ICED

Infrastructure & Cities for Economic Development

Opportunities to Support and Increase Regional Power Trading in Southern Africa

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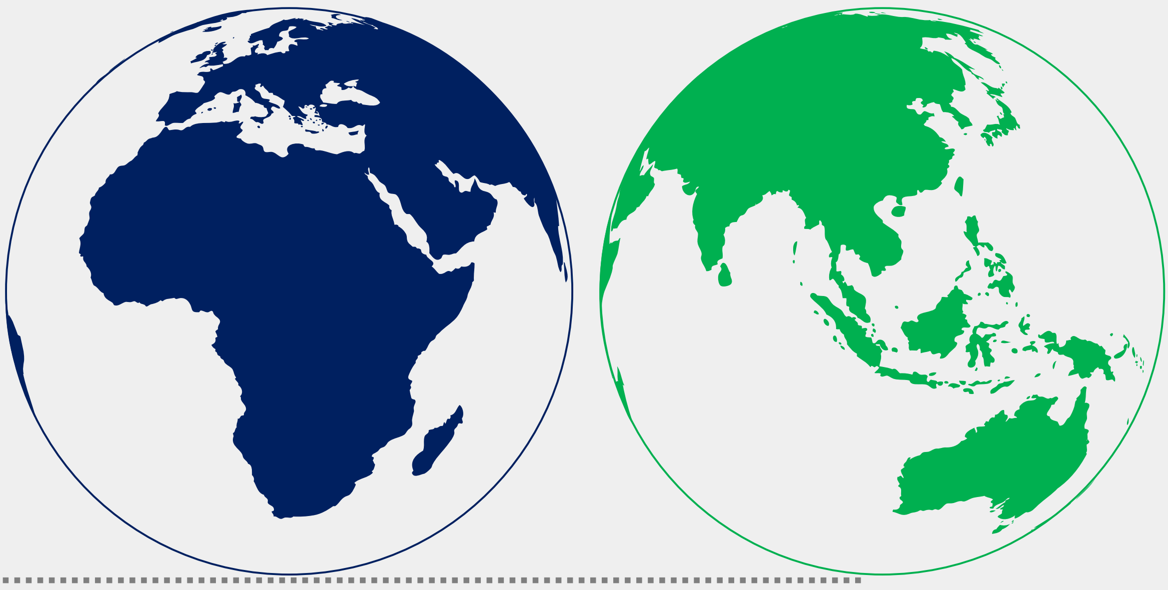


Contents

Executive Summary

The Southern African Power Pool (SAPP) is the most mature of the power pools established in Africa. SAPP was established in 1995 and, while progress has been gradual, SAPP does act as a platform for electricity trading across the region. This includes a competitive day-ahead market. None of the other power pools has a relatively, transparent and competitive market of this type.

The 2017 SAPP Pool Plan provides an indication of the benefits of effective electricity trade across the region. The Plan presents the likely quantum of generation and transmission investments required across the region between now and 2040. This modelling suggests that ~13 GW less generation capacity would be required if a regional approach is taken to optimising planning, compared to simply aggregating national plans. This could save ~$34bn in NPV terms.

	Benchmark – Limited integration	'Realistic' regional integration
Generation investment, NPV to 2040 ($bn)	154.2	117.7
Transmission investment, NPV to 2040 ($bn)	1.1	3.3
Installed generation (GW)	143	130

Source: *SAPP (2017)*

The benefits of electricity trading can be significant:

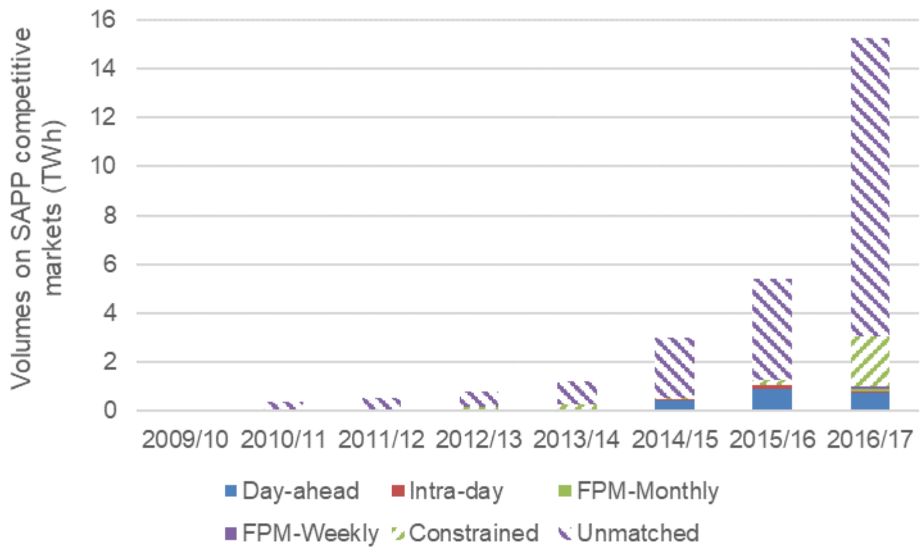
- **System size** – economies of scale can be realised through optimising investment across a bigger market, as illustrate in the SAPP Pool Plan numbers above.
- **Operating efficiency** – trading cross border can help to tackle system operation challenges. This can include both short-term optimisation (e.g. renewables integration) and long-term diversification of supply options, improving climate resilience in a region where hydro has an important role.
- **Market structure** – resilient infrastructure and market mechanisms for regional trade can act as a catalyst for price transparency and domestic energy sector reforms, unlocking a wide range of secondary benefits.

These benefits in turn can help to drive outcomes that are aligned with other DFID priorities:

- **More affordable power** – as illustrated above, regional integration can reduce the cost of electricity supply, making power more affordable.
- **Improved reliability and power quality** – regional infrastructure, accompanied by investment at the national level, can help to improve system resilience.

- **Reduced GHG emissions** – regional integration can help to facilitate renewables integration, acting as an important tool in managing the system operations challenges associated with intermittent renewables.

In spite of these benefits, growth in electricity trade across the region has been slow, and only accounts for ~3% of electricity supply. Electricity trade is heavily constrained, and the most important constraint on trade is the physical transmission infrastructure. A large portion of trades that are matched on SAPP's trading platforms cannot be implemented because the physical transfer capacity either does not exist or is not available. Available capacity is also reduce by the dominance of bilateral trades between member state utilities, which reduces the availability of transmission capacity for the more transparent competitive markets.



Source: *SAPP (2013-2017), Africa GreenCo (2017), ICED analysis*

The barriers to electricity trade span DFID's Whole System Approach[1]:

- **Governance and regulation** – at the national level a desire for self-sufficiency acts as a barrier to integration; planning activities at the national level are not joined up with regional initiatives.

- **Market and commercial** – the financial weakness of national utilities and a lack of transparency in national electricity market operations are barriers. Further, traditional business models for transmission investment are not fit-for-purpose in a future with high penetration of intermittent renewables.

- **Physical infrastructure** – as noted above, the binding constraint on electricity trade today is the lack of sufficient transmission capacity both within countries and cross-border.

[1] DFID (2018): A Whole System Approach: a guide for DFID advisors engaging in the energy sector

Donors are already heavily involved in the electricity sector across the region. There has been a lesser (but growing) focus on electricity trading and related issues. The two largest relevant activities that we are aware of are:

- The Advancing Regional Energy Projects (AREP) initiative, which was seeded by a $20m IDA grant from the World Bank Group (WBG). To date AREP has been focused primarily on project preparation support but plans to tackle a wider range of issues through a new Multi-Donor Trust Fund (MDTF), which the Swedish International Development Agency (SIDA) has already committed funds to. There are significant potential synergies between some of the priorities identifies by this report and WBG's proposals for the MDTF.

- The Southern African Energy Program (SAEP), which is part of US AID's Power Africa initiative. SAEP's activities have primarily been focused at the national level, but it has provided some capacity building support to regional institutions, as well as transaction advisory services to the Malawi-Mozambique interconnector project. Power Africa is built on partnerships and there may again be synergies and opportunities for cooperation when supporting individual transmission infrastructure projects in the region.

1. Introduction

Purpose of this report

ICED has compiled this report through a combination of desktop research and structured interviews and conversations with key stakeholders, primarily other donors working in the energy sector in Southern Africa.

This report presents an evidence base to support electricity trading in the Southern Africa region.

Whole System Approach

DFID has developed a Whole System Approach (WSA) to help with identifying the entry points where UK Official Development Assistance (ODA) in the energy sector can be transformational. Application of the WSA helps to ensure that the complex interdependencies between different parts of the energy sector are properly considered.

The WSA has been considered in preparing this report on electricity trading. We have considered the four components of the WSA (see Figure 1) as follows:

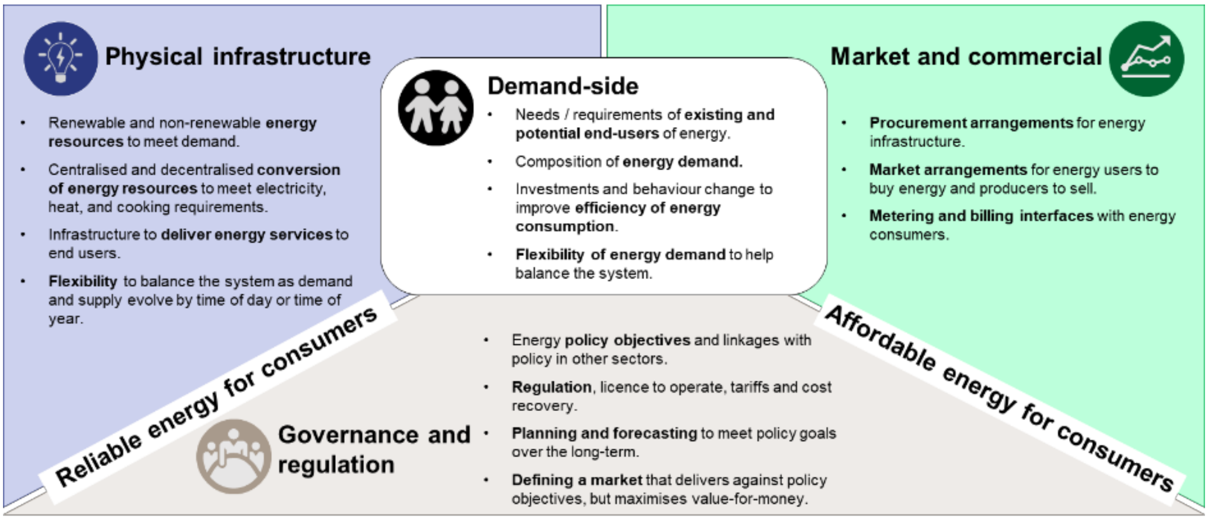
- The **demand-side** is considered through our discussion of the benefits of energy trading (from page 23). Benefits such as reduced wholesale power costs have a direct impact on the affordability of energy for end-consumers. This discussion of benefits is a key input to our recommendations to ensure that any future DFID activities in this area have maximum impact.

- **Governance and regulation** are considered through our review of the Southern African Power Pool (SAPP) itself, along with other key regional power sector institutions.

- Our review of the current status of electricity trading in the region considers **market and commercial** factors from page 17 and the **physical infrastructure** in place to support electricity trading is reviewed from page 12.

Our discussion of the barriers to electricity trading in the Southern Africa region from page 25 also refers to these components of the WSA. These identified barriers are, in turn, used to inform our recommendations on the opportunities where DFID could provide assistance.

