Africa Clean Energy Corridor

IRENA
International Renewable Energy Agency

Analysis of Infrastructure for Renewable Power in Southern Africa

About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.
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FOREWORD

Africa's impressive economic growth in recent years, reflecting growing population as well as rapid economic development and diversification, calls for massive investments to ensure sufficient future energy infrastructure and power supply. With outstanding solar and hydropower resources, complemented in some regions by bioenergy, wind and geothermal resources, the continent can supply both its concentrated urban centres and its remotest, most dispersed rural areas with clean, sustainable energy, based on its indigenous renewable resources.

The initiative to create the Africa Clean Energy Corridor, launched in January 2013 at the Third Assembly of the International Renewable Energy Agency (IRENA), aims to accelerate the expansion of renewable electricity production, taking advantage of the continent's enormous untapped potential and helping to sustain future growth. The initiative, spanning the length of the continent from Egypt to South Africa, links more than 20 countries in a combined endeavour to optimise their grid infrastructure and operations to support high shares of renewable energy. As the costs of renewable energy technologies continue falling, the economic logic for the envisioned African energy transition becomes even more compelling.

As IRENA's executive strategy workshop for the Africa Clean Energy Corridor in June 2013 highlighted, significant barriers remain: an inefficient and under-financed power sector, distorted prices, inadequate access to finance, and the lack of up-to-date information and suitable skills. Rural and urban areas require different, yet parallel, solutions. However, Africa today is well positioned to leapfrog ahead with the latest on- and off-grid renewable energy solutions.

This report, examining the infrastructure of the Southern African Power Pool, represents the first analysis conducted as part of the corridor initiative. With further studies to follow, IRENA will continue to support African countries seeking to unlock their considerable renewable energy potential.

Adnan Z. Amin
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ABBREVIATIONS

ACEC	Africa Clean Energy Corridor
AfDB	African Development Bank
APUA	Association of Power Utilities of Africa
AU	African Union
AUC	African Union Commission
BPC	Botswana Power Corporation
CCGT	Combined Cycle Gas Turbine
CEC	Copperbelt Energy Corporation
CESUL	Mozambique Transmission Backbone Project
COMESA	Common Market for Eastern and Southern Africa
CSP	Concentrating Solar Power
DAM	Day-Ahead Market
DBSA	Development Bank of Southern Africa
DRC	Democratic Republic of the Congo
EAPP	Eastern Africa Power Pool
EDM	Electricidade de Mozambique
ENE	Empresa Nacional de Electricidade, Angola
ENTSO-E	European Network of Transmission System Operators for Electricity
ESCOM	Electricity Supply Commission of Malawi
ESKOM	National Utility of South Africa
ESP	Energy Sector Plan (SADC)
HCB	Hidroelectrica de Cahora Bassa, Mozambique
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IGMOU	Inter-utility Governmental Memorandum Of Understanding
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
ITC	Independent Transmission Company
IUMOU	Inter-Utility Memorandum Of Understanding
LCOE	Levelised Cost Of Energy
LEC	Lesotho Electricity Company
LHPC	Lunsemfwa Hydro Power Company
MCP	Market Clearing Price
MOTRACO	Mozambique Transmission Company
NamPower	National Utility of Namibia
NEPAD	New Partnership for Africa's Development
NERSA	National Energy Regulator of South Africa
OCGT	Open Cycle Gas Turbine

PIDA	Programme for Infrastructure Development in Africa
REC	Regional Economic Community
REIPPPP	Renewable Energy IPP Procurement Programme (South Africa)
RERA	Regional Electricity Regulators Association of Southern Africa
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SEC	Swaziland Electricity Company
SNEL	Societe Nationale d'Electricite (DRC)
STE	Sociadade Nacional de Transporte de Energia, Mozambique
STEM	Short-Term Energy Market
TANESCO	Tanzania Electricity Supply Corporation
UNECA	United Nations Economic Commission for Africa
USD	United States Dollar
ZAR	South African Rand
ZESA	National Utility of Zimbabwe
ZESCO	National Utility of Zambia

EXECUTIVE SUMMARY

One of the major developmental challenges for Africa in the twenty-first century is to achieve universal access to, and efficient utilisation of, adequate, affordable, clean, safe, reliable, secure and sustainable energy services. This will facilitate increased economic productivity and thereby reduce endemic poverty and improve the quality of life of the continent's rapidly growing population. At present, an estimated two-thirds of the population has no access to electricity and clean cooking fuels.

Fortunately Africa is endowed with abundant energy resources, both renewable and non-renewable. With rapid advances in reliability, efficiency and cost-competitiveness of renewable energy technologies, the continent has the opportunity to increase energy access and security without the environmental and economic costs associated with fossil fuels. Regional and inter-regional power-sector integration provides opportunities for exploiting the economies of scale of large hydro-electric, geothermal, wind, solar and biomass projects, saving billions of dollars in development, operation and maintenance costs.

A strong transmission grid linking the Eastern Africa Power Pool (EAPP) and Southern African Power Pool (SAPP) will create the backbone for an Africa Clean Energy Corridor (ACEC) that facilitates the development of the continent's abundant renewable energy potential, to fulfil projected electricity demand at the lowest environmental, social and economic cost. Developing the ACEC, moreover, would fulfil the requirement of creating a north-south transmission corridor, as envisaged in the African Union's Programme for Infrastructure Development in Africa (PIDA).

An executive strategy workshop convened by the International Renewable Energy Agency (IRENA) in June 2013 brought together regional bodies, power pools, utilities, independent power producers (IPPs), government ministries, multilateral financial institutions and development partners to recommend an action agenda to put the corridor in place. The agenda includes: zoning of renewable power development to identify areas with very good renewable power potential (known as hotspots), allowing more cost-effective transmission links with load centres; planning processes that consider renewable power options in a more systematic fashion; and enabling mechanisms that support the development of renewable power options and improve the access of such projects to electricity markets and financing.

This report, which focuses on the Southern African Power Pool (SAPP), is intended to assess the power pool's readiness to embrace the objectives of the ACEC and highlight critical transmission and interconnection gaps. It also proposes high-impact actions for the formation of the corridor, including raising the profile of projects that are ready for investment and identifying stakeholders able to assist in building capacity for the financing and development of such projects. The report also addresses the action agenda items that emerged from June 2013 IRENA workshop in more detail, in order to identify the issues that need to be considered under each of the three pillars of the agenda. Information and data for the report were obtained through a review of existing literature as well as consultation with key stakeholders, such as the power pool secretariats and utility and government officials.

The main findings, conclusions and recommendations of the study are as follows:

- The mandate and current priorities of SAPP have a bias towards large hydropower generation. The ACEC can provide the opportunity to review the regional and national electricity master plans to include non-hydro resources such as wind and solar energy. Member states need to enhance their capability to undertake renewable energy resource assessments to generate bankable data, in order to allow fair and serious consideration for both hydro and non-hydro resources.
- SAPP faces several planning challenges in regard to the scale-up renewable energy technologies, including poor quality of input data (including energy statistics for planning),

inconsistent demand forecasts, and inconsistencies between regional and national priorities. In some cases, negative experiences have contributed to risk-aversion and a preference for self-sufficiency by member countries. Regional plans are only indicative and non-binding. There is, however, agreement on the criteria for project selection and prioritisation, which has produced an agreed list of regional generation and transmission projects.

- SAPP faces a generation deficit and transmission constraints that are limiting electricity trading. A working group has been set up to develop the concept for a strategic network that would direct investments to remove the bottlenecks. This strategic network can become a building block for the ACEC if developed in harmony with ACEC objectives. The strategic network concept arose from the need to resolve electricity trading constraints, specifically where less than 30% of potential energy trades on the Day-Ahead Market (DAM) are successful. Such bottlenecks are due to congestion on the regional grid, especially along the Central Transmission Corridor centred on Zimbabwe and neighbouring countries.

- SAPP is a loose power pool within a regional market structure, characterised by vertically integrated single-buyer utilities, independent power producers and semi-independent regulatory agencies. The financial performance of most utilities is poor, characterised by low profitability and uncollected revenue. There is a mismatch between the national and regional market structure, which is a competitive wholesale market with multiple buyers. Such a market requires empowered regulatory authorities to harmonise rules and regulations. To enable SAPP to move towards deeper regional integration, and hence increasethe benefits of co-operation, member states need to reform their power sectors to align with the regional structure and to delegate more authority to SAPP and the Regional Electricity Regulators Association (RERA) to facilitate project development and to enforce cross-border trading guidelines and cost-reflective pricing.

- Capacity building and adequate staffing are required so that planning, development and operating institutions can adequately discharge their mandates. Within the Southern Africa Development Community (SADC) Directorate for Infrastructure and Services, the Energy Division has only two staff members, one of whom is on a limited donor-funded contract. Thus, the division is inadequately staffed to monitor and facilitate progress in the harmonisation of policies and regulations and the implementation of regional projects. Implementing entities, such as the SAPP Co-ordination Centre, RERA, and utilities, need to attract and retain in-house skills to plan, manage, construct, operate and maintain projects meeting stakeholder expectations. Transmission pricing is a critical issue, as it affects the bankability of transmission projects, especially those developed for relieving congestion.

- International co-operating partners have played a catalytic role in making the SAPP the most advanced operating power pool in Africa. They have provided technical assistance and credit facilities to fund the packaging and preparation of generation and transmission projects. Most of the funding has been from limited public sector resources. The focus of engagement should now emphasise on fascilitating private sector investment, which could be achieved by involving the private sector in policy formulation and planning.

This report is complimentary to a study addressing similar issues for the Eastern Africa Power Pool. Following stakeholder consultation and input, the two reports will be combined to produce a comprehensive analysis of the infrastructure forming the basis for the ACEC.

1. INTRODUCTION

1.1. Why the Clean Energy Corridor for Africa

The International Renewable Energy Agency (IRENA), whose mandate is to promote the accelerated adoption and sustainable use of all forms of renewable energy, has launched an initiative to accelerate the introduction of clean and cost-effective renewable power options in an Africa Clean Energy Corridor (ACEC). Sustained economic growth in Africa, including the countries that comprise the Eastern Africa Power Pool (EAPP) and the Southern African Power Pool (SAPP) (Figure 1), has led to a consistent rise in electricity demand, with associated needs for new generating capacity.

