REGIONAL INTEGRATION IN SOUTHERN AFRICA: A PLATFORM FOR ELECTRICITY SUSTAINABILITY

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Abstract

The energy landscape in Southern Africa has evolved rapidly over the last decades. An economy-wide transition to sustainability is underway, with energy at its core. In addition, a movement toward progressive 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 seeing the emergence of independent power producers. 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 backdrop, this paper reviews the sustainability of the SAPP region's electricity system. Three dimensions are considered to assess electricity sustainability in the region: security, equity, and environmental sustainability. The paper then analyses the existing role of regional integration in promoting electricity sustainability in the Southern African Development Community (SADC) region, and explores the potential to improve 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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Summary: Key findings

Energy sustainability: Three dimensions are at the core of energy sustainability, namely energy security, energy equity, and environmental sustainability. These dimensions complement each other and must be achieved together to reach energy sustainability. They must also be underpinned by inclusive governance.

Electricity security: Despite the region operating a surplus of generation capacity, many countries are facing supply deficit. This is largely due to a lack of regional trade, as well as a maintenance backlog and the poor state of existing power plants. Against this backdrop, the region benefits from tremendous electricity generation potential, notably in renewable energy, which remains mainly untapped.

Electricity equity: The performance of the SAPP in terms of electricity equity in the region remains problematic, despite some notable progress in the last two decades. Furthermore, a clear divide exists between urban areas and their rural counterparts, which rely on solid fuel as a source of energy. Electricity equity is further hampered by tariffs considered to be both too low to stimulate investment and too high for most of the population. Electricity deficits in Southern Africa, coupled with unaffordable tariffs for the poor, continue to reinforce (energy) poverty.

Environmental sustainability: Countries can be divided into three groups: coal-based countries, hydro-based countries, and countries relying on a mix of hydropower and coal. A lack of diversity of energy sources leads to poor resilience. By contrast, the reliance of the region on hydropower brings important benefits to electricity sustainability. The low-carbon nature of the region's electricity sources, however, masks the deep energy inefficiency of the Southern African economies. The poor state of transmission and distribution networks in the region further aggravates inefficiencies.

Electricity sustainability: Southern African countries have historically performed poorly in electricity sustainability. While some countries display a relatively strong performance on one of the metrics (i.e. security, equity or environmental sustainability), this record is undermined by their weak performance in other dimensions. No country in the region manages to leverage strength in one area to perform well in all dimensions. Maximising the potential of regional (notably renewable) resources would lead to increased regional trade, cost savings and a substantial improvement in electricity sustainability.

Regional energy integration: Three key areas, namely harmonised policies and regulatory frameworks, adequate common institutions and technical infrastructure, and the development of human capabilities, can be considered to drive regional integration in the electricity sector. Importantly, there is no need for new institutions, as regional integration can be driven through enhanced regional and domestic capacity and institutions.

Harmonising policies, frameworks and regulations: Energy policy and regulation have been progressing through common implementation of regional frameworks. The implementation of such plans, strategies and frameworks remains, however, problematic. In addition, energy regulation is still nascent in the region and lacks capacity and skills in most countries and at the regional level. In particular, the absence of a clear regulatory framework for cross-border transactions renders such operations difficult.

Building common institutions and technical infrastructure: Notable progress has been made in developing the regional electricity infrastructure since the creation of the SAPP in 1995, from transmission networks to trading platforms. The role of regional trading mechanisms, however, remains limited. Countries have favoured the sovereign route of attempting to attain national self-sufficiency and when turning to the region, countries tend to favour a bilateral approach and long-term supply agreements. Regional trade has also been heavily constrained by the lack of adequate transmission infrastructure.

Fostering the development of human capital: The policy mandate to create a regional market for skills is clear, and some capacity-building and experience-sharing is organised at the regional level. But little progress has been made in developing national and regional expertise or stakeholders in that effort. In addition, there is very little investment in improving the capacity of communities or building a network of community practitioners. Most SADC frameworks, plans, and strategies also emphasise the need to build databases and other repositories of information. But data still remains scarce and of poor quality.

Summary: Policy implications

Regional avenues of intervention: Implementing the regional plans and strategies should be the priority for the region. But the region should avoid a standardised approach (in terms of market structure and tariffs) on countries with differing national circumstances.

Inclusive tariff design: Calls for cost-reflective tariffs are potentially problematic if not associated with a dramatic improvement of the performance of entities and the elaboration of clear plans to mitigate negative impacts on low-income households and businesses. A general push towards small-scale, renewable energy-based systems would, in this respect, provide an elegant avenue toward restructuring the electricity supply in the region, circumventing tariff issues (by turning consumers into prosumers), and shifting to sustainable energy solutions.

Integrated planning: The role and functions of the regional institutions should be reviewed to allow the regional power pool to have more authority on issues of energy development in region. The development of a regional electricity plan, informing national planning exercises in the future, appears to be, based on prior research, a key element to the success of regional integration.

Industrial development: The creation of effective linkages between the energy and industrial development frameworks in the region is needed, with the aim of creating regional energy value chains and building local manufacturing and service capabilities. Further consideration should be given to the possibility of designing a regional (rather than local) content strategy.

Transmission network: Going forward, the SADC, through the SAPP, should pursue planned cross-border projects, with a focus on connecting Angola, Malawi, and Tanzania to the regional grid and enhancing key links. The region should further investigate the role of super-grids, which consist of high-voltage direct current (or even ultra-high-voltage direct current) transmission networks.

Market mechanisms: The SAPP should also pursue the deepening of the regional market. As the regional market grows and trade rises, stronger, particularly long-term, surveillance and improved financial security requirements measures (to minimise financial settlement risks) will be important. The need for increased coordination of maintenance and planned outages of generation and transmission equipment (concentrated in summer), resulting in reduced available power and smaller trade volumes, is also evident.

Small-scale embedded generation: Further work is required to support the local rollout of smart and micro-/mini-grids, particularly to support rural electrification. The potential for micro-grid systems to decisively promote local economic development and contribute to users' income should also be investigated. Additional, short-term government programmes, such as user training, skills development, cooperation schemes, and entrepreneurship support, are necessary to enhance the reliability and sustainability of the systems and trigger the productive usages of energy access. The SADC furthermore should look at funding models for embedded generation.

Financing support: The SADC needs to play a stronger role in effectively securing funding for energy projects in the region. The SADC could actively drive fundraising 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. 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.

Inclusive governance: The lack of representativeness of the regional institutions and governance structures, particularly the absence of labour unions and civil society, is a key obstacle towards inclusive growth. Significant effort must be directed towards broadening the inclusivity of multi-stakeholder institutions and improving the genuine engagement with local stakeholders of regulatory institutions.

Cooperative framework: A regional cooperative framework should be established to assist with the development of the human infrastructure in the energy sector, notably through the enhancement of existing national educational, training, research and development, and electricity institutions. The SADC should also play a central role in building capacity in countries and institutions requiring assistance to adapt to, and implement, regional standards. The region should also engage in lesson-learned activities, borrowing or improving on ideas from other African regional economic zones.

Skills development: A bottom-up, grassroots approach prioritising capacity-building activities that are aligned to the needs of specific institutions and stakeholders. This should be particularly targeted at community and civil society levels to foster inclusive governance in the region.

Skill movement: The SADC should spearhead negotiations for the creation of a regional free-movement area to facilitate the mobility of skills and expertise in the region. The SADC should conduct an assessment of skills needed, and a mapping of skills that are already available (or possibly transferable from other sectors) in the region.

Data and information: A number of data- and information-related initiatives are required to improve the state of knowledge about regional dynamics. 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, feasibility studies and implementation.

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List of abbreviations and acronyms

ACER	Annual Competition & Economic Regulation
CFL	compact fluorescent lamp
CPI	Investment Promotion Centre (Mozambique)
DAM	Day-Ahead Market
DRC	Democratic Republic of the Congo
ECOWAS	Economic Community of West African States
ESIA	Environmental and Social Impact Assessment
FBE	Free Basic Electricity (South Africa)
GW	gigawatt
GWh	gigawatt-hour
HCB	Hidroeléctrica de Cahora Bassa
HVDC	high-voltage direct current
IEA	International Energy Agency
IGMOU	Intergovernmental memorandum of understanding
INEP	Integrated National Electrification Programme (South Africa)
IPP	independent power producer
IRENA	International Renewable Energy Agency
IUMOU	Inter-utility memorandum of understanding
kWh	kilowatt-hour
LED	light-emitting diode
MW	megawatt
REASAP	Regional Energy Access Strategy and Action Plan
RECS	Rural Electrification Collective Scheme (Botswana)
REASAP	Regional Energy Access Strategy and Action Plan
REEESAP	Renewable Energy and Energy Efficiency Strategy and Action Plan
RERA	Regional Electricity Regulators Association of Southern Africa
RIDMP	Regional Infrastructure Development Master Plan 2012-2027 Energy Sector Plan
RISDP	Revised Regional Indicative Strategic Development Plan 2015-2020
SACREEE	SADC Centre for Renewable Energy and Energy Efficiency
SADC	Southern African Development Community
SAPP	Southern African Power Pool
STEM	Short-Term Energy Market
TWh	terawatt-hour
UNCTAD	United Nations Conference on Trade and Development

USD	United States dollar
VAT	value-added tax
VPP	Virtual Power Plant
WEC	World Energy Council
ZAR	South African rand

1. Introduction

A global transition towards sustainable models of growth and development is 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 systems 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, thanks to political commitments, are shifting the region to sustainable (energy) pathways and to leverage the favourable regional endowment in renewable resources (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 for all populations and businesses. This effort is 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 taking place in the region, with the aim of improving efficiency (Eberhard et al., 2011; Promethium Carbon, 2016).

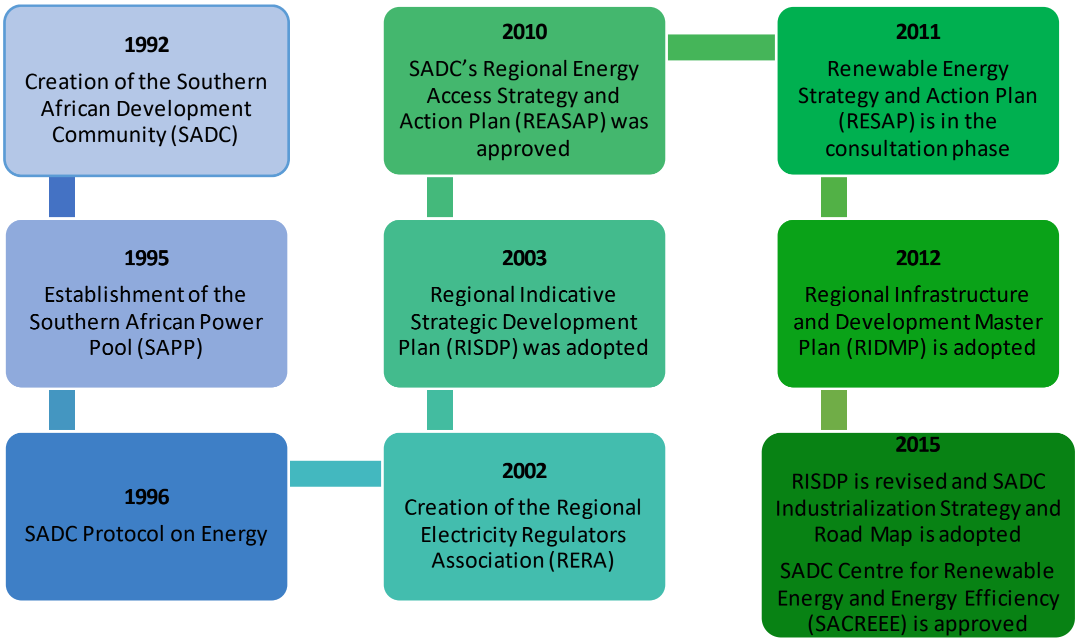
At the regional level, the Southern African Development Community (SADC) has recognised the importance of regional integration as a means to address current energy challenges. This push is in line with developments at the continental level and the African Union, which, in its Agenda 2063, identified energy as one of the key infrastructure pillars for 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).[3] It was founded to establish a network for national electricity generation utilities under the SADC and

[3] See Annex 1 for the list of SAPP members.

provide a common market for electricity through an interconnected power grid between member countries, all in order to promote regional energy trade.