Figure 1 The four components of DFID's Whole System Approach for the energy sector



Source: *DFID (2018)*

Overview of this report

The findings of this analysis are presented as follows:

- A brief overview of the regional electricity sector context is presented in Section 2.
- In Section 3 analysis of the status of electricity trading across the region and it's potential to deliver benefits is presented. This covers the infrastructure in place to interconnect power systems and the markets established for trading.
- In Section 4 an overview of the Southern African Power Pool (SAPP) as an institution is presented. This covers SAPP's role and the governance in place to help it execute that role.
- In Section 5 the current donor landscape covering electricity trading in the Southern Africa region is reviewed.
- In Section **Error! Reference source not found.** opportunities to support power trading in the region are identified. This includes an analysis of activities currently being implanted by other donors, and the priorities that need to be addressed to more effectively remove the remaining barriers to cross-border trading of electricity.
- An attached annex provides a list of the stakeholders that we have engaged in compiling this report. This is followed by a full list of references.

2. Regional electricity sector context

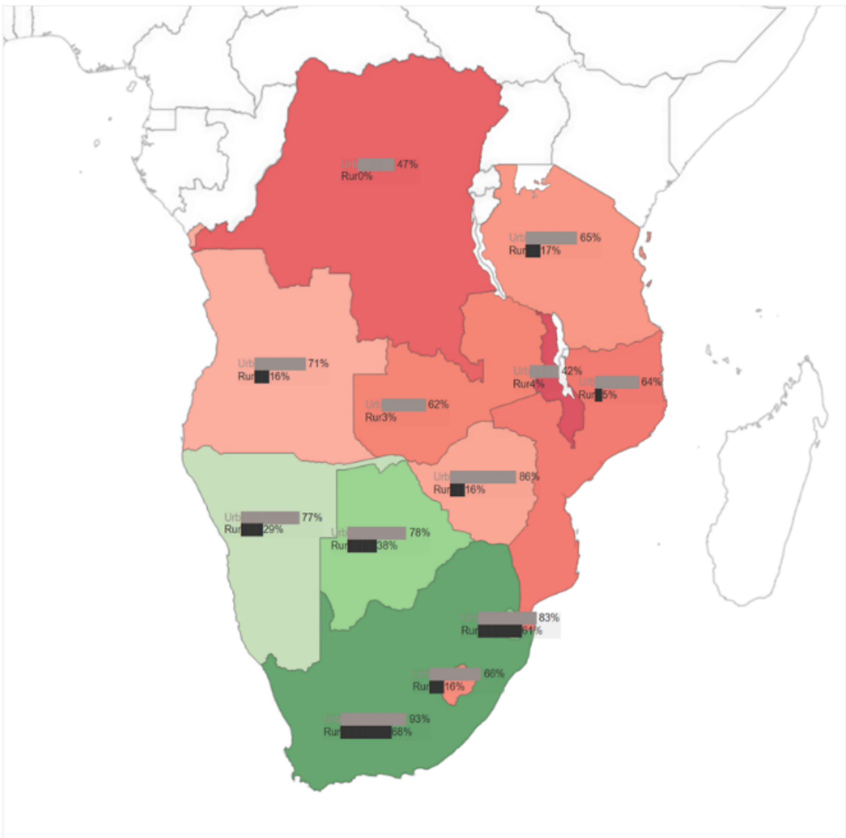
This section presents a brief overview of the status of the electricity sector in the Southern Africa region. Detail on trading and interconnector infrastructure specifically is presented in Section 3; in this section we present an overview of:

- Electricity access in the region,
- Demand for and supply of electricity, and
- The state of utilities in the region.

Electricity access in Southern Africa

The level of access to electricity varies significantly across the region, both from country to country and between urban and rural areas within a country. The latest statistics from ESMAP's Tracking SDG 7 initiative are presented in Figure 2. Access to electricity varies from 11% in Malawi to 84% in South Africa.

Figure 2 Access to electricity in Southern Africa



Country	Access to electricity	Urban	Rural
Angola	40.5%	70.7%	16.0%
Botswana	60.7%	77.7%	37.5%
DRC	17.1%	47.2%	0.0%
Lesotho	29.7%	66.0%	15.7%
Malawi	11.0%	42.0%	4.0%
Mozambique	24.2%	64.2%	5.0%
Namibia	51.8%	77.1%	28.7%
South Africa	84.2%	92.9%	67.9%
eSwatini	65.8%	82.8%	61.2%
Tanzania	32.8%	65.3%	16.9%
Zambia	27.2%	62.0%	2.7%
Zimbabwe	38.1%	85.5%	15.6%

Source: *ESMAP (2018)*

Electricity access is relevant to the analysis of electricity trading that follows for the following reasons:

- The benefits of electricity trading will, in theory, primarily accrue to the portion of the population that is grid connected. Conversely, any action that improves utility efficiency should increase the availability of financial resource for investment in expanding and strengthening the network.

- Electricity access can also be seen as a proxy for how extensive and sophisticated the national electricity system is. There may be little benefit to strengthening infrastructure for electricity trading if country's internal electricity systems are weak. However, even where the immediate beneficiaries are not the poorest, building a resilient national and cross-border transmission system can provide a critical starting point for reliable grid supply in the future.

Electricity supply

Table 1 presents a breakdown of electricity supply across the region. This shows how dominant South Africa is in the region and also how dominant coal is, given its role in South Africa. Outside of South Africa hydro accounts for a large share of generation (~70%). The dominance of South Africa and the important role of hydro are both important in terms of driving trade – this is analysed further in Section 3.

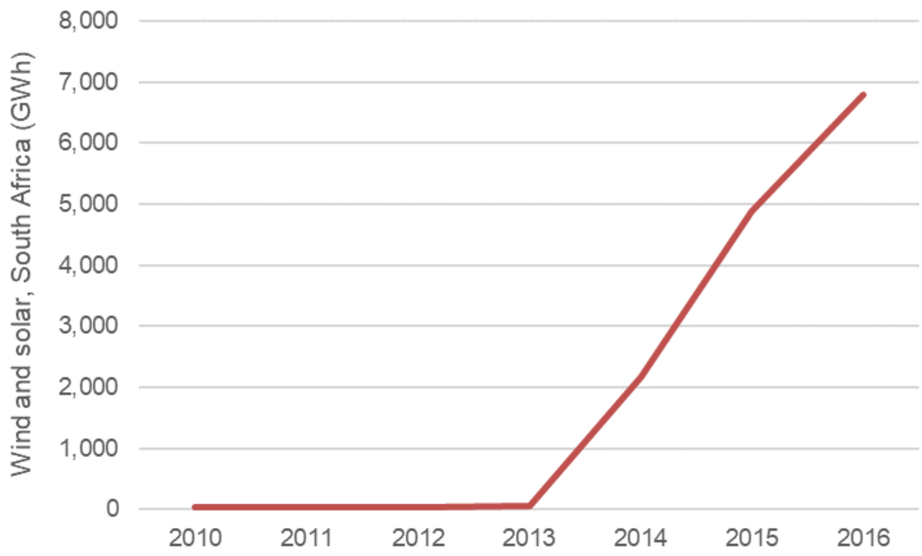
Non-hydro renewables still account for a very small share of generation in the region. However, while still small, the contribution from wind and solar has increased rapidly in South Africa as a result of the REIPPPP tenders. This increase is illustrated in Figure 3.

Table 1 Breakdown of electricity supply in Southern Africa, 2016

	Generation breakdown (GWh)							
Country	**Coal**	**Oil**	**Gas**	**Nuclear**	**Hydro**	**Wind and solar**	**Other**	**Total**
Angola	0	4,546	0	0	5,815	0	0	**10,361**
Botswana	2,680	6	0	0	0	2	0	**2,688**
DRC	0	12	2	0	9,099	0	22	**9,135**
Lesotho								**512**
Malawi								**1,809**
Mozambique	0	19	3,104	0	15,609	0	0	**18,732**
Namibia	53	9	0	0	1,359	0	0	**1,421**
South Africa	226,484	183	0	15,026	3,994	6,800	260	**252,747**
eSwatini								**119**
Tanzania	0	489	4,097	0	2,366	25	21	**6,998**
Zambia	326	344	0	0	11,025	0	0	**11,695**
Zimbabwe	3,908	39	0	0	2,987	0	121	**7,055**

Source: *IEA (2018)*

Figure 3 Wind and solar generation, South Africa (GWh)



Source: *IEA (2018)*

Investment needs

A regional plan for the Southern African Power Pool (SAPP) was completed in 2017, and some of the key outputs from that plan are presented in Table 2. This indicates that it is expected that a significant amount of new generation capacity will be required between now and 2040 (current installed generation capacity across the region is ~75 GW).

The table also indicates the potential importance of electricity trade and diversification of supplies between countries, the focus of the remainder of this report. Outputs for two scenarios are show: a benchmark based on expansion plans for individual countries, and a 'realistic' integration scenario, where the plan has been optimised on a regional basis. In the integration scenario, a small incremental investment in transmission unlocks very significant savings in reduced investments in generation capacity.

Table 2 Summary of investment requirements from SAPP Pool Plan

	Benchmark – Limited integration	'Realistic' regional integration
Generation investment, NPV to 2040 ($bn)	154.2	117.7
Transmission investment, NPV to 2040 ($bn)	1.1	3.3
Installed generation (GW)	143	130

Source: *SAPP (2017)*

The state of utilities

Many of the utilities across the region are financially weak, leaving them poorly equipped to meet the above investment requirements:

- Eskom – by far the largest utility in the region – has weak balance sheet as a result of an accumulation of debt that has resulted from tariffs not keeping up with Eskom's rising cost base.

- ZESCO (Zambia) and EDM (Mozambique) also suffer from tariffs that are not cost reflective, resulting in a utility that is not credit-worthy.

- Zimbabwe as a whole suffers well-publicised liquidity issues, which impact on the credit-worthiness of ZESA.

These issues have a knock-on impact on the ability to trade electricity, as is discussed further in our discussion of the barriers to electricity trade from page 25.

