

# **Regional Integration in Southern Africa:**

## **A Platform for Electricity Sustainability**

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## **Abstract**

The energy landscape in Southern Africa has been rapidly evolving over the last decades. An economy-wide transition to sustainability is underway, with energy at its core. In addition, a progressive movement of regional integration with numerous energy-related initiatives is taking place, principally through the Southern African Power Pool (SAPP). At the same time, electricity supply industries in the region are restructuring, with the emergence of independent power producers and increased individualism. These dynamics call for a renewed approach to regional electricity integration in support of sustainable energy development and a critical analysis of regional electricity dynamics with the aim of improving regional sustainability.

Against this background, this paper reviews the performance of the SAPP region through an electricity sustainability prism of analysis. Three key dimensions are considered to assess electricity sustainability in the region: electricity security; electricity equity; and environmental sustainability. The paper then analyses the existing role of regional integration in terms of electricity sustainability in the SADC region and explores the potential to improve Southern Africa's electricity sustainability through regional integration channels.

**Key words:** energy, sustainability, regional integration, SADC, SAPP, Southern Africa

**JEL classifications:** Q4, Q5, Q01, P48, R1, R58

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## 1. Introduction

A global transition toward sustainable models of growth and development is currently unfolding as a response to multiple crises of sustainability on economic, social, environmental and governance fronts. Energy systems, which are prerequisites for the smooth functioning of economic, political and social spheres, underpinning socio-economic development, are at the core of this transformation. The energy sector is also a cornerstone of the transition due to its primary role in the existing sustainability issues in many countries, from the reliance on fossil fuels and the lack of access to modern energy to the absence of energy security and the persistence of governance problems (IEA, 2015).

The energy sector in the Southern African region follows such dynamics. Numerous initiatives, backed by political commitments, are occurring in the region to shift to sustainable (energy) pathways (Mutanga and Simelane, 2015). In line with the United Nations Sustainable Development Goal 7, which aims to ensure “access to affordable, reliable, sustainable and modern energy for all” (United Nations, 2015), endeavours are primarily driven by the objective of ensuring energy access and security to all populations and businesses. This is notably characterised by an increased emphasis on new energy technologies, principally renewable energy-based and gas-based systems (REN21, 2015a; Santley et al., 2014). Waves of reform in the energy supply industries are also occurring in the region, with the aim of improving the efficiency of energy systems (Eberhard et al., 2011; Promethium Carbon, 2016).

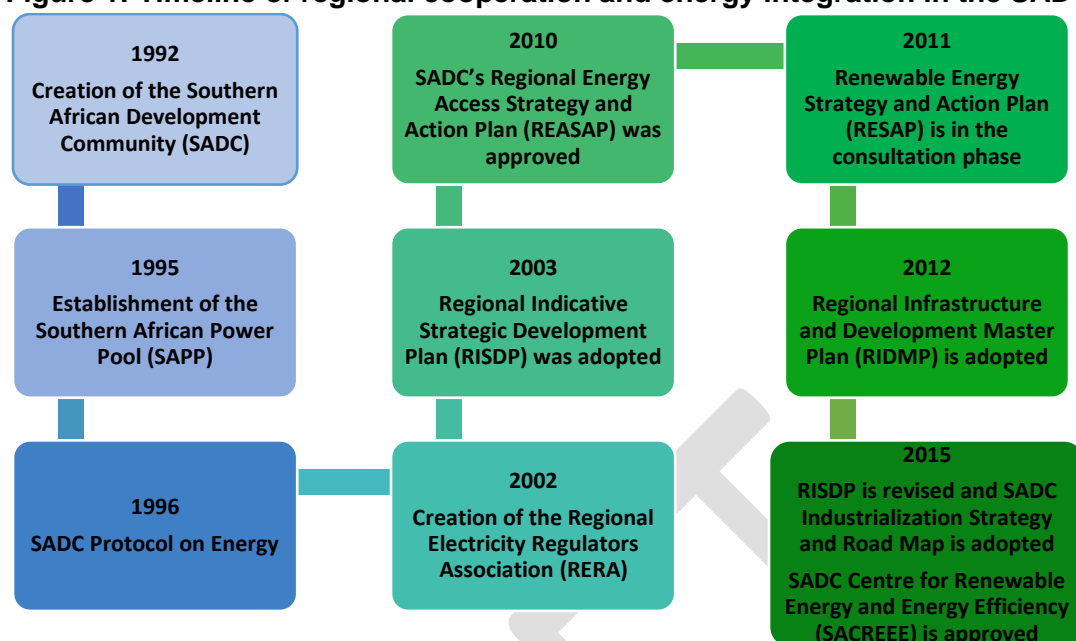
At the regional level, the Southern African Development Community (SADC) has recognised the importance of regional integration as a means to address the current energy issues. This is in line with developments at the continental level and the African Union, in its Agenda 2063, identifying energy as one of the key infrastructure pillars for connecting the continent (African Union, 2015).

This is evident in the various initiatives, plans and strategies deployed in the region (Figure 1). After a period of regional energy integration characterised by bilateral energy trading based on independent neighbours trying to reduce dependency on apartheid South Africa, the establishment of the Southern African Power Pool (SAPP) in 1995 initiated a new phase structured around the institutionalisation of a regional energy market (Vanheukelom and Bertelsmann-Scott, 2016). Under the auspices of the SADC, the SAPP gathers 14 electricity companies from 12 Southern African countries (SAPP, 2015).<sup>3</sup> It was founded to establish a network for national electricity generation utilities under the SADC and provide a common market for electricity through an interconnected power grid between member countries to promote regional energy trade.

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<sup>3</sup> See Annexure 1 for the list of SAPP members.

**Figure 1: Timeline of regional cooperation and energy integration in the SADC**



*Source: Authors' composition, based on (REN21, 2015a)*

Regional energy integration, aimed at supporting energy security through competitive markets and cross-border infrastructure development, has been high on the political agenda since then, relying on cheap, abundant electricity from South Africa. Electricity trade has been viewed as an efficient way to ensure reliable and cost-effective energy security, based on mutual benefits for importing and exporting members of the SAPP. Countries can either export their excess supply of electricity and gain profits, or import electricity from members, thereby eliminating the cost of investing in locally-produced electricity (Vanheukelom and Bertelsmann-Scott, 2016).

This process has been supported by the 1996 SADC Protocol on Energy, which aims to promote the harmonious development of national energy policies and matters of common interest for the balanced and equitable development of energy throughout the region, particularly through data and information exchange (SADC, 1996). Accordingly, SADC's Directorate for Infrastructure and Services has a vision to ensure the availability of sufficient, least-cost, environmentally-sustainable energy services in the region.

The Regional Infrastructure Development Master Plan (RIDMP) 2012-2027 Energy Sector Plan pursues the access to "adequate, reliable, least cost, environmentally sustainable energy" (SADC, 2012) to promote economic growth and poverty alleviation, while the Regional Energy Access Strategy and Action Plan (REASAP) aims to "harness regional energy resources to ensure, through national and regional action, that all the people of the SADC Region have access to adequate, reliable, least cost, environmentally sustainable energy services" (SADC, 2010). The Revised Regional Indicative Strategic Development Plan (RISDP) 2015-2020 further supports the development of "sufficient, reliable, and least-cost energy services" (SADC, 2015), notably through greater co-operation, interconnectedness, power pooling and the connecting of national electricity grids. In addition, the 2015

Industrialisation Strategy and Roadmap 2015-2063 stresses the need to address energy security concerns to underpin the success of the industrialisation strategy.

Most recently, the SADC designed a Renewable Energy and Energy Efficiency Strategy and Action Plan (REEESAP), which is scheduled to be finalised by June 2017, and establish the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), a regional platform to promote the implementation of the REEESAP (SADC, 2016).

Notwithstanding these political commitments, regional energy integration still appears on the back foot. The 2007 electricity crisis in South Africa triggered a new stage for regional energy cooperation with the transition of the regional hegemon from an exporter of cheap electricity to an importer of power. The recent drought has further put energy security to the test in the region, particularly in countries that rely on hydropower.

This situation has strengthened individualism throughout the region, with the development of numerous new power generation projects in the Southern African region (both in South Africa and other countries) (SAPP, 2015) and governments focusing more on national, bilateral or sub-regional interests and initiatives than regional integration. Despite the numerous plans and strategies in place at the SADC level, regional energy integration has progressed at a slow pace, as illustrated by the weak level of inter-connection between Southern African countries (Mutanga and Simelane, 2015).

The demise of some national utilities has also led to the emergence of new players in the region's energy markets through independent power producers (IPPs) and small-scale embedded generators, challenging the market position of state-owned utilities, and reshuffling the cards of regional energy integration (Mutanga and Simelane, 2015; Vanheukelom and Bertelsmann-Scott, 2016).

Considered together, the sustainability transition, the rise in individualism and the emergence of new players in the sector call for a renewed approach to regional energy integration in the Southern African region in support of sustainable energy development and a critical analysis of regional energy dynamics in with the aim of improving electricity sustainability.

Building on a conceptual framework inspired by the World Energy Council (WEC, 2013) and the International Energy Agency (IEA, 2016), three key dimensions, depicted in Figure 2, can be considered to assess electricity sustainability in the region:

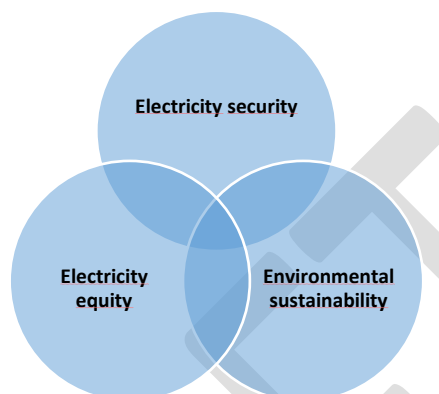
- electricity security, i.e. the effective management of electricity supply, the reliability of the electricity infrastructure and the ability to meet electricity demand;
- electricity equity, i.e. the accessibility and affordability of electricity supply across the population; and
- environmental sustainability, i.e. the achievement of demand- and supply-side energy efficiencies and the development of electricity supply from renewable and low-carbon technologies.

These dimensions speak to a number factors, from electricity availability (adequacy and access), and acceptability (socio-political and environmental, including resource extraction and waste production), to affordability (prices and paying ability) and efficiency (productivity in



the use of energy resources) (Narula and Reddy, 2016). While these three dimensions provide a useful framework for assessing electricity sustainability, a further dimension should be explored in the future, namely, the governance of electricity systems, including institutional capability. An important determinant for the delivery of electricity sustainability would be whether there is a robust, transparent and inclusive electricity governance system with accountability and consequences built in.

**Figure 2: The three dimensions of electricity sustainability**



*Source: Authors' composition, inspired by (WEC, 2016) and (IEA, 2016)*

This paper explores the potential to improve Southern Africa's electricity sustainability through regional integration, harnessing the emerging opportunities associated with new energy sources and technologies, and electricity supply structures. Acknowledging that the region is composed of a diversity of situations, the paper depicts the heterogeneity of the Southern African countries in its analysis.

The paper proceeds as follows. Section 2 reviews the performance of the SAPP in terms of electricity sustainability. Section 3 analyses the role of regional institutions in the electricity sector and explores avenues to harness regional integration to improve the electricity sustainability in Southern Africa and Section 4 concludes.

## 2. The state of play

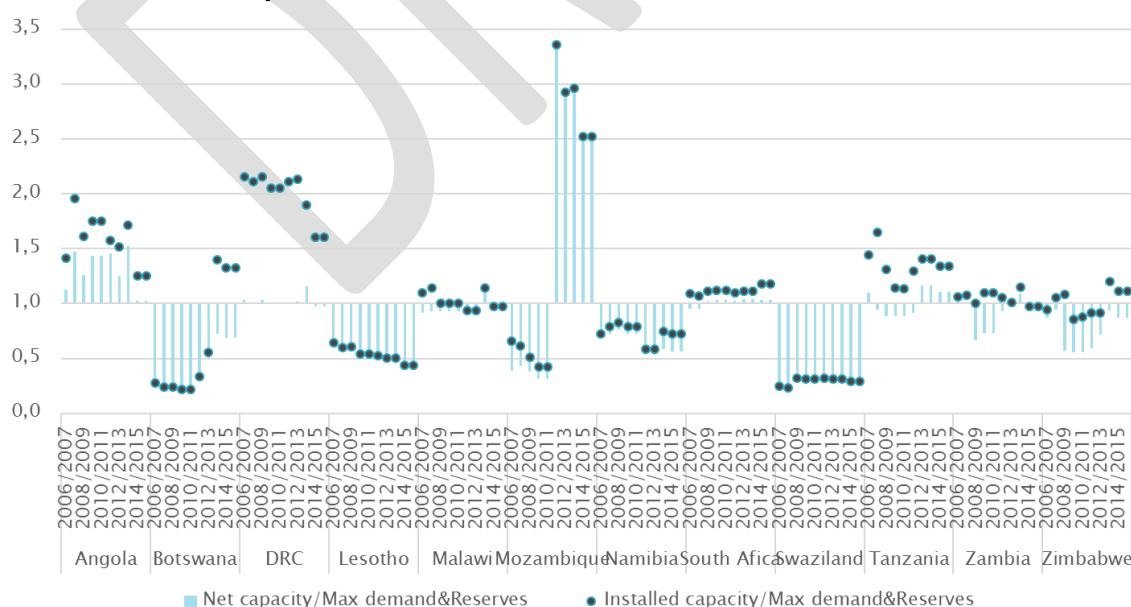
This section reviews the performance of the SAPP in terms of electricity sustainability in the region. Electricity sustainability, which is vital to well-functioning, inclusive, sustainable and modern economies and societies, has gained increased attention at the regional level and progress has been made in a number of areas. Further improvements are nevertheless required to achieve electricity sustainability, particularly in dealing with the interplay between electricity security, electricity equity and environmental sustainability.

### 2.1. Electricity security: Matching supply and demand

Southern Africa's electricity security situation, although diverse, looks bleak. The region has been suffering from electricity shortages, with severe implications for economic growth and social development. Over the last decade or so, Botswana, Namibia, South Africa, Tanzania, Zambia and Zimbabwe have had to resort to load-shedding as a stop-gap measure in order to conserve energy (SADC and SARDC, 2016). As discussed later in Section 2.2, large parts of the population in these countries have still no access to modern electricity. Traditional biomass plays a strong role in the region, primarily but not only in rural areas, further accentuating the security of supply challenge.

Looking at the electricity supply-demand balance, as illustrated in Figure 3, the supply deficit is evident in many countries, despite the region operating a surplus of 1 507 MW (based on 2015/2016 data). In fact, as a regional group, SAPP member countries had a net capacity of 52 760 MW (compared to 61 362 MW of installed capacity) for a peak demand, including reserve margins, of 51 253 MW. The region has moreover displayed a net surplus since 2011/2012, with a peak at 3 437 MW in 2013/2014.