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



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

Regional energy integration, aimed at supporting energy security through integrated markets and cross-border infrastructure development, has been high on the political agenda since 1995, a priority that reflected the cheap, abundant electricity available from South Africa. Electricity trade has been viewed as an efficient way to ensure reliable and low-cost energy security, based on mutual benefits for importing and exporting members of the SAPP. Countries have either exported their excess supply of electricity or imported electricity from members, thereby eliminating the cost of investing in local generation capacity (Vanheukelom and Bertelsmann-Scott, 2016).

This process has been supported by the 1996 SADC Protocol on Energy, which promotes the harmonious development of national policies and matters of common interest for the balanced and equitable development of energy security 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) for the 2016-2030 period, and established the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), a Windhoek-based regional platform to promote the implementation of the REEESAP (SADC, 2016).

Notwithstanding these political commitments, regional energy integration still appears to be 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 low-cost 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 a go-it-alone ethos 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, such as Eskom in South Africa, 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 (Das Nair et al., 2014; Montmasson-Clair and Ryan, 2014; Mutanga and Simelane, 2015; Vanheukelom and Bertelsmann-Scott, 2016).

The sustainability transition, the weakening of regional impulses, and the emergence of new players in the sector all call for a renewed approach to regional energy integration in Southern Africa in support of sustainable energy development. That step demands first a critical analysis of regional energy dynamics in with the aim of improving energy sustainability.

Building on a conceptual framework inspired by the World Energy Council (WEC, 2013) and the International Energy Agency (IEA, 2016), we should consider three key dimensions, which are depicted in Figure 2:

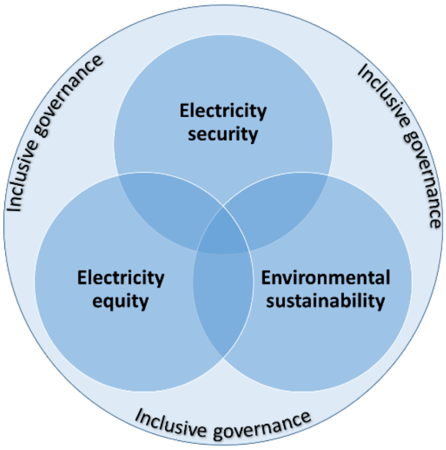
- Energy security, i.e. the effective management of supply, the reliability of infrastructure and the ability to meet demand;
- Energy equity, i.e. the accessibility and affordability of supply across the population; and
- Environmental sustainability, i.e. the achievement of demand- and supply-side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

These dimensions involve other factors, from energy 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 energy sustainability, a further dimension must also be considered, namely the governance of energy systems, including institutional capability. An important determinant for the delivery of energy sustainability is whether there is a robust, transparent, and inclusive energy governance system with in-built mechanism for accountability.

Importantly, these dimensions complement to each other and must be achieved altogether to reach energy sustainability. For example, some countries may rely on low-carbon energy sources (such as hydropower) but have (very) low electrification rates and poor resilience levels, which impedes their delivery of of electricity security and equity. In addition, improving access through traditional means is likely to put further strain on electricity supply due to increased demand. Relying on large-scale, coal-based power generation and centralised grid extension can contribute to security of supply but is incompatible with environmental sustainability and electricity equity principles. Exclusive governance structures can in turn jeopardise the sustainability of energy systems altogether.

While traditional approaches tend to oppose them (by for example framing environmental sustainability against security of supply), in reality, multiple co-benefits exist between the different dimensions of electricity sustainability. Thinking of them in an integrated fashion can foster innovative solutions. For example, renewable energy technologies, particularly small-scale systems (either grid-tied and off-grid), offer an avenue to achieve electricity security, electricity equity and environmental sustainability at the same time. Such systems provide an opportunity to roll out affordable, fit-for-purpose energy solutions, empowering consumers (to become prosumers[4]) based on clean, renewable and socially-acceptable energy sources.

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 energy sustainability through promoting regional integration, harnessing the emerging opportunities associated with new energy sources and technologies, and improving energy supply structures. It focuses on the electricity component of the energy picture and, as such, does not discuss issues pertaining to liquid fuels. Acknowledging the diversity of the region, the paper depicts the heterogeneity of the Southern African countries in its analysis.

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. Section 4 concludes with some overall observations.

[4] In the energy space, a prosumer is an entity that both consumes and produces energy (generally electricity).

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, and sustainable modern economies and societies, has gained increased attention at the regional. Progress has come in a number of areas. Further improvements are nevertheless required to achieve electricity sustainability, particularly in dealing with the interplay between security, equity, and environmental sustainability.

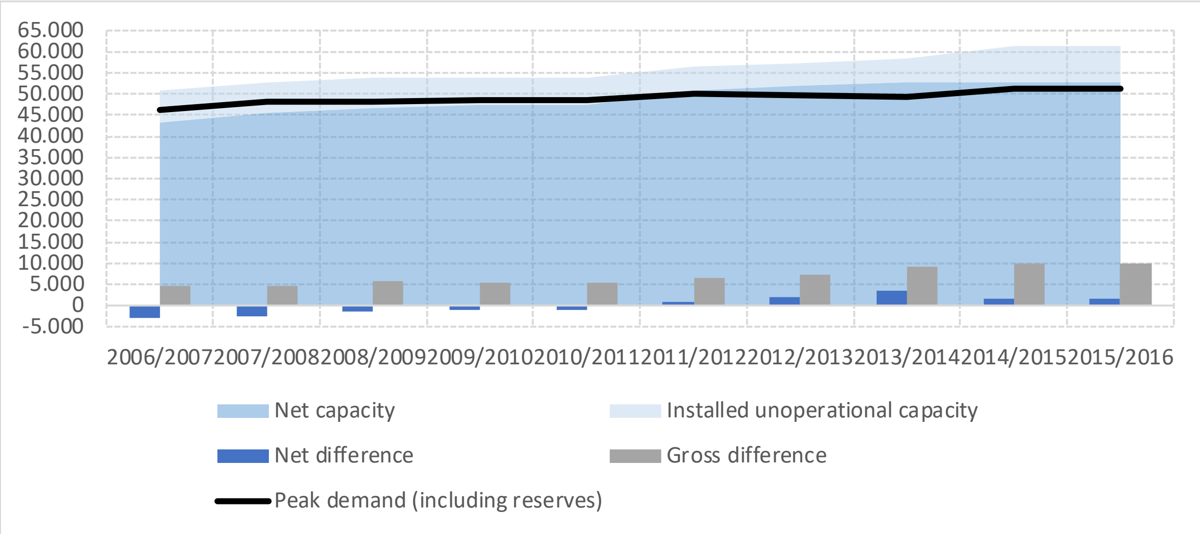
2.1. Electricity security: Matching supply and demand

Southern Africa's electricity security situation, although diverse, looks generally bleak. The region has suffered from electricity shortages, with severe implications for economic growth and social development. Over the past decade or so, Botswana, Namibia, South Africa, Tanzania, Zambia, and Zimbabwe have had to resort to load shedding as a stop-gap measure to conserve energy (SADC and SARDC, 2016). As discussed in Section 2.2, many people in these countries still have no access to modern energy services.[5] The use of traditional biomass continues to be significant 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). 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.

[5] To achieve modern access to energy services, three incremental levels must be met: first, basic human needs (electricity for lighting, health, education, communication and community services, modern fuels, and technologies for cooking and heating); second, productive uses (electricity, modern fuels, and other energy services to improve productivity through notably mechanisation, irrigation, and transport); and third, modern society's needs (modern energy services for many more domestic appliances, increased requirements for cooling and heating both space and water, and, private transportation) (AGECC, 2010).

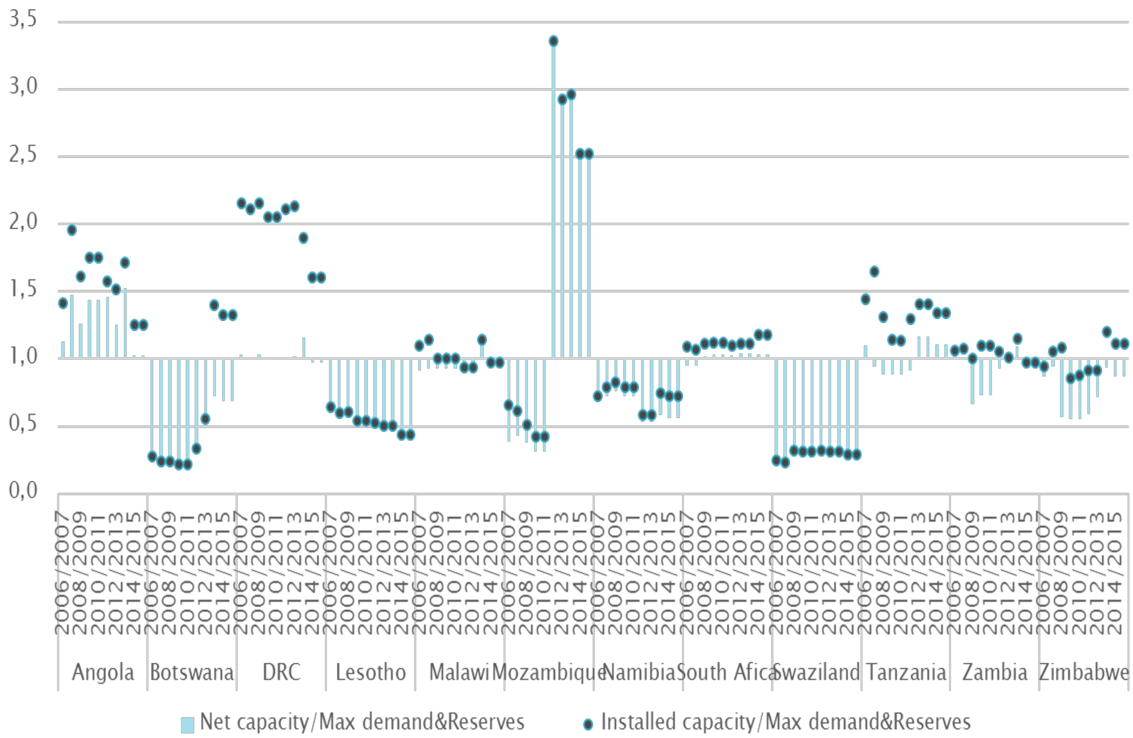
Figure 3: Installed capacity and net capacity over the peak demand and reserve requirements for SAPP countries from 2006/2007 to 2015/2016 (in GWh)



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.

Figure 4: 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. A ratio of 1 corresponds to an exact match between peak demand (including reserve margins) and generation capacity. Ratios of 2 and 0.5 respectively indicate that generation capacity amounts to twice and half the peak demand (including reserve margins).

By contrast, at the country level, only Angola and Mozambique display favourable positions, with a net generation capacity comfortably above their demand and reserve requirements (see Box 1 for more details on Mozambique's journey to security of supply). Other countries are either in a precarious situation (such as the Democratic Republic of the Congo, 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).