Figure 1: Map Showing Countries in the Proposed Africa Clean Energy Corridor

Source: IRENA, (2013)

As clean renewable power sources such as hydro, geothermal, biomass, wind and solar are now cost-competitive in a number of countries, they are technically mature and very fast to deploy. More so, renewable power sources have favourable impacts for the socio-economy that can help to reduce fossil fuel consumption, carbon emissions and electricity costs while expanding access to electricity and creating new jobs in Africa's rapidly growing economies.

1.2 Africa Clean Energy Corridor Action Agenda

An executive strategy workshop was convened by IRENA in Abu Dhabi on 22-23 June 2013 to elaborate an action agenda for the Africa Clean Energy Corridor. The workshop brought together a broad range of stakeholders, including representatives of regional bodies, power pools, utilities, IPPs, ministries, multilateral financial institutions and development partners. The elements of the action agenda they proposed include zoning of renewable power developments to identify areas with very good renewable power potential (hotspots), allowing more cost-effective transmission links with load centres, planning processes that consider renewable power options in a more systematic fashion, and enabling mechanisms that support the development of renewable power options to improve their access to electricity markets and financing.

- **Zoning:** To ensure the cost-effective development of renewable power resources, it is important to identify renewable power development zones in areas of high resource potential and develop high-capacity transmission networks to load centres. At present, the long-range master plans of the Eastern Africa Power Pool and Southern African Power Pool both include substantial hydropower capacity but relatively limited increments of geothermal, wind, biomass and solar power. A number of countries in these power pools have begun to consider their cost-effective renewable resource potential, but detailed resource assessments are needed to foster investment in renewable power projects and such assessments are costly. Thus, it was recommended that IRENA work with countries to help the production of credible data on their renewable energy resources and identify suitable zones for concentrated development of these resources.

- **Planning:** To take advantage of the most cost-effective renewable power options available, and to ensure that renewable power options are compared fairly with fossil-fuel and nuclear options, it is essential to have effective integrated resource planning at both country and regional levels. Co-ordinated planning of generation and transmission facilities in eastern and southern Africa could provide significant cost economies. Currently, generation expansion plans are formulatedby each country in the power pools independently, and the power pools plan new generation and transmission enhancements based on an aggregation of national plans presented to them. The countries' optimised generation projects are grouped together and then optimised to select those generation projects that will have the least cost for the region when implemented as regional projects. The Eastern Africa Power Pool's 2011 Master Plan found that joint regional optimisation of generation and transmission plans could save USD 7.3 billion over 25 years on top of the USD 25.2 billion of savings that are derived from optimisation within each country separately. The SAPP 2009 Pool Plan found that co-ordinated planning could save USD 47.5 billion over 20 years (Nexant, 2008). In this context, IRENA was advised to work with countries to build their capacities to plan, build and operate power grids with a greater share of renewable energy. Effective regional planning would entail agreement on a range of demand scenarios, the costs of competing supply options to meet demand, and the optimal mix of renewables.

- **Enabling:** To help mobilise private capital, it is vital to enable market entry by IPPs and utilities alike and to enable financing through reduction of real and perceived risks, which in turn reduces the cost of capital. Renewable power investments face risk perceptions that do not reflect the current state of technology development, and effective national policies are critical to create the kind of fair and open markets that investors and financiers will find attractive. Thus, it was recommended that IRENA provide advice and expertise to countries on renewable energy strategies that aim to harmonise policy and regulatory frameworks of countries in the region and thereby to create an effective regional power market. It was also recommended that IRENA expand its work with multilateral financial institutions to introduce innovative financing structures that reduce the risks to renewable power investments and support business models for renewable power projects that are tailored to local conditions.

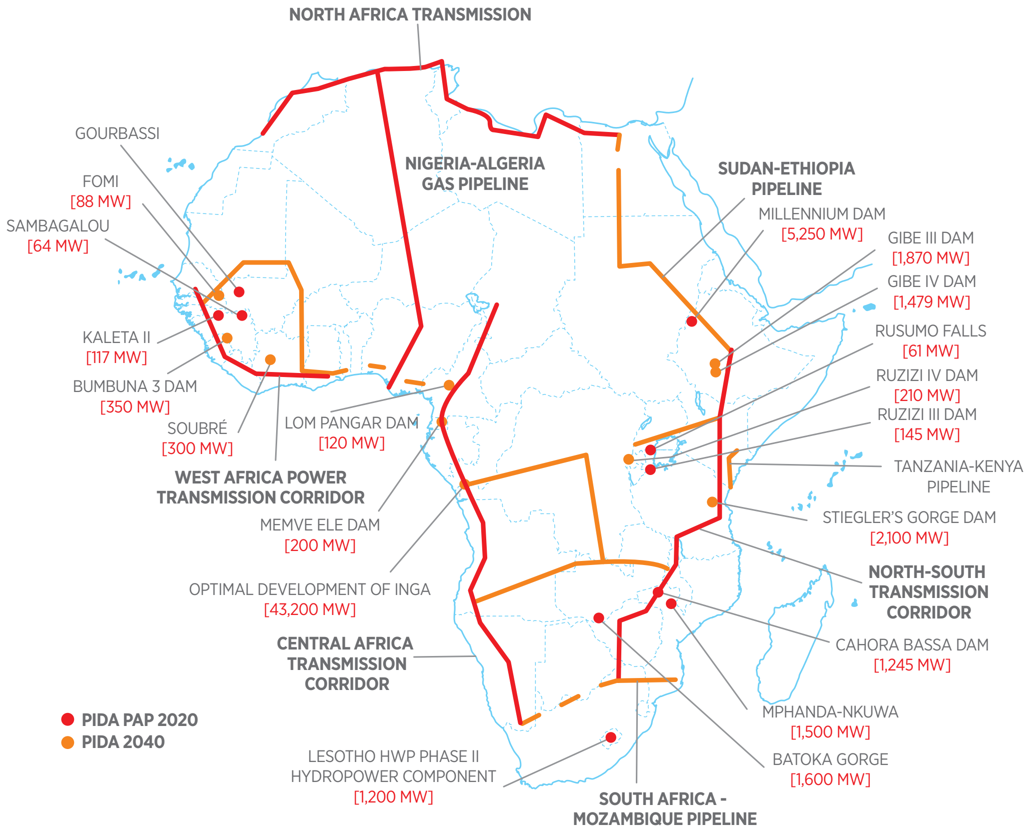
1.3 Infrastructure Backbone for the Africa Clean Energy Corridor

The Africa Clean Energy Corridor would rely upon development of a strong high-voltage transmission corridor from Egypt to South Africa. A key building block would be the North-South Transmission Corridor identified under the Programme for Infrastructure Development in Africa (PIDA). PIDA provides a framework for addressing the infrastructure deficit in Africa through integrated planning and development at regional and inter-regional levels. Pursuant to a decision of the 12th Assembly of Heads of State and Government (Declaration Assembly/AU/Decl.1 (XII)), PIDA was developed by the African Union Commission working with the United Nations Economic Commission for Africa (UNECA), the African Development Bank (AfDB) and the New Partnership for Africa's Development (NEPAD) (AfDB, 2012).

The priority energy projects for PIDA are highlighted in Figure 2. The North-South Transmission Corridor is described as 8 000 km of line from Egypt through Sudan, South Sudan, Ethiopia, Kenya, Malawi, Mozambique, Zambia and Zimbabwe to South Africa. It can be noted that the ACEC portion from Ethiopia to South Africa is identified as one of the Priority Action Plan (PAP) projects to be completed by 2020. Another PAP project is the Central Africa Transmission Corridor, which is a 3 800 km line linking the Democratic Republic of the Congo (DRC) to South Africa through Angola and Namibia and to Chad in the north through Equatorial Guinea, Gabon and Cameroon.

The next stage of the development up to 2040 would involve the completion and interconnection of the corridors.

Figure 2 : Priority Energy Projects for PIDA



Source: AfDB, (2012)

Development of these transmission corridors would help achieve several key objectives that include:

a) **Accelerated development of renewable energy resources**, to meet growing demand for electricity in a clean, reliable, and cost-effective way.

b) **Co-ordinated regional planning and development** of electricity generation and transmission infrastructure to reduce costs, boost reliability, and expand trade.

c) **Enhanced legal, institutional and technical capacity** to plan, build and operate an interconnected grid with a greater share of renewable electricity generation.

1.4 Role of Power Pools in Building the Corridor

A World Bank study on regional power sector integration published in June 2010 notes that there are several motivations as well as benefits and challenges:

"Developing countries are increasingly pursuing—and benefitting from—regional power system integration (RPSI) as an important strategy to help provide reliable, affordable electricity to their economies and citizens. Increased electricity co-operation and trade between countries can enhance energy security, bring economies-of-scale in investments, facilitate financing, enable greater renewable energy penetration, and allow synergistic sharing of complementary resources. At the same time, many RPSI efforts around the world are currently facing challenges that slow progress and mitigate the full benefits of greater integration. These challenges include: difficulty aligning national and regional investment decisions; differences in regulatory environments between countries; insufficient regional institutions; dearth of financing; changes in political frameworks; and national sovereignty and energy independence concerns" (ESMAP, 2010).

These observations arise from a study of 12 regional power sector integration schemes from different parts of the world, including the SAPP. The creation of power pools is the strategy by which countries seek to address these challenges so that the benefits can be realised. The World Bank study identified three stages through which regional co-operation in the power sector evolves:

- **Interconnection Stage:** This typically involves two countries building interconnections on the basis of long-term bilateral power purchase agreements with a joint technical committee supervising simple rules for operation of the interconnector. Where interconnections involve a third country, third party access and wheeling agreements are needed. Projects are derived from national plans.

- **Shallow Integration Stage:** This involves integrating interconnections to create a regional grid that links together several neighbouring countries. A multi-lateral technical organisation is needed to ensure the reliable and secure operation of the interconnected grid through harmonisation of technical operating rules. Trading is based on long-term and short-term bilateral agreements within a competitive short-term wholesale power market. Projects are derived from national plans which may take account of non-binding regional master plans.