**Figure 3: Ratios of installed capacity and net capacity over the peak demand and reserve requirements for SAPP countries from 2006/2007 to 2015/2016**



Source: Authors' composition, based on data from SAPP Annual Reports

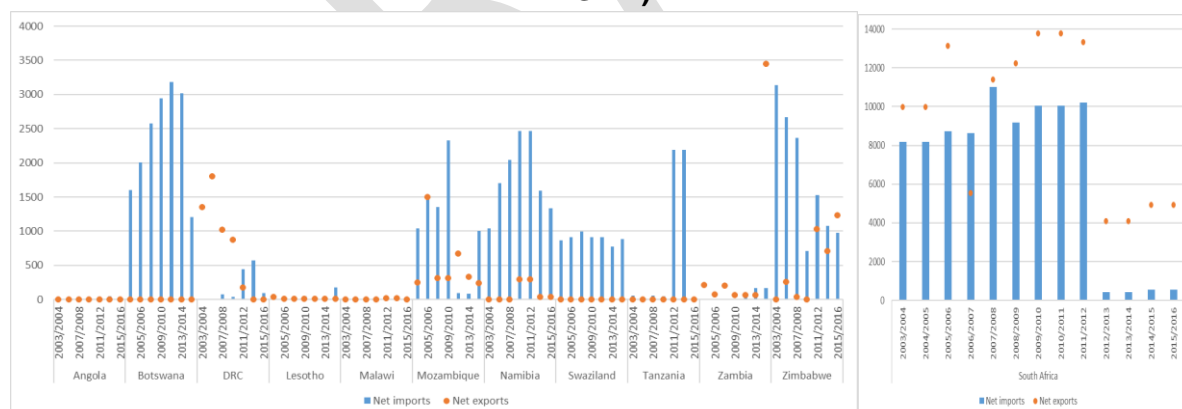
*Note: reserve margins, required to guarantee system reliability, allow for unexpected surges in demand for power and allow for plant maintenance, are equivalent to 10.2% of peak demand as per the SADC's best practices*

At the country level, only Angola and Mozambique display favourable positions, with a net generation capacity comfortably above their demand and reserve requirements. Other countries are either in a precarious situation (such as the Democratic Republic of the Congo [DRC], Malawi, Tanzania and South Africa, although the situation has recently improved for the latter) or experiencing serious supply shortfalls (Botswana, Lesotho, Namibia, Swaziland and Zimbabwe).

Importantly, in a number of cases, the absence of security of supply is not related to the lack of generation capacity, rather to a maintenance backlog and to the poor state of the existing power plants (illustrated in Figure 3 by the difference between the installed and net capacities). This condition is neatly demonstrated by the case of the DRC, whose generation capacity is mostly inoperative.

This unfavourable supply picture is confirmed by the state of electricity trade in the region (Figure 4). Only two countries effectively (i.e. continuously) export electricity in the region, namely Mozambique (from the Cahora Bassa hydroelectric power plant) to South Africa, and South Africa to the rest of the region. Some countries, such as Namibia and Zambia, are *ad hoc* exporters, as they rely on hydropower and depend on weather conditions. As noted below in Section 3.2, Angola, Malawi and Tanzania do not trade electricity with other SAPP members as they are not yet connected to the regional grid.

**Figure 4: Net imports and exports from 2003/2004 to 2015/2016 for SAPP countries (in GWh)**

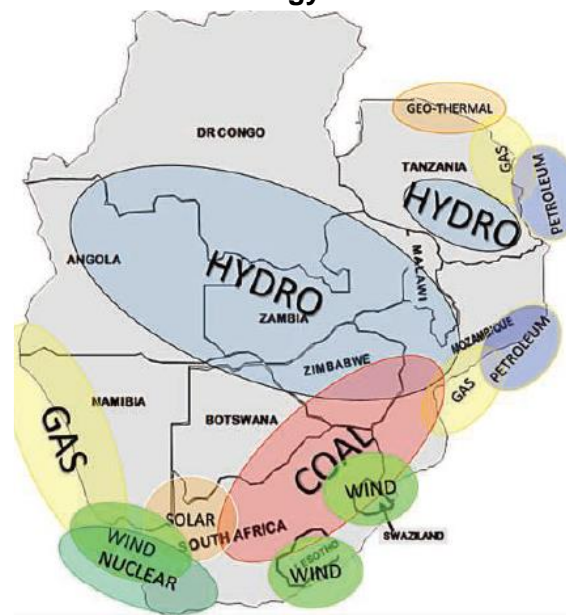


*Source: Authors' composition, based on data from SAPP Annual Reports*

*Note: the scale differs between the two graphs due to the large amount traded by South African compared to other SAPP countries*

Against this background, the region benefits from tremendous electricity generation potential, notably from renewable energy technologies. The Southern African region enjoys a wide array of both renewable and non-renewable energy resources (UNEP and AfDB, 2017). Furthermore, as schematically depicted in Figure 5, these resources are spread across the region, laying the ground for regional trade.

**Figure 5: Illustration of the energy resources in the SADC region**



*Source: (SADC and SARDC, 2016)*

The region hosts large deposits of coal, gas and uranium. Large reserves of coal can be found in Botswana, Mozambique, South Africa and Zimbabwe, while Mozambique, Namibia, South Africa and Tanzania are developing natural gas fields. Significant reserves of uranium also exist in the region, with mining taking place in Namibia and South Africa and exploration underway in Botswana and Zimbabwe (IEA, 2014a).

Large low-cost hydroelectric dams, especially the Inga Reservoir in the DRC and the Kariba Dam on the Zambia-Zimbabwe border, have the potential to generate up to 150 GW of electricity, against the current 12 GW of installed capacity. According to (Karhammar, 2014), the SADC has the potential of generating 1 080 TWh/year of electricity from hydroelectric dams, however, only 31 TWh/year is being utilised.

With regards to new renewable technologies, the SADC region benefits from outstanding solar irradiation (2 500 hours of sunshine per year), translating into a generation capacity potential of 20 000 TWh annually. The potential for wind-based generation is mostly constrained to the coastal regions, but meaningful too, reaching around 800 TWh. Last but not least, geothermal energy (about 4 000 MW) can be harnessed in the countries along the Rift Valley (Tanzania, Malawi, Mozambique and Zimbabwe) (UNEP, 2012).

Although power generation projects are underway in most member states to seize existing opportunities as showed in Table 1, this large electricity generation potential remains mostly untapped. IRENA estimates that only about 1% of the solar and wind potential of the region has been captured so far (Miketa and Merven, 2013). Unfortunately, as discussed in Section 3.2, Southern African countries are adopting a national (or bilateral) rather than a regional approach to electricity security (Madakufamba, 2010). Such a stance is likely to further exacerbate the regional generation surplus while not preventing some countries from experiencing shortages.

**Table 1: Committed generation projects planned from 2016-2022 in SAPP countries (in MW)**

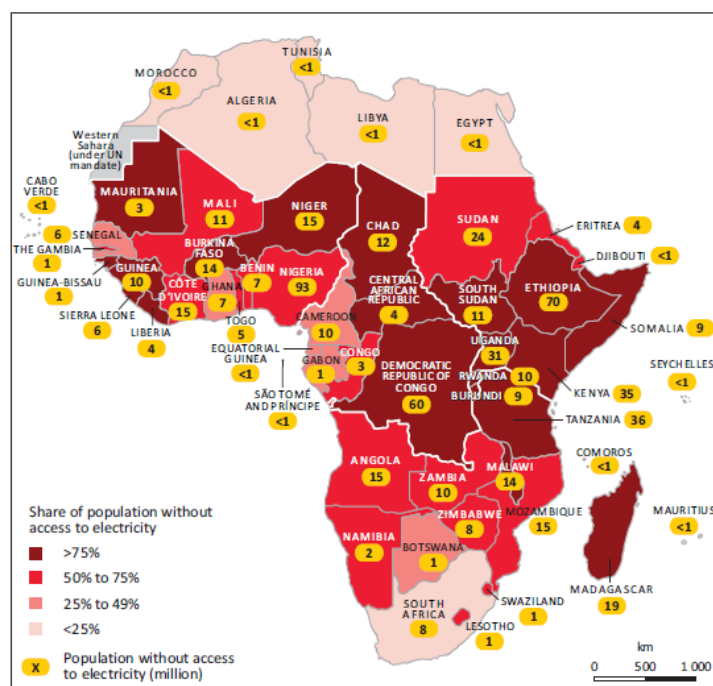
Country	2016	2017	2018	2019	2020	2021	2022	Total
Angola	930	2 545	267	0	0	0	0	3 742
Botswana		120			300			420
DRC	458		150					608
Lesotho								0
Malawi	10	6	72	22	1 006			1 116
Mozambique	360			600	400	600	1 500	3 460
Namibia	40		190			800		1 030
South Africa	1 624	999	2 167	1 445	2 167	723	1 528	10 653
Swaziland				12			300	312
Tanzania		900	1 040	250	1 000			3 190
Zambia	300		27	441	1 450	230	1 200	3 648
Zimbabwe	200		420	837	1 860		1 200	4 517
<b>Total</b>	<b>3 922</b>	<b>4 570</b>	<b>4 333</b>	<b>3 607</b>	<b>8 183</b>	<b>2 353</b>	<b>5 728</b>	<b>32 696</b>

Source: (SAPP, 2017)

## 2.2. Electricity equity: Achieving an affordable access to modern electricity

The performance of the SAPP in terms of electricity equity in the region, despite some notable progress in the last two decades, remains problematic. The SAPP is the worst performing African regional power pool, with only 24% of residents with access to electricity, against 36% in the East African Power Pool and 44% in the West African Power Pool.

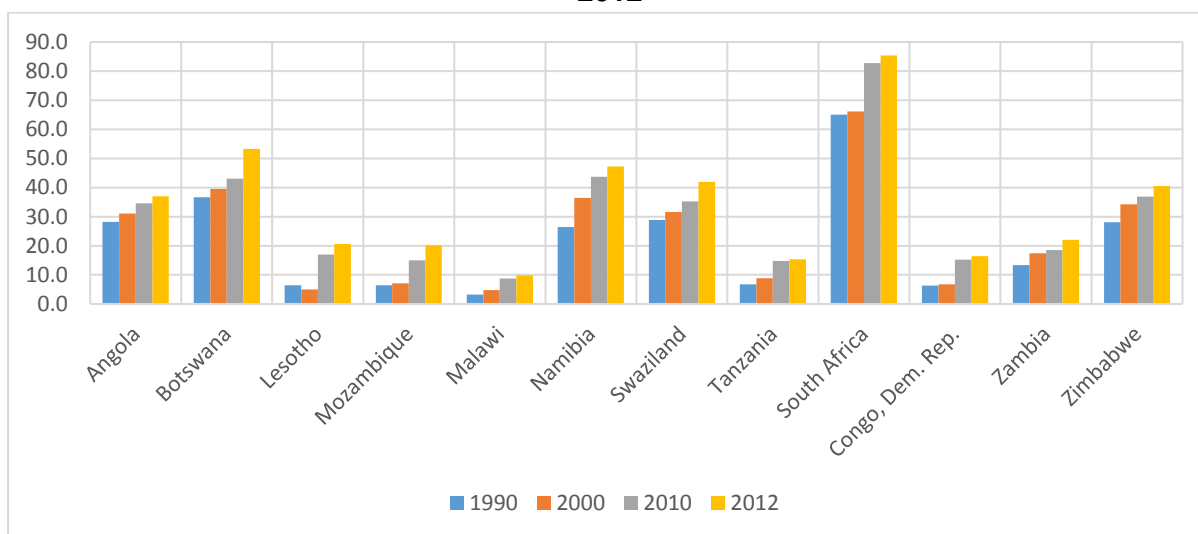
**Figure 6: Population without access to electricity in Africa (in volume and share of total population) in 2012**



Source: (IEA, 2014b)

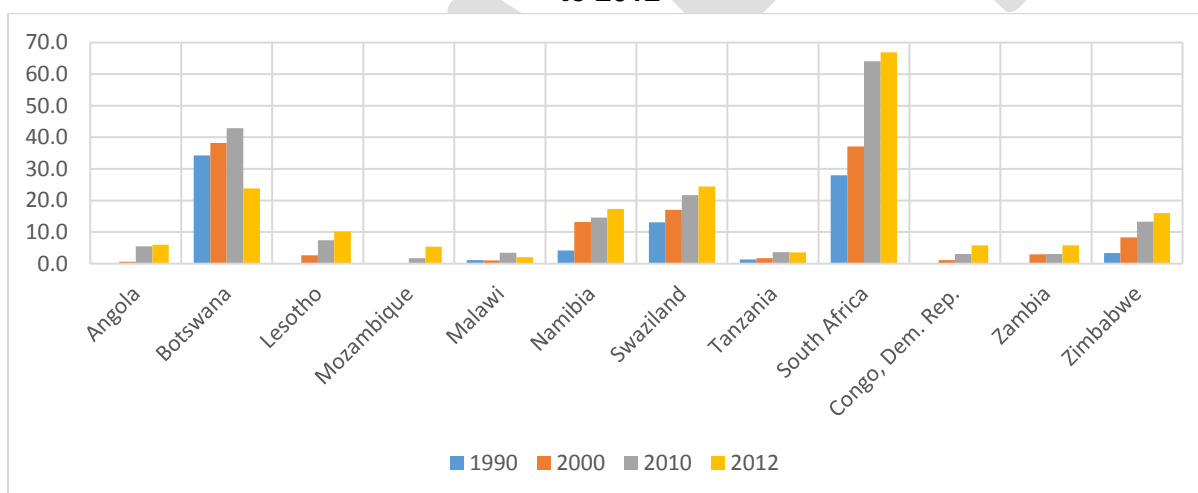
Although this disappointing picture is largely dominated by the DRC and Tanzania (which respectively account for 35% and 21% of the regional population without access to electricity), this situation is reflected in the individual performance of most Southern African countries (Figure 6). Indeed, Figure 7 shows that, despite some overall progress over the last two decades in terms of electrification (see Box 1 for some details on South Africa's experience), electricity access remains highly limited in most countries.

**Figure 7: Access to electricity in SAPP countries (in % of population) from 1990 to 2012**



*Source: Authors' composition, based on data from World Bank*

**Figure 8: Access to electricity in SAPP countries (in % of rural population) from 1990 to 2012**

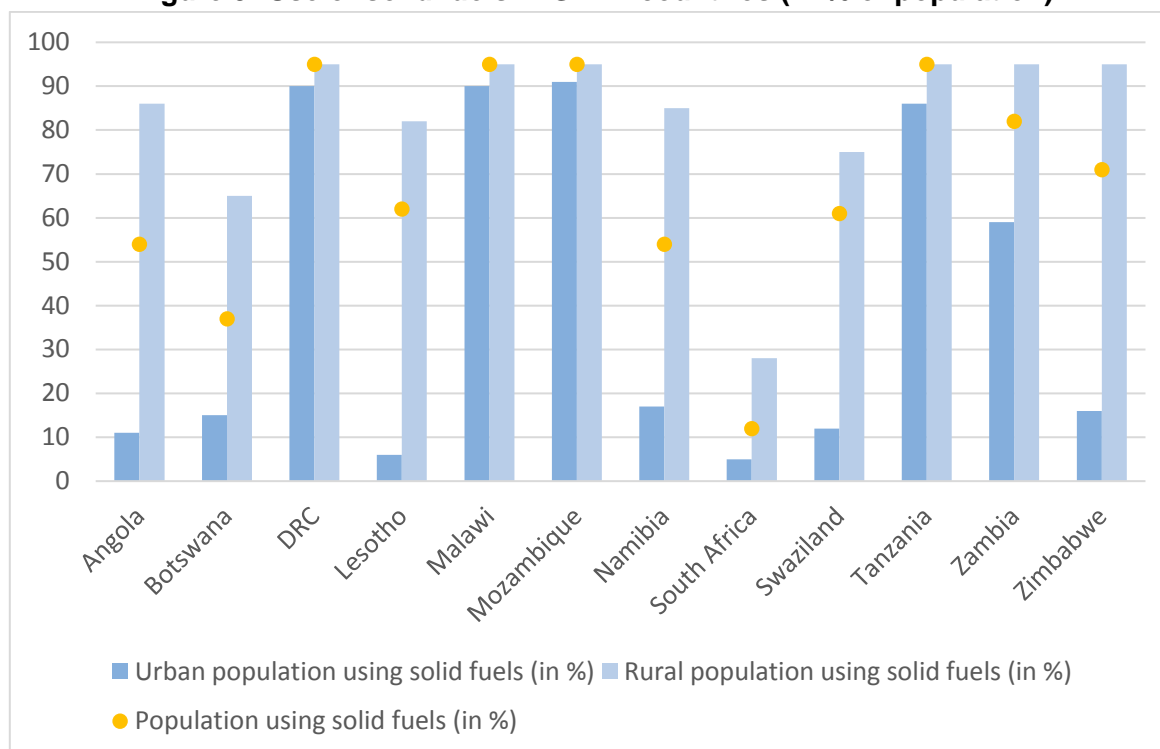


*Source: Authors' composition, based on data from World Bank*

A clear divide exists between rural and urban areas. Only 5% of the region's rural residents have access to electricity in the SAPP coverage area (Figure 8). The urban-rural divide can be illustrated by the use of solid fuel (i.e. traditional biomass) by households (Figure 9). Indeed, around 45% of energy consumption in SADC countries arises from traditional biomass, such as charcoal and wood (SADC and SARDC, 2016) and the divide between urban and rural population is evident, except in countries where the use of solid fuels is widespread throughout the population (DRC, Malawi, Mozambique, Tanzania and Zambia to some extent). Only South Africa shows a favourable situation, thanks to an ambitious electrification programme rolled out since the advent of democracy in 1994 (see Box 1).