Box 1: Mozambique's shift to an energy exporter

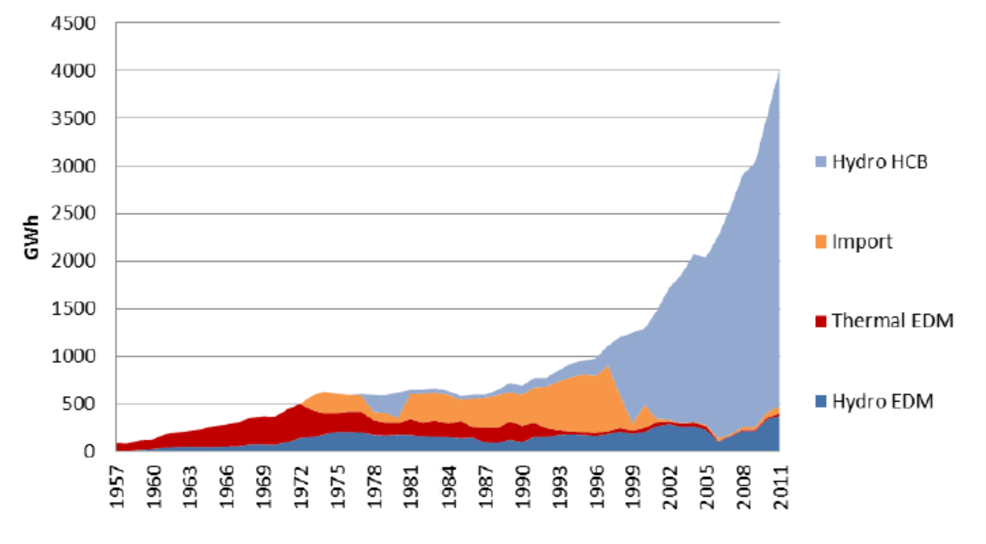
Once identified as one of the poorest countries in the world, Mozambique has, in recent years, managed to overcome the dire legacies of 15 years of civil war (1977-1992) and leapfrog its neighbors to become one of the SADC's primary energy producers. The rapid expansion of the hydropower sector and substantial discoveries of natural gas and coal have propelled Mozambique to the position of 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 projects on the African continent with an installed capacity of 2 075 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^3 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 post-war, as indicated in Figure 5.

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. Its policy framework includes: the Investment Law, which provides tax incentives and a standardised investment framework; the Decree No. 47/200, which assists with establishing small, micro and medium enterprises through the creation of the Institute for Promotion of Small and Medium Enterprises; and the 2009 Code of Fiscal Benefits, which provides value-added tax (VAT) reductions, tax exemptions and investment tax credits.

Figure 5: Mozambique's electricity supply by source from 1957 to 2011



In addition, the Investment Promotion Centre (CPI) and the Office for Accelerated Economic Development Zones were created to assist developers and funders during project planning and implementation. The CPI also supervises 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. Free Industrial Areas and Special Economic Zones have also been set up, providing fiscal benefits, such as eliminating import duties on building and construction material.

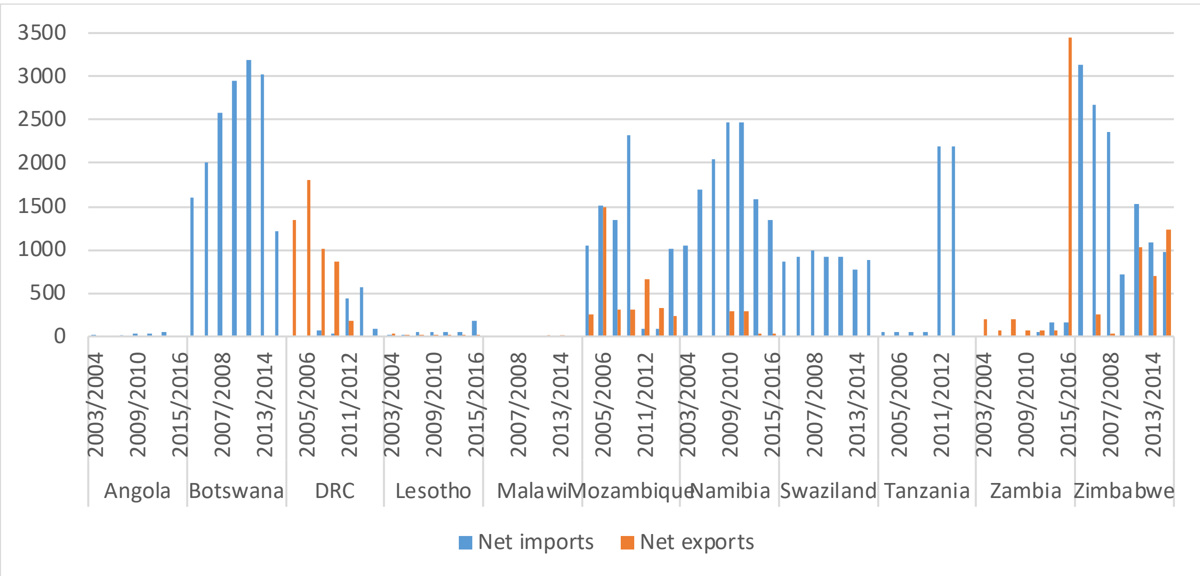
The country aims to continually reform its energy sector, as evident in the recent Electricity Law and the establishment of National Energy Fund (Fundo do Energia), a fund for electrifying rural locations across Mozambique, and the numerous fiscal incentives to attract foreign direct investment. However, despite the plethora of diversified resources, Mozambique continues to struggle with providing electricity to the local population as access to electricity remains relatively low at around 20%, with most of the citizens still relying on traditional sources of energy.

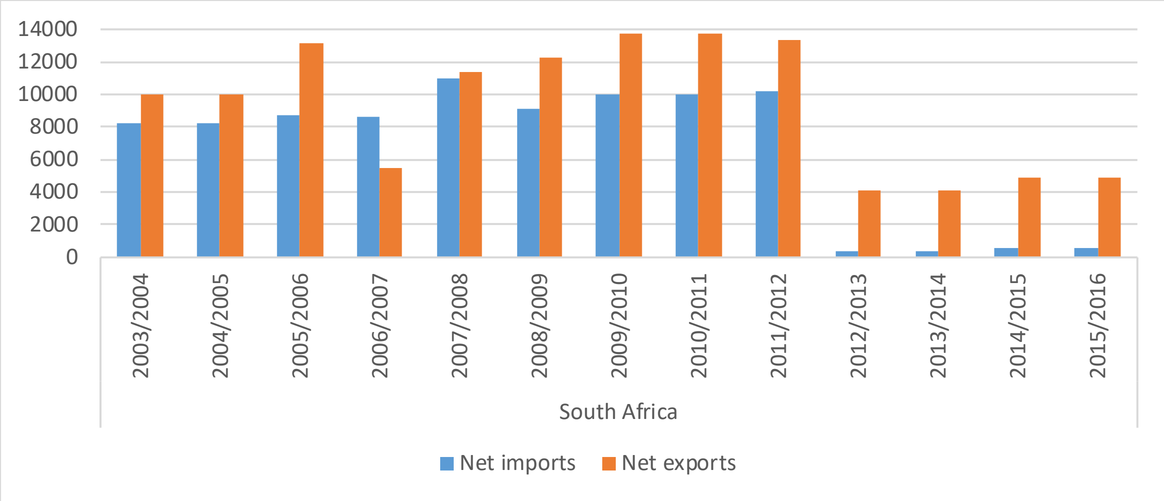
Source: Authors' composition, based on IRENA (2012) and Cuamba et al. (2013)

Importantly, in a number of cases, the absence of security of supply is not related to the lack of generation capacity, but rather to a maintenance backlog and the poor state of the existing power plants (illustrated in Figure 4 by the difference between the installed and net capacities). This condition is neatly demonstrated in the DRC, whose generation capacity is mostly inoperative.

This unfavourable supply picture is confirmed by the state of electricity trade in the region (Figure 6). 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 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 6: Net imports and exports from 2003/2004 to 2015/2016 for SAPP countries (in GWh)



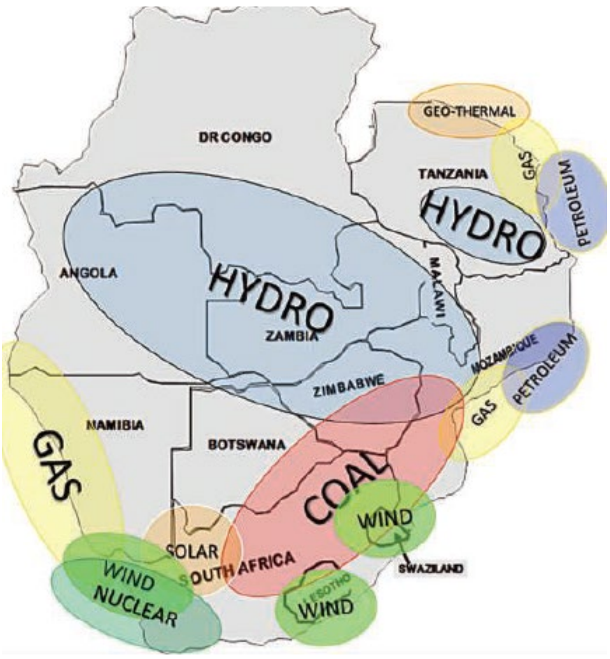


Source: Authors' composition, based on data from SAPP Annual Reports

Note: the scale differs between the two graphs due to the large amount traded by South Africa 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 7, these resources are spread across the region, laying the ground for regional trade.

Figure 7: 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 used.

With new renewable technologies, the SADC region benefits from outstanding solar irradiation (2 500 hours of sunshine a 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 a year. 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) (Miketa and Merven, 2013; UNEP, 2012).

Although power generation projects are underway in most member states aimed at seizing existing opportunities, as shown in Table 1, this large electricity generation potential remains mostly untapped. The International Renewable Energy Agency (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**

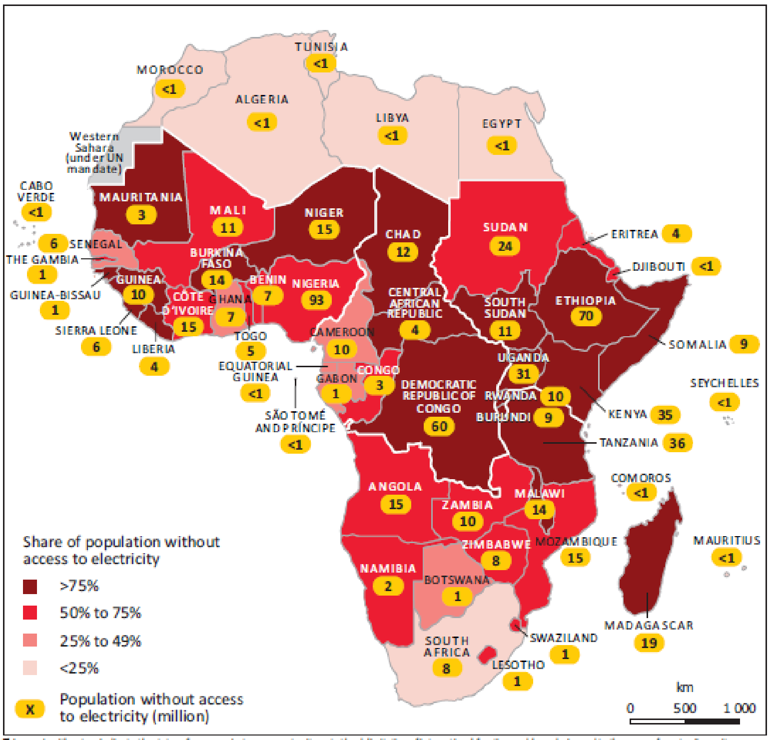
Malawi	10	6	72	22	1 006			**1 116**
Mozambique	360			600	400	600	1 500	**3 460**
Namibia	40		190			800		**1 030**
South Africa	1 624	999	2 167	1 445	2 167	723	1 528	**10 653**
Swaziland				12			300	**312**
Tanzania		900	1 040	250	1 000			**3 190**
Zambia	300		27	441	1 450	230	1 200	**3 648**
Zimbabwe	200		420	837	1 860		1 200	**4 517**
Total	**3 922**	**4 570**	**4 333**	**3 607**	**8 183**	**2 353**	**5 728**	**32 696**

Source: SAPP, 2017

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

The performance of the SAPP in achieving 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.