3. Status and potential of electricity trading in Southern Africa

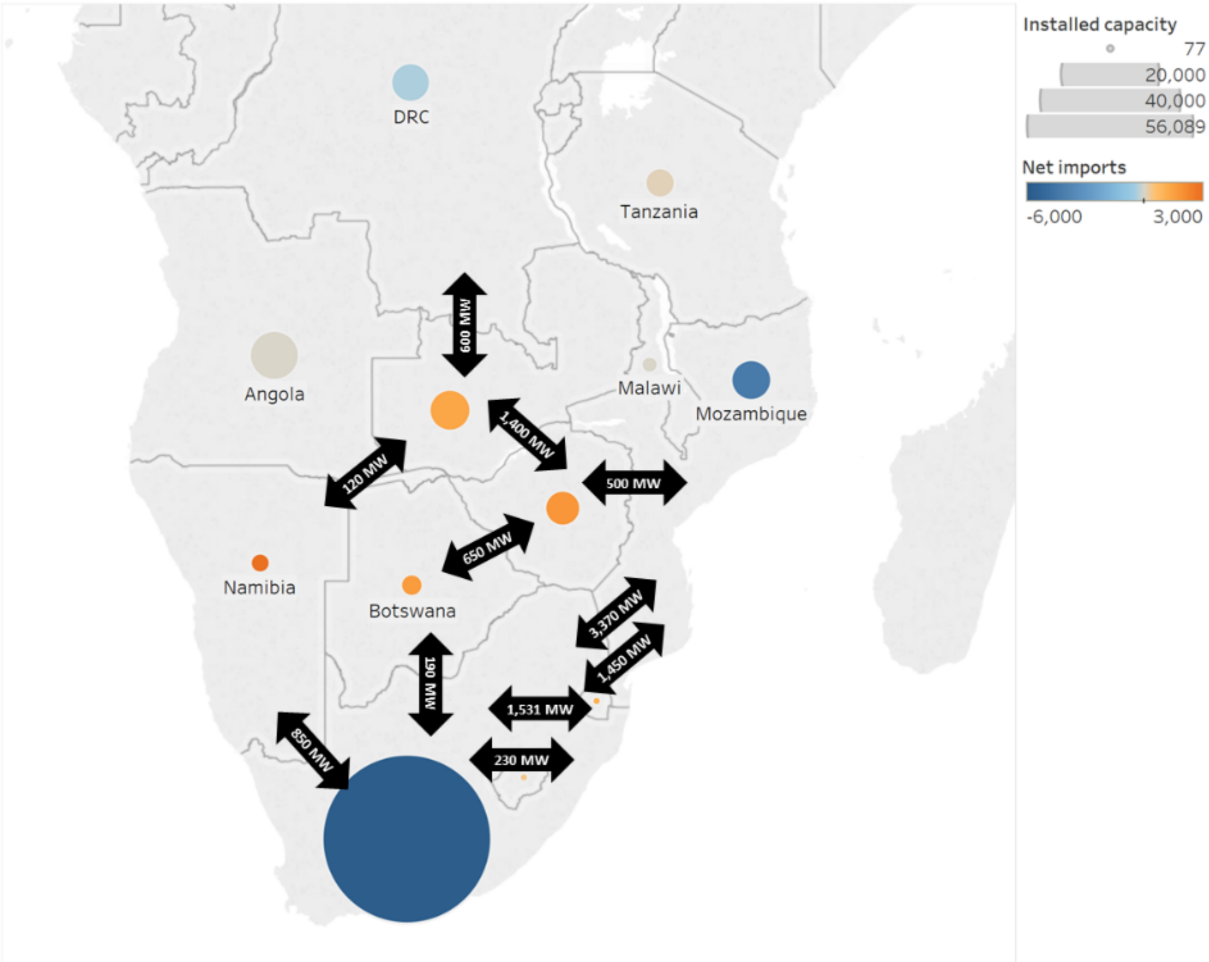
This section presents analysis of the current status of electricity trading between countries in the Southern Africa region. The analysis covers:

- The physical infrastructure in place to connect markets in the region and the physical imports and exports of power that take place today,
- The commercial arrangements, the markets, and the trading processes currently in place to support the execution of trades in the region, and
- The benefits of electricity trading, and the barriers to realising some of these benefits in the Southern Africa region.

Physical interconnection of electricity systems

Across the Southern Africa region there is an increasing amount of interconnector capacity across which electricity can be imported and exported between countries. Figure 4 presents a summary of the interconnection capacity between the different markets. The figure also shows total installed capacity and net imports (in 2016) in each country for comparison. This shows that while some markets (e.g. Angola, Malawi) are not connected to other countries in the region, in other countries (e.g. Lesotho, Mozambique, Namibia) interconnection capacity is very high and often exceeds domestic installed capacity.

Figure 4 Interconnection capacity, total installed capacity 2017 (MW), net imports 2016 (GWh)



Source: *SAPP (2017), Cross-border Information (2018), IEA (2018)*

Figure 4 also shows that there is a particularly complex set of interconnections between the electricity systems in the south-east of the region, notably between Mozambique and South Africa. Much of this infrastructure is related to the 2,075 MW Cahora Bassa hydroelectric dam on the Zambezi river in Mozambique, which was constructed and commissioned during the 1970s. Most of the power generated by the dam is exported to Eskom in South Africa, with some power also being exported to Zimbabwe. However, some of this exported power is then imported back into Mozambique. Most of this relates to the Mozal aluminium smelter near Maputo, which requires ~950 MW of baseload electricity. Together, the Cahora Bassa dam and the Mozal smelter distort the regional picture.

Table 3 shows total imports and exports of electricity for each country in the region and expresses these imports and exports as a percentage of bulk wholesale power. This shows the importance of electricity interconnection to many countries in the region. Imports account for a very high percentage of bulk power in some countries, especially in countries with smaller electricity systems, such as Botswana, Namibia, eSwatini, and Lesotho.

Table 3 Imports and exports of electricity, 2016 (GWh)

					Removing estimated impact of Cahora Bassa and the Mozal smelter in Mozambique			
	Imports (GWh)	Exports (GWh)	Gross imports as % of bulk power[2]	Net imports as % of bulk power	Imports (GWh)	Exports (GWh)	Gross imports as % of bulk power	Net imports as % of bulk power
Angola	0	0	0%	0%				
Botswana	1,673	0	41%	41%				
DRC	20	420	0%	-5%				
Lesotho	374	0	42%	42%				
Malawi	0	0	0%	0%				
Mozambique	9,928	14,269	69%	-30%	1,606	5,947	11%	-30%
Namibia	3,073	99	70%	68%				
South Africa	10,555	16,549	5%	-3%	2,233	8,227	1%	-3%
eSwatini	1,046	0	90%	90%				
Tanzania	102	0	1%	1%				
Zambia	2,185	794	17%	11%				
Zimbabwe	2,220	369	25%	21%				

Source: *IEA (2018), LEWA (2017), SAPP (2017)*

It should be noted that the data in Table 3 are for 2016, the latest year for which the IEA has published its statistics. Imports and exports of electricity will vary from one year to the next, partly as a result of changing economic fundamentals and partly as a result of lapsing or new commercial arrangements, which will be discussed later. In the Southern Africa region imports are exports of electricity have been influenced by two factors in particular:

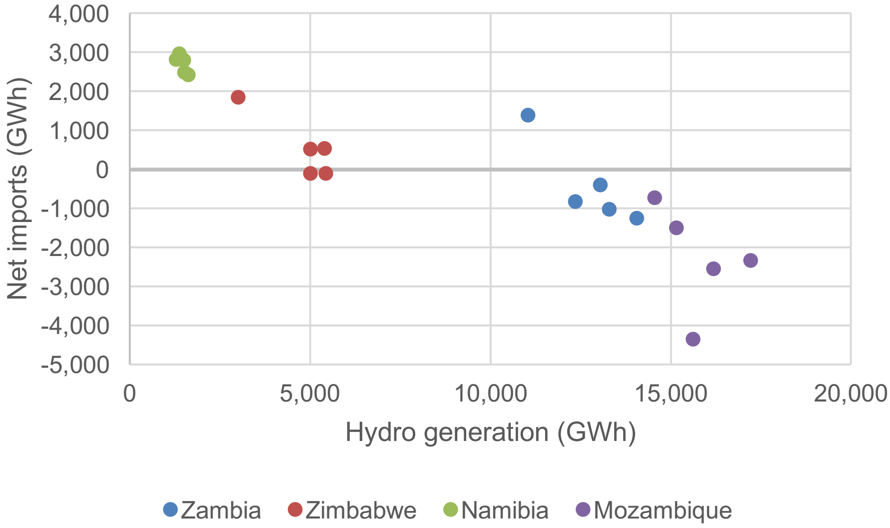
- **Hydro conditions:** hydro is a significant portion of the electricity supply mix in many of the countries across Southern Africa. In recent years hydro conditions have been particularly variable, with drought conditions peaking in 2015-2016. Figure 5 illustrates the importance of hydro conditions on electricity trade in the region. Each point on the scatter plot represents one year in the period 2012-2016. The plot shows how imports to countries reliant on hydro increase in years with low hydro output. The relationship is slightly weaker for Mozambique because the significant storage capacity of the Cahora Bassa dam weakens the reliance on hydro conditions in a given year.

- **South Africa:** The size of South Africa's power market dominates the Southern Africa region; in 2017 56 GW of the region's 75 GW of power generation was in South Africa. This means that South Africa's economic performance, and the performance of its power sector, can have a material impact on electricity trade flows across the region. Figure 6 presents some metrics to illustrate this impact: the left panel shows GDP growth and Eskom's availability factor; the right panel shows total energy demand in South Africa, and net exports. While there are clearly lots of interrelated factors that impact net exports the impact of plant availability in South Africa can be seen. Poor power plant availability in South Africa in 2014-2015 coincided with a significant reduction in exports. Particularly weak economic growth, a recovery in generator availability, and dry hydro

[2] Gross and net imports are shown as a % of bulk power, i.e. generation sent out from domestic power generation facilities, plus net imports, before accounting for losses.

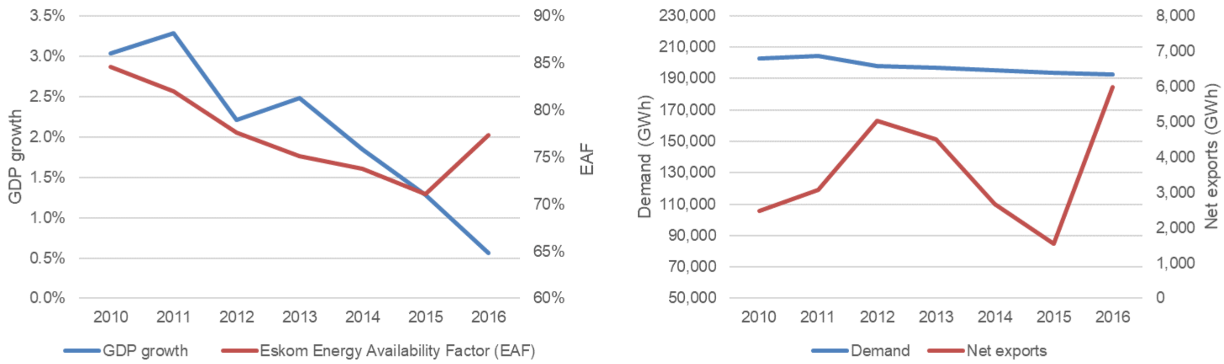
conditions elsewhere in the region coincided with much higher exports in 2016. We understand that load shedding has increased again in South Africa in recent months as a result of poor power plant availability and fuel supply issues. It is too early to conclude whether this is a short-term or longer-term issue, and what the impact on the wider region might be.

Figure 5 Impact of hydro conditions on electricity trade, 2012-2016



Source: *IEA (2018)*

Figure 6 Impact of South Africa's economic performance on electricity trade

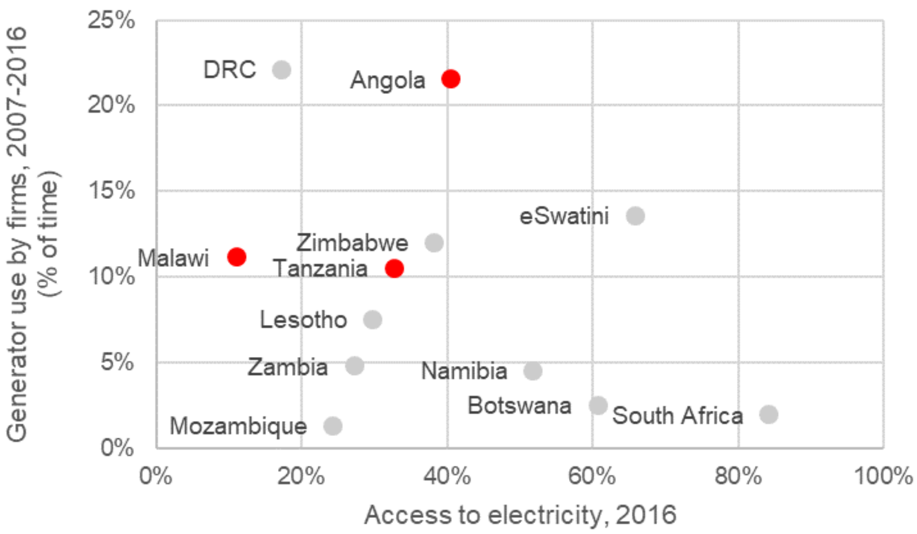


Source: *IMF (2018), Eskom (2011-2017), IEA (2018)*

This analysis shows the importance of a resilient, flexible power system to maintaining security of supply under a range of different scenarios. An extensive transmission system and interconnection with neighbouring markets can be a key ingredient in improving resilience. For example, as shown above in Figure 5, interconnectors can provide an alternative source of supply in a hydro-dominated market during a dry year. However, interconnectors by themselves do not create this resilience; many other ingredients are required. In terms of physical infrastructure, interconnectors cannot compensate for a poor internal electricity network (both transmission and distribution).