**Figure 9: Use of solid fuels in SAPP countries (in % of population)**



*Source: Authors' composition, based on data from the IEA*

### **Box 1: South Africa's successful pro-poor electrification programme**

South Africa's apartheid era was characterised by widespread inequalities whereby service provision favoured the ruling minority while excluding the masses. Since the democratic dispensation, South Africa's energy sector has undergone a rapid transformation to overcome the legacy of skewed electricity provision. Electrification improved from around 50% in 1994 to close to 90% at the end of 2016.

Much of this electrification success can be attributed to the government-led Integrated National Electrification Programme (INEP), which provides grid and non-grid connection. Since 1994, almost 6 million households have been electrified through the INEP. Over the 2017-2020 period, the Department of Energy has committed to spending ZAR234.5 billion on improving the energy access and security of which ZAR203,8 billion will be allocated to Eskom. Although successful in connecting the majority of South Africans to the grid, a vast amount of poor households cannot afford grid-based electricity, and as a result, the government introduced the 2003 Free Basic Electricity (FBE) Policy.

The FBE policy provides households connected to the national grid with 50kWh of free electricity per month. This helps the poorest households, which have a relatively low electricity demand, to meet basic energy need. In the first quarter of 2015, around 1.2 million customers benefited from FBE with approximately 870 060 MWh of FBE consumed for the 2014/2015 financial year. However, informal settlers, the urban poor who occupy land unlawfully, are excluded from the scheme.



Focus then turned towards electrifying households in remote areas where grid connection has not yet been deemed financially and technically feasible. As part of the INEP, the South African government implemented the subsidised solar home systems programme to tackle this challenge. Solar home systems fitted with photovoltaic panels are designed as an interim solution that provides decentralised electricity to rural populations until national grid expansion occurs. The service provider owns the solar home systems with government subsidising ZAR 3 500 for the installation of the system and ZAR 48 of the monthly operational and maintenance costs. The difference between the costs and the subsidy is borne by the users.

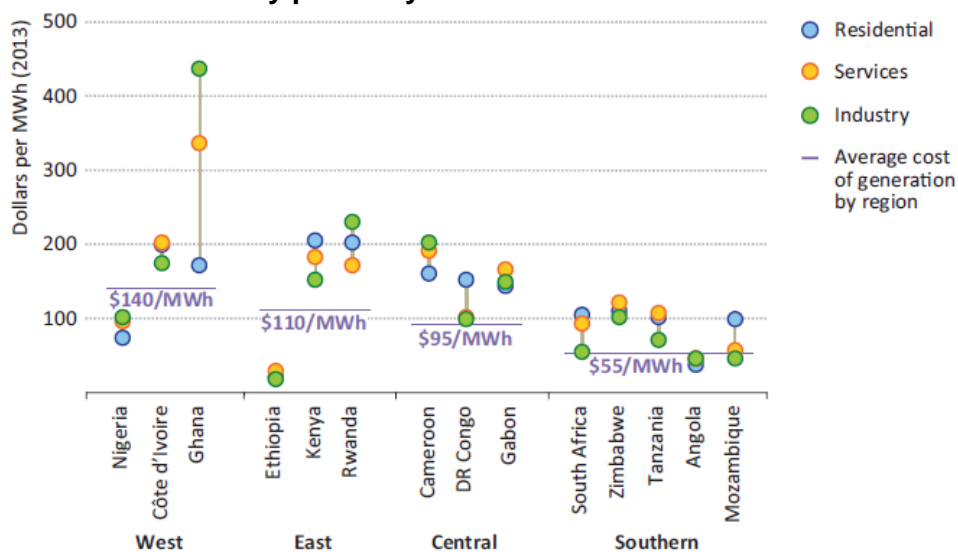
These initiatives are further completed through a VAT exemption on paraffin, the primary source of heating and lightning for households at the lowest income levels, which is meant to reduce energy poverty for households still relying on solid fuels.

From an electricity sustainability perspective, it is important to note that although access to electricity has drastically improved over that past two decades in South Africa, the source of this success originates from the country's vast reserves of "cheap" coal. While the South African government has committed to reducing GHG emissions, coal remains the backbone of the country's electricity supply. However, with the rapid decline in the costs of renewable energy technologies, coupled with the significant potential in the country, South Africa has the opportunity to further improve electricity equity and achieve the goal of universal electricity access through sustainable sources of energy.

*Sources: Authors' composition, based on (le Cordeur, 2017) (Eskom, 2016), (DoE, 2016), (DoE, n.d.), (Montmasson-Clair, 2017; SADC, 2010), (Wilkinson, 2015)*

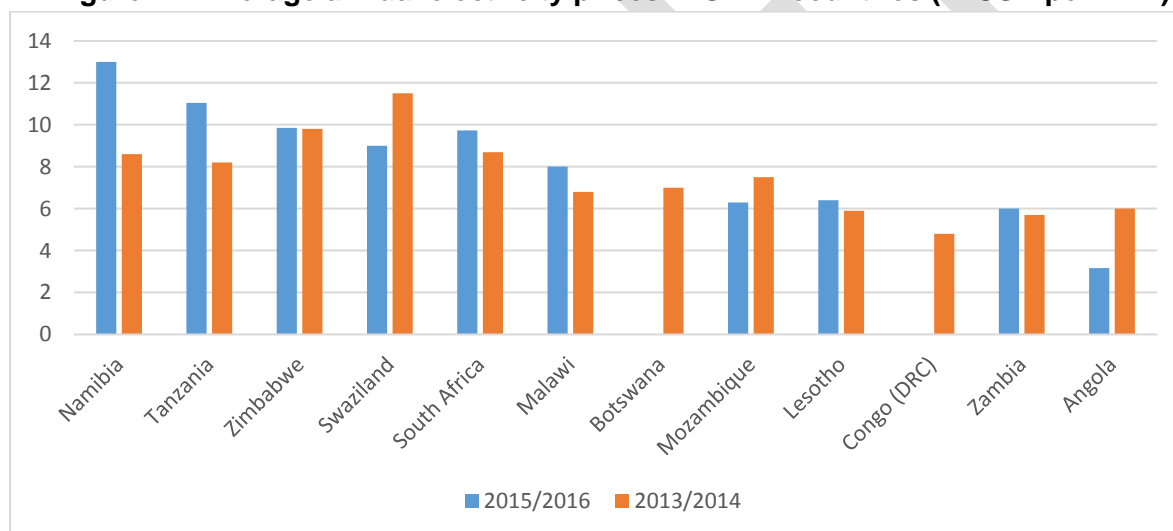
Electricity equity is further hampered by tariffs considered to be too low to stimulate investment (RERA, 2016). Electricity tariffs do not fully reflect the cost of electricity supply in most countries. While tariffs may be higher than the average cost of generation (see Figure 10), additional costs, such as those relating to losses, transmission and distribution can add USD 60-100 per MWh to the total cost of electricity supply. Even so electricity tariffs are among the highest in the world, with some countries, such as Tanzania and Namibia, reaching prices over USD 0.15 / kWh in some years (IEA, 2014b). Indeed, only Namibia and Tanzania have successfully achieved cost-reflectivity (Creamer, 2015), therefore paving the way for further increases in other countries. However, these countries continue to struggle with low electrification rates. While a number of social tariffs and free electricity schemes target the poorest households in most countries, this situation is problematic, all the more so given that electricity tariffs are far from being cost reflective (SADC and SARDC, 2016).

**Figure 10: Grid electricity prices by end-use sector in selected countries in 2013**



Source: (IEA, 2014b)

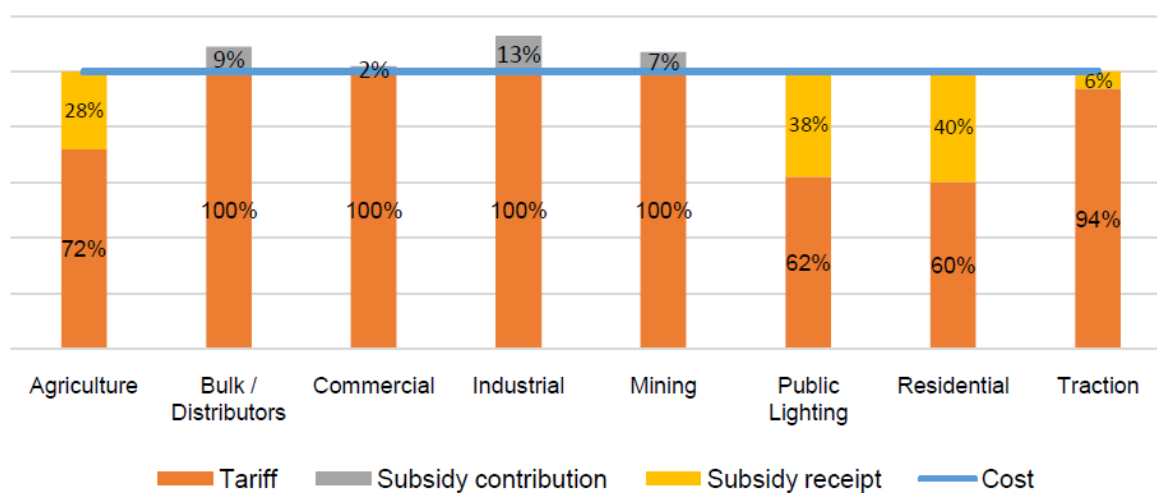
**Figure 11: Average annual electricity prices in SAPP countries (in USD per kWh)**



Source: Authors' composition, based on data from SAPP Annual Reports

Insufficient access to modern electricity limits productivity and economic growth. Electricity deficits in Southern Africa, coupled with unaffordable tariffs for the poor, continue to reinforce (energy) poverty. As such, without universal and affordable access to modern electricity, SADC's socio-economic development targets are virtually unattainable. Centralised electricity systems in Southern Africa were essentially designed to cater for the needs of industrial conglomerates and high-income groups (Scott, 2015). While a degree of progressive cost subsidisation exists between industrial users and the poorest consumers, as illustrated in Figure 12, in the case of South Africa, the most vulnerable households continue to pay the highest tariffs and having access to the least advanced infrastructure. By contrast, energy-intensive users can benefit from special pricing agreements, like aluminium smelting company South32 (previously BHP Billiton) in South Africa and Mozambique (TIPS, 2013).

**Figure 12: electricity subsidy receipts and contributions per sector in South Africa**

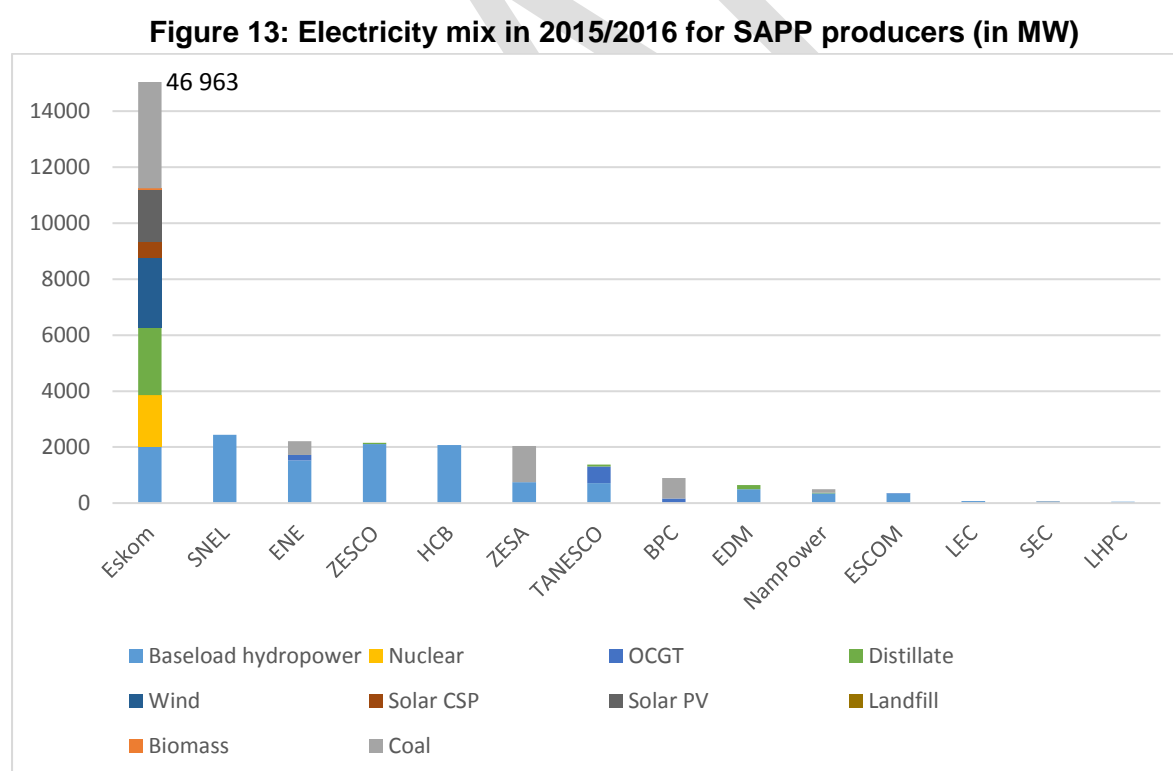


Source: (Maphosa and Mabuza, 2016), based on NERSA data

### 2.3. Environmental sustainability: Ensuring resilience and efficiency

The electricity sustainability performance of the region is further weakened by the poor environmental sustainability of the electricity supply industries. While the region hosts electricity systems of various sizes, structures and qualities, the lack of diversity of energy sources leads to a poor resilience. As displayed in Figures 13 and 14, the region virtually relies only on two sources of electricity, namely hydropower and coal.

