private enterprises)
WAPP	1999	Established by ECOWAS	Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, The Gambia, Togo	39 electricity enterprises
EAPP	2005	Adopted by COMESA in 2006	Burundi, DRC, Djibouti, Egypt, Ethiopia, Kenya, Libya, Rwanda, Sudan, Tanzania, Uganda	14 national utilities

3. Establishing operational agreements, the Agreement Between Operating Members, and delegating system operation to control area system operators.
4. Establishing wholesale energy markets; the Day-ahead market (DAM), the forward physical market-weekly/monthly (FPM-W/M). and the Intra-day market (IDM).
5. Admitting IPPs participation.
6. Establishing a regional market operator, the coordination centre.
7. Establishing a regional grid development unit, the planning committee and the Project Advisory Unit (PAU).

2.2. WAPP

WAPP is a special institution of the Economic Community of West African States (ECOWAS) and was created by Decision A/DEC.5/12/99 of the 22nd summit of 1999 in Lomé, Togo [WAPP, 2018a]. ECOWAS is a supranational entity with a commission authorised to issue legal demands through directives and regulations. ECOWAS strongly in uences WAPP and manages it through its special regional institutions, e.g., the regional regulator ERERA. ECOWAS also adopts the master plans of WAPP and helps market creation by adopting policies and regulations on the national level. Although ECOWAS has the legal power to make binding decisions, it lacks the supranational power to enforce them.

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

1. The establishment of the ECOWAS.
2. The distribution of natural energy endowments in the region and having countries with limited sizes and resources created interdependence and a need for trade between countries, as occurred in SAPP.
3. The presence of the ECOWAS Commission as a regional institution for promoting regional integration, foreign investments, and cooperation in the energy sector.
4. The nancial support received from international institutions.

WAPP approves IPPs and consumer representatives as o cial members. The general assembly is the highest decision-making authority and includes all members with equal voting rights. Hence, the governance model of WAPP is preferable as it is democratic and inclusive, which incentivises agents to join the power pool. However, more than half of the votes belong to only two countries,

Ghana and Nigeria (each with ten votes out of a total of 39 [WAPP, 2021]), making it possible for these two countries to block decisions if they nationally and jointly orchestrate.

The following steps were implemented to enable regional trade through WAPP:

1. Establishing legal documents and agreements permitting trade, the WAPP Articles of Agreement
2. Establishing a regional regulator, ECOWAS Regional Electricity Regulatory Authority (ERERA).
3. Establishing commercial market rules for trade, the WAPP Market Rules and Procedures.
4. Establishing a regional market and system operator, WAPP information and coordination centre
5. Admitting IPPs participation.
6. Establishing a regional grid development unit, the strategic planning and environmental committee, WAPP Special Purpose Company/Vehicle and Project Unit.

The primary reason why WAPP has not yet established a competitive market is that interconnections are still being constructed to connect all member countries, and the WAPP ICC has yet to become fully operational as the regional market and system operator.

2.3. EAPP

EAPP was initially founded by agreements between member countries and was then adopted by the Common Market for Eastern and Southern Africa (COMESA). COMESA is a platform aimed at the creation of a large trading area based on the Preferential Trade Area Treaty, which explicitly promotes regional integration by removing trade barriers. COMESA is the largest regional economic community in Africa, it includes countries from East and South Africa, yet it does not include all EAPP members (e.g., Tanzania). Therefore, EAPP is loosely tied to COMESA. The only important factor in the establishment and development of EAPP is the support from international institutions and the facilitation of funds through COMESA.

EAPP has a more politically driven governance structure. Its highest decision-making authority is the Council of Ministers, which includes countries' energy ministers. EAPP rejects IPPs in its membership and only allows national utilities.

To enable regional trade, EAPP only established legal documents and agreements permitting regional trade, an Inter-Governmental Memorandum of Understanding and an Inter-Utility Memorandum of Understanding. Also, the power pool modestly contributes to regional infrastructure planning by delivering a regional master plan through its planning committee. On the other hand, the Council of Ministers decided to establish a regional regulator, the IRB, but it is yet to be operationalised. Thus, the region still lacks su cient infrastructure and institutional capacity for establishing the regional market.

Table 2 summarises the regional institutions and decision-making bodies of the three power pools. More information about the governance structure and infrastructure is given graphically in Appendix A.