Figure 7 presents some basic indicators for electricity availability and reliability across the region. The x-axis shows access to electricity in each SAPP member country and the y-axis shows how much generators are used by firms. The non-interconnected members of SAPP (especially Malawi and Angola) tend to perform poorly against these indicators. While this does not prove any causality between interconnection and the availability and reliability of electricity, it does suggest that interconnection tends to be associated with more mature electricity systems. Tanzania of course has interconnection with other countries outside of the SAPP region. While DRC is connected to the SAPP region, this is primarily so that SAPP can serve mining customers in the south of the country.

Figure 7 *Access to electricity and generator use by firms*[3]*, SAPP members (red indicates non-interconnected members)*



Source: *ESMAP (2018), World Bank (2007-2016)*

SAPP and its member countries are working on a range of proposed transmission and interconnection projects to improve the infrastructure in place to support power trading. Table 4 lists the current interconnection projects in the region, as mentioned in SAPP's latest Annual Report. Note, however, that many of the projects listed in this table have been 'live' for a long time and have made little progress. There are a number of reasons for this, which are explored later in this report, but they include:

- The lack of a robust economic case for the projects, or a change in economic circumstances undermining the original business case.
- The poor financial state of utilities in the region, undermining credit-worthiness.
- Reliance on an 'anchor' offtake and difficulty in securing such a counterparty.

[3] In this graph, "generator use by firms" is inferred as the product of two indicators from the World Bank's Enterprise surveys: "percent of firms owning or sharing a generator" and "if a generator is used, average proportion of electricity from a generator". For the purpose of this analysis it is assumed that this is a proxy for grid unreliability. Note that this data is taken from the latest available Enterprise Survey for each country, which ranges from 2007-2016.

Table 4 Live transmission interconnector projects in the SAPP region

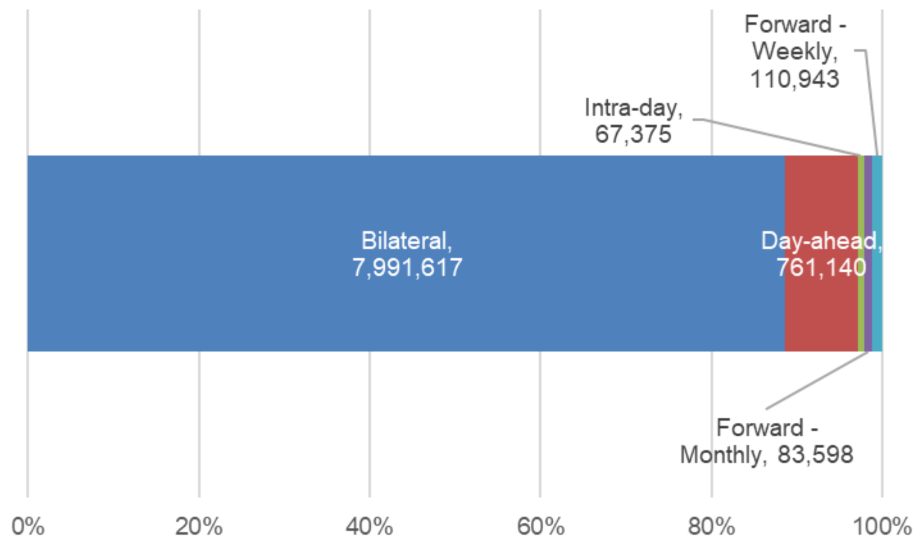
Project name	Estimated status	Expected COD, where stated
Zimbabwe-Zambia-Botswana-Namibia interconnector (ZIZABONA)	Development	-
Zambia-Tanzania-Kenya interconnector	Under construction	End 2019
MOZISA transmission project, connecting South Africa, Zimbabwe, Mozambique	Development	-
Mozambique transmission backbone project	Development	-
Central transmission corridor in Zimbabwe	Late development	-
Mozambique-Malawi interconnector	Late development	2020
Botswana-South Africa interconnector (BOSA)	Early development	-
Namibia-Angola interconnector	Early development	-
Malawi-Zambia interconnector	Early development	-
Malawi-Tanzania interconnector	Development	-
Mozambique-Zambia interconnector	Development	-
Mozambique-Tanzania interconnector	Early development	-

Source: *SAPP (2017)*

Electricity markets and trading

SAPP is the most advanced of the power pools in Africa in terms of establishing market mechanisms that can be used for trading electricity between member states. Figure 8 presents a breakdown of volumes traded in the SAPP region in the year ended March 2017, the last full year for which data has been made publicly available by SAPP. This data shows that ~9 TWh of power was traded across the region in 2016-2017. This is ~3% of bulk power demand in the region, which was 289 TWh in 2016 according to IEA data.

Figure 8 Traded electricity volumes across the SAPP region, 2016-17 (MWh)



Source: *SAPP (2017)*

Figure 8 shows that the power traded across the region was split across a range of different markets:

- Most of the trading was through **bilateral contracts** between SAPP members. This trading does not take place on the SAPP trading platform itself; rather, contracts are agreed between SAPP members, often on terms that are not disclosed to the market. However, these contracts do have a significant impact on the competitive (non-bilateral) markets that are administered by SAPP, because they impact the availability of transmission capacity for competitive trading.

- Across SAPP's competitive markets, the most developed market is the **day-ahead** (DA) market, which was set up in 2009. Auctions take place daily through the SAPP trading platform for hourly energy contracts for the next trading day.

- After the day-ahead auction, hourly contracts can be struck between matching bids and offers on the **intra-day** market (IDM). The IDM was established in 2013.

- New forward products were introduced by SAPP in 2016, through the **Forward Physical Market** (FPM). Baseload, peak, and off-peak contracts can be stuck at the week-ahead (FPM-Weekly) and month-ahead (FPM-Monthly) stage.

We understand that the dominance of bilateral contracts has weakened somewhat since 2016-17 (the last period for which complete data is readily available), but that the volumes traded bilaterally remain much higher than those traded in the competitive markets.

As shown by Figure 8, liquidity in the competitive markets is low, especially outside of the DA market. Even in the DA market, volumes traded only account for <0.3% of bulk power in the region. It should, however, be noted that this is not a challenge that is unique to electricity markets in Africa. Even in the UK liquidity in the DA market has only increased in the last few years.

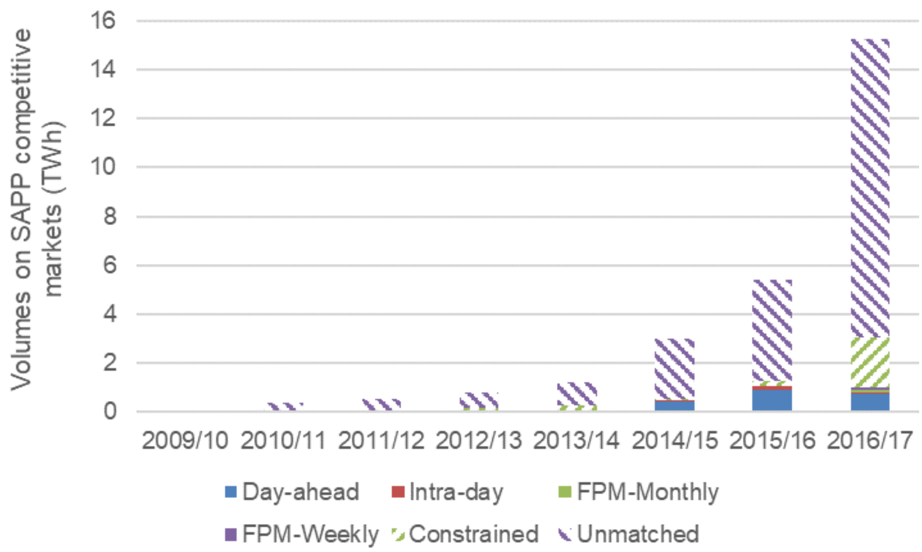
Many of the bilateral contracts struck between parties in SAPP are non-firm contracts, i.e. there is no firm commitment by the seller to provide electricity during the periods in which the contract applies. These agreements are often used by utilities for optimisation, for example if there is an opportunity to procure cheaper power from a neighbouring market during a period of over-supply. These contracts are not transparent and, other than the volumes data shown above, no information is published about the contracts.

Figure 9 shows how volumes traded on the SAPP competitive markets have evolved over time. While the absolute volume traded on these markets remains small, the figure shows how these volumes have increased in recent years. The figure also shows the impact of some of the constraints that have held back the growth in electricity trading:

- The green hatching shows the impact of **transmission constraints** within SAPP on the volumes of electricity traded. An offer to sell power and a bid to buy power might be matched on SAPP's trading platform, but it might then be impossible to fulfil that transaction because there is insufficient transmission capacity to support the demand to trade power. In 2016/17 transmission constraints curtailed energy trading in the SAPP region by ~2 TWh.

- The purple hatching shows an estimate[4] of the impact of unmatched bids and offers; i.e. where a bid submitted to SAPP cannot be matched with an offer, or vice versa. These volumes can be explained by a few factors:
  - A supply-demand mismatch, either where the bids submitted exceed the number of offers, or vice versa. In 2016/17, supply of offers into SAPP's competitive markets exceeded demand, but in most previous years demand exceeded supply.
  - A mismatch in supply-side and demand-side pricing. For example, there might be both potential seller and buyers in the market, but bids are priced too low to be able to match the available offers. We understand that this is the primary reason for the unmatched bids.
  - It is possible that transmission constraints again have an impact if some market participants decide not to submit bids or offers to the market if they know that it is likely that the trade can be physically fulfilled anyway.