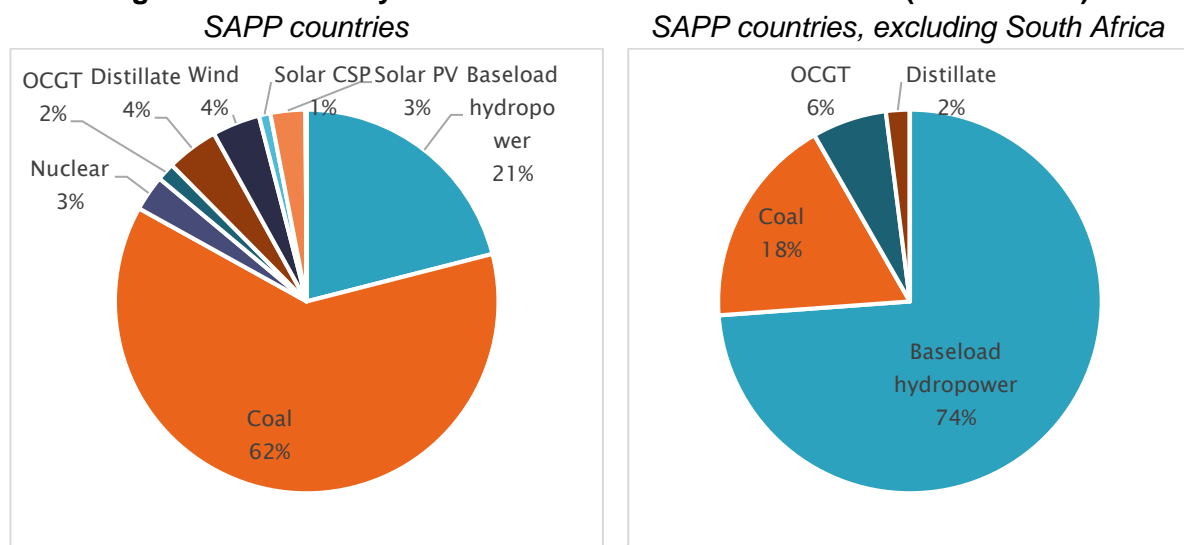
Countries can be divided in three groups: coal-based countries (South Africa and Botswana), hydro-based countries (Mozambique, Malawi, Angola, Lesotho, DRC, Namibia, Zambia and Swaziland), and countries relying on a mix of hydropower and coal (Tanzania, and Zimbabwe) (Miketa and Merven, 2013). Although other technologies are slowly emerging (gas is growing fast, solar PV and wind technologies are rising), they remain too small to meaningfully diversify electricity supply and improve the resilience of electricity systems at this stage. New generation projects, such as new coal-based power stations in South Africa (primarily Kusile and Medupi) and Botswana (Morupule B), are expected to entrench the current picture in coal-based countries (Eskom, n.d, n.d.; World Bank, 2017). Similarly, a number of projects, on the Congo (DRC), Zambezi (Zambia-Zimbabwe), Kwanza (Angola) and Ruhuhu (Tanzania) rivers, will further enhance the domination of hydropower in other countries (Miketa and Merven, 2013).



Source: Authors' composition, based on data from SAPP Annual Reports

Note: for readability, South Africa's generation capacity, which reaches 46 963 MW, including 35 721 MW from coal-fired power plants, is not fully displayed in the graph

**Figure 14: Electricity mix in SAPP countries in 2015/2016 (in % of total)**



*Source: Authors' composition, based on data from SAPP Annual Reports*

*Note: Both charts must be considered independently due to the overwhelming domination of South Africa, which accounts for more than three quarters of the region's total generation capacity.*

Resilience is primarily a challenge for hydropower-based countries, as illustrated by the electricity shortages triggered by the drought experienced in 2015-2016. In the long run, the region is likely to suffer from the effects of climate change and the stronger El Niño-induced weather conditions that have seen dam levels in most countries dropping (IEA, 2016). Box 2 on Zambia's experience illustrates the erratic nature of hydroelectric power in the region. Resilience can however also be a challenge for coal-based countries. While originating from multiple causes, South Africa's recent load shedding crises (in 2008 but also in 2014) were, for example, exacerbated by poor coal stock management (Das Nair et al., 2014).

### **Box 2: Zambia's experience with hydro**

Zambia's large hydropower initiatives supply 99% of the country's electricity, with the remaining percent arising from mini-hydro and diesel plants. Zambia has an installed capacity of 1 900 MW in terms of hydro power, originating from four main plants: Kafue Gorge (990 MW), Kariba North Bank (720 MW), Kariba North Bank Extension (36 MW) and Victoria Falls (108 MW). The country encompasses an array of renewable energy resources ranging from hydropower, biomass and geothermal energy to solar and wind, with an existing untapped potential surpassing 6 000 MW.

Despite the scope of resources available in the country, energy security has been a recent challenge, as the country continues to grapple with electricity deficits, arising from dwindling water reserves due to the recurring drought across the African continent. As such, the country is producing 1 000 MW less than the installed capacity leading to the national utility ZESCO, which dominates the sector, initiating periods of electricity outages, and thereby turning Zambia from an electricity-rich country to an importer of power. For example, in a three-month period from September to December 2015, the Zambian government imported 148 MW of electricity at a cost of around USD 40 million. The 2015/2016 electricity shortages had a

damaging effect on local businesses with many companies having to shut down operations during the episodes of eight-hour outages.

The government has moreover committed to providing access to electricity to at least 90% and 51% of urban and rural households respectively, by 2030, with renewable energy being the focal point to meet these objectives.

Despite climate uncertainties, a number of hydro projects are underway to improve the resilience of Zambia's electricity systems. The African Development Bank (AfDB) recently pledged to fund the 2 400-MW Batoka Gorge hydro interconnection between Zambia and Zimbabwe. Furthermore, discussions are underway between MDH, a South African developer, to construct a USD 1.26-billion, 235-MW hydroelectric dam along the Luangwa River in Zambia. On the other hand, Neoen, a French IPP has also entered into a power purchased agreement with ZESCO to commission a 54MW, USD-60 million solar project in Zambia.

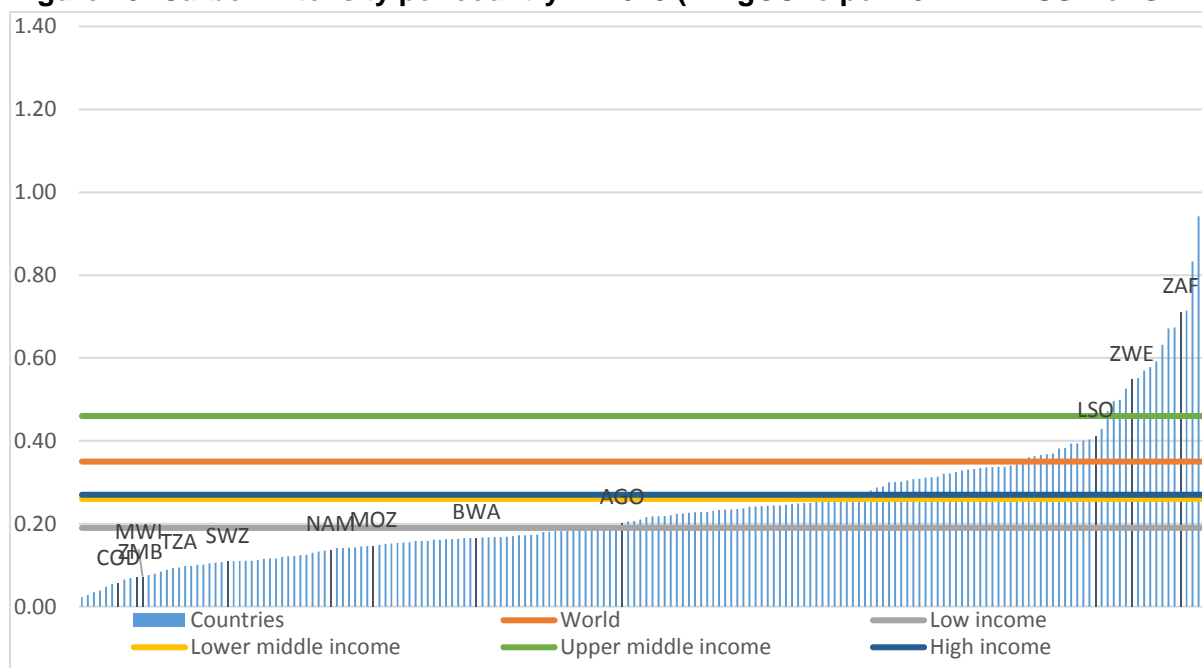
However, the largest initiatives in the country remain hydro-based, further entrenching the lack of diversity of the electricity mix. Based on recent environmental indicators, this is likely to place Zambia in an unfavourable position to achieve electricity security and electricity access. The need to diversify the energy mix and further explore the regions solar energy potential remains urgent.

*Sources: Authors' composition, based on (Miketa and Merven, 2013), (Energy Sector Report, 2014), (Mills, 2016), (Jeffrey, 2015), (New Business Ethiopia, 2017), (Lusaka Times, 2017), and (Engineering News, 2017).*

By contrast, the reliance of the region on hydropower brings important benefits in terms of electricity sustainability. While the socio-environmental drawbacks of large hydropower systems (such as population displacement) must be acknowledged, the low-carbon nature of the water-based schemes results in most Southern African countries displaying a relatively low carbon intensity (Figure 15). South Africa is a notable exception in this respect due to the country's essentially coal-based electricity system.

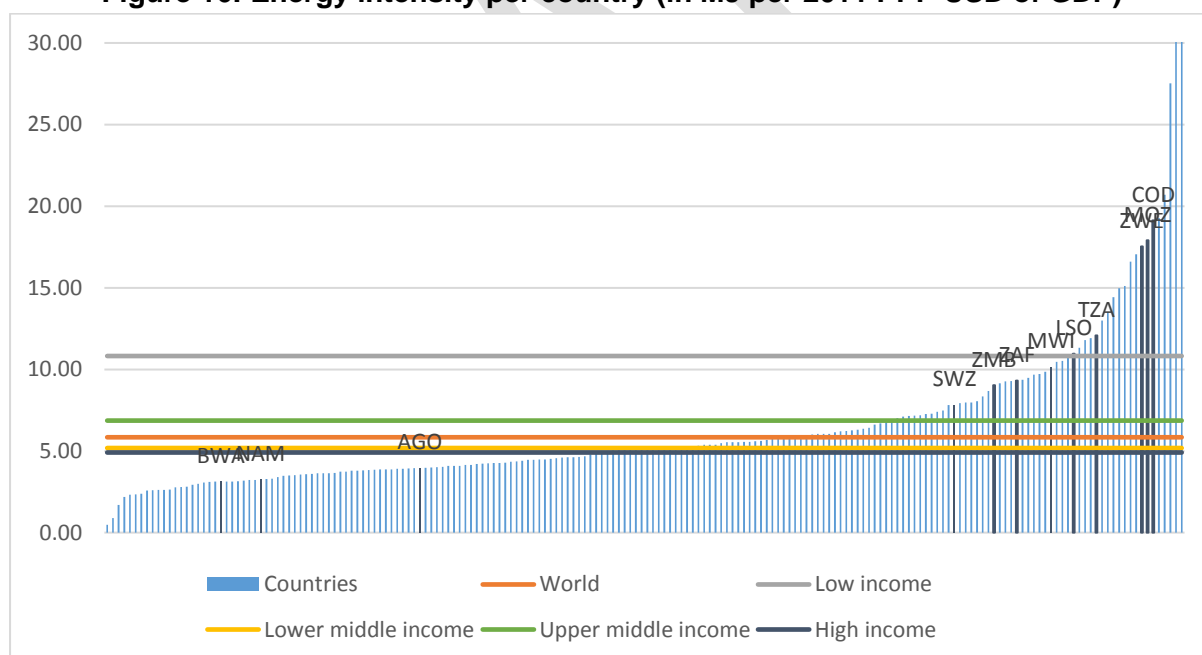
The low-carbon feature of the region however masks the deep energy inefficiency of the Southern African economies, which largely performs worse than global benchmarks (Figure 16). A high degree of diversity, both in terms of carbon and energy intensity, must nevertheless be noted in the region, due to the differences in electricity mixes, levels of economic development and industrial structures.

**Figure 15: Carbon intensity per country in 2013 (in kgCO<sub>2</sub>e per 2011 PPP USD of GDP)**



*Source: Authors' composition, based on data from the World Bank*

**Figure 16: Energy intensity per country (in MJ per 2011 PPP USD of GDP)**

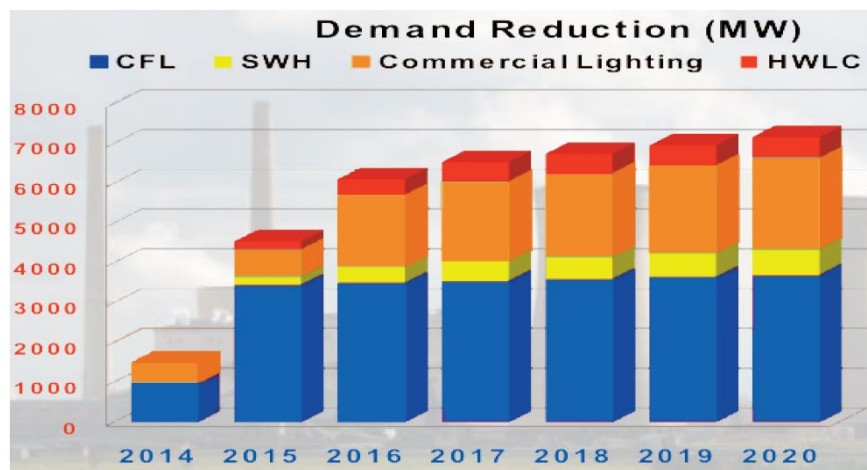


*Source: Authors' composition, based on data from the World Bank*

The potential for energy efficiency improvement in the region therefore remains significant. A 2012 estimate by Eskom identified an energy demand savings potential in South Africa alone of 12 933 MW (IDC, 2013). This is significantly more than what has been achieved and is ambitioned throughout the region. According to the SAPP secretariat, demand-side management (DSM) measures in the region already achieved savings of 4 561 MW, from 2009 to September 2015, including 3 461 MW from CFL and LED programmes and 700 MW

from commercial lighting energy savings. As shown in Figure 17, still far from the regional potential, these savings are expected to gradually increase to about 7 000 MW by 2020, notably through the phase out of incandescent bulbs by 31 December 2017.