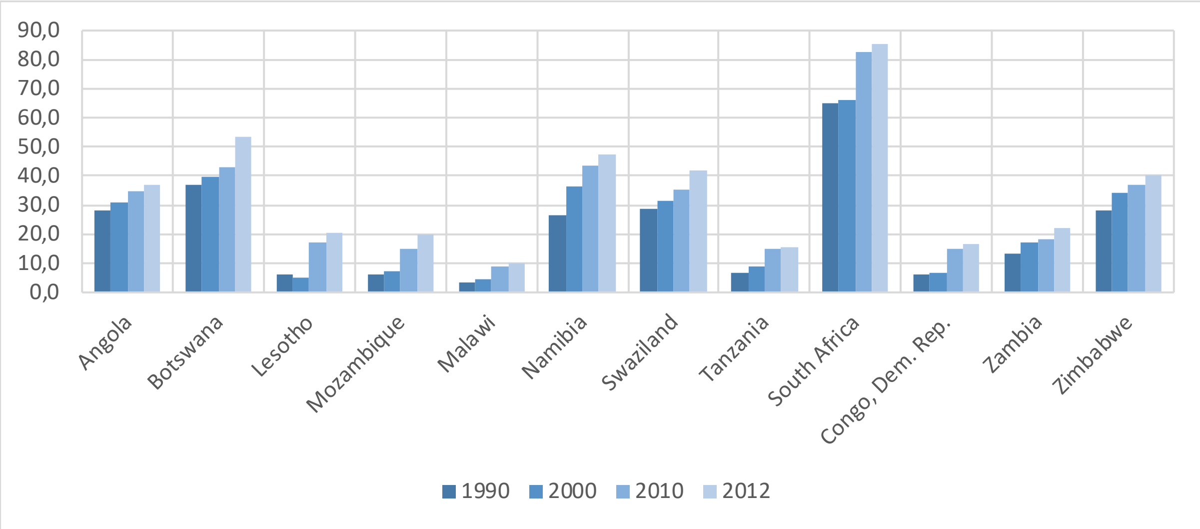
Figure 8: Population without access to electricity in Africa (in volume and share of total population) in 2012



Source: IEA, 2014b

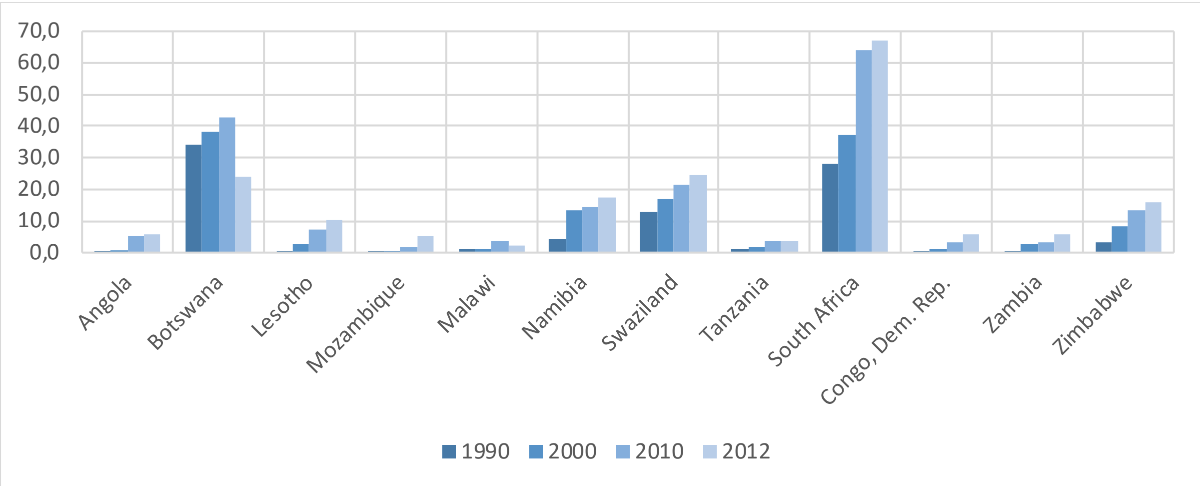
Although this disappointing picture is mainly dominated by the DRC and Tanzania (which respectively account for 35% and 21% of the regional population without access to electricity), the individual performance of most Southern African countries (Figure 8) has not been impressive. Indeed, Figure 9 shows that, despite some overall progress over the last two decades in terms of electrification (see Box 2 for some details on South Africa's experience), access to electricity remains highly limited in most countries.

Figure 9: Access to electricity in SAPP countries (in percentage of population) from 1990 to 2012



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

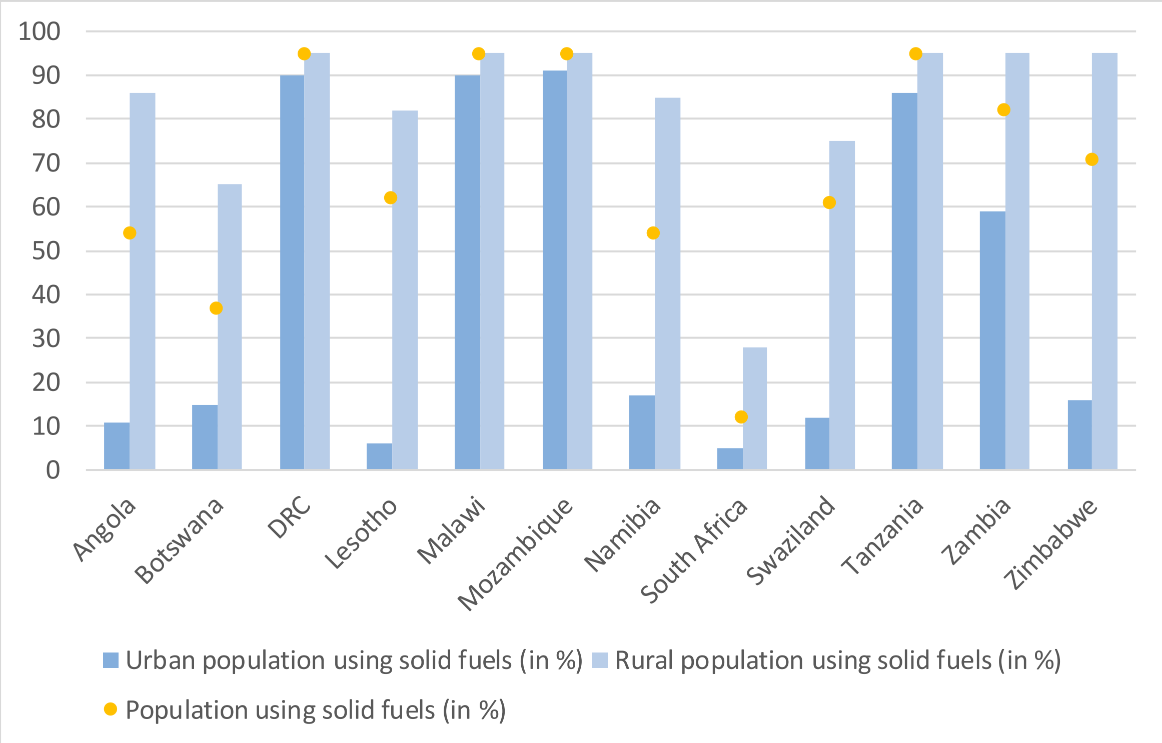
Figure 10: Access to electricity in SAPP countries (in percentage of rural population) from 1990 to 2012



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

Furthermore, 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 10). Around 45% of energy consumption in SADC countries arises from the use of solid fuel (i.e. traditional biomass, such as charcoal and wood) (SADC and SARDC, 2016) and the divide between the 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) (Figure 11). The heavy use of traditional biomass is a key indicator of the lack of access to modern energy services, notably electricity. Only South Africa shows a favourable situation, thanks to an ambitious electrification programme rolled out since the advent of democracy in 1994 (see Box 2).

Figure 11: Use of solid fuels in SAPP countries (in percentage of population)



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

Box 2: 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 connections. Since 1994, almost six million households have been electrified through the INEP. Over the 2017-2020 period, the Department of Energy has further committed to spending ZAR 234.5 billion on improving the energy access and security of which ZAR 203.8 billion will be allocated to Eskom.

Although successful in connecting the majority of South Africans to the grid, a vast number 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 50 kWh of free electricity a month. This helps the poorest households, which have a relatively low electricity demand, to meet basic energy needs. In the first quarter of 2015, around 1.2 million customers benefited from FBE with about 870 060 MWh of FBE consumed for the 2014/2015 financial year. However, people living in certain informal settlements, 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 a 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 inexpensively mined coal. While the South African government has committed to reducing greenhouse 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), DoE (2016), DoE (n.d.), Montmasson-Clair (2017), SADC (2010) and Wilkinson (2015)

Electricity equity is further hampered by tariffs considered to be both too low to stimulate investment and too high for most of the population (RERA, 2016). While tariffs may be higher than the average cost of generation (see Figure 12), 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. Furthermore, only Namibia and Tanzania have achieved cost-reflectivity (Creamer, 2015) and most countries are embarking on utility-scale, centralised investment programmes, therefore paving the way for further increases in other countries.

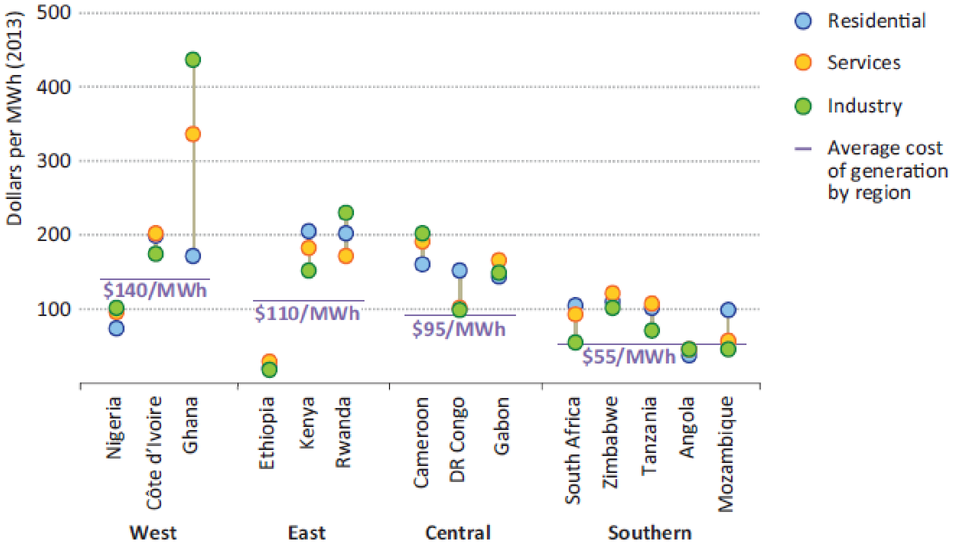
However, electricity deficits in Southern Africa, coupled with unaffordable tariffs for the poor, continue to reinforce (energy) poverty. Insufficient and/or inadequate access to modern energy services limits inclusive growth. As such, without universal and affordable access to modern electricity, SADC's socio-economic development targets are virtually unattainable.