Figure 9 Volumes on SAPP competitive markets



Source: *SAPP (2013-2017), Africa GreenCo (2017), ICED analysis*

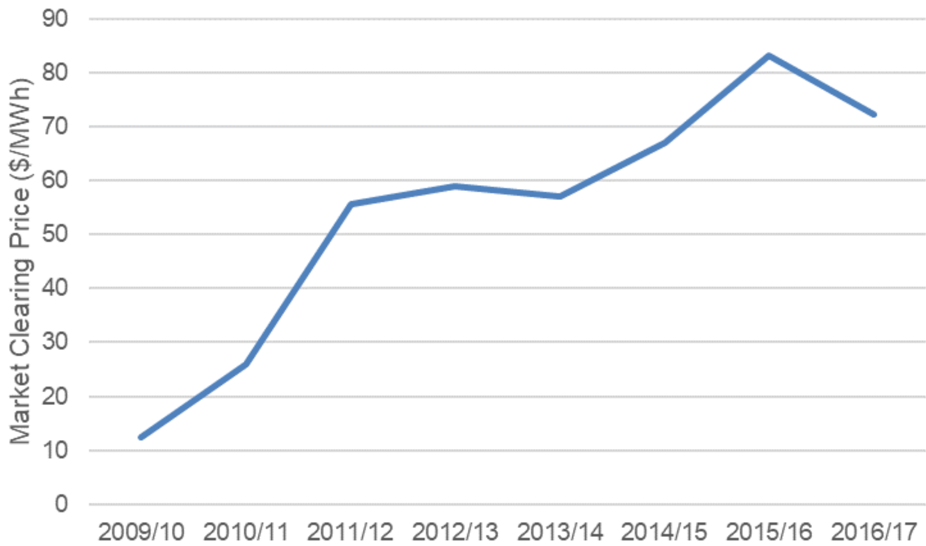
Figure 10 shows annual average prices traded in SAPP since the DA market was launched in 2009. Note that this figure shows the Market Clearing Price (MCP), which is the unconstrained price that results from matching bids and offers across the SAPP region, i.e. before transmission constraints are taken into consideration. We have not

[4] The graph shows a lower bound estimate for unmatched bids. The estimate is calculated as MIN(Total sell offers – Matched volumes, Total buy bids – Matched volumes). In a year where total offers exceed total bids (as was the case in 2016/17) this will ignore some cases where, in an individual hour, bids exceed offers.

performed a detailed analysis of SAPP prices, but the primary price drivers are hydro conditions and prevailing commodity prices. For example, dry conditions in 2015/16 are likely to have contributed to a higher MCP, while commodity prices generally increased from a low in 2009/10. The very low MCP values during the first two years of the SAPP DA market are also likely to have been distorted by very low market liquidity during those years.

As stated above, Figure 10 shows the unconstrained MCP, but we have already observed in Figure 9 that the transmission is heavily constrained. When transmission constraints are binding, restricting the physical trade of power, this results in ‘price splitting’, i.e. a divergence in wholesale power prices between different price nodes[5] in the SAPP region. Where a transmission constraint is active, wholesale power prices will increase on the short side of the transmission constraint when compared against prices on the long side of the constraint. This effect can be seen, for example, when analysing the spread between prices in the Copperbelt region of Zambia (ZAMC) and the northern part of South Africa (RSAN). Figure 11 shows a duration curve of this price spread for 2016, 2017, and 2018. During 2016, the end of the recent drought spell, prices in ZAMC were higher than those in RSAN (shown as a negative spread) about the half the time, and the spread was often significant. With more ‘normal’ hydro condition in 2017 and 2018 the bias towards negative price spreads was reduced. Our understanding is that this ‘price splitting’ effect is primarily a result of transmissions constraints in the central transmission corridor in Zimbabwe, which is one of the priority projects listed in Table 4.

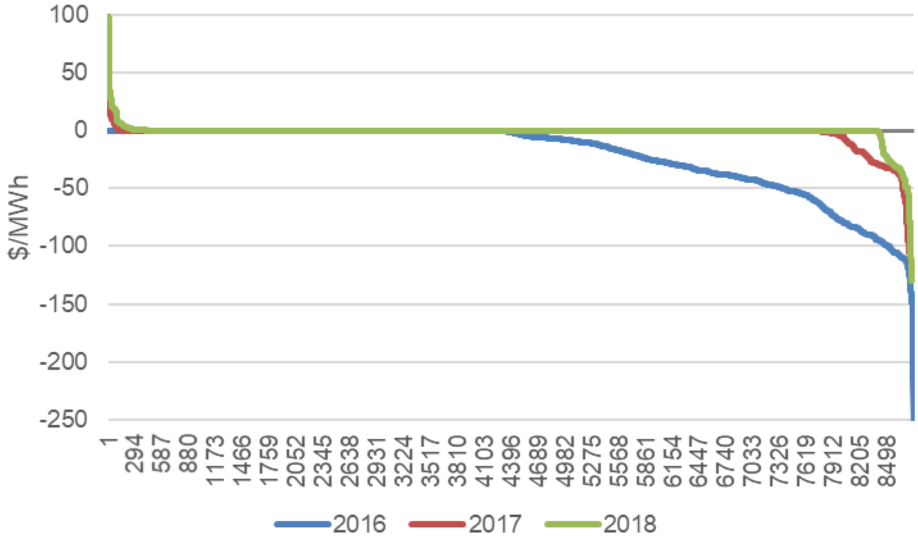
Figure 10 SAPP DA Market Clearing Price (MCP)



Source: *SAPP (2013-2017)*

[5] The SAPP region is broken down into several price nodes. For most countries there is a single node, but for larger countries or countries with a more complex or constrained transmission network (e.g. Mozambique) there can be more than one price node.

Figure 11 Duration curves[6] of DA price spread from ZAMC to RSAN price nodes, 2016-2018



Source: *SAPP market data website, ICED analysis*

Trading operations in SAPP

As already mentioned, a range of different products are sold through SAPP, ranging from bilateral contracts arranged OTC (over-the-counter) between countries, through to transactions that take place closer to real time through SAPP's DA and IDM markets. This section presents a summary of some of the operational processes and timings in the operation of these markets.

Table 5 lists each of the product types traded on SAPP's competitive markets. As already noted, most of the volumes traded through the competitive markets are traded as hourly volumes in the DA market, but market participants can also buy and sell baseload, peak, and off-peak products at the month-ahead and week-ahead stage, and continuous trade of hourly volumes takes place after gate closure in the DA market, through the IDM. The table indicated the timing of trading actions in each of these markets.

Table 5 Trading timelines for SAPP competitive markets

Product	Description	Trading day
FPM-Monthly	Delivery of volume for a month, normally baseload, but can be peak/off-peak	Last Wednesday and at least 5 days before delivery month starts
FPM-Weekly	Delivery of volume for a week, normally baseload, but can be peak/off-peak	Every Thursday in the week prior to the delivery week
Day-ahead market	Delivery of volume in each individual hour	Day before delivery day – gate closure is at 12 noon
Intra-day market	Delivery of volume in each individual hour	Continuous trading

Source: *SAPP (2016)*

[6] A duration curve shows the distribution of price spreads over the course of a year. The curve stacks up the price spreads for each hour of the year (8760 hours, or 8784 in a leap year) from the highest (on the left of the figure) to the lowest (on the right of the figure).

In parallel with the trade of these products through SAPP's competitive markets, market participants may enter into bilateral contracts. The seller in a bilateral arrangement is responsible for entering the details of such a contract through SAPP's systems. They are also responsible for then informing SAPP of the volumes nominated through the contract at the day-ahead stage. This information is important for SAPP operations as it is used in allocating transmission capacity.

Capacity allocation rules are key to the operation of any power market. Table 6 summarises the priority order in capacity allocation for SAPP. The rows in grey are only relevant close to delivery, after gate closure of the DA market. Firm bilateral contracts normally take priority, so as noted above it is important that commitments made under these contracts are considered when clearing the competitive markets. Before clearing each of the competitive markets the Available Transmission Capacity (ATC) is calculated, which subtracts any capacity that has already be committed through bilateral contracts or through competitive market transactions that have already cleared.

Table 6 Prioritisation in allocating transmission capacity in SAPP

Ranking	Contract type
1	Emergency energy support
2	Firm bilateral contracts as nominated day-ahead
3	FPM-Monthly and FPM-Weekly
4	Day-ahead market
5	Non-firm bilateral contracts
6	Intra-day market
7	Pay-back of 'inadvertent' energy (essentially imbalance)

Source: *Africa GreenCo (2017)*

When power is traded between members in SAPP transmission losses are suffered, and transmission infrastructure is used. There is a cost associated with both, and where the costs in this case can be across multiple power systems those costs have to be allocated. SAPP has agreed methodologies for allocating these costs for transactions settled through its competitive markets, and efforts are being made to align the allocation methodologies used in contracts that are struck bilaterally within the region.

Transmissions losses are calculated according to loss factors that are determined periodically by SAPP. The cost of transmission losses associated with each transaction on the competitive market is split 50/50 between buyer and seller and is added to the invoice parties receive from SAPP.

Wheeling charges are also calculated by SAPP; these charges allow the utilities that own the transmission infrastructure that is used to fulfil trades executed on SAPP to recover some of the costs of maintaining and upgrading that infrastructure. Wheeling charges are calculated for each possible trading route for each possible paid of trading counterparties. For most of these routes the total wheeling fees are well under 0.5 $c/kWh. Our understanding is that the low level of charges reflects the fully depreciated nature of some transmission infrastructure (JICA, 2017), although the methodology used for calculating wheeling charges is not published by SAPP. However, we note that this approach may not allow utilities to recover the funds needed to expand or upgrade their transmission systems.

The current methodology for wheeling charges only applies a charge for the use of third-party transmission systems. For example, the wheeling charges for Eskom selling power to ZESCO includes a charge for BPC and ZESA, the utilities in Botswana and Zimbabwe. But there is no wheeling charge for the use of the system in South Africa or in Zambia, on the basis that the buyer and seller will recover these costs from their own customer base. This reflects the fact that trading today is always between SAPP members that have full control of their system, i.e. there is vertical integration between system ownership and trading.

We understand that SAPP is working on a new wheeling methodology that will also apply charges relating to the source and destination systems for a given trade. This is likely to be a pre-requisite for third parties to join SAPP and for further liberalisation of the market. Our understanding is that little progress has been made on this methodology.

The benefits of electricity trading

There are many potential benefits of trading electricity regionally, and this section aims to summarise them. The benefits can broadly be listed under three headers:

- Benefits that result from the increased **system size** of multiple countries cooperating with each other.
- **Operational efficiencies** that result from optimising the electricity system across multiple countries.
- Benefits that result from changes to the **market structure,** which are required for electricity trading to take place.

More detailed benefits can be listed under these headers, as is summarised in Table 7. This table also indicates the outcomes that might be expected from each of the more detailed benefits. Electricity trading can yield benefits in each of the areas of the policy trilemma that normally prevails in the sector: power can become more affordable, security of supply and power quality can improve, and greenhouse gas emissions can fall.

Table 7 Summary of the benefits of regional electricity trading

Benefits of regional trading	Outcomes: Improved affordability	Improved reliability and power quality	Reduced GHG emissions
System size			
Economies of scale	✓		
Diversification of supply (and demand) options	✓	✓	
Operating efficiency			
Short-term optimisation	✓	✓	✓
Seasonal optimisation	✓	✓	?
Multi-year optimisation and climate resilience	✓	✓	
Market structure			
Increased transparency of pricing	✓		

Source: *ICED analysis*

The benefits listed in Table 7 can be described in more detail:

- **Economies of scale** can result from regional power trading as larger projects can become possible if there is a shared interest across a few countries. This might, for example, be in the form of a multi-country large scale generation project (which might supply power to multiple client countries) or a project that required access to a larger market for it to be economically viable. Larger projects might lead to economies of scale (e.g. for large hydro projects) that result in lower generation costs.

- **Diversification of supply (and demand) options** can improve the risk profile of power sector project, improving their bankability. From a utility's point of view, access to an effective regional market reduces the risk of not being able to meet demand in the event of an isolated supply issue, such as an unexpected outage. The reverse is also true: a truly liquid and liberalised wholesale market would allow an Independent Power Producer (IPP) to find alternative buyers of its electricity output in the event of a default, which could help to mitigate credit risk. This concept of diversification is at the heart of Africa GreenCo's proposals for a new collateralised offtaker for renewable energy projects[7].