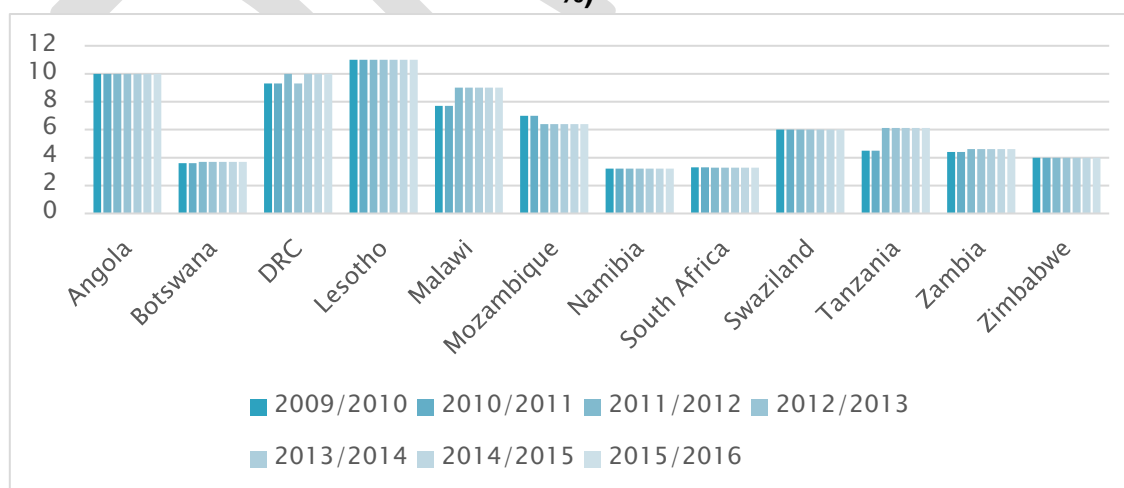
**Figure 17: Projected savings from demand-side management initiatives within the SAPP**



Source: (SADC and SARDC, 2016)

The poor state of transmission and distribution networks in the region further aggravates the inefficiency of the electricity systems (Economic Consulting Associates, 2009). While poor data on the issue make it difficult to paint a true picture of the quality of the electricity wires in the region (see Box 3), SAPP data, showed in Figure 18, provide a general idea of the situation, with a number of countries experiencing high transmission losses (Angola, DRC and Lesotho for example) and deteriorating performance.

**Figure 18: Transmission losses from 2009/2010 to 2015/2016 for SAPP countries (in %)**



Source: Authors' composition, based on data from SAPP Annual Reports



### Box 3: Data considerations on electricity losses

As electricity travels through transmission and distribution networks, a share of the current is lost. Transmission losses typically range from 4 to 8%. However, they can be higher due to a multitude of reasons, such as the rollout and maintenance of transmission and distribution lines (quality, distance, size, operating hours) and associated systems (conductors, transformers).

**Table 2: Energy losses for SAPP countries from various sources**

Country	World Energy Council Statistics 2013	IEA Statistics 2013	SAPP Statistics 2014 (transmission losses only)	RERA database (2014) Energy losses	RERA database (2014) Transmission losses	RERA database (2014) Distribution network losses
Angola		11.3	10	≈33	≈8 (2011)	
Botswana	6.9	39.0	4		≈4 (2013)	
DRC		7.5	10			
Lesotho				≈13	≈5	8
Malawi			8	≈16	≈6.2	≈18.8
Mozambique		17.9	6	≈25	6	≈19
Namibia	12.6	27.7	3	≈11	10	≈11
South Africa	9.2	8.5	3		≈2.5	≈6.8
Swaziland	13		6	≈15	4	10
Tanzania	20	20.5	6	≈15.5	≈6.1	≈12.8
Zambia		8.8	5	≈17	6	≈12.1
Zimbabwe	24.5	28.1	4	≈12	≈3.8	≈13

In the SADC region, transmission losses are strongly influenced by network length from generation points, energy intensity, loading of the network, as well as the age and condition of the power delivery system. Five countries (Mozambique, Namibia, South Africa, Tanzania, and Zambia) have a transmission grid code in force. All of these, with the exception of Mozambique, have been approved by the national regulator. By contrast, Zimbabwe's transmission grid code has been approved by the regulator but is not yet in force.

While the nature of the problem has been widely acknowledged, its extent remains highly uncertain, particularly due to the lack of reliable data. **Table 2** compares electricity losses metrics from various sources, highlighting the degree of variability. Differences can be partly explained by definitional problems, particularly the difference between transmission losses and distribution losses, and the treatment of municipalities' consumptions, that is somewhat included in the calculation of losses.

*Source: Authors' composition, based on data from (IEA, 2014c), (WEC, 2013), (SAPP, 2015), (RERA, 2016)*

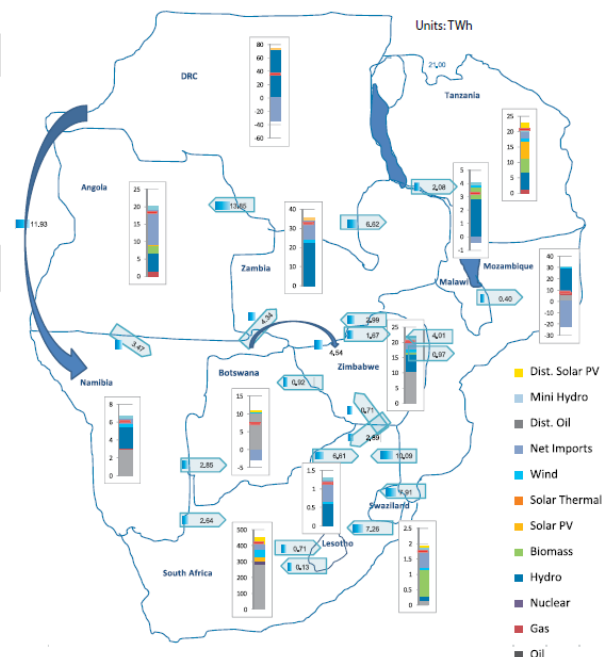
## 2.4. Conclusions

Southern African countries have historically performed poorly in terms of electricity sustainability, due to strong energy supply concerns, poor and expensive access to modern energy and the lack of diversity of electricity supply. Based on the (WEC, 2016), which ranks countries in terms of energy sustainability (i.e. not just electricity but also fossil fuels), South Africa, SAPP's best-ranking country, stands at the 84<sup>th</sup> position (out of 125 countries ranked by the WEC). Botswana and Swaziland rank 94<sup>th</sup> and 95<sup>th</sup> respectively while Zimbabwe, the DRC and Malawi close the table at the 113<sup>th</sup>, 117<sup>th</sup> and 120<sup>th</sup> places. The general poor performance of the region must not however mask regional disparities, as SADC member countries are at different developmental stages, partly explaining the variation in ranking and scores, and pockets of strong performance.

Importantly, while some countries display a relatively strong performance on one of the metrics (i.e. electricity security, electricity equity or environmental sustainability), their situation is undermined by their weak performance in other dimensions. No country in the region manages to leverage the co-benefits existing between the three areas and perform well on all dimensions.

However, the region benefits from huge natural resources, as highlighted in Section 2.1, which are largely untapped. Maximising the potential of regional resources (particularly renewable energy technologies) would lead to increased regional trade (see Figure 19), cost savings and a substantial improvement in electricity sustainability.

**Figure 19: Potential projected flows and volume of regional trade by 2030 according to IRENA's Renewable Promotion scenario**



Source: (Miketa and Merven, 2013)

Based on modelling from (Miketa and Merven, 2013), SADC's identified renewable energy potential can assist the region in achieving universal access to modern electricity while reducing costs in the long term (the share of renewable energy technologies, excluding large hydropower, in electricity production in the region could increase from the current level of 10% to as high as 46% by 2030). This is confirmed by a 2009 SAPP Regional Generation and Transmission Expansion Plan study (Nexant, 2009), which indicated that significant cost savings of up to USD 48 billion (over a 2006-2025 period) could be achieved if countries coordinated better and pursued projects collectively as a region. Seizing this potential requires harnessing the benefits of regional integration in the Southern African sub-continent, which is the focus of the next section.

DRAFT

### 3. The role of regional integration: Status quo and way forward

The need for further progress in terms of electricity sustainability in the SADC region has been highlighted in Section 2. This section analyses the existing role of regional integration in the electricity sector and explores the main channels through which it can contribute to an improvement in electricity sustainability. Three key areas, namely harmonised policies and regulatory frameworks, adequate common institutions and technical infrastructure and coordinated implementation, are considered.

#### 3.1. Harmonising policies, frameworks and regulations

The first area of regional intervention revolves around the development and harmonisation of policies, frameworks and regulations in the energy sector. Energy policy and regulation have been progressing in the region, with 11 out of 12 SAPP countries having a national regulatory body as of April 2017,<sup>4</sup> both clarifying and complexifying the legal and regulatory landscape.

The Regional Electricity Regulators Association of Southern Africa (RERA) was launched in 2002 in order to support the harmonious development of policy and regulatory frameworks in the region.<sup>5</sup> The Association took an important concrete step towards the harmonisation (i.e. compatibility) of national regulatory systems with the development of 'regulatory guidelines', approved by the SADC Energy Ministers in April 2010 (Sichone, 2015).

The guidelines aim to ensure that efficient cross-border deals are not constrained by unclear or complicated processes for making regulatory decisions. They focus on large-scale/long-term transactions, which are predominant and more likely to influence investment decisions, the efficiency of electricity interconnections and electricity trade in the region.

The regulatory guidelines seek to:

- clarify how regulators carry out their powers and duties in regulating cross-border electricity transactions in order to minimise regulatory risks for power investors and electricity consumers;
- promote efficient and sustainable cross-border electricity transactions that are fair to selling and buying entities, are consistent with least-cost sector development, and can help to ensure security of supply; and
- promote transparency, consistency and predictability in regulatory decision-making.

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<sup>4</sup> See Annexure 3 for a list of the regulatory institutions. The DRC does not have a fully-fledged regulator yet. The Botswana Energy Regulatory Authority, created in 2016, is not yet a member of RERA.

<sup>5</sup> The RERA has the following objectives:

- Capacity building and information sharing, i.e. facilitate electricity regulatory capacity-building among members at both a national and regional level through information sharing and skills training;
- Facilitation of electricity policy, legislation and regulations, i.e. facilitate harmonised policy, legislation and regulations for cross-border trading, focusing on terms and conditions for access to transmission capacity and cross-border tariffs; and
- regional regulation cooperation, i.e. deliberate and make recommendations on issues that affect the economy (Sichone, 2015).

While noteworthy, these guidelines have however no formal legal status and remain voluntary. Indeed, the RERA is primarily a forum through which national regulators share their experiences. The guidelines are moreover incomplete as they do not cover short-term/small transaction (less than 20MW of power and duration inferior to a year) and the competitive market. As a result, they have had the unintended consequences of perpetuating and further entrenching the domination of long-term, bilateral transactions over the regional market (discussed below in Section 3.2).

Furthermore, concerns on the physical security of transmission infrastructure and contract security remain high in the region, particularly due to the absence of a regional regulatory framework. Importantly, the current framework is silent on measures to regulate pilferage of power imports meant for another country, leaving electricity importers with no control over the transmission infrastructure in other states through which their own imports pass (SADC and SARDC, 2016).

Indeed, energy regulation is still nascent in the region and lacks independence (from political powers), capacity and skills in most countries and at the regional level. Energy policy appears fundamentally inadequate, with long-term planning being largely outdated in time and best practice, and lagging in implementation. As raised in Section 2.2, electricity tariffs are also not cost-reflective and competitive, despite the political calls of SADC Energy Ministers to achieve cost-reflective tariffs by 2013 (initially) and by 2019 (now).

The SADC has developed numerous regional plans and strategies in the energy space to attempt to remedy the situation, as raised in the introduction. The Regional Strategy for Increasing Energy Access (March 2010), the SADC Regional Energy Access Action Plan, the SADC Regional Renewable Energy and Energy Efficiency Strategy and Action Plan (2016), and also the development of a Climate Change Adaptation Strategy are but a few examples.

Common implementation frameworks are furthermore being progressively developed. The SAPP Energy Efficiency Framework, finalised in 2014/2015, is one example. The framework proposes a tracking mechanism to ensure compliance and standardisation, especially in the measurement and verification of energy savings. It informs how the power pool should roll out its energy efficiency programme, including the roles of the private sector and energy service companies. It also developed a LED roll-out business case as well as specific programmes for CFL replacement involving 11 national utilities (SADC, 2016). It also supports the development of a Virtual Power Plant (VPP), as it seeks to augment ongoing efforts to increase electricity generation capacity to beat shortages in the region<sup>6</sup> (SADC and SARDC, 2016).

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<sup>6</sup> A VPP is not a physical power station and makes extensive and sophisticated use of information technology, advanced metering, automated control capabilities, and electricity storage to match short-interval load fluctuations. It aims to integrate the operation of supply- and demand-side assets to meet customer demand for energy services in both the short- and long-term. It also makes use of long-term load reduction achieved through energy efficiency investments, distributed generation, and verified demand response on an equal footing with supply expansion (SADC and SARDC, 2016).

The Smart Grid Concept Paper prepared in 2014/2015 to assist individual utilities in the migration to smart grids is another instance.

The implementation of such plans, strategies and frameworks, as illustrated in Box 4 in the case of the SADC strategy and action plan for energy access, remains however problematic. The SADC has limited clout to fast-track implementation and ensure adopted initiatives are adequately resourced and funded. In fact, energy policy is not integrated at the regional level. The regional energy policy is more a collection of national situations than an integrated regional framework. For instance, no electricity planning takes place at the regional level, and policy and regulatory frameworks, including standards and labelling of equipment, are not harmonised.

#### **Box 4: The SADC strategy and action plan for energy access**

The Regional Strategy for Increasing Energy Access was published in March 2010. It aims, at the strategic level, to harness regional energy resources to ensure, through national and regional action, that all the people of the SADC region have access to adequate, reliable, least cost, environmentally sustainable energy services. At the operational level, the Strategy has an objective to ensure that the proportion of people without such access is halved within 10 years for each end use and halved again in successive five-year periods until there is universal access for all end users.

It encompasses seven key elements:

- improved systems to provide accurate information, especially quantitative data and statistics, on energy access;
- better applications, with a focus on energy end-uses rather than technologies;
- the recognition of the dominant role of biomass in the present and projected energy balance of most SADC countries;
- the transition to cost-reflective but competitive prices;
- the prioritisation of access over consumption subsidies;
- a focus on the use of energy to enhance economic productivity for poverty reduction and enhanced quality of life; and
- an improved capacity, with the ability and willingness to implement, operate and maintain energy access projects and programmes.

A SADC Regional Energy Access Action Plan was also developed at the same time (2010) to operationalise the strategy. It states that the main roles of the SADC Energy Programme are to mobilise resources for energy access activities and to be a catalyst or facilitator of exchange of information on best practice within the region. A three-year action plan, with clear strategic objectives, activities (with responsibilities), measurable outputs and expected outcomes was also designed, with four main streams:

- the recruitment and employment of a full-time Energy Access Adviser for an initial period of three years;
- the hiring of consultants to execute a one-year project during which they will produce Guidelines on National Energy Access Strategies and Energy Access Reporting Guidelines, as well as producing the baseline SADC Energy Access Yearbook;
- support for establishing and maintaining a SADC Energy website; and

- a Drawdown Facility to support two streams of activity: Regional exchange of experience; and commercially viable pilot projects to enhance access for light, heat and/or power delivery.

There is unfortunately no evidence, as of April 2017, that any of the actions envisaged in the three-year plan have been implemented.

*Source: Authors' composition, based on (SADC, 2010)*

The Market & Investment Framework for SADC Power Projects (previously known as the SADC IPP Framework), approved in June 2016, is the latest attempt of the regional body to fast-track implementation and introduce a set of harmonised legal and regulatory rules by 2022. The Framework formulates ambitious targets, including the rollout of a Target Market Model Design based on unbundled electricity supply industries, the introduction of IPPs along national utilities and the development of a financial framework to develop bankable project structures, secure support from financiers and implement projects. From a legal and regulatory perspective, the Framework plans to address numerous bottlenecks by:

- developing a regional license, through regional coordination in terms of the types and content of licenses, and the recognition of licenses across borders;
- harmonising rules and standards for metering;
- developing a cross-border dispute settlement methodology;
- harmonising tariffs, particularly for transmission, and moving towards cost reflective tariffs;
- managing transmission losses at the regional level;
- establishing common grid access rules for connecting to the networks;
- developing regional rules for interconnector congestion management;
- setting up a regional grid code; and
- coordinating generation and transmission asset development planning (Sichone, 2016).