- **Deep Integration Stage (the ideal stage):** This involves the co-ordinated planning, development and operation of a regional grid. Project planning and regulation are delegated to empowered regional institutions. National plans follow and incorporate the regional master plan. Trading takes place through a wide range of spot, short-term and medium-term contracts as well as long-term bilateral power purchase agreements. The maximum benefits of regional integration are achieved at this stage of co-operation.

The role of the power pools in building the ACEC largely depends on the stage of integration. The SAPP is at the shallow integration stage while the EAPP is still at the interconnection stage. IRENA commissioned this report to facilitate stakeholder consultation and promote interest in the corridor by assessing power pool readiness to embrace the objectives of the corridor, assessing critical transmission gaps, identifying projects that are ready for investment and development, assessing capacity building requirements, and suggesting measures to implement the Corridor's Action Agenda. SAPP's readiness for making the transition from shallow to the desired deep integration stage is assessed.

It is important to highlight the fact that the transition between stages of regional integration requires a high degree of mutual trust and operational experience that can take several decades to achieve. It takes time for countries with different policies, laws and institutional frameworks to create an integrated regional organisation with harmonised rules and regulations that are legally binding for all participating entities. The European Network of Transmission System Operators for Electricity

(ENTSO-E) (www.entsoe.eu), which is responsible for the co-ordinated development and operation of the electricity grids in 34 countries in Europe, represents what is probably the most advanced integration stage.

The ENTSO-E was created in 2009 from six predecessor organisations – the Union for the Co-ordination of Transmission of Electricity (UCTE) for Continental Europe, Nordic Electricity (NORDEL) for Nordic countries, United Kingdom Transmission System Operators Association (UKTSOA) for Great, Association of Transmission System Operators of Ireland (ATSOI), European Transmission System Operators (ETSO), and Baltic Transmission System Operators (BALTSO). The European Transmission System Operators (ETSO) was an association of Association of Transmission System Operators of Ireland, Nordic Electricity, Union for the Co-ordination of Transmission of Electricity, United Kingdom Transmission System Operators Association and an early model for the ENTSO-E.

The ENTSOE-E operates through the following committees organised on continental and regional structures: legal and regulatory, system development, system operations, market and research & development. The work of the committees is monitored by the Agency for the Cooperation of Energy Regulators (ACER) (www.acer.europa.eu), an EU body created in 2010, whose mandate is to ensure harmonisation of regulatory frameworks to facilitate the achievement of a single EU energy market for electricity and natural gas.

Power sector integration in Europe is facilitated by legally-binding EU directives and regulations. The regulations are progressively moving towards deeper integration. For example, at its establishment in 2009 the ENTSO-E was required by Regulation (EC) 714/2009 to "adopt a non-binding community-wide ten-year network development plan" , including a European generation adequacy outlook, with the objective of identifying investment gaps and ensuring greater transparency regarding the entire electricity transmission network in the community (ENTSO-E, 2013). A new regulation (EU 347/2013) on guidelines for a trans-European energy infrastructure, which entered into force on 15 May 2013, now requires the ten-year plan to also form the sole base for the selection of projects of common interest (PCIs). The Agency for the Cooperation of Energy Regulators (Europe) identifies any inconsistencies between the ten-year network development plan and national plans and recommends amendments.

Although the ideal deep integration stage is still a work in progress, the ENTSO-E and the Agency for the Cooperation of Energy Regulators (Europe) have created an institutional framework that will allow European countries to move towards deeper integration. This provides an appropriate model for the SAPP and EAPP to aspire to as it demonstrates how inter-pool co-ordination can be achieved through appropriate continental and regional institutions.

2. STATE OF THE ELECTRICITY SECTOR IN SAPP

Paradoxically, while the SADC region has greater installed electricity generating capacity than any other regional economic community (REC) in Africa, it has one of the lowest rates of electricity access. The energy sector plan (ESP) of the Regional Infrastructure Development Master Plan (RIDMP) of SADC, which was approved by its heads of state in 2012, notes that the region has electricity access of 24% compared to 36% for the Eastern Africa Power Pool (EAPP) and 44% for the West African Power Pool (SADC, 2012a). In some countries, access in rural areas is lower than 5%.

Since 2007 the region has been in a generation supply deficit that is being managed through planned load shedding. Transmission bottlenecks have also made it difficult to manage the shortfalls through trade. This situation has impeded efforts to increase access and economic growth to the rates required to reduce poverty. The weighted average growth in electricity consumption for the region for the year ending March 2013 was only 2.5%.

The ESP highlights a number of reasons for the lack of progress in resolving the known electricity infrastructure deficits:

- Slow progress towards achievement of cost-reflective tariffs
- Poor project preparation capacity
- Lack of creditworthy energy off-takers that can sign power purchase agreements (PPAs) under the single buyer model that is prevalent in the region
- Inadequate policy and regulatory frameworks
- Challenges of ownership and accountability for regional programmes

These observations are the consequence of the shallow integration stage that the SAPP is at. The resolution of the shortcomings noted in the ESP implies a major policy decision to move SAPP to the ideal deep integration stage. SAPP, and its regulatory counterpart, Regional Electricity Regulators Association of Southern Africa (RERA), will need to be transformed into the empowered institutions that can direct national projects and programmes to be in line with regional objectives. As highlighted above the ENTSO-E and the Agency for the Cooperation of Energy Regulators (Europe) are appropriate models that could be considered in the transformation of the SAPP and RERA.

2.1 Current Electricity Supply and Demand

The latest available statistics for the year ending 31 March 2013 published in the SAPP Annual Report, the details of which are summarised in Table 1 and Table 2 below, show that the region had a peak power demand of 53.8 GW against an available capacity of only 51.7 GW, which is 96% of the requirement. Total energy sales were 268.5 TWh. The peak demand figures include a target reserve margin of 15%. Statistics in Table 1 show that the available capacity in all but one country, Angola, falls short of requirement.

Planned load shedding has become a permanent feature in most SADC countries, forcing consumers to invest in standby capacity, usually petrol or diesel generators using expensive imported fuel. Short- and medium-term contracts among members for import and export help to reduce the extent of load shedding for countries with the largest deficits. The energy statistics in Table 2 provide an indication of how each country balances supply and demand through its own generation as well as imports and exports. Hidroeléctrica de Cahora Bassa (HCB) of Mozambique is not reflected in this table, as its output is accounted for in Electricidade de Mozambique (EDM), National Utility of South Africa (ESKOM) and National Utility of Zimbabwe (ZESA) statistics.

Table 1: SAPP 2013 Generation Statistics

Country (Utility)	Installed Capacity	Peak Demand*	Available Capacity	
	MW	MW	MW	% Peak Demand
Angola (ENE)	1 793	1 341	1 480	110
Botswana (BPC)	352	604	322	53
DRC(SNEL)	2 442	1 398	1 170	84
Lesotho (LEC)	72	138	72	52
Malawi (ESCOM)	287	412	287	70
Mozambique (EDM)	233	636	204	32
Mozambique (HCB)	2 075	-	2 075	-
Namibia (NamPower)	393	635	360	57
South Africa (ESKOM)	44 170	42 416	41 074	97
Swaziland (SEC)	70	255	70	27
Tanzania (TANESCO)	1 380	1 444	1 143	79
Zambia (ZESCO)	1 870	2 287	1 845	81
Zimbabwe (ZESA)	2 045	2 267	1 600	71
ALL	**57 182**	**53 833**	**51 702**	**96**
Interconnected	**53 722**	**50 636**	**48 792**	**96**

Source: Analysis based on SAPP (2013a) *Figures include estimates of suppressed demand.

Table 2: SAPP 2013 Energy Statistics

Country (Utility)	Generation Sent Out			Energy Sales	Transmission Losses
	Plant Output	Net Imports	Net Exports		
	GWh	GWh	GWh	GWh	%
Angola (ENE)	5 613	49	-	3 427	10
Botswana (BPC)	372	3 017	-	3 118	3.7
DRC(SNEL)	7 641	562	69	6 323	9.3
Lesotho (LEC)	486	49	7.4	488	11
Malawi (ESCOM)	1 809	-	19.1	1 476	9
Mozambique (EDM)	390	89	330	2 380*	6.4
Namibia (NamPower)	1 305	1 591	36	3 648	3.2
South Africa (ESKOM)	237 430	413	4 089	224 446	3.3
Swaziland (SEC)	288.1	773	-	1 018.6	6
Tanzania (TANESCO)	3 034	2 192	-	3 770	6.1
Zambia (ZESCO)	11 381	164	65.6	10 688	4.6
Zimbabwe (ZESA)	6 951	1 076	701	7 367	4
ALL	**276 700**	**9 975**	**5 317.1**	**268 149.6**	

Source: SAPP (2013a). **Note:* The balance of energy is from Cahora Bassa supplied directly or via ESKOM

An analysis of the numbers in Table 2 shows a significant difference between some of the generation sent out and energy sales, which is not explained by the given transmission losses. Many of the plant output figures are the same as in the annual report for 2012 but there are significant differences on the trading figures. This may be a reflection of poor utility record keeping or very high distribution losses.

Of particular note are statistics for South Africa and Tanzania. In the 2012 report South Africa's net imports and exports were recorded as 10 190 GWh and 13 296 GWh respectively with generation sent out of 237 430 GWh. The 2013 report has the same sent out figures but with net imports of 413 GWh and net exports of 4 089 GWh. TANESCO, which had 3 034 GWh sent out and net imports of 2 192 GWh, had energy sales of only 3 770 GWh and transmission losses of 6% suggesting distribution losses in excess of 22%. The SAPP Co-ordination Centre would need to undertake an audit to assist members in compiling accurate statistics or to institute loss-reduction programmes.

Projected Electricity Demand

The current demand forecasts for the power pool published in the SAPP Annual Reports were originally developed as part of the studies for the SAPP 2009 Pool Plan (Nexant, 2008). Most utilities prepared their own forecasts while others used consultants. Table 3 provides a summary of the projected power and energy demand and compares this to the observed trends since the forecasts were made.