Centralised electricity systems in Southern Africa have been designed to cater for the needs of industrial conglomerates and high-income groups (Scott, 2015). All SAPP countries continue to struggle with low electrification rates and/or widespread energy poverty. While a number of social tariffs and free electricity schemes target the poorest households in most countries, this situation is extremely problematic, all the more so given that electricity tariffs are already unaffordable to large groups of the population (SADC and SARDC, 2016).

Despite a degree of progressive cost subsidisation that exists between industrial users and the poorest consumers, as illustrated in Figure 13, in the case of South Africa, the most vulnerable households continue to pay the highest tariffs and have 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). The repressiveness of this unbalanced situation, structured on centralised and vertically-integrated systems, has undermined the sustainability of the region's economic growth and energy systems, and hampered the emergence of more sustainable alternatives.

As discussed in Section 3, the introduction of renewable energy technologies, particularly small-scale systems, offers an opportunity to break this deadlock, through new, cost-effective and sustainable solutions to electricity security and electricity equity.

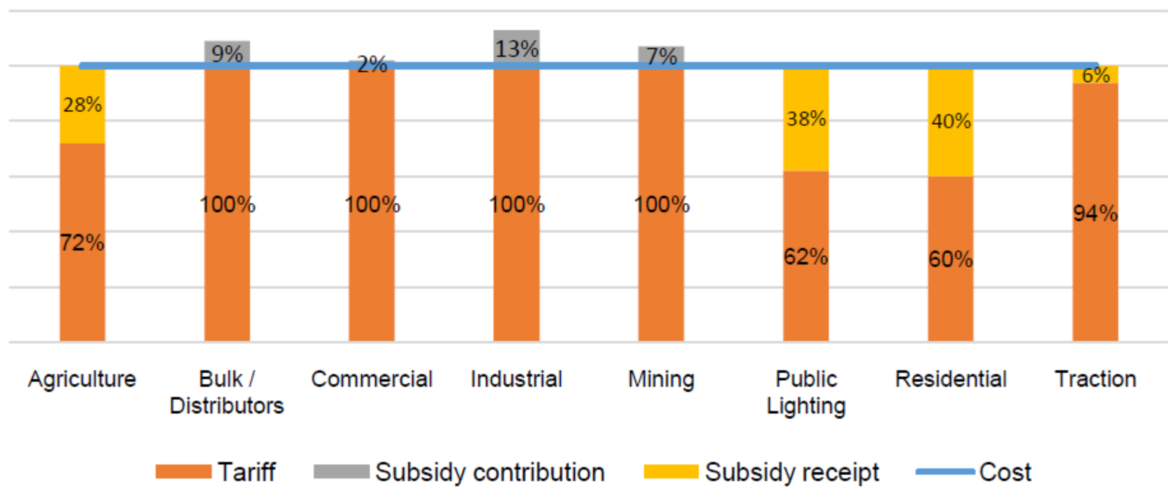
Figure 12: Grid electricity prices by end-use sector in selected countries in 2013



Source: IEA, 2014b

Note: the average cost of generation in Southern Africa stood at USD 55 per MWh in 2013, materially lower than in other African regions. Electricity prices are in most countries substantially higher than the cost of generation, particularly from residential customers.

Figure 13: Electricity subsidy receipts and contributions per customer group in South Africa



Source: Maphosa and Mabuza, 2016

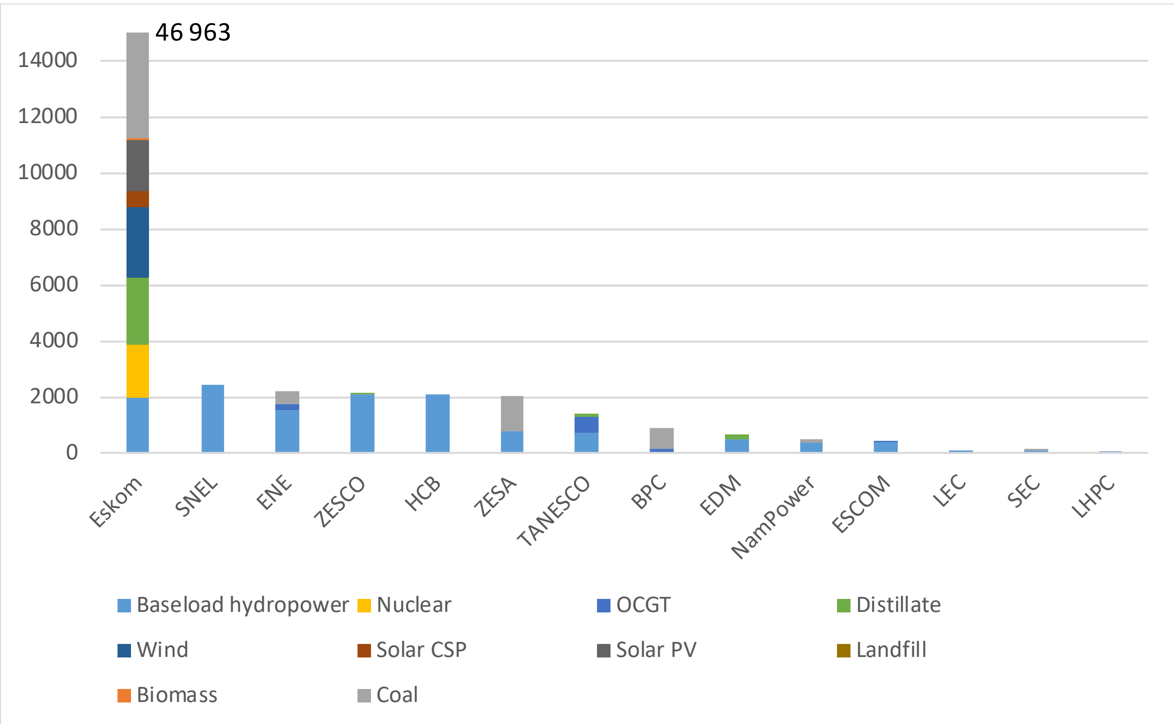
Note: the electricity tariffs for bulk/distributors, commercial, industrial and mining categories covers more than the cost of supply, allowing to subsidise other customer groups, which pay less than their cost of supply.

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 industry. 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 14 and 15, the region virtually relies on only 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). Although other technologies are slowly emerging (gas is growing fast, solar and wind technologies are improving), 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.a, n.d.b; World Bank, 2017). Similarly, several 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).

Figure 14: Electricity mix in 2015/2016 for SAPP producers (in MW)

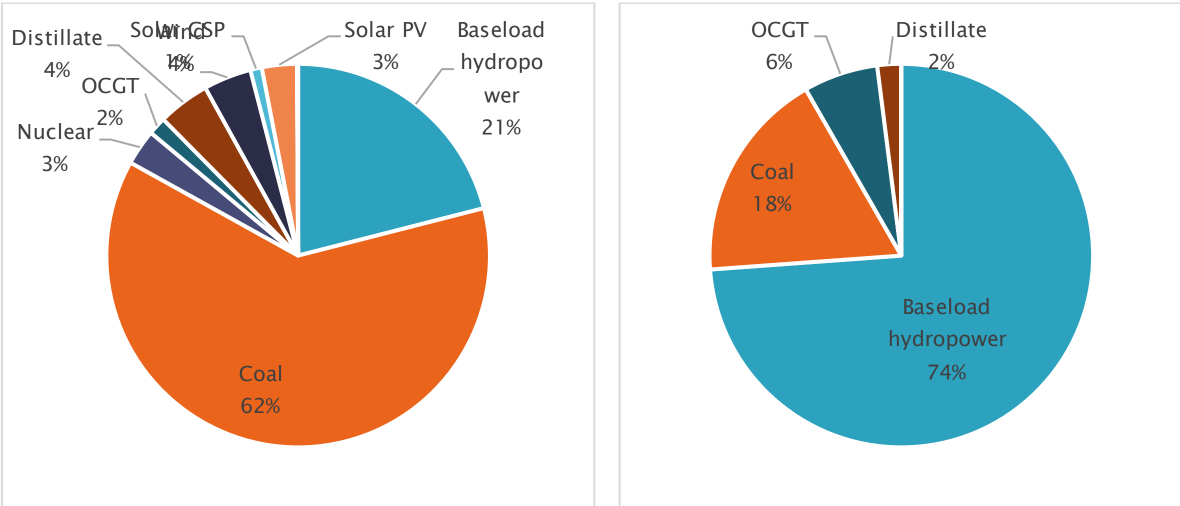


Source: Authors' composition, based on data from SAPP Annual Reports

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 15: Electricity mix in SAPP countries in 2015/2016 (in percentage of total)

SAPP countries *SAPP countries, excluding South Africa*



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 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 3 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 2008-2009 but also in 2014-2015) were, for example, exacerbated by poor coal stock management (Das Nair et al., 2014).

Box 3: Zambia's experience with large-scale hydroelectric power

Zambia's large hydropower initiatives supply 99% of the country's electricity, with the remaining percent arising from small-scale hydroelectric and diesel plants. Zambia has an installed capacity of 1 900 MW 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 challenge, as the country grapples 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 that 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.

At the same time, the government has 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. Neoen, a French IPP has also entered into a power purchased agreement with ZESCO to commission a 54-MW, USD-60 million solar project in Zambia.

However, despite climatic uncertainties, the largest initiatives in the country remain hydro-based, further entrenching the lack of diversity of the electricity mix. The African Development Bank recently pledged to fund the 2 400-MW Batoka Gorge hydro interconnection between Zambia and Zimbabwe. Furthermore, discussions are underway with MDH, a South African developer, to construct a USD 1.26-billion, 235-MW hydroelectric dam along the Luangwa River in Zambia.

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 region's renewable energy potential remains urgent.

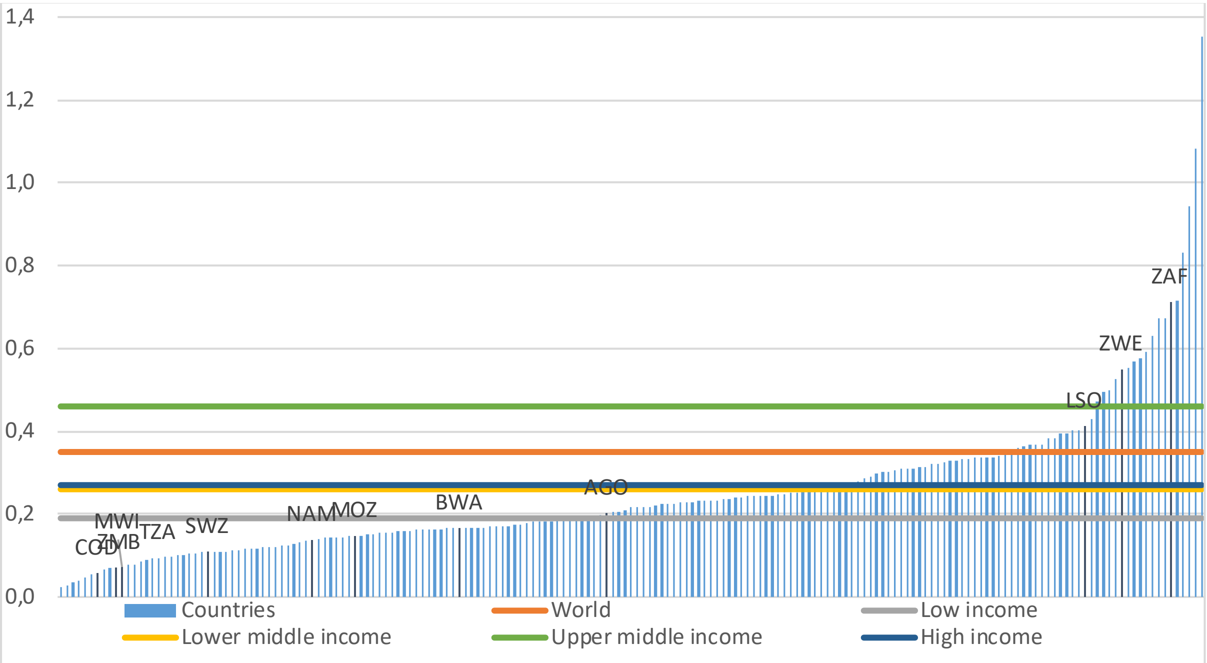
Sources: Authors' composition, based on Miketa and Merven (2013), Energy Regulation Board (2014), Mills (2016), Jeffrey (2015), New Business Ethiopia (2017), Lusaka Times (2017), and Engineering News (2017).