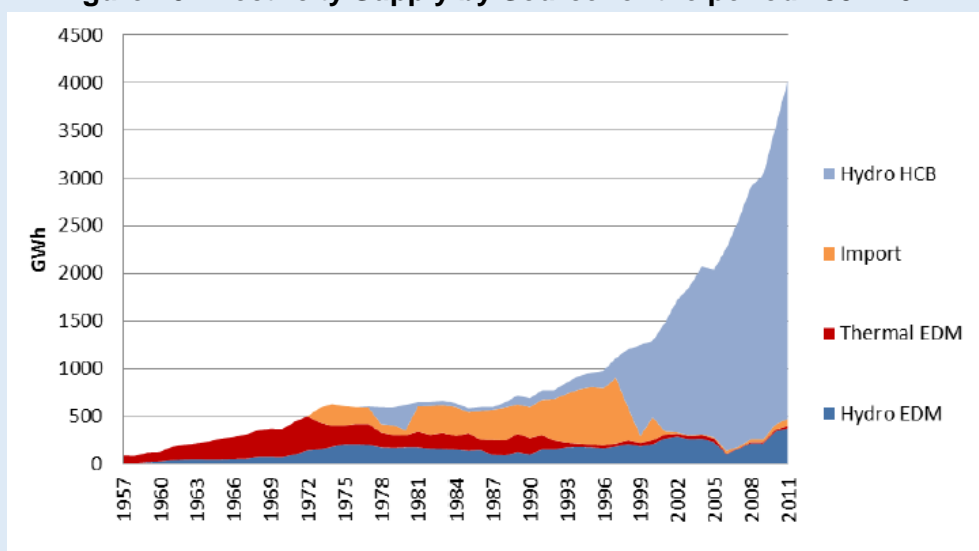
#### **Box 5: Mozambique's shift to an energy exporter**

Once identified as one of the poorest countries in the world, Mozambique has, in recent years, managed to overcome the dire legacies of 15 years of civil war (1977-1992) and leapfrog as one of the SADC's primary energy producer. Rapid expansion of the hydropower sector and substantial discoveries of natural gas and coal have propelled Mozambique as an electricity exporter. A favourable investment framework has attracted considerable amounts of foreign direct investments in developing, exploring and expanding the country's energy industries.

The Cahora Bassa dam in Mozambique is one of the largest hydroelectric schemes on the African continent with an installed capacity of 2075 MW, exporting electricity to Botswana, South Africa, Zimbabwe and the SAPP. With an additional 12 000 MW of untapped hydropower potential identified, the dam is viewed as a catalyst for economic growth and future development in the country, especially since 85% of the shares are controlled and owned by Mozambique. Coal reserves and natural gas deposits have been estimated at 4 billion tonnes and 127 billion m<sup>3</sup> respectively, with further exploration underway.

Mozambique historically relied on imported power to provide for electricity needs, until the establishment of Hidroeléctrica de Cahora Bassa (HCB), which started producing electricity in 1974, signalled a shift away from foreign imports to locally-produced hydroelectricity. However, transmission infrastructure did not escape the impact of the civil war, causing the country to resort yet again to importing electricity in the 1980s and 1990s. These disruptions led to the country rehabilitating electricity infrastructure and developing new power lines, ultimately resulting in HCB producing a greater output during post-war development as indicated in Figure 20.

**Figure 20: Electricity Supply by Source for the period 1957-2011**



In attempts to further harness the country's energy resources, create employment and facilitate investment, the Mozambican government established an environment to attract foreign investors. Such policy framework includes: the Investment Law, which provides tax incentives and a standardized investment framework; the Decree No. 47/200, which assists with the establishment of small, micro and medium enterprises through the creation of the Institute for Promotion of Small and Medium Enterprises (IPEME); and the Law No. 4/2009 the Code of Fiscal Benefits, which provides VAT reductions, tax exemptions and investment tax credits.

In addition, the Investment Promotion Centre (CPI) and Office for Accelerated Economic Development Zones (GAZEDA) was created to assist funders during project planning and implementation. The CPI also supervises so-called 'rapid development zones' that are exempt from VAT and subject to low custom duties. These zones are located across Mozambique in regions with significant volumes of natural resources but relatively low levels of income generating activities, due to infrastructure constraints. The Free Industrial Areas and Special Economic Zones are also regions which benefit from fiscal measures, such as the elimination of import duties on building and construction material.

The country aims to continually reform its energy sector, as evident in the recent Electricity Law and the establishment of FUNAE, a fund for electrifying rural locations across Mozambique, and the numerous fiscal incentives to attract foreign direct investment. However,



despite the plethora of diversified resources, Mozambique continues to struggle with providing electricity to the local population as access to grid based electricity remains relatively low at around 20%, with majority of the citizens still relying on traditional sources of energy.

*Source: Authors' composition, based on (IRENA, 2012), (Cuamba et al., 2013)*

### *Policy implications*

Going forward, the implementation of the Market & Investment Framework arises as the priority for the region from a policy and regulatory perspective. The SADC and the SAPP are in this respect instrumental in addressing sovereignty concerns and ensuring that the development of regional regulation is not limited to the lowest common denominators. The ambition of regional integration is to harmonise frameworks upwards.

Such a situation also calls for reviewing the role and functions of the regional institutions to allow the regional power pool to have more authority on issues of energy development in region, and thus ensure that SAPP and RERA have the power to enforce decisions made by Member States (SADC and SARDC, 2016). Indeed, the implementation difficulties experienced by previous plans and strategies warrants that the SADC, the SAPP and the RERA play a driving force in the operationalisation of a regional framework and the development of a regional *acquis*. The development of a regional electricity plan, informing national planning exercises in the future, appears as a key element to the success of the Market & Investment Framework. Similarly, the establishment of regulatory benchmarks arise as a pre-requisite to any meaningful performance monitoring.

Along with the implementation of the financial leg of the Market & Investment Framework, which aims to design and experiment with bankable project structures, the SADC needs to play a stronger role in effectively securing funding for energy projects in the region. There is currently limited support available for bankable project preparation and a lack of capacity to initiate, implement and manage innovative projects. The SADC could actively drive fund raising for strategic and/or cutting-edge projects, notably by bundling similar small projects together for funding applications. The creation of a regional one-stop-shop for potential project developers and investors would also help facilitate investment in the region. Such a clearing house could include the development and maintenance of a database covering all existing funding sources available to the region. The creation of a regional financing mechanism, including a regional fund, would also ease the implementation of multi-country electricity-related projects in the region.

The regionalisation of the financial burden should be complemented with a harmonisation of the policy frameworks on the role of the private sector. Some countries, such as Zambia and Tanzania, have made major stride towards the restructuring of their electricity supply industries. Despite a regional understanding on the role of the private sector reached at the operational level in June 2015 (SAPP, 2017), the region displays a variety of situations and approaches with regards to the unbundling of vertically-integrated national utilities and the introduction of competition, through IPPs, at the generation level. The harmonisation of the architecture of the electricity supply industries, with the aim of creating a regional market should be actively pursued. The development of a regional approach on the role of the private

sector and the modalities of its involvement, with clear, common legislation, would be a stepping stone in this direction.

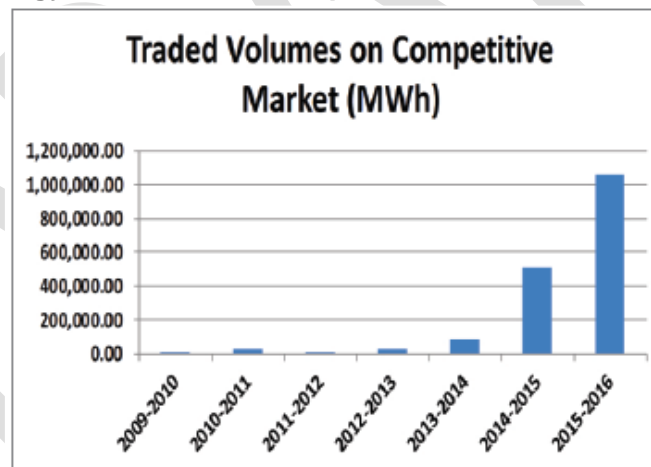
A last important avenue is the creation of effective linkages between the energy and industrial development frameworks in the region, with the aim of creating regional energy value chains and building local manufacturing and service capabilities. As regional energy integration occurs in the Southern African region, a regional strategy to reap industrial development benefits should be designed accordingly. Markets for energy projects, technologies and services are fragmented along national boundaries and the experience of local economies with the development of local industrial capacity (see for example (Montmasson-Clair and Das Nair, 2015) for South Africa's experience) has shown the difficulty in sustaining industrial development in the sector. The creation of an integrated regional market for energy, rather than fragmented national markets, would enable the emergence of regional firms to manufacture the required energy technologies and service the market. Further reflection should be done on the possibility of designing a regional (rather than local) content strategy, therefore creating a regional market. The creation of free movement areas for skills and competences among SADC countries would also be important in this respect.

### 3.2. Building common institutions and technical infrastructure

The second avenue for regional integration to assist with achieving electricity sustainability is the development of the technical infrastructure. Notable progress has been made in developing the regional electricity infrastructure since the creation of the SAPP in 1995, from the transmission networks to the trading platforms. Despite its limited role and functions, SAPP is regarded as the most advanced power pool on the African continent in terms of trading structures.

Regional trading was initially confined to bilateral contracts among member utilities, i.e. fixed, long-term (generally from one to five years, but possibly longer) co-operative contracts between utilities. SAPP then operated the Short-Term Energy Market (STEM) from 2001 until 2007, when the region (i.e. South Africa) ran out of surplus capacity. The STEM market catered for about 5% of SADC's energy trade. Comprising daily and hourly contracts, mainly covering off-peak periods, the STEM was a precursor to the full competitive electricity market that was successfully developed in the form of the Day-Ahead Market (DAM). The development of the DAM started in 2003 and the market went live in December 2009. Volumes of power traded on the DAM have increased significantly over the seven years of existence of the market, and especially in the last biennium, as showed in Figure 21, and more than USD 3 million is exchanged on the DAM each month. In 2016, SAPP introduced a Forward Physical Market and an Intra-Day Market.<sup>7</sup>

**Figure 21: Total energy traded on the competitive market from 2009/2010 to 2015/2016**



Source: (SAPP, 2017)

<sup>7</sup> Trading is facilitated by SAPP pricing arrangement, set out in 13 detailed schedules in the operating agreement. The schedules cover four broad types of transaction: firm power contracts of varying duration; non-firm power contracts of varying duration; mutual support contracts, such as operating reserve, emergency energy and control area services; and scheduled outage energy, energy banking, and wheeling. With support from Sweden, SAPP developed the Ancillary Services and Transmission Pricing System whose implementation was phased in over a three-year period starting in 2011. Ancillary services are essential to the reliability and security of power system operation in any competitive electricity market environment.

The role of regional trading mechanisms however remains limited. Indeed, the quest for regional electricity sustainability in SADC involves a delicate balance between national and regional interests. Amid acute shortages, countries have favoured the sovereign route of attempting to attain national self-sufficiency, rather than depending on imports from other countries. For example, while the coal-based Mmamabula Power Station project, located in Botswana near the South African border, was initially meant as a regional initiative, Botswana decided, in the face of electricity shortages, to build the project on its own rather than wait for the long process of regional negotiations to take place (Jindal Africa, n.d.). Initiated by five member states to draw power from the DRC to Angola, Botswana, Namibia and South Africa, the Westcor Power Project is another illustration of the difficulty in building regional initiatives. The project is now moribund due to a number of factors, including national concerns over security of supply (Mathews, 2017).

Furthermore, when turning to the region, countries tend to favour a bilateral approach, striking long-term supply agreements. As displayed in Table 3, long-term bilateral transactions dominate the market (85-99% depending on the year) while the regional, competitive market accounts for the remaining share. For example, South African Eskom and Namibian NamPower signed a five-year electricity sales agreement in March 2017. While the unidirectional deal does not have a fixed payment but will depend on the energy consumed, the agreement should see Eskom supply NamPower a firm capacity of 200 MW as well as an additional supply dependent on transmission capacity. NamPower has also power purchase agreements with the Zimbabwe Power Corporation (ZPC), a subsidiary of the Zimbabwe Electricity Supply Authority (ZESA), and the Zambia Electricity Supply Corporation (ZESCO) of 80 MW and 50 MW, respectively. Similarly, Eskom already has long-term agreements in place with Lesotho Electricity Company and the Swaziland Electricity Company, and it intends to conclude agreements with other SAPP members (Eskom, 2017; Timo Shihepo, 2017).

**Table 3: Share of electricity traded in the SAPP region according to trading channels**

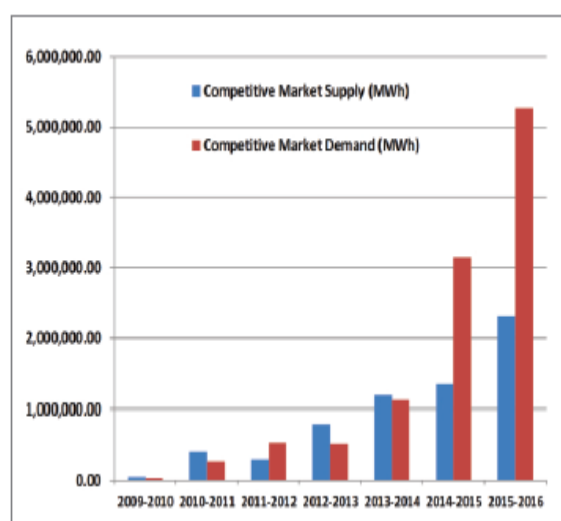
Share of electricity traded	2013/2014	2014/2015	2015/2016
Regionally	0.9%	6%	14%
Bilaterally	99.1%	94%	86%

*Source: Authors' composition, based on data from SAPP Annual Reports*

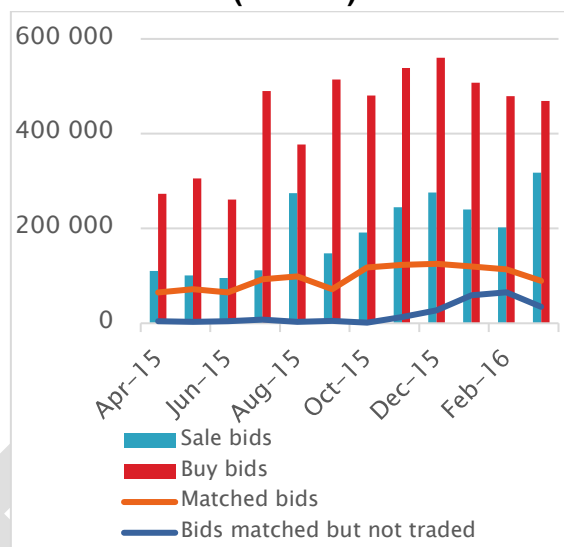
Regional trade has also been heavily constrained by the lack of adequate transmission infrastructure. While many more projects are underway and in the pipeline to improve the regional electricity grid (see Annexure 4), weak and limited electricity grid infrastructure has indeed limited regional integration.