3. Common issues and challenges

3.1. Issues with the vertically integrated structure

Although African power pools show that competition can indeed happen between vertically integrated power systems, there are issues with the conventional structure of national power systems (refer to Figure 10 in Appendix A) as it is naturally not conducive to competition. The following are some of these potential issues:

Table 2. The regional institutions of the three power pools.

	SAPP	WAPP	EAPP
Regional policy	SADC policy	ECOWAS policy	None
Decision-making	National utilities in the executive committee	All members in the general assembly	The Council of Ministers
Regional regulator	RERA without rule-making authority	ERERA with rule-making authority	IRB to be established
Regional infrastructure planning	Planning committee	Strategic planning and environmental committee	Planning committee
Regional market operator	SAPP coordination centre	WAPP information and coordination centre	None
Market structure	Bilateral agreements, Forward, day-ahead, intra-day, and balancing markets	Bilateral agreements	Bilateral agreements
Regional system operator	Control area system operators	WAPP information and coordination centre	None

- In most countries, electricity prices are determined by state-owned monopolies and are usually not cost-re ective. This reduces the prospects for deriving e ciency gains from power pooling, as such gains are maximized where the prices of electricity exchanged through the pool re ect the dynamics of a cost-re ective competition between countries. Transaction cost theory explains that vertical integration is an inferior organisational 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 IPPs are obliged to sell to 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 pro ts [Helpman and Krugman, 1985]. Consequently, under this imperfect competition, economic e ciency is limited in African power pools.

- Because of the vertically integrated structure, market power is more prominent in the power pools, with countries having more than 50% of the total generation (South Africa in SAPP, Nigeria in WAPP, and Egypt in EAPP, see ??). Big utilities can exercise price manipulation and predatory pricing in the regional market, especially when the market players are few in number (oligopolies). This was observed with Eskom in SAPP [Dseni and Pollitt, 2014, ECOWAS, 2006].

3.2. Issues with members' engagement

One of the main issues with the development of African power pools is the lack of genuine engagement of members. This issue 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 bene ts should then begin to ow. However, most of the time, there is the protectionist issue that monopolistic rms have a vested interest in withholding their position in the

market. These rms tend to in uence political decisions to inhibit liberalisation (crony capitalists) [Kimbugwe et al., 2012]. The theory also describes the uneven distribution of integration bene ts between members, a function of asymmetric interdependence and outside options between members. Members who are less dependent on regional integration because they are less a ected tend to join as a defensive necessity against possible exclusion from markets (what is known as Baldwin's domino e ect). In the context of power pools, these issues manifest themselves in the same way. Major monopolistic utilities, especially state-owned ones, 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 bene ts from regional integration and have alternative development options tend to join as a defensive necessity with no genuine interest in engaging with the power pools and could even block decisions for deeper integration (e.g., Egypt opposing the regional master plan of EAPP because it includes the Grand Renaissance Dam). On the other hand, utilities with a strong interest in power trade, if they seek to dominate the decision-making process and marginalise other members, this will result in other members abandoning the power pools and having a passive engagement (for instance, what is happing in EAPP with Ethiopia).

3.3. 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 not to a ect domestic production facilities. This could expose an importing country to a hold-up problem if the other country refuses to export[1]. 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 to regional trade (89 disturbances transpired in 2019 that interrupted the scheduled trade). Similarly, most countries have inadequate investments in generation capacity and su er from unavailable capacity. All these impede the power pools from reaching the desired capacity of trade.
- As indicated in the reports of each power pool, it is challenging to attract and retain quali ed sta to develop expertise in African power pools. All power pools continue relying on external experts to develop their projects and activities. Although this is acceptable to a certain degree, it is not sustainable in the long term. It is also true for relying on foreign investments excessively, which could create a lack of local ownership (as in the case of WAPP).

4. The Way Forward

This section provides suggestions for moving forward with the development of the three power pools and managing the common issues and challenges.

4.1. SAPP

The infrastructure development in SAPP took a decentralised approach (no single entity is entrusted with carrying on regional projects). Consequently, not all the members are connected to the regional network despite the fact that the market has been running for two decades. E ective functioning power pools require further investments in underlying infrastructure (su cient transmission and critical mass of generation capacity) and a shift in thinking from short-term objectives to long-term gains. A centralised approach would accelerate connecting all member countries and following up with the generation capacity in the region. However, the issue is that

[1] A hold-up problem is when an investment in local generation is paused due to a failure in bargaining export price, unlike in a market context where you have a price signal to guide investments.