By contrast, the reliance of the region on hydropower brings important benefits for 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 16).

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 perform worse than global benchmarks (Figure 17). A high degree of diversity, both in carbon and energy intensity,[6] must nevertheless be noted in the region, due to the differences in electricity mixes, levels of economic development, and industrial structures.

Figure 16: Carbon intensity per country in 2013 (in kgCO2e per 2011 PPP USD of GDP)



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

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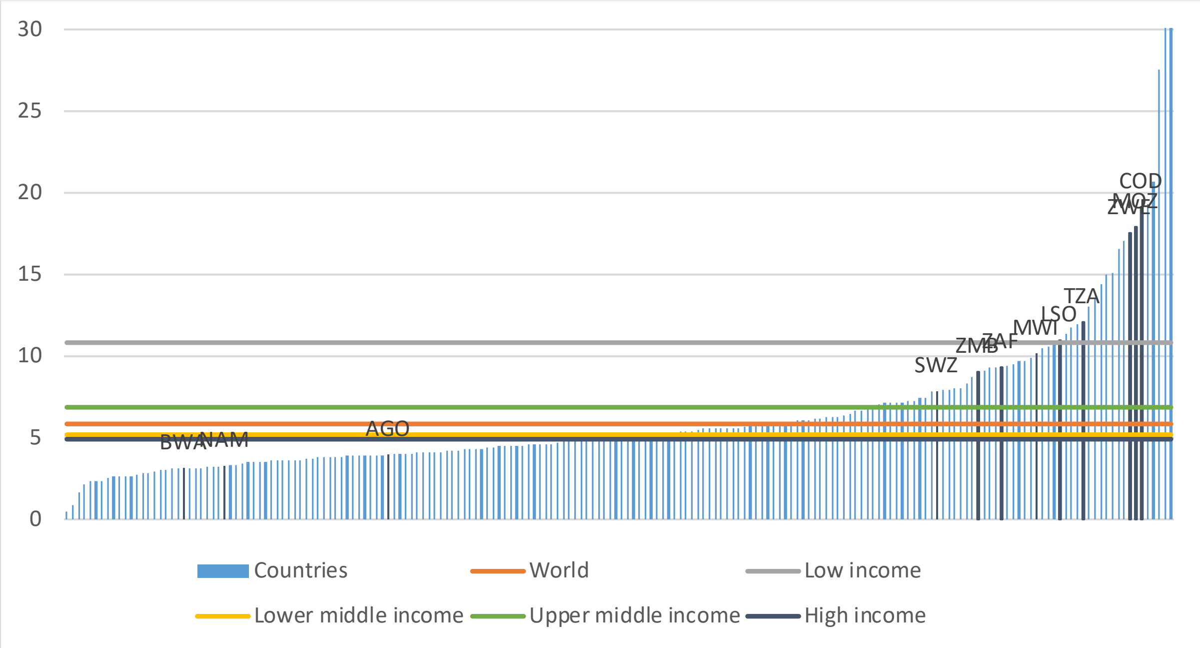
[6] Energy intensity is a measure of the energy efficiency of a nation's economy. It is the ration between the consumption of energy and the gross domestic product of a country. Carbon intensity applies the same reasoning to CO2 emissions (or greenhouse gas emissions in some cases). The two are highly correlated in countries where energy is generated through carbon-intensive processes, such as coal-fired electricity. The use of low-carbon power generation technologies (such as hydropower) helps reduce the carbon intensity but does not have an impact on the energy intensity. A low energy intensity indicates a high degree of efficiency in using energy in producing goods and services, irrespective of the source. By contrast, a low carbon intensity results from both a high degree of efficiency in using energy in producing goods and services and the use of low-carbon production processes.

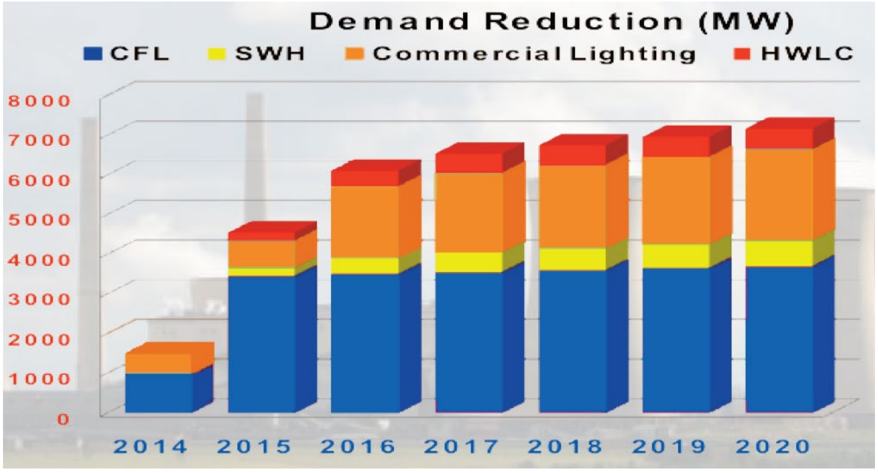
Figure 17: Energy intensity per country (in MJ per 2011 PPP USD of GDP)



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). Despite their ambitions, countries in the region have not achieved their goals in reducing demand. According to the SAPP Secretariat, demand-side management measures in the region already achieved savings of 4 561 MW, from 2009 to September 2015, including 3 461 MW from compact fluorescent lamp (CFL) and light-emitting diode (LED) programmes and 700 MW from commercial lighting energy savings. As shown in Figure 18, these savings are expected to gradually increase to about 7 000 MW by 2020, primarily through the phase out of incandescent lightbulbs by 31 December 2017, but are still far from the regional potential.

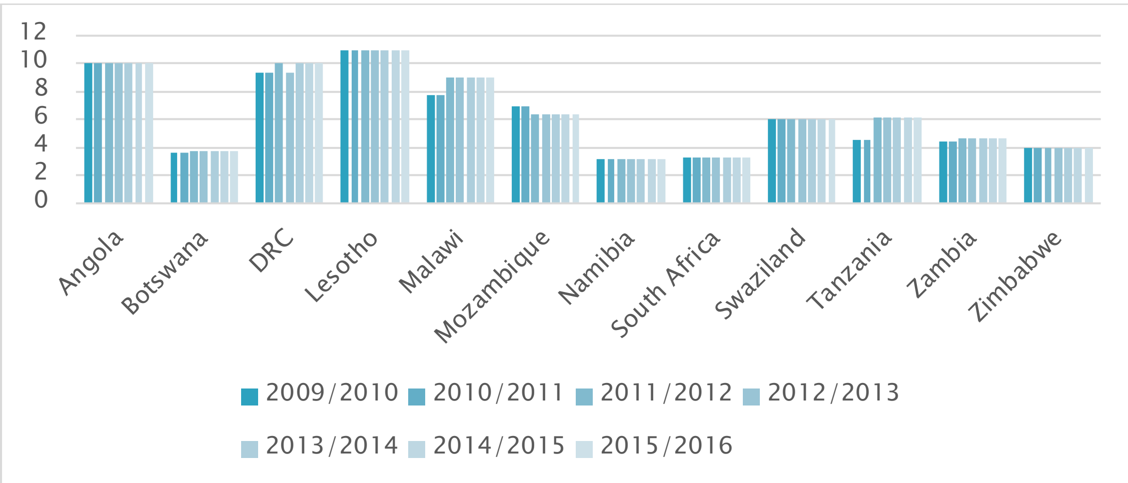
Figure 18: Projected savings from demand-side management initiatives within the SAPP



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 4), SAPP data, shown in Figure 19, provide a general idea of the situation. Several countries experience high transmission losses (Angola, DRC, and Lesotho, for example) and deteriorating performance.

Figure 19: Transmission losses from 2009/2010 to 2015/2016 for SAPP countries (in percentage of total)



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

Box 4: 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, the 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, except Mozambique, have been approved by a national regulator. 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 and distribution losses, and the treatment of municipalities' consumption, that is sometimes included in the calculation of losses.

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

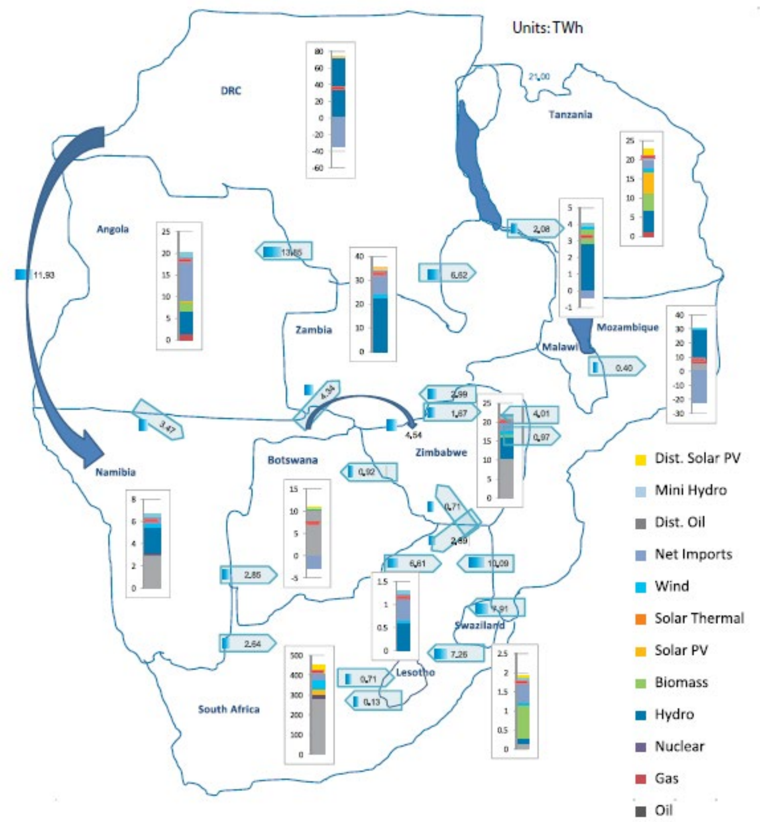
2.4. Preliminary conclusions: Bringing it together

Southern African countries have historically performed poorly in terms of electricity sustainability, due to strong energy supply challenges, limited access to modern energy, and the lack of diversity of supply sources. Based on the WEC (2016), which ranks countries in terms of energy sustainability (i.e. not just electricity but also liquid fuels), South Africa, SAPP's best-ranking country, stands at the 84th position (out of 125 countries ranked by the WEC). Botswana and Swaziland rank 94 and 95 respectively while Zimbabwe, the DRC and Malawi close the table at the 113, 117 and 120 places. The general poor performance of the region masks regional divides, 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. security, equity or environmental sustainability), their situation is undermined by their weak performance in other dimensions. No country in the region manages to leverage the synergies existing between the three areas to perform well on all dimensions. The dimensions of electricity sustainability are complementarity in nature and have the potential to reinforce one another. The challenge is not to find ways to make the three core dimensions compatible but to implement the right policies (and inclusive governance) to harness the synergies between them.