Angola, Malawi and Tanzania are not yet connected to the rest of the region and the allocation of resources is not optimised. Figures 22 and 23 show that electricity demand has been much larger than the supply offer on the regional market over the last few years, and highlight the potential for further regional trade, provided adequate planning. In addition, a share of possible transactions (matched bids) is not realised as a result of infrastructure constraints. Such matched but not traded bids can reach more than half of matched bids in the summer months of the Southern hemisphere.

**Figure 22: Demand and supply trends on the competitive market from 2009/2010 to 2015/2016**



**Figure 23: Bids submitted and matched on the Day-Ahead Market in 2015/2016 (in MWh)**



Sources: (SAPP, 2017) and author's composition, based on data from SAPP Annual Reports

### Policy implications

Going forward, the SADC, through the SAPP notably, should pursue planned cross-border projects, with a focus on connecting Angola, Malawi and Tanzania to the regional grid and enhancing key backbone links. While a number of projects are underway, the inter-connection of the region remains limited and primarily structured around bilateral contracts.

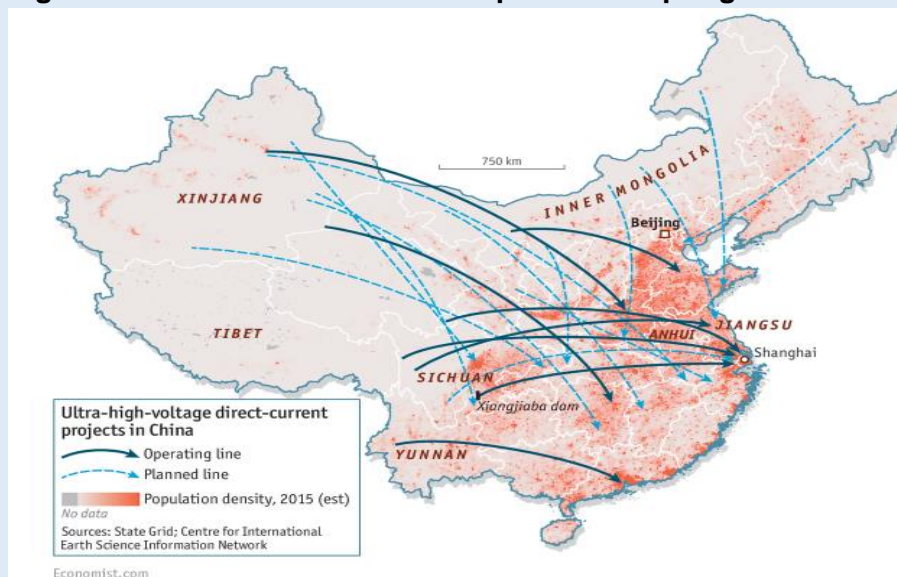
The region should further investigate the role of super-grids, which consist of high-voltage direct current (HVDC) (or even ultra-high-voltage direct current) transmission networks. While HVDC lines are not new (the Cahora Bassa to Johannesburg transmission line was built from 1977-1979) (ABB, 2012), the super-grid concept suggests a network of HVDC transmission systems that are strategically designed and implemented to maximize efficiency and tap into the best available (renewable) resources (Hansen, 2016). HVDC lines may be more expensive to construct than high-voltage alternating current (HVAC) lines, but they generate cost savings in the long run due to high system efficiency, such as reduced transmission losses. Lower voltages of transmission or distribution lines, coupled with great distances, lead to high energy losses (RERA, 2016). In addition, super-grids are emerging in China (see Box 6), Brazil and India, opening opportunities for South-South cooperation and capacity building.

### Box 6: The development of super-grids in China

As illustrated by Figure 24, the construction of super-grids is booming in China. This trend is primarily driven by geography. Three-quarters of China's coal is in the far north and north-west of the country and four-fifths of its hydroelectric power is in the south-west, while most of the country's people, are in the east, 2 000 km or more from these sources of energy.

For example, in 2010, China completed a 6 400-MW, 800 000-volt transmission line transporting electricity from the Xiangjiaba dam to Shanghai and a 7 200-MW line was completed in 2013 connecting a hydroelectric power plant in Sichuan to Jiangsu. A Changji-Guquan interconnector under construction will also transmit 12 000 MW of wind and coal generated electricity from the north-west province to the east of the country spanning 3 400 km.

**Figure 24: Illustration of the development of super-grids in China**



*Source: The Economist, 2017*

The SADC should make use of its geopolitical links with China and other developing countries to secure funding and engage in knowledge sharing on the development of a super-grid in the region. Like China, the SADC region has access to a wide array of resources, such as coal, hydro, natural gas, solar and wind, spanning across the region. The development of a super-grid would provide the platform to diversify the electricity mix of the region and maximize the use of sustainable sources, such as the identified 390 000 MW hydro potential in the DRC's at the Inga Falls.

*Sources: Authors' composition, based on (The Economist, 2017) and (REN21, 2015b).*

Complementing the development of large cross-border infrastructure, the SAPP should also pursue the deepening of the regional market. The limited but growing role of regional mechanisms (compared to bilateral deals) is promising. So far, the SAPP has been able to provide the sufficient market-related conditions for regional trade to take place. For example, no market abuse has been recorded over the last few years. The trading system also provides online information to market participants, answering short-term market transparency needs. As the regional market grows and trade rises, stronger, particularly long-term, surveillance and improved financial security requirements measures (in order to minimise financial settlement risks) will be important. For example, the need for increased coordination in terms of maintenance and planned outages of generation and transmission equipment (concentrated in summer), resulting in reduced available power being offered on the market and reduced trade volumes, is evident.



In addition to cross-border transactions, further work is required to support the local rollout of smart and micro-/mini-grids, particularly in support of rural electrification. Micro/mini-grids and off-grid technologies (such as PicoPv Systems, Solar Home Systems and Solar Residential Systems) are effective solutions for the electrification of areas that are not financially feasible for utility grid connection, such as rural and remote locations within SADC (ODI, 2016). Box 7 describes Tanzania's experience in this respect.

#### **Box 7: Tanzania's Small Power Producer Programme**

Tanzania is among some of the least electrified countries on the continent, with only 24% of its inhabitants (and 7% of rural population) benefiting from access to electricity. In order to address this challenge, the country's Rural Energy Agency and Rural Energy Fund have identified off-grid technologies as a key driver of electrification in the country. Solar energy has indeed been prized as an effective measure to combat energy poverty, with off-grid solar home systems and pico-PV systems providing electricity to around 15% of the country's population.

Tanzania employs a unique system, known as the Small Power Producer Programme (SPPs), comprised of fixed feed-in tariffs and standardised contracts to supply Tanesco and customers not connected to the grid, with 11 local and foreign SPPs operating in the country. Investments in mini- and off-grid electricity systems have already proved feasible, increasing the competitiveness of renewable energy sources and providing rural access to electricity in a cost-effective manner. The import of solar technologies (inverters, panels, batteries) has moreover been facilitated by VAT and tariff exclusions.

These efforts paved a way for the rise of private sector intervention with local companies seizing opportunities to fill the market gap, such as Zara Solar, a Tanzania-based privately-owned business operating in Mwanza and Dar es Salaam and currently servicing up to 20 000 households.

However, despite an abundance of standardised regulation in place, poor quality Chinese solar PV systems have permeated the market, lowering local confidence levels in solar-based electricity, thereby limiting the uptake of models from local companies. These sub-standard systems are generally much cheaper than those produced by local companies, but suffer from a shorter life-span and are often prone to malfunctions.

Despite these hurdles and in order to attract additional foreign investment, the Tanzanian Investment Centre created a One Stop Centre. Bringing together ten government agencies and ministries, the Centre is tasked with assisting foreign and local investors overcome administrative and regulatory obstacles by providing step-by-step, detailed information on how to start up a business and obtain the required permits. Furthermore, once projects are approved, international investors are guaranteed conversion exemptions for foreign exchange, further improving the investment climate. As a result, Tanzania attracted nearly USD 850 million worth of foreign direct investment in the energy sector between 2000 and 2011.

*Source: Authors' composition, based on (ODI, 2016), (Prinsloo, 2016) and (Bailey et al., 2012), (Tanzanian Investment Centre, n.d.)*

The IRENA projected that 14 TWh of rural electricity could be provided by decentralised electricity systems in the region by 2030 (Miketa and Merven, 2013). Rooftop solutions are also adequate solutions for most residential and commercial operations. Such technologies also constitute major manufacturing opportunities for the region, echoing the recommendation made in Section 3.1.

The economic sustainability of such systems, particularly for poor rural populations, requires some public support, at least to cover both the initial investment and the operation and maintenance of the systems or for subsidising private investment in rural electrification (Ngoepe et al., 2016). The SADC, as part of the financial integration leg of the Market & Investment Framework introduced in Section 3.1, should look at funding models for embedded generation. Financial schemes, such as Botswana's Rural Electrification Collective Scheme (Box 8) or South Africa's framework (Box 1) can be established to assist lower income communities.

The potential for micro-grid systems to decisively promote local economic development and contribute to users' income should complementarily be investigated. Promoting the productive uses of off-grid systems, while desirable, does indeed require different public programmes from simple energy provision. Additional, short-term government programmes, such as user training, skills development (notably for operation and maintenance), cooperation schemes and entrepreneurship support, are necessary to enhance the reliability and sustainability of the systems (particularly in the long run) and trigger the productive usages of energy access (Feron, 2016).

#### **Box 8: Botswana's rural electrification experience**

Botswana, like most countries in the region, faces high challenges in terms of electricity equity. Ensuring the modern and affordable access to electricity, notably to rural areas, is at the core of issue.

During the latter stages of the 1980s, Botswana initiated a country-wide rural electrification programme in attempts to reduce poverty, known as the Rural Electrification Collective Scheme (RECS). The programme recognises that the uptake of electricity connection increases considerably when initial upfront payments and monthly instalments are low and flexible repayments are spanned across a longer timeframe. As such, while the programme charges customers for grid extension to their villages, it encourages customers to apply for loans to cover these costs and/or their electricity consumption. In order to develop economies of scale when applying for electrification, the RECS also encourages consumers to form groups consisting of a minimum of four customers. The consumer group is then required to contribute 5% of the initial upfront cost and the total payment can be distributed over the span of 18 to 180 months.

Over the years, political will coupled with constant monitoring and evaluation and subsequent adaptations of this pro-poor policy has ensured that the financial mechanisms in place encouraged participation from the poor and successfully ensuring consumers attain full cost recovery. When barriers and obstacles occurred, the government swiftly amended the scheme to rectify the challenges and ensure success. Nevertheless, the poorest populations remain unable to reap the benefits of the RECS as they cannot afford the upfront cost of connection



nor the monthly instalments, largely explaining the low electrification rate of Botswana's rural areas (still at 24% in 2017).

In light of this challenge, the Government of Botswana and the Global Environment Facility (GEF) initiated a five-year, USD 6.6-million Renewable Energy Rural Electrification Programme in 2005 aimed at providing solar home systems to populations without access to electricity while promoting private sector participation to create renewable energy-based service provision.

The programme, implemented by the Botswana Power Corporation, has however faced many challenges. According to an official evaluation report undertaken by the GEF, the implementation of off-grid PV systems has not been satisfactory, with insufficient Botswana Power Corporation staff and a part-time project manager unable to efficiently manage the programme, as focus has been primarily targeted to expanding grid connection. Stakeholder engagement has also been identified as an issue hindering the successful implementation of the programme as key stakeholders in government, civil society, research communities and the private sector have not been able to participate in the implementation of the project due to lack of funding to attend meetings. Moreover, in contrast with the RECS, the monitoring and evaluation of the Renewable Energy Rural Electrification Programme has been sub-standard with the UNDP accepting partial blame for the lack of oversight on this phase of the programme.

Going forward, there are key lessons that can be taken away from Botswana's experience. Rural electrification and cost recovery can occur simultaneously given proper pro-poor financial incentives, as apparent in the RECS, are implemented. Furthermore, institutional governance and internal implementation commitment have the ability to significantly influence the success or failure of project outcomes, as evident from the Renewable Energy Rural Electrification Programme.

*Sources: Author's composition, based on (SADC, 2010), (SE4All Africa Hub, 2017), (Jain et al., 2014) and (Vyas, 2011).*

### *3.3. Fostering the development of human capabilities*

The development of the regional human capabilities is the third key avenue for regional integration. Given the nascent nature of energy regulation in the region and the rapidly evolving techno-economic environment in the energy space, the presence of well-capacitated teams with up-to-date knowledge, skills and competences is at the core of a successful regional integration.

The policy mandate to create a regional market for skills and competences is clear, as formulated by the Regional Indicative Strategic Development Plan, the SADC Regional Industrial Policy Framework and the Post-2015 Inclusive and Sustainable Industrial Development (ISID) agenda.

Some capacity building and experience sharing is organised at the regional level, through the SADC, the SAPP and the RERA. Through the SAPP, the region hosts several technical sub-committees (on markets, planning, operating issues and environmental matters). In addition, experience sharing workshops are regularly hosted with the support of international partners. Examples included an Energy Management and IPP Framework workshop in June 2015, a Joint IRENA-SAPP workshop on Renewable Energy Zoning in the region (2014), workshops on the integration of renewable energy sources to the interconnected power grid (2014 and 2015), a workshop on Framework for Open Access to the Transmission Grid (2014), a World Bank Workshop on Water and Energy Nexus in the Zambezi Basin and a Training on Equator Principles and Due Diligence in 2014.

The RERA is also facilitating capacity building activities. As part of an initiative to establish a regional platform for sustainable long-term capacity building for RERA's members, commissioners, and other technical and support staff, a RERA Training Needs Assessment was conducted with support from USAID, leading to the development of training curricula and modules for RERA. In addition, the European Union is supporting a four-year technical assistance programme to develop regulatory frameworks and strengthening local capacity, particularly with regards to renewable energy and energy efficiency. IRENA is providing support to RERA as part of the Regulatory Empowerment Project (REP) to improve the governance of electricity planning and the integration of renewable energy (Magombo, 2016).

Furthermore, the Energy Thematic Group (ETG) was created based on the recommendations of a review of the 2006 Windhoek Declaration on a New Partnership between SADC and the international cooperating partners. It is a multi-stakeholder group, including the SADC Secretariat, SADC subsidiary organisations, international cooperating partners, the Southern African Research and Documentation Centre, the private sector, multilateral and bilateral financial institutions. The ETG serves as a technical coordination and advisory group, and acts as a forum for dialogue, networking, partnership building and the creation of shared understanding between the main regional partners (Moser, 2015).

Against that mandate, little progress has been made to develop national and regional experts. There is notably limited capacity and awareness on available energy resources and technologies (particularly renewable energy and energy efficiency), and their techno-economic possibilities. Similarly, knowledge on the socio-environmental impacts and

acceptability of various technologies is strongly lacking. Such a situation is correlated to the lack of expertise at vocational and university levels in the region. Outside of South Africa, there is little R&D capacity, particularly due to a dearth of funding. At the same time, regional cooperation between research institutions appears limited. Overall, the scale and reach of the existing initiatives remain too small to meaningfully address the lack of experience sharing and capacity building (SADC and UNIDO, 2014).

In addition, most capacity building programmes target existing human resources in the sector, higher education institutions and decision-makers. There is very little investment in building the capacity of communities or building a network of community practitioners, especially those engaged in the delivery of decentralised electricity systems. The result is that communities have little or no role in decision-making about the electricity systems being planned and delivered and are not included in any governance structures. This oversight needs to be addressed if electricity sustainability is to be achieved. There are a number of existing examples of community-based electricity systems in the region, for example in Tanzania, that can form the basis of a region-wide community network of learning.