- Improved **short-term optimisation** over multiple countries, which can be facilitates by regional trading, can reduce operating costs. For example, there might be periods during which it is more cost-effective for a country to import power instead of using an expensive domestic peaker. The displaced generators are often likely to be liquid fuel plants with high emissions. On very short timescales regional optimisation of reserve and system ancillary services could

[7] See Africa GreenCo (2017): Feasibility Study

help to improve security of supply. The improvements to short-term optimisation offered by regional markets could have significant benefits for **integrating renewables** as well. Intermittent renewable generation (e.g. wind, solar) can be difficult to integrate to the electricity system. Flexibility is important in being able to manage this intermittency and respond quickly to the changing output from renewable generators; interconnection with neighbouring markets is one possible source of this flexibility. Realising these benefits requires not only robust interconnection (and within-country transmission and distribution) infrastructure to be in place; it also requires that infrastructure to be available for short-term trading (rather than its utilisation being prescribed through long-term contracts).

- **Seasonal optimisation** can also be improved in the same way. This can be particularly beneficial in regions with significant seasonality in hydro resource, for example. Hydro-dominated systems can import during a dry season, but export during a rainy season. This in turn might link to the economies of scale benefit mentioned earlier: the same country might be able to invest in more hydro resource where this is economically attractive if it is confident that it will be able to export any surplus power that results.

- **Multi-year optimisation and climate resilience** could become an increasingly important benefit of taking a regional approach in future. If climate change leads to more extreme weather patterns this might lead to more extreme droughts and hence more volatile output from hydro facilities. A regional approach, and diversification of supply options, could improve a power system's resilience to these scenarios. Operating procedures that stress test system optimisation against these scenarios might also lead to a better allocation of hydro resources that considers climate variability.

- The **increased transparency of pricing** in the market can help market participants negotiate better prices in the wholesale power market and can help to expose excess economic rents. Transparency can also help to catalyse wider markets reforms: for example, there can be synergies with unbundling and increasing competition in the sector where these reforms are appropriate. All these reforms can help to increase the economic efficiency of the sector and improve the value for money delivered to end consumers.

Barriers to electricity trading in Southern Africa

The potential benefits of electricity trading that are summarised above do not all apply, or cannot all be easily realised, in the SAPP region. This is the result of numerous barriers to realising those benefits, which can be articulated with reference to the Whole System Approach, as explained earlier on page 6.

- **Governance and regulation**
    - The **political economy** of electricity can act as a barrier as many governments and utilities are keen to be seen to be self-sufficient, rather than relying on electricity imports. In some ways this is not unreasonable: most European countries (including the UK) have debated the contribution made by interconnection to security of supply, and they generally adopt a

conservative stance when quantifying interconnection's contribution to security of supply.

- A **disjoint between regional and national activities** means that some roles are repeated and the value of some roles is lost. For example, planning exercises have been performed at both the regional and national levels, but there is no obviously connection between these. Plans are treated as static documents, rather than being owned, maintained, and updated. The role of regional institutions (including SAPP, but also the regional regulator, RERA) and how these interact with national institutions is not always well defined.

- To date, **planning has not properly considered the role of trading** and interconnection. When least-cost expansion plans are executed, they are often supply-side focused and consider a range of candidate generation investments. Interconnector and transmission infrastructure are often considered exogenously, rather than considered as candidate investments in the same way as generation projects are. We note that the SAPP Pool Plan uses a combination of exogenous (for internal transmission) and endogenous (for interconnection) assumptions, partly tackling this shortcoming.

- A linked issue is the **role of transmission infrastructure** is likely to change as the role of renewables increases in importance. In the past interconnectors have often been used to buy and sell 'blocks' of baseload, peak, or off-peak power. In the future, interconnectors might need to be used more flexibly to integrate more intermittent renewables. This will require different commercial arrangements – see below. These challenges are often not properly considered in planning exercises, and analysis of economically optimal interconnector dispatch is not used to inform the commercial and financial structuring of transmission projects.

- The **dominance of vertically integrated** utilities in the region often limits the potential for establishing a liquid electricity market in the region. Under the current market arrangements, IPPs do not improve this situation as they contract directly with the national utility. This could be improved, for example through setting up early stage electricity markets (e.g. a mandatory pool with strict cost-based bidding rules) while maintaining the commercial intent of existing PPA arrangements.

- Lack of progress with improving **national energy sector and governance** can also act as a constraint on regional trading. While it is not clear whether this is a significant issue in Southern Africa, credit-worthiness issues (largely a result of tariffs being below cost-reflective levels) are a barrier to trade in the West African Power Pool[8]. Anecdotal evidence from some stakeholders in the region suggests that some of the unmatched volumes on SAPP may be a result of utilities submitting unrealistically low bids, because of the limitations of their own tariff policies. In some cases,

[8] World Bank (2018): Strengthening payment security for cross-border electricity trade in the West African Power Pool

customers may have paid more for available power, but the constraints of tariff regulation may have led to an inefficient market outcome.

- **Market and commercial**
    - **New and innovative commercial structures** are needed to catalyse investment in the transmission infrastructure that is required to facilitate more electricity trading. The lack of a customer willing to act as an 'anchor' to underwrite the business case for a project is the primary barrier for many of the pending interconnector projects in the SAPP region. However, even if such a counterparty were available, this type of commercial structure is unlikely to be fit for purpose in a scenario with increasing amounts of intermittent renewable generation.
    - Some market **methodologies and rules** lack transparency and need reform to support further liberalisation in the future. For example, we noted above that the methodology used for calculating wheeling charges is not transparent; it has not been published by SAPP. Further, reform of this methodology will be required to ensure use of system costs are allocated fairly if third parties are granted membership of SAPP in the future.
    - The **financial weakness of many national utilities** can act as a barrier to electricity trading. Poor credit-worthiness and late payments can undermine confidence in the market. Further, some utilities might be unable to post the collateral required to participate in the SAPP market. We understand that ZESA of Zimbabwe is unable to trade for this reason. Given Zimbabwe's central position in the region this constraint could undermine the efficient functioning of the market. The credit-worthiness of both ZESCO (Zambia) and EDM (Mozambique) is also an increasing concern for the region.
    - Greater use of the regional market is held back by the **lack of transparent market processes at the national level**[9]. This is linked to the points on the dominance of vertically integrated utilities, noted above. As stated above this could be partly addressed through targeted market reforms at the national level. Improved transparency over SAPP methodologies would also help with harmonising market and system operations across national utilities.
- **Physical infrastructure**
    - **Physical transmission constraints are a major impediment to trading**, as shown by the analysis of SAPP market resulting in Figure 9. Physical electricity trading cannot be increased without addressing these constraints.
    - Across the region there will be a greater need for flexibility, including interconnection, to facilitate the integration of more intermittent renewable

[9] We understand that reforms to introduce a single-buyer model have been introduced in both Malawi and in Namibia. These reforms appear to be primarily aimed at creating an environment that facilitates private investment on the supply side. Additional reforms are likely to be necessary in future to create a transparent wholesale power price that can act as a catalyst for electricity trading.

generation. **Little consideration in planning of the future need for flexibility** hold back the investments that might increase the role of electricity trading in meeting future system challenges.

- **Poor transmission and distribution infrastructure within country** is also barrier as it prevents electricity from being delivered to end consumers. Building an interconnector that connects two weak systems together is likely to yield little or no benefit.

These barriers reduce the extent to which many of the benefits of electricity trading, which were described from page 23, can be accessed in the SAPP region. Table 8 summarises a qualitative assessment of this impact.

Table 8 Impact of barriers on the potential benefits from electricity trade

	Impact of barriers in the SAPP region			Potential outcomes		
Benefits of regional trading	**Governance and regulation**	**Market and commercial**	**Physical infra-structure**	**Improved affordability**	**Improved reliability and power quality**	**Reduced GHG emissions**
System size						
Economies of scale				✓		
Diversification of supply (and demand) options				✓	✓	
Operating efficiency						
Short-term optimisation				✓	✓	✓
Seasonal optimisation				✓	✓	?
Multi-year optimisation and climate resilience				✓	✓	
Market structure						
Increased transparency of pricing				✓		

Red indicates that the barrier has a significant impact on realising a given benefit
Amber indicates that the barrier has some impact on realising a given benefit
Green indicates that the barrier has little or no impact on realising a given benefit

Source: *ICED analysis*

Based on the commentary above and the high-level assessment presented in Table 8 we can start to draw some conclusions on which barriers might be prioritised:

- While the commercial arrangements in place for SAPP itself are relatively well developed, new and innovative commercial models are urgently needed to unlock investment in transmission projects that facilitate trade, especially flexible short-term trading that facilitates renewables integration.

- Physical infrastructure constraints need to be addressed so that the existing binding constraints on trade, which we understand to primarily be through the central corridor[10] from South Africa, through Botswana and Zimbabwe, up to Zambia, can be addressed.

- Gradual and targeted liberalisation of national electricity markets needs to take place to tackle credit-worthiness concerns and to increase the demand for trading and increase liquidity in the market. Increased participation in the market will also require improved transparency in market operations at both a regional and national level.

The recently published Power Africa Transmission Roadmap[11] provides some indication of where the priority infrastructure investments might be. Figure 12 summarises some of the analysis presented by Power Africa as part of the roadmap. We have lifted the analysis from the Roadmap and have not interrogated the underlying assumptions. The figure presents three sets of data:

- The median generation cost in each country, as modelled by Power Africa. This is indicated by the size of the grey bubbles in each country.

- The modelled peak de-rated capacity surplus or deficit for 2025, which is indicated by the shading for each country. There are two interesting points to note:

    - Over the Southern Africa region as a whole the analysis projects a de-rated surplus of >10 GW. This could be interpreted as suggesting over-build is likely, especially in countries hoping to export a significant amount of power (e.g. South Africa).

    - Apart from in the obvious case of South Africa, projected surpluses are not always in countries with low generation costs. This again suggests that planning decisions are not coordinated or optimised at a regional level.