The region benefits from huge natural (renewable) resources, as highlighted in Section 2.1, which remain largely untapped. Maximising the potential of regional resources (particularly through renewable energy technologies) would lead to increased regional trade (see Figure 20), cost savings, and a substantial improvement in electricity sustainability.

Figure 20: 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 assessment was 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 region, which is the focus of the next section.

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

The need for further progress in achieving 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. It considers three key areas, namely harmonised policies and regulatory frameworks, adequate common institutions and technical infrastructure, and the development of human capabilities. Importantly, there is no need for new institutions, as regional integration can be driven through enhanced and empowered regional and domestic institutions.

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 progressed in the region, with 11 out of 12 SAPP countries having a national regulatory body as of April 2017,[7] both clarifying and complexifying the legal and regulatory landscape.

The Regional Electricity Regulators Association of Southern Africa (RERA) was launched in 2002 to support the harmonious development of policy and regulatory frameworks in the region.[8] 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

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[7] 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.

[8] 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).

transactions, which 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.

While noteworthy, these guidelines have, 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 a year and 20 MW of power) 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 in Section 3.2).

Indeed, the absence of a clear regulatory framework for decentralised, cross-border transactions renders such operations difficult and unpredictable. 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 power passes (SADC and SARDC, 2016).

In addition, energy regulation is still nascent in the region and lacks 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. Furthermore, regulators lack independence and remain pray to regulatory capture and political pressure.

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 REEESAP (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 aims to inform 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 an LED roll-out business case, specific programmes for CFL replacement involving 11 national utilities (SADC, 2016), and 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[9] (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 example of regional strategizing.

The implementation of such frameworks, as illustrated in Box 5 in the case of the SADC strategy and action plan for energy access, remains 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 in any way. The region's energy policy is more a collection of national approaches 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 5: 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, and environmentally-sustainable energy. 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:

[9] A VPP is not a physical power station and makes sophisticated use of information technology, advanced metering, automated control capabilities, and electricity storage to smooth out short-term 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).

- 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: the regional exchange of experience, and the rollout of commercially-viable pilot projects to enhance access for light, heat and/or power delivery.

There is unfortunately no evidence, as of September 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 among 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 licence, through regional coordination in terms of the types and content of licences, and the recognition of licences 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).

As a response to low tariffs and the lack of investment in the region's energy sector, the Framework has been complemented by political calls of SADC Energy Ministers to achieve cost-reflective tariffs by 2013 (initially) and by 2019 (now).

Policy implications

Going forward, the implementation of the regional plans and strategies arises as the priority for the region from a policy and regulatory perspective. The SADC and the SAPP will be 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 should be to harmonise frameworks upwards and with a development (rather than private sector) focus. Forcing a standardised approach on countries facing varied national circumstances should only proceed with great caution . The aim of the Market & Investment Framework for SADC Power Projects to roll out a Target Market Model Design is problematic, as it attempts to mainstream particular market structures and tariffs methodologies in countries, potentially depriving governments of important policy levers.

In fact, even though a regional understanding on the role of the private sector was 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 (Eberhard et al., 2011). Harmonisation does not signify one-size-fits-all solutions. A harmonisation of the regulatory frameworks does not mean that the architecture of the electricity supply industries needs to be identical in every country. While common rules are required for a regional market to operate, the role of market players, such as state-owned enterprises and IPPs as well as tariff structures, can remain different from one country to the other.

While the calls for cost-reflective tariffs is understandable from the perspective of national utilities, which need to be financially sustainable, it is potentially problematic if it is not associated with a dramatic improvement in the performance of such entities and the elaboration of clear plans to mitigate negative impacts on low-income households and businesses. A general push towards small-scale, renewable energy-based systems would, in this respect, provide an elegant avenue to re-structure the electricity supply industries in the region, circumvent tariff issues (by turning consumers into prosumers) and shift to sustainable (from an economic, social, environmental and governance perspective) energy solutions.

At the same time, such a situation also calls for reviewing the role and functions of the regional institutions and regulation and, as raised by Muller (2013), the "challenges of network infrastructure provisions the twenty-first century" (p. 2). Importantly, the region does not need new or additional institutions, and implementation can be driven by existing entities at the regional and national levels. In fact, 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* (SADC and SARDC, 2016). The development of a regional electricity plan that can inform national planning exercises in the future is key to the success of regional integration. Similarly, establishing regulatory benchmarks are a pre-requisite to any meaningful performance monitoring.

More broadly though, the past and present difficulties in delivering energy sustainability in the region suggest the need to review the forms of governance and regulation in the electricity sector in Southern Africa. In the case of South Africa, for example, the regulatory agency's approach has been manifestly inadequate in preventing electricity supply crises and precipitated significant tariff increases at the expense of the economy and society (Das Nair et al., 2014; Muller, 2013). Improved regulatory performance is vital for regional development. This challenge does not, however, rest solely with the regulators. In addition to regulatory entities, capable states (i.e. departments, municipalities and state-owned enterprises) and other stakeholders are required to ensure efficient and adequate regulation. As such, the region should explore complementary models for the regulatory agencies. Such options include: retaining or (re-)introducing direct regulatory oversight (ideally at the regional level) as part of governmental administrative functions and creating a framework for structuring regulatory processes in which stakeholders can participate and actively influence decisions. The region should also consider regulating by contract to achieve the benefits of private-sector provision by allowing competitive bidding for the development and operation of new infrastructure. Countries could rely on contractual provisions to enforce conditions and protect investors and the state (Muller, 2013).

Another 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. 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 then 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. SADC countries should consider exploring cumulation[10] of local content rules for regional agreements. This would involve counting components sourced from the region as local, and thus allowing imports from the region to feed into the procurement of designated products. The creation of free movement areas for skilled workers among SADC countries would also advance this goal.

[10] Cumulation refers to rules of origin, the restrictions in trade agreements that define how much value a country must add to a product for that product to be said to have originated in that country. Cumulation of rules of origin allows for the value added by certain third countries to count as local value added. For example, a product that is made in South Africa, using components from Botswana, and exported to the European Union could count a portion of those Botswanan components as 'locally-made', because all three are party to an Economic Partnership Agreement that allows for some cumulation of origin (Wood, 2017).

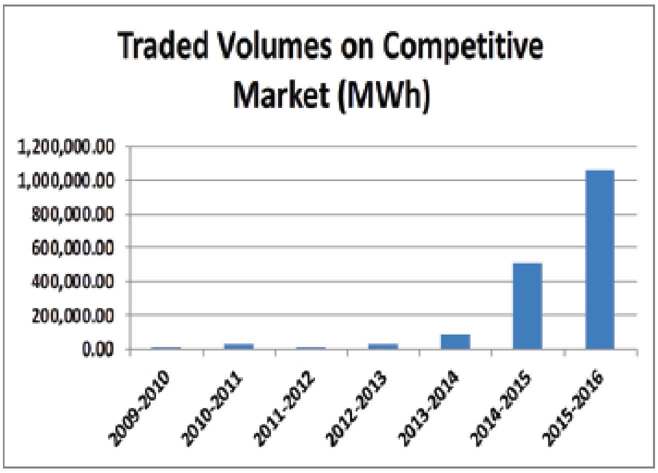
3.2. Building common institutions and technical infrastructure

The second avenue for regional integration to assist with achieving electricity sustainability is the development of 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 based on its 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 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 (especially in the last two, as shown in Figure 21) demonstrating the increased maturity of the market. In 2016, SAPP introduced a Forward Physical Market and an Intra-Day Market.[11]

[11] Trading is facilitated by SAPP pricing arrangement, set out in 13 detailed schedules in an 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 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 for the reliability and security of power system operation in any competitive electricity market environment.

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



Source: SAPP (2017)

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 various factors, including national concerns over security of supply (Mathews, 2017).

Furthermore, countries tend to favour a bilateral, rather than fully regional approach, striking long-term supply agreements. As displayed in Table 3, while the regional, competitive market accounts for an increasing share, long-term bilateral transactions still dominate the market. For example, South Africa's Eskom and Namibia's NamPower signed a five-year electricity sales agreement in March 2017. The unidirectional deal does not have a fixed payment and will depend on the energy consumed, but the agreement should see Eskom supply NamPower a firm capacity of 200 MW as well as an additional supply dependent on transmission capacity. NamPower also has power purchase agreements with the Zimbabwe Power Corporation, a subsidiary of the Zimbabwe Electricity Supply Authority, and Zambia's ZESCO of 80 MW and 50 MW, respectively. Similarly, Eskom already has long-term agreements in place with the Lesotho Electricity Company and the Swaziland Electricity Company, and it intends to conclude agreements with other SAPP members (Eskom, 2017; 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, a fact that highlights the potential for further regional trade, provided adequate planning. In addition, a share of possible transactions is not realised as a result of transmission infrastructure constraints. In other words, the maximum possible trade based on price, demand, and supply at a given time (matched bids in Figure 23) is larger than the capacity of the network. 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

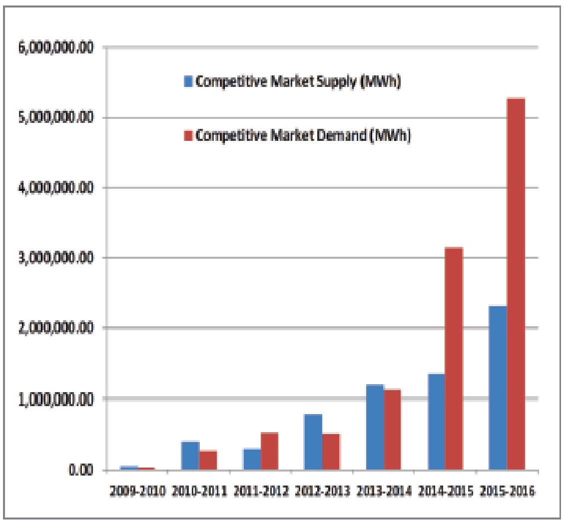
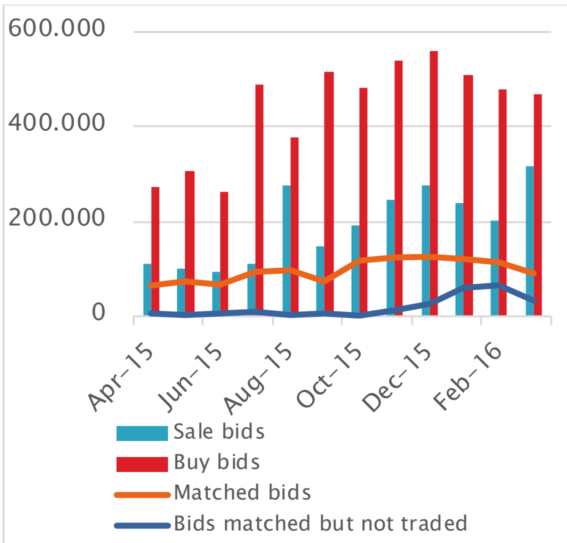


Figure 23: Bids submitted and matched on the Day-Ahead Market in 2015/2016 (in MWh)



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 several 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 maximise efficiency and tap into the best available (renewable) resources (Hansen, 2016). HVDC lines may be more expensive to construct than high-voltage alternating current lines, but they generate cost savings in the long run due to high system efficiency, notably via 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 being built 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

The construction of super-grids is booming in China, as illustrated in Figure 24. 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.