SAPP does not have the mandate to perform this role. SAPP also does not have a regional regulator, but the region has a regulatory association, RERA, that does not have the mandate to regulate transmission projects. These two institutional gaps are required for centralised planning. Although SAPP is trying to address the issue with PAU and RTIFF, but these solutions do not address the problem directly and not to its root. It will remain crucial to have sound regional transmission regulations and enforcement authority. Thus, it is recommended that the institutions of RERA and SAPP should be strengthened to give authority for rule-making and issuing regional regulations.

4.2. WAPP

WAPP was developed top-down based on the directives and regulations of ECOWAS and took a centralised approach to 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 believed to be complicated. The WAPP ICC is planned to be both the system and market operator. This design option requires all the utilities to be technically prepared and on board in relegating the operation control to WAPP. This can be challenging in the current situation as some of the utilities do not have the capabilities and others do have trust issues about regional trade due to frequently unpaid debts. Therefore, the market should be built step-wise and bottom-up to allow utilities to integrate easily. One 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 cannot design the market because of its sta 's inexperience, but the market design should be simpli ed and aligned with utilities' capabilities and interests.

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 [Schimmelfennig, 2018, Dixit and Norman, 1986]. This explains some of the reluctance from utilities and foresees some issues from increasing foreign investments (the losers are domestic investors). WAPP could complement regional programs supported by international institutions with initiatives to develop national energy markets, 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 integrates national utilities, WAPP can transform into a tight pool that optimises the generation across the region, similar to the Independent System Operator (ISO) model in the United States (U.S.).

4.3. EAPP

The development of EAPP has been limited to conducting studies, workshops, and attempting to develop market-related documents and regulations. However, 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, EAPP would bene t more from a bottom-up approach for a market design that would attend to the utilities' interests. One blockage for adopting this approach adopting is how decisions are made in EAPP. With the Council of Ministers, EAPP is a more political organisation and political support is very much needed due to the lack of a common REC. 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 Council of Ministers' meeting is considered a dysfunction [Norda and KPMG, 2019]. The same goes for approving the Power Purchase Agreement model. Changing the governance structure to de-politicize EAPP would not yield the desired results. Instead, emphasis should be placed on decision-making protocols and giving the pool a degree of autonomy to decide on these matters internally.

EAPP would also bene t from a centralised approach to infrastructure development and has the mandate (objectives) for it. The issue then remains with the sta capacity and EAPP activities. Additionally, the nancing arrangements need to be improved, but perhaps the major obstacle

to taking an investment role is the lack of necessary institutions and frameworks for protecting foreign investments, as in the case of 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 adopting initiatives to coordinate with donors and other regional organisations working on infrastructure development, e.g., the Nile Equatorial Lakes Subsidiary Action Program (NELSAP). For this to happen, proper capacity-building programs are needed to strengthen EAPP's legal and nancial 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 harmonisation (through their own regional regulatory, EREA) and rati ed the EAC Common Market Protocol. Additionally, most of the bilateral agreements in the region are between EAC members that will soon be interconnected. Then via Ethiopia, the rest of the countries can be connected. A hurdle for this course of development is the strong interest of Ethiopia in centralising EAPP institutions in Addis Ababa (previously, Egypt requested to host the IRB and Rwanda requested to host the market operator but were both blocked by Ethiopia). This could lead to starting a separate market between EAC countries and later integrating it with EAPP. By not attending to all members' requests and interests, EAPP would run the risk of further increasing members' disinterest (there have been occasions when countries' representatives do not attend o cial meetings, and some countries, like Sudan, do not have an o cial representative).

4.4. Development approaches and classi cation

A power pool can be established bottom-up or top-down. The bottom-up approach does not necessitate the development of regional regulations but rather signing internal agreements between utilities and establishing market rules for trade among electrically connected systems. SAPP is a case of a bottom-up established power pool. Oppositely, the top-down approach means that national systems adapt to the requirements of the power pool by implementing necessary regulations and policies. The condition is to have a regional authority through supranational bodies or agreements designating such authority to the power pool. WAPP is a case of a top-down established power pool. The two approaches coincide with the two theoretical views debating regional integration: intergovernmentalism and neofunctionalism. The bottom-up approach is in line with intergovernmentalism, which views regional integration as a process of members negotiating their interests and building bargains on them. The top-down approach is aligned with neofunctionalism, which views regional integration as an outcome of supranational institutions that do away with state-centrism for transnational interdependence.