Table 3: SAPP Load Forecast compared to 2006 - 2013 growth rate

Country (Utility)	Power Demand		Energy Sent out			2013 actual	
	2006 MW	2025 MW	2006 GWh	2025 GWh	% p.a.	MW	% p.a.
Angola (ENE)	620	2 871	3 529	16 345	8.4	1 341	11.7
Botswana (BPC)	456	1 272	2 627	7 336	5.5	604	4.0
DRC(SNEL)	821	2 723	5 485	16 915	6.9	1 398	7.9
Lesotho (LEC)	115	214	490	1 063	3.3	138	2.6
Malawi (ESCOM)	242	629	1 266	3 293	5.2	412	7.9
Mozambique (EDM)	440	1 208	2 622	7 262	5.5	636	5.4
Namibia (NamPower)	408	933	2 533	5 767	4.4	635	6.5
South Africa (ESKOM)	33 968	53 878	226 571	365 152	2.5	42 416	3.2
Swaziland (SEC)	188	323	1 064	1 828	2.9	255	4.4
Tanzania (TANESCO)	633	1 566	3 556	8 900	4.9	1 444	12.5
Zambia (ZESCO)	1 413	2 407	10 214	17 291	2.8	2 287	7.1
Zimbabwe (ZESA)	2 102	3 674	12 240	21 295	3.0	2 267	1.1
ALL	**41 406**	**71 698**	**272 196**	**472 447**	**2.9**	**53 833**	**3.8**

Source: Calculations based on SAPP (2013a) statistics and Nexant (2008).

It can be observed that for most utilities, actual demand growth between 2006 and 2013 has generally been higher than forecast.

The basic methodology for all forecasts used historical trends, especially the relationship between gross domestic product (GDP), population and electricity consumption, adjusted for known economic developments, to forecast energy sales for different consumer categories. The generation sent out is calculated by adding the estimated transmission and distribution losses to the energy sales. The peak demand is then calculated from the figures for energy sent out using an estimate of the system load factor.

The major weakness in the demand forecasts based on an extrapolation of history is the inconsistency with regional and national electricity access policies and targets. The targets are meant to be policy-based and a departure from business as usual. In 2010 SADC energy ministers adopted a Regional Energy Access Strategy and Action Plan (REASAP) which was given a target of halving the number of people without access to modern energy services by 2020, and halving the number again every five years thereafter (SADC, 2010) until universal access is achieved. The current estimate of electricity access in the Energy Sector Plan is 24% of the population. At this rate, the region would achieve universal access by 2040. The 2013 SADC Energy Ministers Meeting decided to align the targets to the even more ambitious United Nations Sustainable Energy for All (SE4ALL) goal of universal access by 2030. These targets are not reflected in current SAPP forecasts, although the SAPP has created the Electrification Working Group whose aim is to work together with rural electrification agencies/units/utilities to achieve universal access for all.

The same governments have also adopted access targets through the African Union's Programme for Infrastructure Development in Africa (PIDA). The programme assumes a 6% average annual economic growth rate for Africa for the period 2010-2040, which is estimated to translate to electricity energy consumption growth rate of 5.7%. At this rate it is estimated that two-thirds of the population would have access to electricity by 2040 which still leaves a third of the population without electricity access. The projected growth rates for the different regions of Africa are summarised in Table 4.

Table 4: PIDA Regional Electricity Forecasts for 2010-2040

Region	Average Annual Growth in GWh Consumption (%)	Access (Share of Population (%))		Additional capacity required
		2010	2040	MW
West African Power Pool (WAPP)	8.9	45	67	90 000
Central African Power Pool (CAPP)	7.3	21	63	26 000
Eastern African Power Pool (EAPP)	6.5	37	68	140 000
Maghreb Committee on Electricity (COMELEC)	6.0	>95	>99	298 000
Southern African Power Pool (SAPP)	4.4	25	64	129 000
TOTAL	**5.7**			**683 000**

Source: Sofreco *et al.* (2011)

To put the above figures into perspective, PIDA estimates the current installed capacity and annual energy consumption for Africa to be 125 GW and 600 TWh, respectively. Annual consumption by 2040 is then projected to exceed 3 100 TWh.

To demonstrate how difficult it is to get a consensus on this critical issue of demand forecast it is interesting to highlight other estimates by the Common Market for Eastern and Southern Africa (COMESA) and IRENA. COMESA has its own integrated planning strategy that estimates a

7% annual growth rate (higher than the PIDA estimate of 6.5% for EAPP and 4.4% for SAPP, which are the power pools in the COMESA region) (Seif Elnasr, 2013). The COMESA targets assume an increase in electricity access from 30% in 2010 to 80% by 2030 and an increase in installed capacity from 48.7 GW in 2010 to 188.6 GW in 2030. IRENA's analysis estimates that an additional 900 TWh (to bring the total to 1 500 TWh) is what is required for full electricity access to be achieved in Africa by 2030 (IRENA, 2013).

These conflicting views on demand forecasts need to be reconciled because the projected demand is the most important assumption for generation and transmission expansion planning. The differences are not only based on the diversity of institutions involved but also on whether these are a projection of historical trends or are strategy-driven to achieve regional and international access targets. Enhancing member countries' capability to forecast and project energy demand, by improving the accountability and transparency of the methodologies, quality of data inputs, and timely updates of the plans, is critical to effective regional resource planning in the Africa Clean Energy Corridor.

2.2 State of Infrastructure in SAPP

2.2.1 Current Power Generating Capacity

The bulk of the 57 GW of current power generation capacity in SADC is from coal (70%), mainly in South Africa, hydropower (21%), mainly in the Zambezi and Congo basins, distillate oil (5%), nuclear (3%) and gas (1%). Details by country are illustrated in Table 5. The discrepancies between some of the figures in this table and those given in Table 1 reflect the need for an audit of the record-keeping by the utilities and the SAPP Co-ordination Centre.

Table 5: SAPP Generation Mix for 2012/13

	Technology										
	Coal		Hydro		Nuclear		CCGT		Distillate		Total
Country (Utility)	MW	%	MW	%	MW	%	MW	%	MW	%	MW
Angola (ENE)	492	32	833	55	-	-	190	13	-	-	**1 515**
Botswana (BPC)	282	64	-	-	-	-	-	-	160	36	**442**
DRC(SNEL)	-	-	2 442	100	-	-	-	-	-	-	**2 442**
Lesotho (LEC)	-	-	72	100	-	-	-	-	-	-	**72**
Malawi (ESCOM)	-	-	286	100	-	-	1	-	-	-	**287**
Mozambique (EDM &HCB)	-	-	2 573	97	-	-	-	-	51	3	**2 624**
Namibia (NamPower)	132	34	240	61	-	-	-	-	21	5	**393**
South Africa (ESKOM)	37 831	86	2 000	5	1 930	4	-	-	2 409	5	**44 170**
Swaziland (SEC)	9	12	63	88	-	-	-	-	-	-	**72**
Tanzania (TANESCO)	-	-	561	50	-	-	485	43	78	7	**1 124**
Zambia (ZESCO)	-	-	1 802	99	-	-	-	-	10	1	**1 812**
Zimbabwe (ZESA)	1 295	63	750	37	-	-	-	-	-	-	**2 045**
TOTAL MW	**40 041**		**11 622**		**1 930**		**676**		**2 729**		**56 998**
TOTAL %	**70**		**21**		**3**		**1**		**5**		**100**

Source: Analysis based on SAPP (2013a)

Due to old age or operation and maintenance challenges, the capacity available to meet demand is less than 52 GW against a demand of nearly 54 GW. Several countries are undertaking rehabilitation and new generation projects. Almost 1 100 MW additional capacity became available in 2012 and about 17 000 MW is planned for the period 2013 to 2016 (Table 6). Detailed information and estimated investment costs for the 2012-2025 projects are listed in Annexes 2 and 3. Differences in the totals between Table 6 and the annexes are due to the fact that the annexes refer to November 2011 while Table 6 has updated information as of the second quarter of 2013.

It is important to note that South Africa accounts for nearly four-fifths of the installed and available generation capacity and an average of 85% of the energy sent out and sold, as shown in Table 7 below. The country is currently the largest energy trader and a net exporter. Cahora Bassa in Mozambique is the largest source of imports for South Africa while Botswana, Namibia, Swaziland and Zimbabwe are its largest export markets. The dominance of South Africa's power sector relative to the rest of the SAPP implies that most regional strategies and projects are dependent on South Africa becoming a net importer.

Table 6: SAPP - Currently Committed Generation Projects (MW)

Country	2013	2014	2015	2016	TOTAL	
	MW	MW	MW	MW	MW	%
Angola	389	640	550	1 246	2 825	16
Botswana	600	-	-	300	900	5
DRC	55	-	580	-	635	4
Lesotho	-	-	35	-	35	-
Malawi	64	-	-	-	64	-
Mozambique	-	150	300	300	750	5
Namibia	-	-	120	50	170	1
South Africa	923	3 105	2 543	1 322	7 893	46
Swaziland	-	-	-	-	-	-
Tanzania	60	160	500	1 110	1 830	11
Zambia	230	315	600	164	1 309	8
Zimbabwe	-	300	30	300	630	4
TOTAL	**2 321**	**4 670**	**5 258**	**4 792**	**17 041**	**100**

Source: SAPP (2013b)

Table 7 illustrates the energy statistics from the 2012 report, which is close to a normal operating year with respect to the trading statistics.