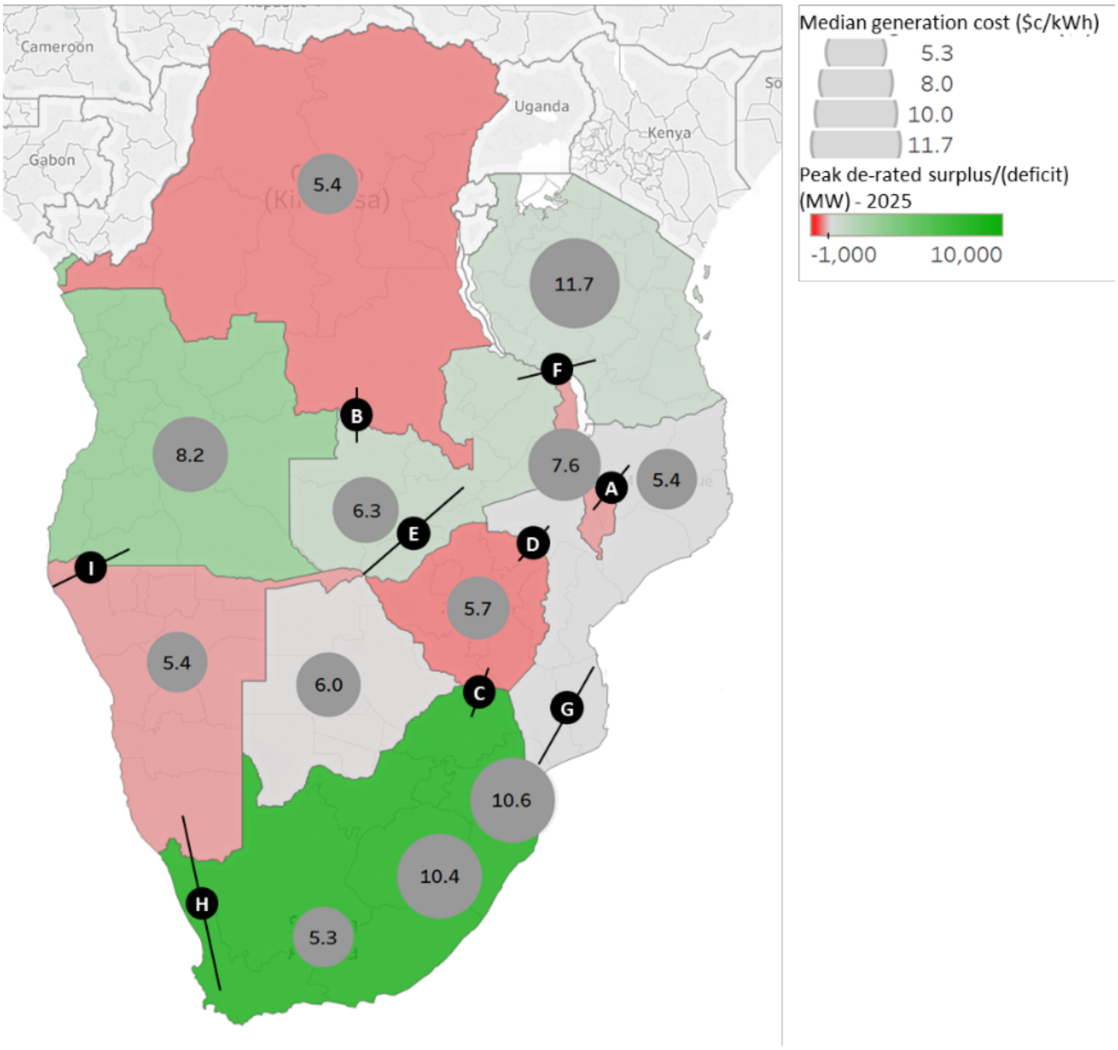
- Finally, the letters indicate specific projects that the Roadmap has identified as priorities. Further information on these projects and the rationale for them is presented in Table 9.

Power Africa's analysis suggests that projects A, C, D, G, and I are in particular need of support. While this information may need further validation to support a future DFID business case these priorities are broadly consistent with the anecdotal evidence collected through stakeholder conversations held by ICED that the central corridor is a priority.

[10] Some conversations have suggested that this constraint is a particular problem for southbound flows. While this might not be the dominant direction of power flows today, using power trade to facilitate renewables integration will rely on flow in both directions.

[11] Power Africa (2018): Transmissions Roadmap to 2030: A practical approach to unlocking electricity trade

Figure 12 Generation cost, projected de-rated surplus/deficit, and Power Africa priority projects



Source: *Power Africa (2018)*

Table 9 Southern Africa priority projects identified in the Transmission Roadmap

	Route	Status	COD	Rationale
A	Phombeya – Matambo	Feasibility	2020	Connecting Malawi to the power pool
B	Solwezi – Kolwezi	Feasibility	-	Central corridor opportunity
C	Triangle – Nzhelele (MOZISA)	Feasibility	-	
D	Bindura – Songo (MOZISA)	Feasibility	-	
E	Kafue Town – Victoria Galls	Feasibility	2023	Bringing new power capacity to the regional market
F	Kasama – Mbeya (ZTK)	Development	2020	
G	Vilanculos – Maputo	Feasibility	2023	
H	Harib – Kenhardt	Development	-	Western corridor opportunity / delivering power to Namibia
I	Baynes hydropower plant – Ondjiva (ANNA)	Feasibility	-	

Source: *Power Africa (2018)*

4. Status of the Southern African Power Pool

Economic cooperation across the Southern Africa region

The Southern African Development Community (SADC) was established in 1992 with the objective of improving development, peace and security, and economic growth, alleviating poverty, and improving the quality of life of people in Southern Africa. SADC set the trend for regional cooperation with commitments to establishing a regional free trade area, common market, and eventually a single currency.

None of these original targets has been met on time, but the commitment to increasing cooperation on trade more broadly remains, as demonstrated through SADC's involvement in the Tripartite Free Trade Area (TFTA), a joint initiative between member SADC governments, the Common Market for Eastern and Southern Africa (COMESA), and the East African Community (EAC). ICED has separately prepared more detailed analysis on trade in the Southern Africa region for DFID[12].

SADC has also had a role in promoting regional coordination across the energy sector. SADC member states signed a Protocol on Energy in 1996, which defines a framework for cooperation across the sector. The objectives of the Protocol, set out in Article 3, include the harmonisation of national energy policies, and the use of "energy pooling to ensure security of supply and the minimisation of costs." We understand from SADC that the Protocol is currently being amended e.g. to reflect that the "Commission" established by the Protocol is no longer active, partly as a result of other institutions being established.

SADC has been instrumental in catalysing regional cooperation, resulting in several regional institutions being established in the energy sector:

- The Southern African Power Pool (SAPP) itself, which we describe further below.
- The Regional Electricity Regulatory Association (RERA), which aims to harmonise electricity regulations across the region, was established in 2002.
- Recently, SADC has established the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), which aims to support sustainable development objectives in the sector at a regional level.

These regional institutions aim to coordinate and harmonise policy and regulation where appropriate, and to drive the development of new policy and regulation frameworks where these are needed to facilitate regional collaboration (an example being the trading of electricity through SAPP).

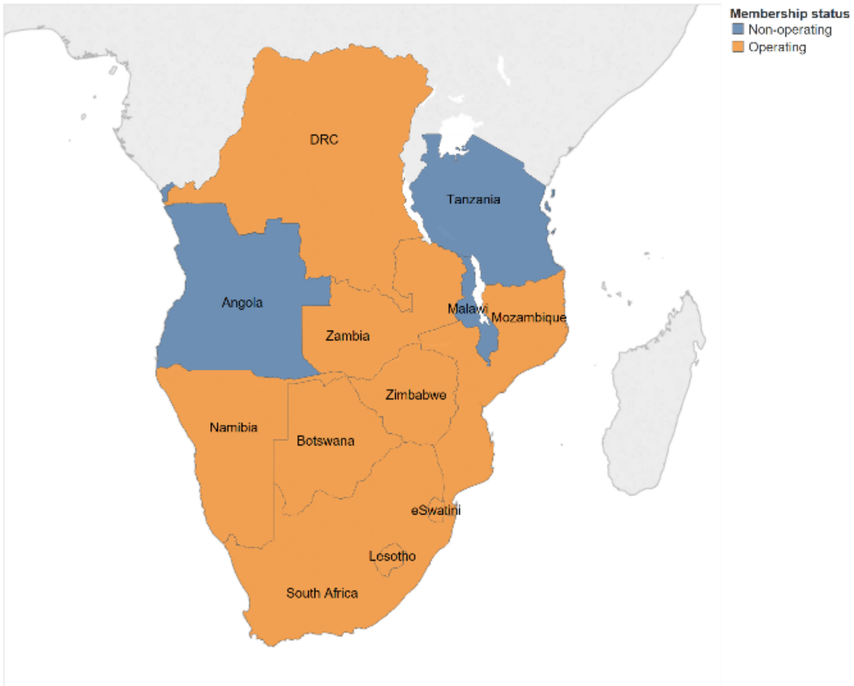
Electricity trading and the Southern Africa Power Pool

SADC established the Southern African Power Pool (SAPP) in 1995. We have already discussed the state of physical infrastructure to facilitate electricity trading, and the

[12] ICED (2018): Trade Infrastructure: Programming options in Southern Africa.

electricity markets that have been established by SAPP, in Section 3. 12 of the 15 members of SADC are members of SAPP; this includes all SADC members on the main African continent (i.e. excluding Seychelles, Mauritius, and Madagascar). As explained earlier, Tanzania, Malawi, and Angola are not physically connected into the SAPP network, so they are "non-operating" members of the power pool, as shown in Figure 13.

Figure 13 Operating and non-operating member countries of SAPP



Source: *SAPP (2017)*

In addition to the utilities of each the countries shown in Figure 13, the following are also members of SAPP, bringing total membership to 16:

- Copperbelt Energy Cooperation (CEC), which is a vertically integrated utility operating in the northern (Copperbelt) region of Zambia and supplies electricity to mining companies operating in Zambia and DRC. CEC's geographical position means that it is a significant electricity trader in SAPP, earning ~$100m of its revenues from electricity trading in both 2017 and 2016[13].

- Hidroelectrica de Cahora Bassa (HCB), which as already mentioned is a large hydroelectric dam on the Zambezi in Mozambique. HCB supplies much of its output to the Eskom network via a DC connection. HCB also supplies power into Zimbabwe.

- Lunsemfwa Hydro Power Company is an IPP with 56 MW of hydropower capacity in Zambia.

[13] Copperbelt Energy Corporation (2017): Annual Report

- Mozambique is unusual in the region in that its electricity sector has been partially unbundled. The Mozambique Transmission Company (MOTRACO) is a member of SAPP as well as Electricidade de Mocambique (EdM), which is the main electricity utility in the country.

The role of SAPP

Table 10 presents SAPP's Vision and Objectives, lifted directly from its annual report. Broadly, the Objectives and Mission are specific to SAPP and describe things that SAPP can influence together with other regional institutions in the sector. The Vision and Strategy cannot be achieved by SAPP alone, but can be facilitates through SAPP meeting its objectives. For example, it is not within SAPP's role to introduce retail competition across the region but having a platform for competitive trading of wholesale electricity is one key ingredient that would need to be in place for this vision to be realised.

Table 10 Vision, objectives, mission, strategy, and values of SAPP

Vision
Facilitate the development of a competitive electricity market in the SADC region.
Give the end user a choice of electricity supplier.
Ensure that the southern African region is the region of choice for investment by energy intensive users.
Ensure sustainable energy developments through sound economic, environmental and social practices.
Objectives
Provide a forum for the development of a world - class, robust, safe, efficient, reliable and stable interconnected electrical system in the southern African region.
Co-ordinate and enforce common regional standards of quality of supply, measurement and monitoring of systems performance.
Harmonise relationships between Member utilities.
Mission
Aim to provide the least cost, environmentally friendly and affordable energy and increase accessibility to rural communities.
Strategy
To be the most preferred region for investment for value for money by energy intensive users.
Values
Respect for others and develop mutual trust.
Honesty, complete fairness and integrity in dealing with issues.
Selfless discharge of duties.
Full accountability to the organisation and its stakeholders.
Encourage openness and objectivity.

Source: *SAPP (2017)*

SAPP as an organisation is arranged as illustrated in Figure 14; again, this is lifted directly from SAPP's annual report.