Similarly, regional infrastructure can be developed through a centralised or a decentralised approach. In a 'low politics' integration, the power dynamic of member states shapes the integration process. As states maintain their sovereignty, national utilities also maintain their independence; hence, the development is decentralised. In this situation, the power pool would play a minor role that re ects the preference of powerful member states. This level of integration takes the form of a regional executive secretariat (e.g., SADC). Initially, SAPP had no role in infrastructure development beyond identifying priority projects. Later, when member states needed expertise in facilitating projects, SAPP PAU was established. This functionality expansion is a demand-generating process known as 'spillover' in regional integration theories. As EAPP does not belong institutionally to any of the RECs (fragmented 'low politics' integration), its infrastructure development is de facto decentralised. It is not surprising that infrastructure has developed to connect member states of the sub-regional communities (EAC: Kenya, Uganda, and Tanzania, and Great Lakes countries: Burundi, DRC, and Rwanda).

In contrast, the 'high politics' integration takes the form of transnational institutions with a degree of supranational power (e.g., ECOWAS commission) that requires a transfer of power from member states. The power pool has more authority in this situation, and its role re ects regional needs. This explains why WAPP has a strong investment focus due to the investment needs in the region.

Comparing the three cases, SAPP has the best physical, economic, and political conditions while

WAPP has the best institutional conditions. The governance structure, nancing arrangements, and dispute resolution were the best in WAPP, while sta capacity and technical readiness were the best in SAPP. All power pools have good relationships with international institutions and receive support from them (namely, the World Bank, the African Development Bank, the United States Agency for International Development (USAID), the Swedish International Development Cooperation Agency, the Norwegian Agency for Development Cooperation, and the European Union), and SAPP has the best relationship with its members. There are similarities in the structure of national systems (the majority are vertically integrated), the generation mix of all countries, the involvement of regional economic communities (with di erent degrees), and the presence of a dominant country with more than 50% of the generation capacity in each region (South Africa, Nigeria and Egypt).

Each power pool has a di erent set of objectives, and because of the di erences in the development factors, the regional dynamic was di erent and, consequently, the performance was di erent. Both infrastructure development and market establishment were approached di erently. SAPP and EAPP have a decentralised approach to regional infrastructure that leaves project execution for member countries. WAPP adopted a centralised 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' interests 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. Each case has its unique forces for development. The development of each case can be classi ed di erently. 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 .

4.5. Managing the vertically integrated structure

Although the vertically integrated structure has several issues, it is justi ed under several conditions. The transaction cost theory explains the advantages of the structure in reducing opportunistic behaviour, the cost of coordination and planning, and removing internal information asymmetries [Joskow, 2004]. 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 re ect average cost-re ection (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-re ective 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 in uence over time [Correljé and De Vries, 2008]. In light of the regional market, regulation of IPPs could allow exibility for trading in the regional market without compromising the national agreements. This does not require the removal of the monopoly and is bene cial in the long run for national systems as well. The new power sector regulation of Namibia provides a good example of this (see the Modi ed 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 reducing 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]).

4.6. 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 for just not missing an opportunity. The secretariat of the power pool or the coordination centre should ensure the alignment of the pool activities to member interests and prevent any possible conflict of interest. This entails fair consideration of the interests and requests of 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.

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. 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 (increases accountability) and increases the chances of reinvesting in other projects.

As an organisation, the power pools have the challenge of developing their own organisational 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 by evaluating and assessing the pool's ability to perform its tasks. Instead of relying solely on foreign investments, 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.

5. Conclusions

In conclusion, the establishment of power pools in Africa presents an opportunity to develop regional electricity markets and facilitate electricity trade among countries in different regions. This, in turn, requires establishing frameworks for organising trade activities. In this paper, drawing on experiences from global regional electricity markets, we identify five frameworks and institutions to facilitate regional trade and based on them, we reviewed the steps that were taken in each region of the three power pools and found that the regional economic communities provide the political support and policy framework for the power pools, while the latter are designated with activities corresponding to system and market operation, as well as regional infrastructure planning. Additionally, we listed the key factors that helped with establishing the three power pools and the main reasons for being unable to start the market in some of the regions, WAPP and EAPP.