Table 7: South Africa Capacity and Energy Demand Compared to the Rest

Country	Installed capacity 2013		Peak demand 2013		Available capacity 2013		
	MW	%All	MW	%All	MW	%All	%Peak
South Africa	44 170	78	42 416	79	41 074	79	97
Others	12 828	22	11 417	21	10 628	21	93
TOTAL	**56 998**	**100**	**53 833**	**100**	**51 702**	**100**	**96**

	Energy sent out 2012		Energy Sales 2012		Trading		
	GWh	%All	GWh	%All	Net imports	Net Exports	Net
South Africa	237 430	86	224 446	84	10 190	13 296	Exporter
Other countries	38 650	14	44 104	16	10 936	2 251	Importer
TOTAL	**276 080**	**100**	**268 550**	**100**	**21 126**	**15 547**	**Importer**

Source: Analysis from SAPP (2012a, 2013a)

2.2.1.1 Cost of Conventional Electricity Generation

The cost of conventional generation in SAPP is not in the public domain as members keep this confidential for trading purposes (Musaba, 2013). However, it is possible to get a good estimate from published information on SAPP trading activities. Emergency energy rates for 2011 ranged from USD 0.046 per kWh to about USD 0.21 per kWh, as reflected in Table 8. The average annual market clearing prices (MCP) on the Day-Ahead Market (DAM) have been steadily increasing since 2009 when the market was introduced.

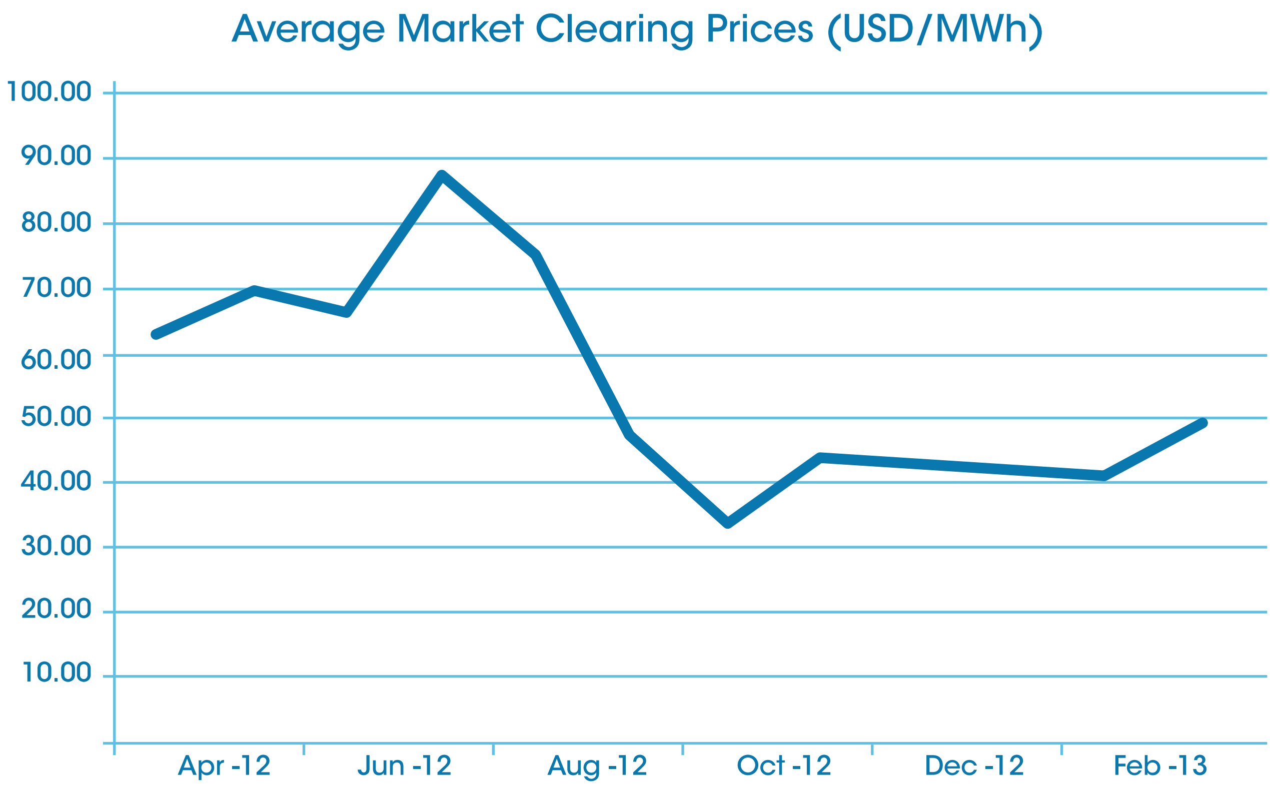
Table 8: SAPP - Market Trading Prices

Group	Country Utility	2011 Emergency rates		2009-2013 Average Market Clearing Prices (USD/MWh)			
		Time of Use	USD/MWh	2009/10	2010/11	2011/12	2012/13
1	Botswana (BPC)	Peak (0600-1100 Hrs) & (1700-2100 Hrs)	46.47	12.38	25.90	55.55	58.93
	DRC (SNEL)						
	Lesotho (LEC)						
	Namibia (NamPower)	Standard (1100-1700 Hrs)	46.47				
	Mozambique (HCB)						
	Swaziland (SEC)	Off-peak (2100-0600 Hrs)	46.47				
	Zambia (CEC & ZESCO)						
2	Mozambique (EDM)	Peak	150.00				
		Standard	150.00				
		Off-peak	150.00				
3	Zimbabwe (ZESA)	Peak	201.10				
		Standard	172.95				
		Off-peak	136.75				
4	South Africa (ESKOM)	Peak	213.90*				
		Standard	149.70*				
		Off-peak	85.50*				
NOTES: * Figures converted from ZAR to USD at 10:1; Emergency rate with no time of use: USD 46.47/MWh							

Source: Musaba (2013), SAPP (2013a), Time of use as defined in DAM Book of Rules SAPP (2009)

The variation of the DAM prices over a typical year is shown in Figure 3, which gives the figures for the year ending March 2013. The prices peak during the April to August period when consumption increases due to cold weather.

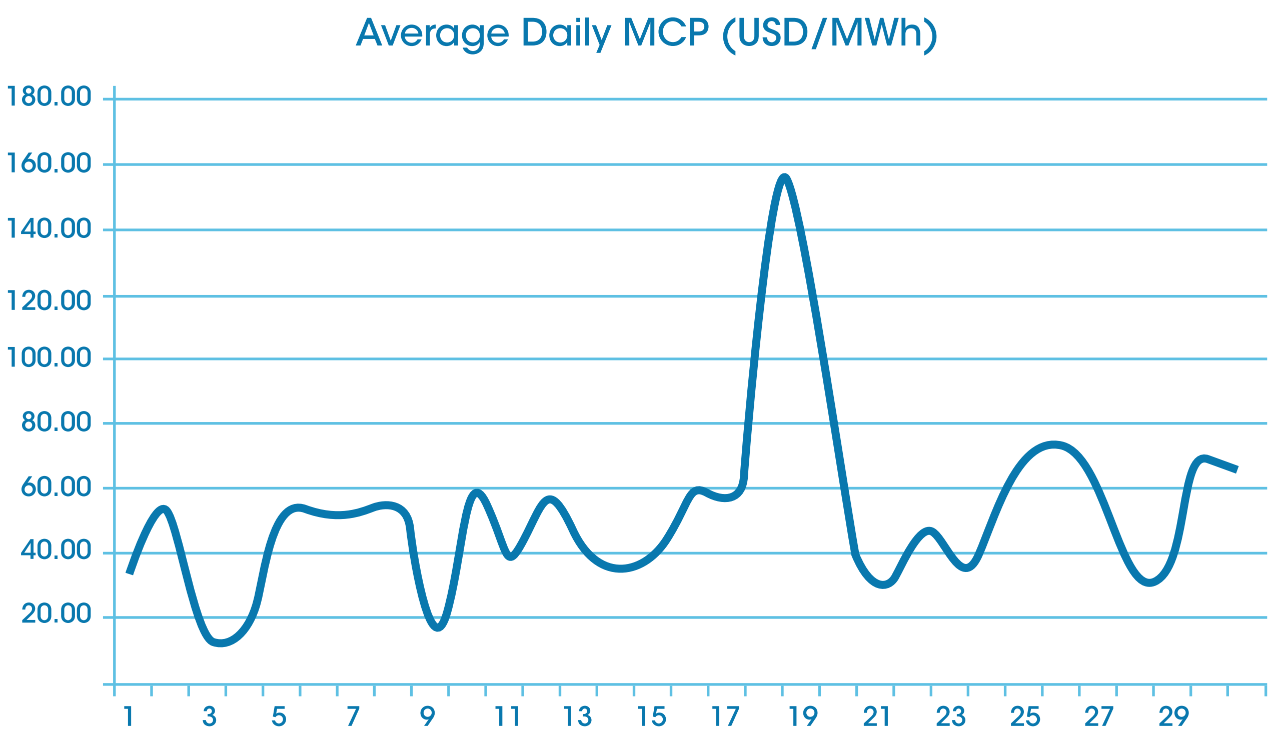
Figure 3: Annual Variation of DAM Market Clearing Prices (2012/13)



Source: SAPP (2013a)

During a month prices can remain steady until there is an emergency situation, as can be seen from Figure 4 for the month of April 2013.

Figure 4: Daily Average Market Clearing Prices for April 2013



Source: SAPP (2013c)

Costs for new generation projects are highlighted in the annexes and are summarised in Table 9. The estimated costs are overnight capital costs (which exclude financing), operation and maintenance.

Table 9: SAPP – Technology and Estimated Costs for New Generation

Generation technology	2012-2016				2015-2025			
	MW	% of total MW	MUSD	USD/kW	MW	% of total MW	MUSD	USD/kW
Conventional hydro	3 534	24	4 202	1 189	16 015	52	23 986	1 498
Coal	8 063	56	16 205	2 010	7 830	25	15 583	1 990
Gas	2 265	16	1 455	642	800	3	640	800
Distillate	-	-	-	-	5 750	19	2 012	350
Heavy Fuel Oil (HFO)	60	-	60	1 000	-	-	-	-
Co-gen	290	2	642	2 214	-	-	-	-
Wind	160	1	231	1 444	300	1	600	2 000
Solar	100	1	400	4 000	-	-	-	-
TOTAL	**14 472**	**100**	**195 23**	**1 603**	**30 695**	**100**	**42 821**	**1 395**

Source: Analysis based on SAPP (2011a)

Many of the costs are derived from the input data used for the SAPP 2009 Pool Plan Study (Nexant, 2008). The consultants noted inconsistencies in the data because many of the projects either lacked feasibility studies or had outdated studies in need of revision. The South African competitive bidding process called the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), which was introduced in 2011, has produced costs much lower than the SAPP estimates (see Table 10).