Figure 14 SAPP organogram

Source: *SAPP (2017)*

In Figure 14 the component parts of the SAPP organisation have been shaded in three colours to indicate different types of role:

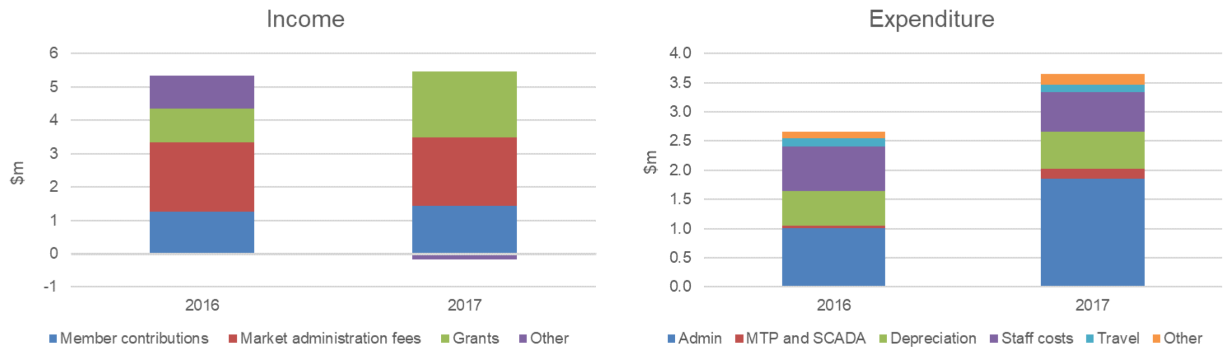
- The parts of the organisation that set SAPP's strategic direction are shown in blue. This is led by the Executive Committee (EXCO), on which each of SAPP's members has representation.

- The operational parts of SAPP are shown in orange. This includes both the co-ordination centre (based in Harare), which run the SAPP markets, and the Johannesburg-based Project Advisory Unit, which provides advice and input to regional generation and transmission projects.

- The sub-committees then provide oversight of SAPP's various functions.

The panel on the right-hand side of Figure 15 provides a breakdown of SAPP's expenditure. The largest item in admin costs is the utilisation of grants to carry out the work authorised by those funds; from the left-hand side it can be seen that grants increased significantly from 2016 to 2017. Of the $1.7m total in grant funding in 2017, $1.6m was from the WB. Donor support is covered further in Section 5 of this report. One of SAPPs main expenses relates to the running of the Market Trading Platform (MTP) and its SCADA systems – most of the depreciation charge shown also relates to these assets. Note that the 'other income' line relates primarily to exchange rate differences.

Figure 15   SAPP income (left) and expenditure (right)



Source: *SAPP (2017)*

5. Status of external support for power trading in Southern Africa

Current donor landscape

Many donors, including DFID, are already engaged in the energy sector in the Southern Africa region. This section summarises the main donor programmes that we are aware of that specifically seek to improve the conditions for electricity trading in the region, tackling some of the barriers that have been identified in this report.

The first point to note is that the region and its member states have increasingly been self-funding work in this area. As shown in Figure 15 the majority of SAPP's income comes from members, through a combination of direct contributions and market administration fees. This amounted to ~$3.5m in FY2017. Individual member states have also increasingly been self-funding work to drive forward reforms at a national level. We understand, for example, that support provided for the Namibian market reforms mentioned earlier was self-funded.

The donors that have been most engaged with the issues explored in this report are the World Bank and US AID.

<u>World Bank: Advancing Regional Energy Projects</u>

The World Bank (WB) has been heavily engaged with the SAPP since 2016 through the Advancing Regional Energy Projects (AREP) initiative. Our understanding is that AREP was initially funded by a $20m IDA grant. At the start of this engagement (which coincided with energy shortfalls and blackouts in South Africa) the focus was very much on the need for more hard generation and transmission infrastructure to address what were primarily seen as supply-side constraints.

Noting that there were a large number of generation and transmission projects that had been in development for some time, but made little progress, AREP's initial focus was to set up the Project Advisory Unit (PAU) within SAPP (see Figure 14). Before the PAU was set up donors often supported individual studies required for a given project, but there was no overall coordination of these activities This often meant that studies were out-of-date by the time a project was ready to proceed to the next stage. While the challenges have not disappeared, we understand that the PAU has improved coordination across project preparation activities.

Since the AREP initiative was launched, the supply-demand dynamics in the region have shifted again, with South Africa having surplus capacity and acting as an exporter of electricity to the rest of the region. There has also been an increasing recognition of the political economy challenges in increasing electricity trade; in particular, the need to be able to articulate the economic benefits of trade to national governments. The WB funded the SAPP Pool Plan, which started to address this challenge by identifying ~$38bn in reduced investment costs if a regional approach is taken to optimising electricity supply in the region.

The WB is now establishing a Multi-Donor Trust Fund (MDTF) to fund AREP, supplementing the original IDA grant. By setting up a MDTF, WB is aiming to increase coordination between different donors operating in the region, and the level of coordination with the key regional institutions such as SADC and SAPP. SIDA has indicated a willingness to contribute $15m to the MDTF, of which $2.2m has been provided so far. The MDTF aims to formalise dialogue between donors, rather than relying on *ad hoc* conversations. To this end, biannual steering committee meetings are held, at which SAPP proposed a comprehensive work programme. The WB is currently working on a paper to be shared with its MDTF partners ahead of the next steering committee meeting. This paper will explore some of the medium-term priorities that the MDTF might help to address. Castalia has been supporting the WB in preparing this paper.

The WB has identified four categories of barrier that need to be tackled, which align well with DFID's Whole System Approach: hard infrastructure, soft infrastructure (i.e. commercial barriers), regulatory, and political economy barriers. Two of the specific areas that we understand WB are proposing for funding align particularly well with the barriers identified in Section 3 of this report:

- **More granular economic analysis of the benefits of trading.** As noted above the SAPP Pool Plan identifies the potential for significant savings from electricity trading at a regional level. The WB has suggested that follow-on analysis might help to analyse the costs and benefits at a national level, to help gain traction at a national level. This analysis might also help to inform commercial negotiations for interconnector investment where the costs and benefits are unevenly distributed between member countries.

- **Regional business models for transmission and interconnection.** The WB is considering a range of different areas where new business models could be developed to help catalyse the development of transmission and interconnection projects. Potential models include:

    - Adopting Transmission Use of System (TUoS) charges to allocate transmission costs across users of the transmission network. Ideally, a common TUoS methodology would be adopted across multiple countries.

    - A Regional Transmission Finance Facility (RTFF) is also being considered as an option. The RTFF could allow some risk and benefit sharing across member states and might allow for costs to be allocated between different countries according to the benefits they could expect to realise from the project.

Funding has not been committed to these activities yet, so there remains an opportunity for donors, including DFID, to provide funding through the MDTF.

<u>US AID: Southern African Energy Program</u>

The Southern African Energy Program (SAEP) is a 5-year programme that runs to 2022 under the Power Africa initiative. The lead partners implementing SAEP are Deloitte, McKinsey, WorleyParsons, and CrossBoundary. Much of the activity under SAEP in at a national level, with support being provided directly to national institutions. However, SAEP has also provided assistance both at the regional and national level with the aim of improving electricity trade between different countries in the region. These activities have included:

- Capacity building within SAPP, for example on establishing regional markets for ancillary services, which will become increasingly important as the role of intermittent renewables increases.
- Transaction advisory support to the Malawi-Mozambique interconnector, which we understand is expected to be operational in 2020.
- Analytical input to the Power Africa Transmission Roadmap, indicating which projects should be treated as a priority within the Southern Africa region (see Figure 12).
- Support to IPPs seeking to become members of SAPP.
- SAEP's activities at the national level are wide-ranging but include efforts to tackle the poor credit-worthiness of many utilities in the region, which currently acts as a barrier to trade.

<u>Other donor activities</u>

While the WB and US AID activities noted above are the most significant live programmes, there are other relevant donor activities, which are summarised below in Table 11.

Table 11 Summary of other relevant support

Donor(s)	Summary of activities
EU	The EU has been a major supporter to RERA through a 4-year technical assistance facility of ~€7m. The technical assistance under this programme is focused on: • Developing regulatory frameworks to nurture a regional energy market • Capacity building in RERA so that it can better influence developments in the region • Capacity building in member state regulators • Developing renewable energy and energy efficiency policy and regulation to promote investment in clean energy
US AID	In addition to SAEP, Power Africa's Senior Advisor's Group (implemented by the Tony Blair Institute) has been heavily engaged with the power pools and analysing the barriers to electricity trading across the continent. However, this programme has mostly been focused on the power pools in West Africa and East Africa, rather than in Southern Africa.
AfDB	While AfDB has not focused resources on electricity trading *per se* many of its activities are relevant. It has provided support to individual projects, including the Batoka Gorge and ZIZABONA projects. This support is often provided through existing MDTFs such as the NEPAD-IPPF (Infrastructure Project Preparation Facility) and AGTF (Africa Growing Together Funds). AfDB also has an important convening role, and often arranges and attends key regional meetings. AfDB has provided funding to the Association of Power Utilities of Africa (APUA).
JICA	JICA commissioned a comprehensive review of the SAPP from Jera, which is an alliance between TEPCO and Chubu, both of which are large Japanese energy companies. Our understanding is that the primary objective of this study was to identify areas where there might be demand for Japanese technologies in implementing SAPP's plans.

A further initiative worth mentioning is Africa GreenCo (AGC), which aims to develop an independently managed but government co-owned creditworthy intermediary offtaker.

AGC aims to tackle some of the barriers identified in this report, such as the challenges associated with the financial weakness of most of the regional utilities. However, the long-term effectiveness of a new business model like AGC's would also be somewhat dependent on tackling some of the other barriers we have noted. For example, AGC would benefit from greater participation in SAPP, both in terms of number of members and in terms of the volumes of electricity traded through SAPP. AGC has received support from The Rockefeller Foundation, Convergence (a blended finance network funded by the Government of Canada), and SADC through its Project Preparation and Development Facility (PPDF).

Assessment of existing engagement and analysis of gaps

Earlier, in Section 3, we identified some of the key barriers to electricity trade in the Southern Africa region. The main donor interventions outlined above are somewhat aligned with these barriers. However, there are gaps that remain:

- We noted the need for **new business models**, especially new business models that allow interconnectors to operate flexibly, bringing down the cost of integrating intermittent renewables.
    - The WB is proposing that some funds from the AREP MDTF are allocated to developing new business models that might help to unlock more investment in transmission.
    - The business models proposed so far clearly have potential to address some of the barriers we have identified although it is likely that even more commercial solutions will be needed.
- We also noted the need for **market reforms at the national level**, to strengthen utilities and to improve wholesale price transparency.
    - There are many donors working with national energy sector institutions across the continent on many issues related to design and implement reform, such as tariff reforms. While some specific gaps are likely to remain in each individual country, this is a crowded space.
    - However, we are not aware of much work being done to increase wholesale price transparency at the national level. Discussions with other donors have suggested that this is because it is not seen as a priority when compared against other candidate areas for support.
- Finally, we noted the need for **hard infrastructure constraints** to be addressed, which to some extent requires action on both of the above.
    - Donors, including both the WB AREP initiative and US AID's SAEP programme, are providing transaction support to transmissions and infrastructure projects, but progress continues to be slow.
    - Further support is likely to be needed to make progress on more of these projects:

- As the WB have also suggested, more analysis is needed to tackle some of the national political economy barriers that result in countries aiming for self-sufficiency in electricity.

- Further transaction advisory support is likely to be required, for example applying some of the new business model proposed above to specific projects.

In summary, further input is required to address some of the barriers to electricity trade that we have identified in the Southern Africa region. This is particularly the case at the regional level, where there are opportunities both for DFID to bring new ideas of its own and to work in partnership with others, for example from the AREP MDTF. The donor landscape is more crowded at the national level, although there may be some specific areas where there could be value add.

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