By analysing the structure of national power systems and the dynamics of regional integration, the paper sheds new light on the unique challenges and issues facing African power pools. The issues

relate closely to the vertical integration structure in African countries and member engagements with the power pools, while the challenges concern investments, independency and retaining quali ed sta . Through a comparative analysis of three cases, the paper shows that although the established regional institutions were similar in the three cases, the levels of delegated power and authority were di erent. This is due to the fact regional integration were approached di erently. The paper also classi es the development of each case and discusses the di erent development approaches on the ground of regional integration theories. Ultimately, the paper gives practical recommendations on managing the identi ed issues and tackling the development in each case. As a common guidance, it is important that the pool activities should be tailored to address members' concerns, and the market should be designed to t their needs.

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A. Appendix

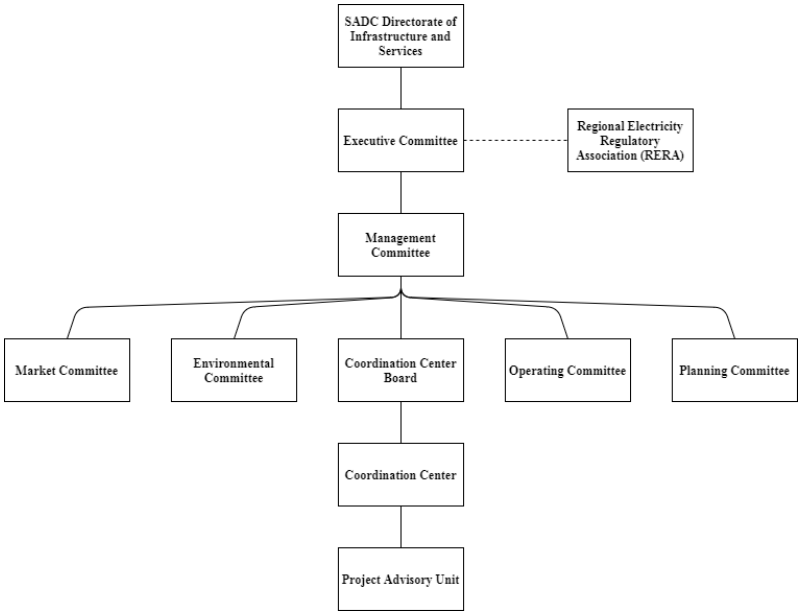

Figure 4. The governing structure of SAPP. Source: [SAPP, 2021]

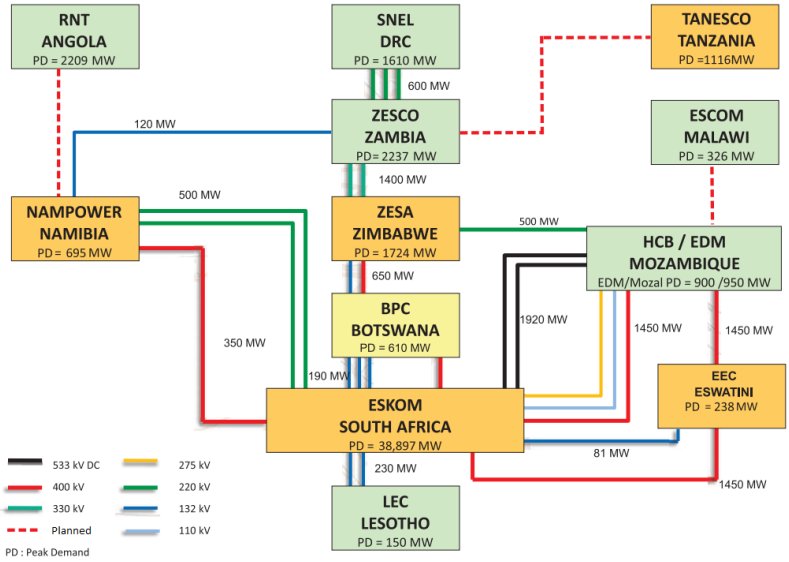

Figure 5. Peak demand and transmission capacity of SAPP regional power grid. Source: [SAPP, 2019]