It is necessary to invest human and material resources to ensure that all project options have similar level of economic, environmental and social cost data. Other key assumptions that need investigation include firm and average generation figures for hydropower projects, and plant capacity factors, forced outage rates, quantity and quality of fuel for fossil-fuel projects.

2.2.1.2 Costs of Renewable Electricity Generation

Use of renewable energy for power generation in SAPP is mainly restricted to large-scale hydropower projects. The SAPP 2009 Pool Plan did not consider non-hydro renewable energy options such as wind and solar. Thus, the utility scale costs of most types of renewable electricity generation in the region must be inferred from other sources.

South Africa, which does not have large hydropower resources like its northern neighbours, has an independent power producer (IPP) programme promoting the development of non-hydro renewables such as solar PV, concentrating solar power (CSP) and wind. The REIPPPP was introduced by the Department of Energy in place of the Renewable Feed in Tariff (REFIT) scheme that had been planned by the National Energy Regulator of South Africa (NERSA). The costs from REIPPPP are much lower, especially for solar PV, compared to those proposed under the REFIT. The cost comparisons are given in Table 10, which also gives the international costs as researched by IRENA.

Table 10: Non-Hydro Renewable Cost Comparisons (Regional and International)

Generation technology	South Africa (SA)			IRENA	
	2012 SA REIPPPP (USD/kW)	2012 SA REIPPP (USc/kWh)	2009 NERSA Feed in tariffs (USc/kWh)	2012 USD/kW	2012 LCOE (USc/kWh)
Solar PV	2 889-3 471	16.5-27.6	23.1 – 39.4	3 600-6 000	15-31
CSP*	7 577-8 966	25.1-26.7	14-31.4	4 600-10 500	22-25
Wind	1 935-2 007	9.0-11.4	9.4 – 12.5	1 300-2 200	8-12
Bio-energy					5-6
NOTES: *The higher CSP costs reflect 3 to 15 hour storage; USD costs from 2010.					

Sources: Modise (2013), Musaba (2013), IRENA (2012)

Note: (SA figures converted at 10 Rand to 1 USD)

It is interesting but expected to note that the REIPPPP has produced prices that are generally more favourable than the REFIT scheme. The costs are also competitive when compared to levelised costs of energy from a survey of similar international projects. Preliminary results, from various media sources, on the three rounds of bidding under REIPPPP, indicate a sharp drop in tariffs proposed by bidders across all renewable energy technologies from the first to the third round.

2.2.2 Electricity Transmission and Interconnection Pricing

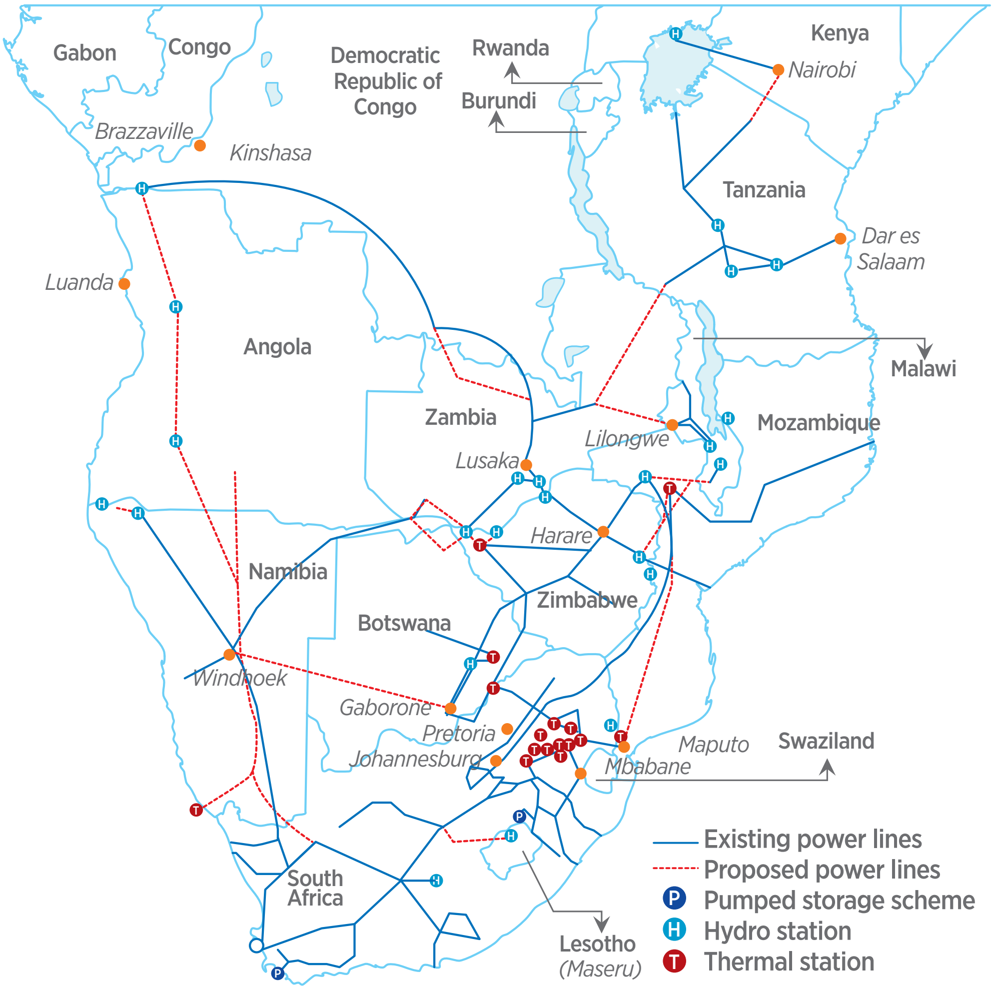
There are currently 16 SAPP members comprising 12 national power utilities from the 12 continental SADC countries[1] , two IPPs namely Hidroeléctrica de Cahora Bassa (HCB) of Mozambique and Lunsemfwa Hydro Power Company (LHPC) of Zambia and two independent transmission companies (ITCs), Copperbelt Energy Corporation (CEC) of Zambia and MOTRACO of Mozambique. The CEC is also an IPP.

Nine of the national utilities are interconnected and are SAPP operating members. The remaining three non-operating members – ENE of Angola, ESCOM of Malawi and TANESCO of Tanzania – are not yet connected to the SAPP grid. Two countries, DRC and Tanzania, are also members of the Eastern Africa Power Pool (EAPP). The DRC is, in addition, a member of the Central African Power Pool (CAPP).

A map showing the SAPP member countries, some power plants and an approximate layout of the regional grid is given below (Figure 5).

[1]SADC continental member countries are: Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. SADC island countries are: Madagascar, Mauritius and Seychelles.

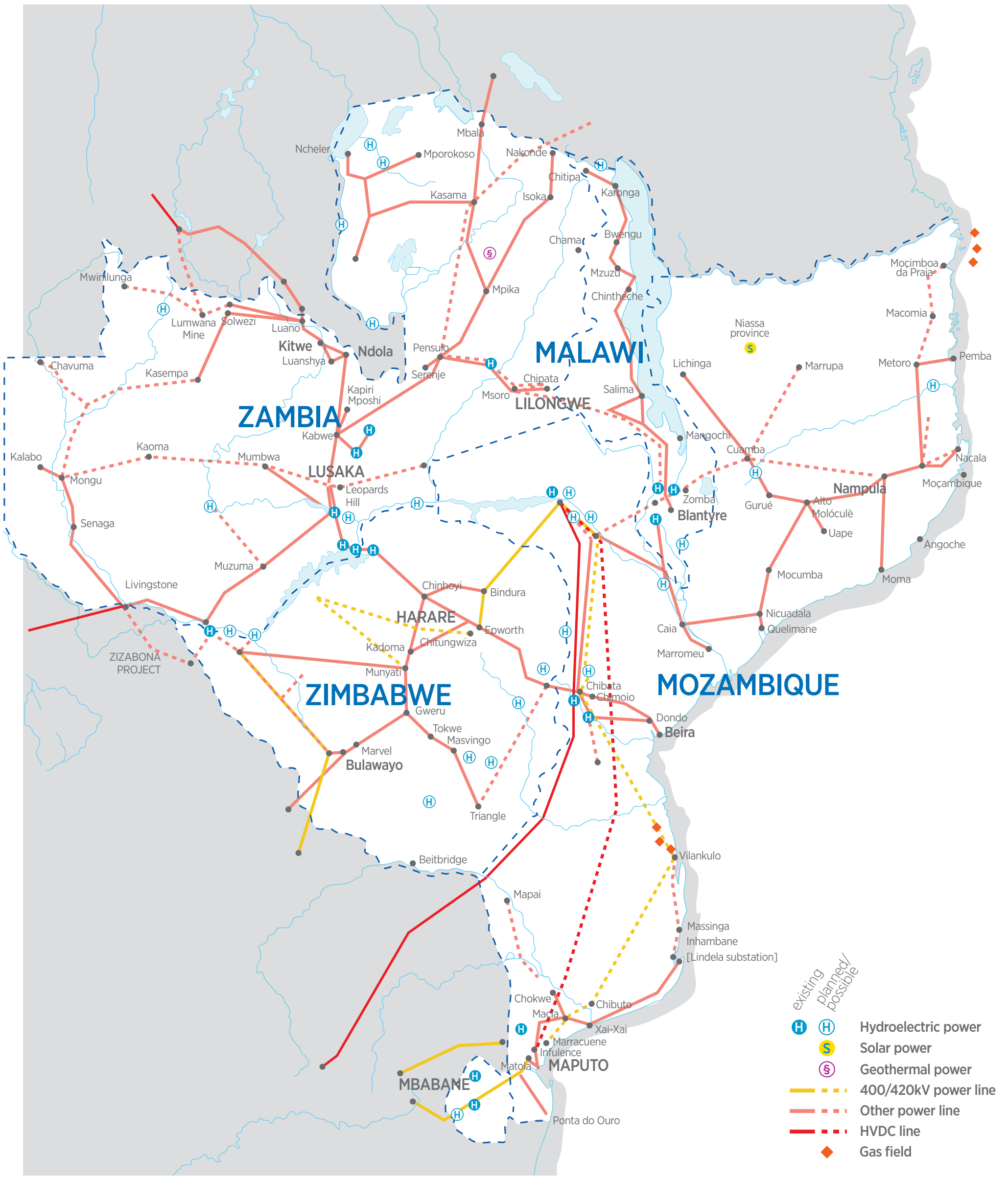
Figure 5: SAPP Map



Source: SAPP (2013a). Key: Blue lines are existing lines; red lines are proposed links to interconnect isolated members, evacuate power from new generating plants or to reinforce transmission corridors as detailed in the rest of the report.