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 could use its geopolitical links with China and other developing countries to secure funding and engage in knowledge-sharing on developing 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 the region. The development of a super-grid would provide a platform to diversify the electricity mix of the region and maximise 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 sufficient market-related conditions for regional trade to take place. For example, according to SAPP's Annual Reports, no market abuse has been recorded over the last few years. The trading system also provides online information to market participants, creating short-term transparency in the market. As the regional market grows and trade expands, stronger long-term surveillance and improved financial security requirements measures (to minimise financial settlement risks) will be important. The need for increased coordination 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 also evident.

In addition to cross-border transactions, further work is required to support the local rollout of smart and micro-/mini-grids, particularly to support rural electrification. Small-scale, localised power generation technologies (based, for instance, on solar, wind, hydropower and/or biomass 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). 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). Box 7 describes Tanzania's experience in this respect.

More broadly, rooftop solutions are also adequate solutions for most residential and commercial operations, and crucial empowerment channels for all consumers, creating the ability to become prosumers. The whole region should investigate the potential for micro-grid systems to decisively promote local economic development and contribute to users' income. Promoting the ownership and productive uses of off-grid systems, while desirable, does indeed require different public programmes from simple energy provision. Additionally, 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). Such technologies furthermore constitute major manufacturing opportunities for the region (see Montmasson-Clair et al. (2017) for more details on the potential in the South African context), echoing the recommendation made in Section 3.1.

Box 7: Tanzania's Small Power Producer Programme

Tanzania is among the least electrified countries on the continent, with only 24% of its inhabitants (and 7% of rural population) benefiting from access to electricity. 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 been prized as an effective measure to combat energy poverty, with off-grid solar-based systems providing electricity to around 15% of the country's population.

Tanzania employs a unique system, known as the Small Power Producer Programme, comprised of fixed feed-in tariffs and standardised contracts to supply the state-owned Tanzania Electric Supply Company and customers not connected to the grid. Investments in mini- and off-grid electricity systems have already proven feasible, increasing the competitiveness of renewable energy sources and providing rural access to electricity in a cost-effective manner. VAT and tariff exemptions has facilitated the import of solar technologies such as inverters, panels and batteries.

However, despite the standardised regulation in place, poor-quality Chinese solar photovoltaic 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.

In order to attract additional foreign investment, the Tanzanian Investment Centre created a One Stop Centre. Bringing together 10 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.

These efforts paved a way for the rise of private sector intervention with local companies seizing opportunities to fill the market gap, with 11 local and foreign small power producers operating in the country. For example, Zara Solar, a Tanzania-based private business operating in Mwanza and Dar es Salaam, is servicing up to 20 000 households.

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

The economic sustainability of such systems, particularly for poor rural populations, often 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 described 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 low-income communities.

In this respect, the SADC needs to play a stronger role in effectively securing funding for energy projects in the region. There is currently a lack of capacity to initiate, implement, and manage innovative projects. The SADC could actively drive fundraising for strategic and/or cutting-edge projects, especially 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 clearinghouse 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.

Box 8: Botswana's rural electrification experience

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

During the latter stages of the 1980s, Botswana initiated a country-wide rural electrification programme in an attempt 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 stretch 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. To develop economies of scale when applying for electrification, the RECS also encourage 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, evaluation, and adaptation has ensured that the financial mechanisms in place have encouraged participation from the poor, successfully promoting 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 and the Global Environment Facility 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 state-owned Botswana Power Corporation has, however, faced many challenges. According to an official evaluation report undertaken by the Global Environment Facility, the implementation of off-grid solar systems has not been satisfactory. Botswana Power Corporation staff and a part-time project manager have been unable to efficiently manage the programme, as the focus has been primarily on expanding grid connections. Stakeholder engagement has also hindered 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 to the RECS, the monitoring and evaluation of the Renewable Energy Rural Electrification Programme has been sub-standard. The United Nations Development Programme has accepted partial blame for the lack of oversight on this phase of the programme.

There are lessons to be learned from Botswana's experience. Rural electrification and cost recovery can occur simultaneously given proper financial incentives aimed at the poor, as apparent in the RECS, are implemented. However, institutional governance and internal implementation commitment could 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 regional human capital 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-trained and diverse teams and stakeholders with up-to-date knowledge, skills, and education is at the core of a successful regional integration.

The policy mandate to create a regional market for skills is clear, as formulated by the RISDP, the SADC Regional Industrial Policy Framework and the Post-2015 Inclusive and Sustainable Industrial Development 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. The IRENA is providing support to RERA as part of the Regulatory Empowerment Project to improve the governance of electricity planning and the integration of renewable energy (Magombo, 2016).

Furthermore, the Energy Thematic Group 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, and multilateral and bilateral financial institutions. The Energy Thematic

Group 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). However, the absence of labour and civil society representatives in the Group is a key factor hindering inclusive governance in the sector.

Against that mandate, little progress has been made to develop national and regional experts as well as other stakeholders. There is notably limited capacity and awareness of 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 badly lacking. This problem correlates with the lack of expertise at vocational and university levels in the region. Outside of South Africa, there is little research and development 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 (particularly electricity equity) is to be achieved. There are 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 large-scale 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 best practices for governance, high risks in terms of fiduciary responsibilities, and a lack of institutional capacity for implementation and technical design (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 5. 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 remains 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

The un-representative nature of the regional institutions and governance structures, particularly the absence of labour unions and civil society, is a key obstacle to achieving inclusive growth in the sector. Countries need to direct significant effort toward broadening the inclusivity of multi-stakeholder institutions, like the Energy Thematic Group, and improving engagement with local stakeholders of regulatory institutions. More broadly, inclusive regionalism (also known as new regionalism) should be actively pursued through the involvement of a wide range of stakeholders and the creation of more networked forms of governance (see Muller et al. (2015) for more details on such approaches).

Such a process should be complemented by a bottom-up, grassroots approach prioritising capacity-building activities that are aligned to the needs of specific institutions and stakeholders, while considering their position in the regional arena (AfDB, 2013). This should be particularly targeted at community and civil society levels to foster inclusive governance in the region.

A regional cooperative framework should be established to assist with developing the "human infrastructure" of the energy sector, as proposed by the African Development Bank (AfDB, 2013). 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. Establishing regional educational, training and electricity institutions, through the enhancement of existing national institutions, such as the South African Renewable Energy Technology Centre, which trains wind turbine service technicians locally, as opposed to sending them abroad for training or recruiting experts from developed countries, is another example.

Moreover, the region should facilitate and organise enhanced cooperation between research and development institutions on energy issues. This could take the form of exchange programmes, joint research projects and/or knowledge sharing workshops. Additionally, more efforts are required to engage and experiment with community-based initiatives. As raised in Section 2, the rollout of small-scale power solutions is a crucial pathway to empower communities in a sustainable fashion.

The SADC, through the SAPP and the RERA, should also play a central role in building capacity in countries and institutions requiring assistance to adapt to and implement regional standards. Regional institutions should foster the sharing of experience and skills, particularly technical and non-technical capacity building of power pool member countries. This effort 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 also take steps to borrow or improve on ideas from other African regional economic zones, such as the Economic Community of West African States (ECOWAS), which has embarked on various capacity-building initiatives. These initiatives have included regional assessments of human infrastructural needs and subsequently developing tailor-made programmes for specific sectors and technologies. The ECOWAS Regional Centre for Renewable Energy and Energy Efficiency had, as of 2013, trained 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).

The SADC should spearhead negotiations for the creation of a regional free movement area to facilitate the mobility of local skills and expertise in the region. 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).

A number of data- and information-related initiatives are also required to improve the state of knowledge about regional dynamics. The necessity of improving mapping tools for needs assessment and diagnostic (such as 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, feasibility studies, and implementation. 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, 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 could shape the energy landscape of the region.

4. Conclusion

The road to energy sustainability in Southern Africa remains long and difficult. Countries of the region, each facing unique circumstances, all remain far from achieving their potential and from harnessing the synergies between the challenges of electricity security, equity and environmental sustainability. Far from conflicting with each other, the synergies existing between them, as illustrated by the rollout of decentralised solar-based systems, represent an important opportunity for the region.

Southern Africa is a rich region with a vast array of energy resources. These remain unfortunately largely untapped, mainly due to a lack of regional integration. Deeper regional energy integration in the SADC region could speed progress towards electricity sustainability. Existing initiatives, structured around the SAPP and the RERA, provide the necessary building blocks for regional integration that would help countries meet their energy challenges. However, this task cannot be left to utilities and regulatory bodies alone. Regional institutions could help achieve inclusive governance in the sector and leverage individual countries' experiences. Indeed, regional integration is not an end in itself, but a means to achieving a sustainable development pathway in the region.

Ultimately, regional integration depends on the engagement of member countries and national institutions as well as robust, inclusive, and transparent governance systems. The task at hand is manifestly complex and unquestionably ambitious. But the long-term benefits associated with inclusive regional integration remain central to Southern Africa's future 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
Société Nationale d'Electricité (SNEL)	DRC	OP
Swaziland Electricity Company (SEC)	Swaziland	OP
Tanzania Electricity Supply Company (TANESCO)	Tanzania	NP
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)

Note: OP stands for operating member, NP stands for non-operating member, ITC stands for independent transmission company, and IPP stands for independent power producer

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), we should consider three key dimensions of 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 gross domestic product 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

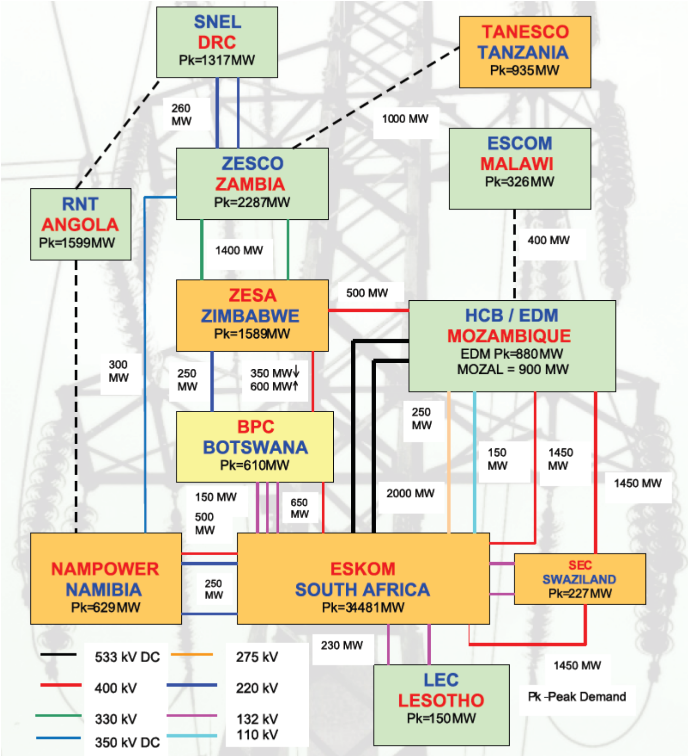
Table 5: Members of the RERA

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) and 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 Engineering, Procurement, and Construction 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, Environmental and Social Impact Assessment (ESIA) and engineering designs completed. Intergovernmental memorandum of understanding (IGMOU) and inter-utility memorandum of understanding (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 ESIA studies completed. Commissioning planned for 2019

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