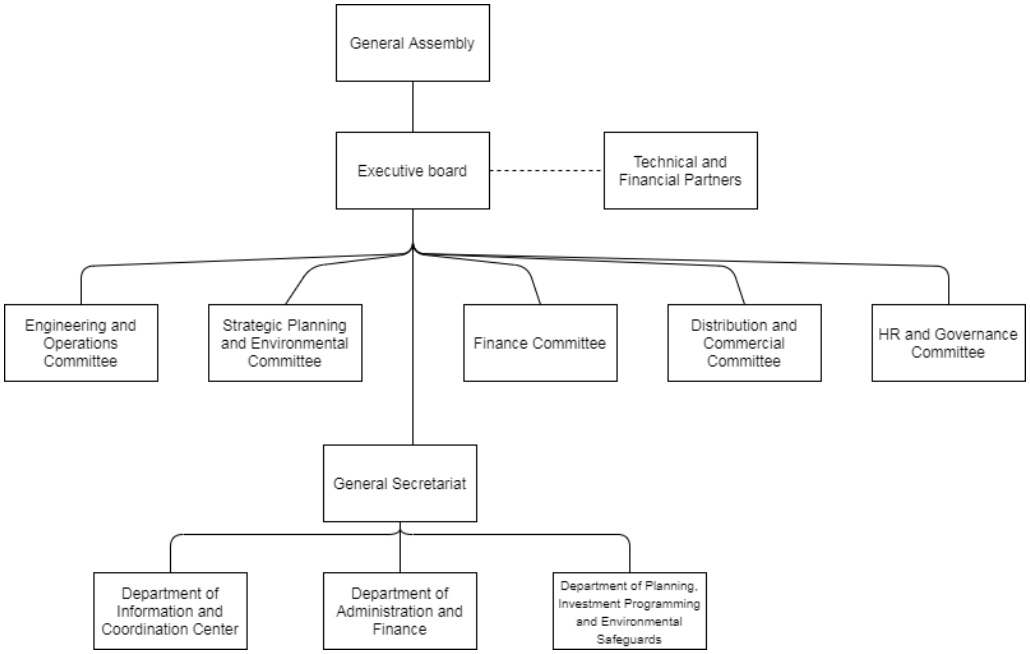

Figure 6. The governing structure of WAPP. Source: [WAPP, 2019b]

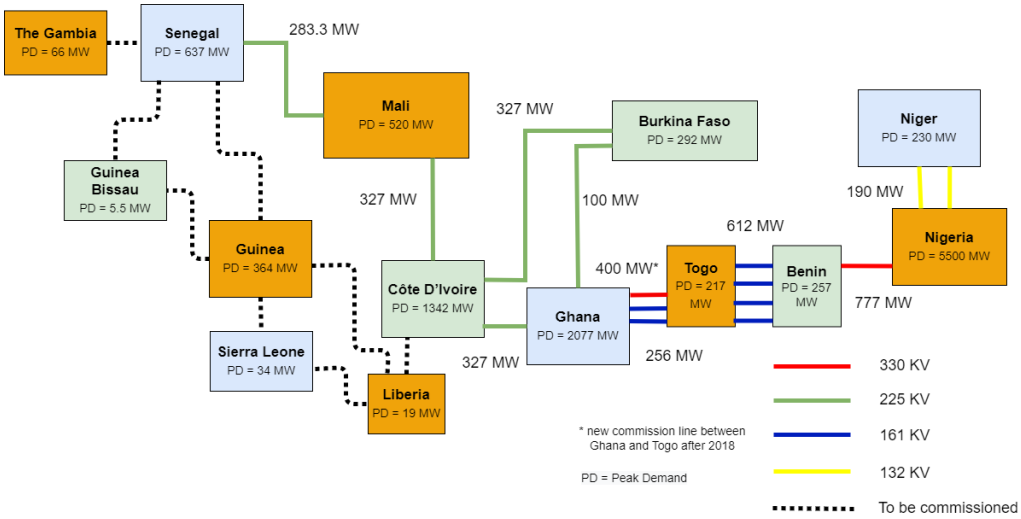

Figure 7. Peak demand and transmission capacity of WAPP regional power grid. Composed by the author from various secondary data sources: [WAPP, 2018b], [WAPP, 2020], and projects documentations from the World Bank