The operation of the interconnected grid is split into three control areas where the system operators are ESKOM (covering Botswana, Lesotho, Southern Mozambique, Namibia, Swaziland and South Africa), ZESA (covering Zimbabwe and Northern Mozambique) and ZESCO (covering DRC and Zambia). The system operators are responsible for balancing supply and demand within their areas and for managing power flows between control areas within the set targets. Most of the power exchanges take place within the eastern and central area shown in more detail in Figure 6.

Figure 6: Existing and Planned Generation and Transmission Projects in the Zambezi Basin



Source: Adapted from SAPP

The synchronous operation of the grid from the Cape in South Africa to the DRC was made possible by transmission interconnections inherited from pre-SAPP days. The historical interconnections were designed for bilateral trading between neighbouring countries. SAPP started to transform from the interconnection to the shallow integration stage in 2001 with the introduction of a competitive short-term energy market (STEM). This trading platform was changed into the DAM in December 2009. The main difference between the STEM and DAM markets is the determination of the market clearing price at which trading takes place. STEM trades were at the sellers' offer prices but in the DAM all sellers receive the same market price established by the market operated by the SAPP Co-ordination Centre. In the DAM, the price at which demand matches supply is the market clearing price.

The competitive trading has exposed transmission network constraints, especially within the eastern and central corridors of the interconnected grid around the Zambezi Basin. The transfer limits for the interconnected members of SAPP, starting from the northern to the southern part of the grid, are highlighted in Table 11.

Table 11: SAPP 2011 Interconnection Capacity Statistics

Power Flow Direction		Number of lines & Voltage	Operational Transfer Limit	
From	To	kV	MW Flow Direction	MW Reverse Direction
DRC	Zambia	1x220	260	310
South through Zambia			**210**	**260**
Zambia	Zimbabwe	2x330	700	450 – 700
Zimbabwe	Mozambique	1x110	40	70
Mozambique	Zimbabwe	1x330	350	150
South through Zimbabwe			**300**	**-**
Zimbabwe	South Africa	1x132	20	-
Zimbabwe	Botswana	1x220	250	250
Zimbabwe	Botswana	1x400	300	450
Botswana	South Africa	1x400	300	270
Botswana	South Africa	3x132	150	225
Botswana	South Africa	1x132	75	225
South through South Africa			**1 800-1 900**	**1 800-1 900**
South Africa	Lesotho	2x132	100	100
South Africa	Namibia	2x220	225	500
South Africa	Namibia	1x400	410	500
South Africa	Mozambique	1x275	165	210
South Africa	Mozambique	1x110	200	200
South Africa	Mozambique	1x400	1 200	1 400
South Africa	Swaziland	1x132	70	85
South Africa	Swaziland	1x400	1 200	1 400
Swaziland	Mozambique	1x400	1 100	1 400
Mozambique	South Africa	2x533 HVDC	1 500	-

Sources: Adapted from SAPP (2011b)

Note: The gaps in the table mean that power transfer is possible only in one direction because of supply constraints or absence of demand in the reverse direction.

These transfer limits are largely due to thermal, voltage or stability limits. Trading among countries is largely through firm or non-firm bilateral contracts (over 95%) of anywhere from a duration of one month to several years. These trades take precedence in scheduling of power transfers. The

balance of the power is traded through the over-the-counter (OTC) market and DAM. Over-the-counter market is similar to bilateral trading but is for a shorter duration of up to one month to deal with short-term supply and demand balances. DAM is for one hour up to 24 hours to optimise use of available generation.
The expectation is that the DAM will increase as bilateral contracts are terminated. Until the transmission reinforcement projects are completed, transmission congestion may partially be managed by splitting the market into a number of bid areas to avoid transmission capacity being exceeded. Instead of a single market price, there are area prices established on the basis of area offers and bids.

Details of Competitive Trading Arrangements

Members wishing to sell on the DAM submit offers that define quantity and price. Members wishing to buy make a bid to purchase a defined quantity at a defined price. The SAPP Co-ordination Centre, which is the market operator, establishes a market clearing price (MCP) by aggregating all sell offers and buy bids to create supply and demand curves. Only the market participants and market operator know the individual sell and bid prices. The market clearing price, which is the intersection of the supply and demand curves, is what is published. The bidding in DAM happens a day before the actual operation and delivery of energy and the bids are in blocks of a minimum of one hour.

The impact of transmission constraints on trading is shown in Table 12, which summarises transactions over the period December 2009 to March 2013. Only 62.1 GWh was traded, which is only 27% of the 230.1 GWh that buyers and sellers had agreed to trade.

Table 12: Transmission Constraints on DAM Trading

From	Sell Offers	Buy Bids	Energy Matched	Energy Traded	Untraded Energy Matched
	GWh	GWh	GWh	GWh	GWh
2009 -2010	31.5	7.7	0.5	0.5	0
2010-2011	395.6	258.4	44.4	27.4	17.0
2011-2012	285.7	525.1	21.8	10.4	11.4
2012-2013	790.0	505.5	163.4	23.8	139.6
TOTAL	**1 502.8**	**1 296.7**	**230.1**	**62.1**	**168.0**

Source: SAPP (2013a)

Although energy matched is much lower than the sell offers and buy bids, the potential matches are actually higher because there is a post-DAM market, which emerges once the market clearing prices for the day are known. Many market participants are then willing to revise their offers and bids to the market clearing prices. Therefore the energy matched but not traded due to transmission constraints is potentially much higher than the 168 GWh shown.

The two critical links that are responsible for most lost trades is the 400 kV Cahora Bassa to Zimbabwe interconnector (currently operating at 330 kV) and the Zimbabwe to South Africa 400 kV interconnector through Botswana. The Zimbabwe National Grid also needs to be reinforced to allow more north-south power flows through this Central Transmission Corridor (CTC). Reinforcement and extension of the transfer capacity of these corridors is urgently needed to accommodate generation output from current and planned developments of new power stations within the Zambezi basin.

Transmission costs in the region are currently recovered on the basis of the distance based MW-km method where the purchaser pays a wheeling price that is based on the amount of power and a share of the cost of the transmission assets used along the length of the contractual transmission path. A fairer and more cost-reflective system, which is still under study, is the zone or nodal transmission pricing system whereby costs are recovered based on short-run marginal costs of transmission at each point in time. Short-run marginal costs in transmission are the costs associated with supplying an additional increment of transmission service without necessarily increasing transmission capacity. Such costs include energy wheeling charges, congestion charges and energy losses within the transmission network which are on average 13% of the total revenue realised on the Day Ahead Market (SAPP, 2013a).

Because of its impact on transmission investment, transmission pricing is an important agenda item for the power pool and the Africa Clean Energy Corridor.

2.2.3 Institutional Structures for System Planning and Operation

The SAPP is a subsidiary institution of the Southern African Development Community (SADC). SADC comprises fifteen member countries – twelve on the continent and three island nations of Mauritius, Seychelles and Madagascar. SAPP reports to the SADC Secretariat through the Directorate of Infrastructure and Services (DIS) (Figure 7).

Figure 7: SAPP Administrative Structure

The SADC Secretariat is based in Gaborone, Botswana and reports to the SADC energy ministers on all energy matters including those submitted by the SAPP Executive Committee. The executive committee, which is the Governing Authority of the Power Pool, comprises the chief executives or managing directors of the member electricity supply enterprises. Chairmanship rotates among the operating members. Effective control is vested in the chief executives/managing directors of the enterprises that are designated as the national utilities of the member countries.

The planning and operational functions of the power pool are vested in a management committee that is supported by relevant subcommittees and a co-ordination centre based in Harare, Zimbabwe. The management committee reports to the executive committee on non-routine and policy matters. The management committee comprises senior officials from the members who have the ability to make decisions relating to the planning and operation of the power pool and who are sufficiently senior to be alternate members of the executive committee.

Committees and sub-committees select their own chairpersons and meetings are held at least once or twice a year. The Co-ordination Centre facilitates the convening of the meetings and is also the secretariat and repository of all minutes, documents, information and data of the power pool. The centre also manages the energy trading and helps to co-ordinate the development of multinational projects.

2.2.3.1 Policy and Regulation

The SADC Protocol on Energy signed in Maseru on 24 August 1996 is the principal policy document governing the SADC energy sector. The protocol defines the following guidelines for co-operation in the electricity sector:

- Promote electricity trading and power pooling as described in the SAPP agreements adopted by the member states.
- Promote integrated resource planning to take advantage of economies of scale and optimisation of investment and sharing of benefits.
- Co-ordinate the development and updating of a regional electricity master plan.
- Promote the evolution of common regional standards, rules and procedures relevant to the generation, transmission and distribution of electricity including the standardisation of electrical manufacturing facilities.
- Develop and utilise electricity in an environmentally sound manner.
- Emphasise the provision of universal, affordable and quality customer service to all citizens.
- Encourage agreements between member and non-member states on regional electricity development and trade in accordance with the institutional mechanism established for the implementation of the protocol.

SAPP was established in August 1995 pursuant to the signing of an inter-governmental memorandum of understanding (IGMOU). The IGMOU was updated in 2006 to allow for expanded membership from new SADC member countries as well as new electricity supply enterprises arising out of the restructuring of the power sectors of the member countries. In addition to designated national power utilities, membership is now open to IPPs, ITCs and other relevant service providers.