The fiasco of the Grand Inga project in the DRC, often described as a 'white elephant', illustrates the lack of capacity to deliver projects. In 2016, the World Bank announced it had suspended its financial support to the project. The main reasons behind this decision revolve around the lack of transparency and independence, the failure to observe international good practice in terms of governance, high risks in terms of fiduciary responsibilities, and a lack of institutional capacity for implementation and technical design capacities (Fabricius, 2016). South African Eskom's extreme difficulty in delivering on time and on budget the two large-scale coal-fired power plants Medupi and Kusile is another example of the lack of internal capacity (Yelland, 2016).

Most SADC's frameworks, plans and strategies also emphasise the need to build data and information databases and repositories to improve evidence-based decision- and policy-making. This is notably the case of the SADC' Regional Strategy for Increasing Energy Access and its Action Plan discussed in Box 4. A number of areas are generally considered in this respect, namely the collection of baseline data and information on the current state of play, the access to up-to-date information on academic and professional knowledge (from a policy, regulatory, socio-economic, technical and technological perspective), and the development of forecasting and planning capabilities.

Information and data, on energy like many other topics, remains however very scarce and of poor quality in the region. As illustrated by Box 3 on energy losses, this poses significant challenges for decision-making in both policy and investment circles.

### *Policy implications*

A regional cooperative framework should be established to assist with the development of the 'human infrastructure' in the energy sector, as proposed by the (AfDB, 2013). Capacity building programmes can be determined using both a top-down and a bottom-up approach, depending on the national, regional or individual institutional level.

From a top-down approach, the SAPP could act as the implementing agency in project development while the RERA could in the long term be able to check and monitor national compliance. Such a cooperative framework should include the development of regional knowledge programmes, through the harmonisation of regional curricula at tertiary institutions and centres of excellence, as well as the facilitation of the mutual recognition of (vocational) certifications.

Such a process should be complemented by a bottom-up approach prioritising capacity building activities that are aligned to the needs of specific institutions, while considering their position in the regional arena (AfDB, 2013). The establishment of regional educational, training and electricity institutions, through the creation of new training centres and the enhancement of existing national institutions, such as the South African Renewable Energy Technology Centre (SARETEC) which trains wind turbine service technicians locally, as opposed to sending them abroad for training or recruiting experts from developed countries, is an example of the ground-level perspective.

The SADC, through the SAPP and the RERA, would play a central role in building capacity in countries and institutions requiring assistance to adapt to and implement regional standards. Regional institutions should foster experience and skills sharing in the region, particularly technical and non-technical capacity building of power pool member countries. This could take the form of an extensive platform for regional workshops, with the aim of bringing experts in particular fields to train and engage in knowledge sharing with local experts.

The SADC should engage in lesson drawing activities, borrowing or improving on ideas from other African regional economic zones, such as the Economic Community of West African States (ECOWAS), which embarked on various capacity building initiatives, such as undertaking regional assessments on human infrastructural needs and subsequently developing tailor-made programmes for specific sectors and technologies. The ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE) has since trained around 742 technical, financial and policy experts from various sectors on a range of issues and opportunities that affect the energy development of the region (AfDB, 2013). In this respect, the SADC should conduct an assessment of skills needed and a mapping of skills that are already available in the region. Furthermore, the SADC should consider the possible deployment of available skills from other industries (such as mining research drilling to oil and gas drilling).

The SADC should spearhead the negotiation for the creation of a regional free movement area to facilitate the mobility of local skills and expertise in the region. Moreover, the region should facilitate and organise enhanced cooperation between R&D institutions on energy issues. This could take the form of exchange programmes, joint research projects and/or knowledge sharing workshops.

A number of data- and information-related initiatives are also required to improve the state of knowledge about regional dynamics. The necessity to improve mapping tools for needs assessment and diagnostic (e.g. systems losses) is apparent in the region, as is enhancing monitoring and evaluation tools to assess the needs of populations in terms of energy sustainability. The SADC should develop a one-stop information system providing insight on

planned and potential energy generation projects along with the various sources of funding available for project conception, to feasibility studies and implementation phases. Under the auspices of the SADC, member states should develop country reports on the state of electricity sustainability in the region.

Regionally-integrated sector-specific capacity building initiatives, involving the multiple stakeholders mentioned above, are of vital importance for infrastructure project development and implementation. Sustained capacity building must occur, ensuring that human capital is up-to-date with technological and policy advancements, especially since the SADC's access to competent skills and expertise has the ability to shape the energy landscape of the region.

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#### **4. Conclusion**

The road to electricity sustainability in Southern Africa remains long and difficult. Countries, while diverse and facing unique challenges and circumstances, all remain far from achieving their potential and harnessing the synergies between the three challenges of electricity security, electricity equity and environmental sustainability. Whereas these dimensions have been considered as conflicting and impeding each other, the co-benefits existing between them, as illustrated by the rollout of decentralised solar-based systems, constitute an opportunity for the region.

Southern African is a rich region with a vast array of energy resources. These remain unfortunately largely untapped, mainly due to a lack of regional integration. The deepening of regional energy integration in the SADC region indeed offers a platform to fast-track progress towards electricity sustainability. Existing initiatives, structured around the SAPP and the RERA, notably provide the necessary building blocks for regional integration to meaningfully help countries meet their energy challenges. However, this task cannot be left to utilities and regulatory bodies alone. Many avenues are available for regional institutions to play a driving and supporting role and leverage countries' vast experience. Indeed, regional integration is not an end in itself but a means to achieving a sustainable development pathway in the region.

Ultimately, regional integration however remains conditioned on the willingness and engagement of member countries and national institutions as well as robust, inclusive and transparent governance systems. The task at hand is evidently complex and ambitious, but the long-term benefits associated with regional integration are at the core of Southern Africa's prosperity.

Or in the words of Tanzania's Haya proverb: Many hands make light work.

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## Annexure 1: The Southern African Power Pool

**Table 4: SAPP's membership**

Member Utility	Country	Status
Botswana Power Corporation (BPC)	Botswana	OP
Electricidade de Mozambique (EDM)	Mozambique	OP
Hidroelectrica de Cahora Bassa (HCB)	Mozambique	IPP
Mozambique Transmission Company (MOTRACO)	Mozambique	ITC
Electricity Supply Corporation of Malawi (ESCOM)	Malawi	NP
Empresa Nacional de Electricidade de Angola (ENE)	Angola	NP
Rede Nacional de Electricidade de Angola (RNT)	Angola	NP
Eskom	South Africa	OP
Lesotho Electricity Corporation (LEC)	Lesotho	OP
NamPower	Namibia	OP
Societe National d'Electricite (SNEL)	DRC	OP
Swaziland Electricity Company (SEC)	Swaziland	OP
Tanzania Electricity Supply Company (TANESCO)	Tanzania	NP
Zambia Electricity Supply Corporation (ZESCO)	Zambia	OP
Copperbelt Energy Corporation (CEC)	Zambia	ITC
Lunsemfwa Hydro Power Company (LHPC)	Zambia	IPP
Zimbabwe Electricity Supply Authority (ZESA)	Zimbabwe	OP

Source: (SAPP, 2017)

## **Annexure 2: Defining electricity sustainability**

Building on a conceptual framework developed by the World Energy Council (WEC, 2013) and the International Energy Agency (IEA, 2016), three key dimensions can be considered to assess electricity sustainability in the region: electricity security, electricity equity, and environmental sustainability.

Electricity security is the effective management of electricity supply, the reliability of the electricity infrastructure and the ability to meet electricity demand. It can be further unpacked in three complementary components:

- security of supply, i.e. the ability to meet current and future demand (such as the ratio of total electricity production to consumption, import dependence, energy consumption in relation to GDP growth);
- the quality of infrastructure and electricity delivery, i.e. the condition and adequacy of the electricity grid and systems (such as the rate of electricity transmission and distribution losses); and
- the resilience of electricity systems, i.e. the ability to cope with change and avoid electricity insecurity (such as the diversity of electricity generation, risk management and preparedness)

Electricity equity is the accessibility and affordability of electricity supply across the population. It can be further unpacked in three complementary components, which constitute a modern access to electricity:

- availability, i.e. the access to electricity;
- acceptability, i.e. the cultural acceptability and the consumers' willingness to pay; and
- affordability of electricity usage, i.e. the competitiveness and affordability, particularly for the poorest households, of the electricity supply.

Environmental sustainability consists in the achievement of demand- and supply-side energy efficiencies and the development of electricity supply from renewable and low-carbon technologies. It can be further unpacked in three complementary components:

- energy efficiency, i.e. the efficiency of both electricity usages and power generation, transmission and distribution;
- renewable and low-carbon sources of electricity supply, i.e. the share and role of renewable energy technologies in electricity supply, both at utility and embedded levels; and
- the resilience of electricity systems, i.e. the ability to cope with change and avoid electricity insecurity (such as the diversity of electricity generation, risk management and preparedness), particularly from a climatic perspective.

### Annexure 3: The Regional Electricity Regulators Association of Southern Africa

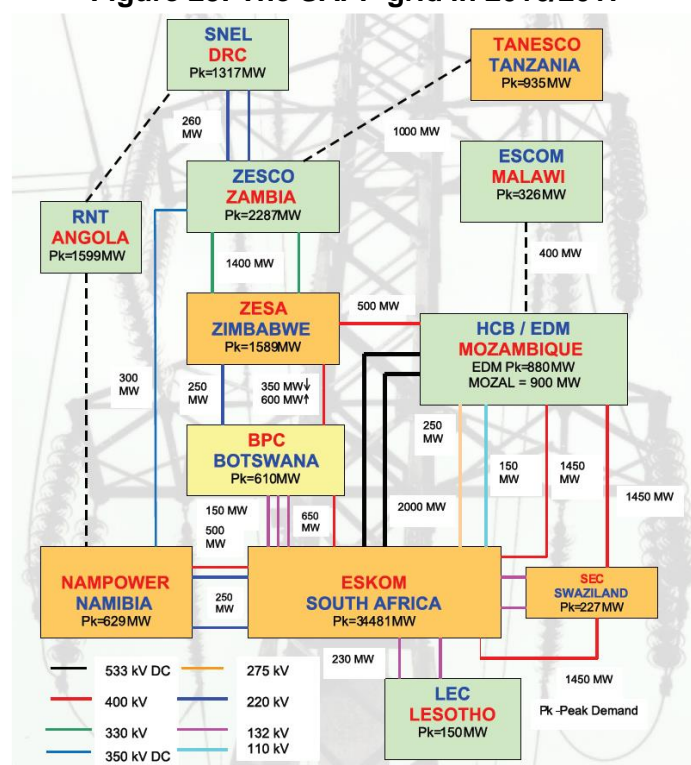
**Table 5: Members of the RERA**

Regulator name	Country
Institute for Electricity Sector Regulation (IRSE)	Angola
Lesotho Electricity and Water Authority (LEWA)	Lesotho
Malawi Energy Regulatory Authority (MERA)	Malawi
National Electricity Advisory Board (CNELEC)	Mozambique
Electricity Control Board (ECB)	Namibia
National Energy Regulator of South Africa (NERSA)	South Africa
Swaziland Energy Regulatory Authority (SERA)	Swaziland
Energy & Water Utilities Regulatory Authority (EWURA)	Tanzania
Energy Regulation Board (ERB)	Zambia
Zimbabwe Energy Regulatory Authority (ZERA)	Zimbabwe

*Source: (SADC and SARDC, 2016) and RERA (2016)*

## Annexure 4: The regional electricity grid of the Southern African Power Pool

Figure 25: The SAPP grid in 2016/2017



Source: (SAPP, 2017)

Table 6: List of main existing inter-connexion infrastructure projects in the SAPP

Project	Countries connected	Current status
Matimba-Insukamini (400 kV)	South Africa and Zimbabwe	Operational (1995)
Cahora Bassa to Zimbabwe (Songo-Bindura) (400 kV)	Mozambique and Zimbabwe	Operational (1997)
Cahora Bassa-Apollo substation upgrade (533 kV DC)	Mozambique and South Africa	Operational (1998)
Phokoje substation-Matimba (400 kV)	Botswana and South Africa	Operational (1998)
Aggeneis-Kookerboom (400 kV)	South Africa and Namibia	Operational (2001)
Motraco (2x400 kV)	South Africa and Mozambique	Operational (2000)
Camden-Edwaleni-Maputo (400 kV)	South Africa, Swaziland and Mozambique	Operational (2000)
Livingstone-Katima Mulilo (220 kV)	Namibia and Zambia	Operational
Zambia-Namibia (220 kV)	Namibia and Zambia	Operational (2007)
Arnot-Maputo (400 kV)	South Africa and Mozambique	Operational (2001)

Caprivi link (350 kV)	Namibia and Zambia	Operational (2010)
Kafue-Lingstone upgrade (from 220 to 330 kV)	Zambia	Operational (2013)
Kasama-Pensulo (330 kV)	Zambia and Tanzania	Operational (2015)
Third DRC-Zambia interconnector (220 kV)	DRC and Zambia	Operational (2015)
Botswana North West Transmission Grid Connection	Botswana	Operational (Phase 1; 2016)

*Sources: Authors' composition, based on (REN21, 2015b; SADC and SARDC, 2016; SAPP, 2017)*

**Table 7: List of main planned inter-connexion infrastructure projects in the SAPP**

Project	Countries Connected	Current Status
ZiZaBoNa (300-600 kV)	Zimbabwe, Zambia, Botswana and Namibia	Financial feasibility underway. Completion expected in 2019
Zambia-Tanzania-Kenya Interconnector (400 kV)	Zambia, Tanzania and Kenya	Some components completed, others under way. Completion expected in 2018
Mbeya-Tunduma (400 kV)	Zambia and Tanzania	Feasibility study to be completed in 2016
Nakonde-Kasama (330 kV)	Zambia and Tanzania	Procuring EPC contractor and financing
Mbeya-Kasama-Kabwe	Zambia and Tanzania	Feasibility study completed, awaiting stakeholder approval. Completion expected in 2018
Mozambique-Malawi Interconnector	Mozambique and Malawi	Commissioning expected in 2020
BOSA interconnector	Botswana and South Africa	Commissioning expected in 2022
Namibia-Angola Interconnector	Namibia and Angola	Secured funding for a feasibility study. Completion expected in 2020
MoZiSa	Mozambique, Zimbabwe and South Africa	Project structure phase. Completion expected in 2022
Central transmission corridor	Zimbabwe	Feasibility study to be completed
Botswana North West Transmission Grid Connection	Botswana	Completion of Phase 2 expected in 2018
Malawi-Tanzania interconnector (400 kV)	Malawi and Tanzania	Feasibility, ESIA and Engineering designs completed. IGMOU and IUMOU in development

Malawi-Zimbabwe Interconnector (400 kV)	Malawi and Zimbabwe	Feasibility study completed- securing funding for the project
Malawi-Zambia Interconnector (330 kV)	Malawi and Zambia	Feasibility and ESIA completed. Commissioning planned for 2019
Mozambique-Zambia Interconnector	Mozambique and Zambia	IUMOU and IGMOU signed
Mozambique-Tanzania Interconnector	Mozambique and Tanzania	IUMOU signed
Mozambique backbone (400 + 800 kV)	Internal but links Mphanda Njua to regional grid	Economic and SEIA studies completed. Commissioning planned for 2019

*Sources: Authors' composition, based on (REN21, 2015b; SADC and SARDC, 2016; SAPP, 2017)*