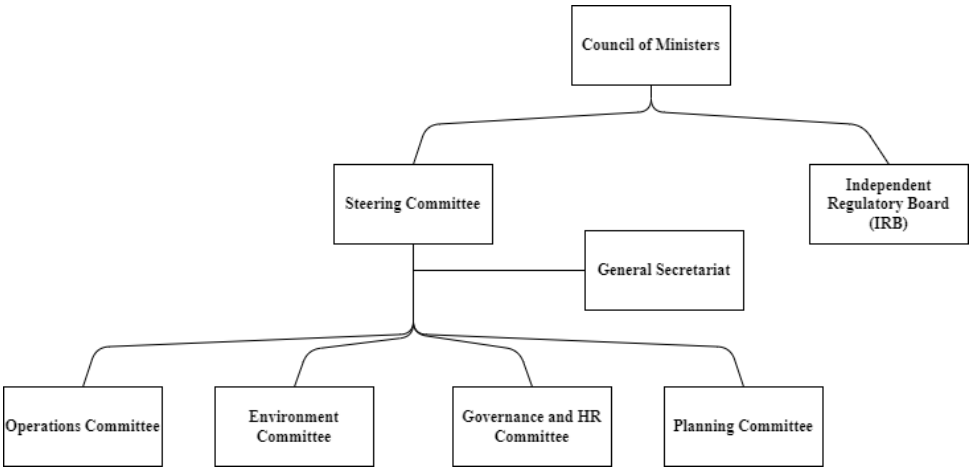

Figure 8. The governing structure of EAPP. Source: [EAPP, 2020]

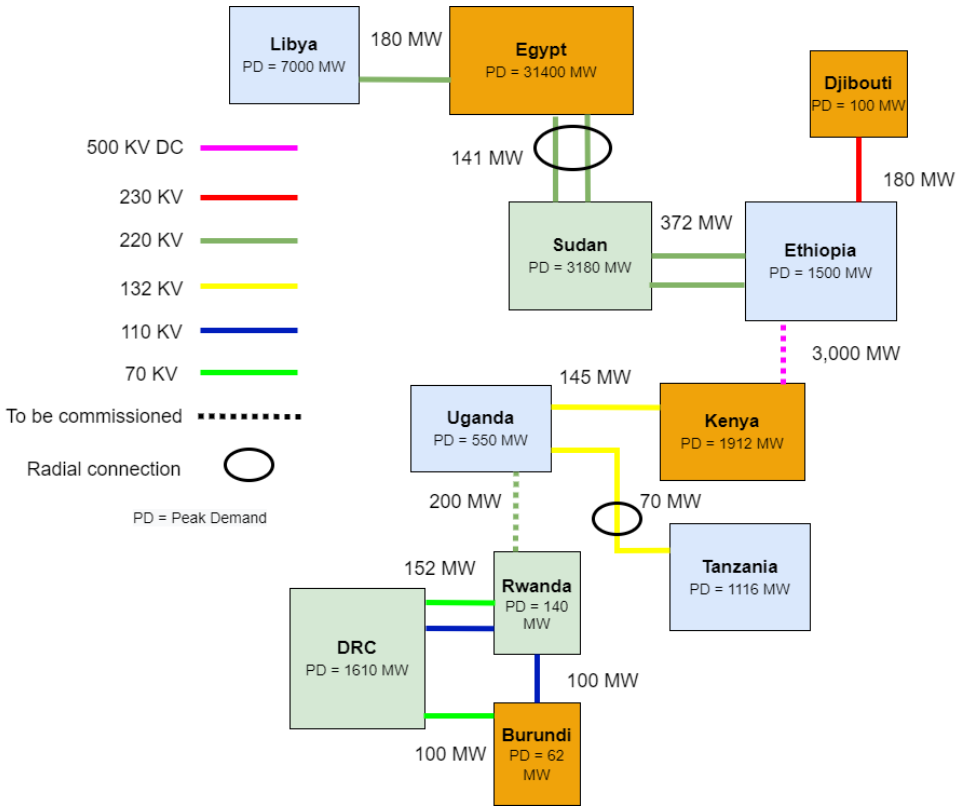

Figure 9. Peak demand and transmission capacity of EAPP regional power grid. Composed by the author from various secondary data sources: [SNC Lavalin International Inc and Brinckerhoff Parsons, 2011], [EAPP, 2014], [EAPP et al., 2014], and projects documentations from the World Bank