The IGMOU is the principal document governing the SAPP. Other supporting documents, in order of importance, are the inter-utility memorandum of understanding (IUMOU), the agreement between operating members, operating guidelines and any other guidelines.

The Mandate of SAPP

According to the SAPP IGMOU (SAPP, 2006), the power pool was established to enable all participants to:

a) Co-ordinate and co-operate in the planning, development and operation of their systems to minimise costs while maintaining reliability, autonomy and self-sufficiency to the degree they desire; (emphasis added)

b) Fully recover their costs and share equitably in the resulting benefits, including reductions in required generating capacity, reductions in fuel costs and improved use of hydro-electric energy; and

c) Co-ordinate and co-operate in the planning, development and operation of a regional electricity market based on the requirements of SADC member states.

The SAPP mandate focuses on hydro-electric energy where joint development allows countries to share the benefits of economies of scale. IRENA can help the power pool and member countries increase the scope of regional co-operation to include a wider range of renewable energy technologies.

Electricity Regulation

Subsequent to the establishment of SAPP, many countries in the SADC region restructured their power sectors and established electricity regulatory agencies. In order to fulfil the objective of harmonisation of electricity sector rules and procedures to promote regional co-operation, the regulatory agencies soon recognised the need to form an association as a regional regulatory counterpart to SAPP. The SADC energy ministers approved the establishment of RERA at a meeting in Maseru, Lesotho on 12 July 2002. RERA was launched on 26 September 2002 in Windhoek, Namibia and its secretariat became functional in 2005. RERA is one of the members of the African Forum for Utility Regulators (AFUR).

Eleven of the fifteen SADC countries have energy or electricity regulators, and ten of the eleven are members of RERA. The remaining 4 countries (Botswana, the DRC, Mauritius and the Seychelles) are at various sector reform stages that include plans to establish independent energy regulatory agencies. The ten RERA member regulators are in countries that are SAPP member states:

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

RERA has the following three strategic objectives:

a) **Capacity-building and information sharing:** Facilitate electricity regulatory capacity building among members at both a national and regional level through information sharing and skills training.

b) **Facilitation of electricity supply industry policy, legislation and regulations:** Facilitate harmonised electricity supply industry (ESI) policy, legislation and regulations for cross-border trading, focusing on terms and conditions for access to transmission capacity and cross-border tariffs.

c) **Regional regulatory co-operation:** Deliberate and make recommendations on issues that affect the economic efficiency of electricity interconnections and electricity trade among members that fall outside national jurisdiction, and to exercise such powers as may be conferred on RERA through the SADC Energy Protocol.

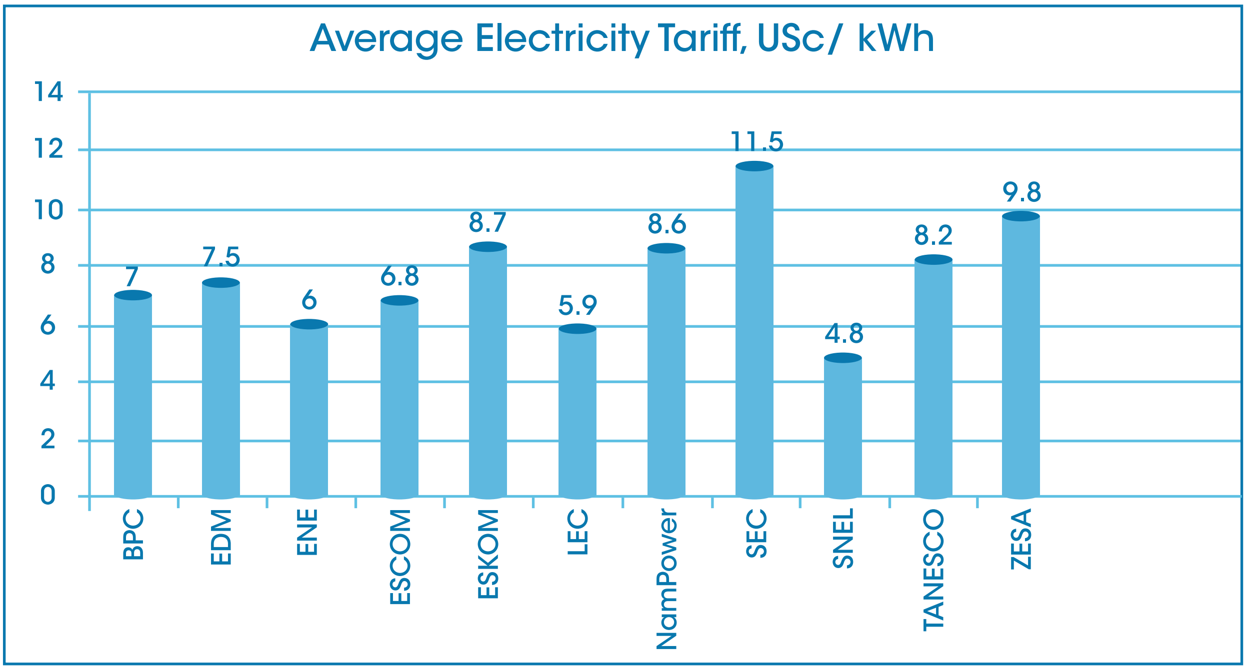
Pursuant to these objectives RERA has so far addressed two key regulatory issues – guidelines for cross-border trading and adoption of cost-reflective tariffs.

With support from the World Bank, RERA developed its Guidelines for Regulating Cross-border Power Trading in the SAPP (RERA, 2010). This was the first concrete step towards the goal of harmonisation of regulatory practices among the exporting, importing and transit countries involved in electricity trading. The guidelines were approved at the 31st SADC Energy Ministers Meeting held in Luanda, Angola in 2010. There the ministers urged SADC member states to adopt the guidelines to create an enabling framework for new investment in transmission and generation facilities in order to expand electricity trading in the region. The guidelines are focussed on long-term transactions rather than the short-term DAM transactions.

At the 33rd SADC Energy Ministers Meeting held in Maseru, Lesotho on 16 May 2013, it was noted that only seven RERA members had formally adopted the guidelines. This slow pace in adopting regional guidelines is the unfortunate consequence of totally subordinating the regional plans to national priorities.

In 2005 the SADC energy ministers agreed at their meeting held in Namibia to implement cost-reflective tariffs and in 2008 a target of achieving cost-reflectivity within five years was adopted. The 2013 SADC Energy Ministers Meeting observed that only three SAPP member states, namely South Africa, Swaziland and Zambia, had expressed commitment to achieve full cost-recovery by the end of 2013.

Figure 8: SADC Utility Tariffs for 2012/13



Source: SAPP Annual Report (2013)

In order to contribute to the adoption of cost-reflective tariffs RERA intends to have regular publication of electricity tariffs and other indicators. The publications will be able to indicate the gap between existing tariffs and the full-cost recovery levels. The SAPP Annual Report for 2013 provides the current average tariffs as shown in Figure 8. The acronyms are further elaborated in Table 13 below.

Table 13, which illustrates the financial performance of the utilities, helps to assess the extent of cost-reflectivity of the tariffs. The statistics reflect poor financial performance and accountability by most utilities characterised by non-existent information, low or negative rates of return and poor revenue collection with money tied up with debtors. Since most utility revenues are in local currencies and the conversion to USD is at official exchange rates that may not reflect the true market rates, the figures are likely to be an over-estimation. Some utilities do not even have the financial results or have rates of return figures that are inconsistent with the net income figures, for example positive net income and negative rate of return and vice versa. There are also significant mismatches between the reported average tariffs and the average revenue per unit. This demonstrates the need for regulators to exercise better oversight on financial reporting and performance by utilities.

Table 13: SAPP – Utility Financial Performance for 2012/13

Country	Utility	Sales		Revenue	Reported average tariff	Net Income	Rate of Return	Debtors
		GWh	MUSD	USc/ kWh	USc/kWh	MUSD	%	Days
Angola	ENE	3 427	513.4	15.0	6.0	?	?	64
Botswana	BPC	3 118	216	6.9	7.0	22.0	-6.0	69
DRC	SNEL	6 323	?	?	4.8	?	?	?
Lesotho	LEC	488	31.5	6.5	5.9	5.1	5.2	32
Malawi	ESCOM	1 476	90	6.1	6.8	38.0	15.0	74
Mozambique	EDM	2 380	?	?	7.5	?	?	37
Namibia	Nampower	3 648	310	8.5	8.6	53.0	6.0	41
South Africa	ESKOM	224 446	13 649	6.1	8.7	1 247.0	2.91	22
Swaziland	SEC	1 018.6	14.4 1	11.2	11.5	9.7	7.0	70
Tanzania	TANESCO	3 770	2 77.3	7.4	8.2	-19.1	4.86	240
Zambia	ZESCO	10 688	350	3.3	5.7	60.0	9.0	107
Zimbabwe	ZESA	7 367	469	6.4	9.8	-120.0	-34	157
TOTAL		**26 8149.6**			**7.5**			
NOTES: ? denotes information that is not available.								

Source: Analysis based on SAPP (2013a)

2.2.3.2 Electricity Market Structure

Internationally and regionally, electricity market structures have been evolving according to the following models:

- **Stage I - Vertically-integrated monopoly:** A single entity is responsible for regulation, generation, transmission, distribution and retail. The regulation function is jointly exercised with the energy ministry where the utility has recommendatory authority. This was the traditional structure of SADC utilities when SAPP was established in 1995.

- **Stage II – Vertically-integrated single buyer with IPPs:** Multiple generating companies compete to supply the vertically integrated utility. Regulatory functions are removed from the utility to avoid the conflict of interest involved in having the vertically integrated utility being a referee and player. The regulatory functions should ideally be vested in an independent regulatory agency in order to minimise political interference, especially in tariff setting and revenue collection. In practice it takes time for governments to have sufficient trust to grant full independence to regulatory agencies. The regulatory agencies usually start as semi-independent entities, notwithstanding the legal provisions. This is the structure that is now prevalent in most SAPP member states.

- **Stage III - Unbundled industry with wholesale competition:** Separate entities are in place for generation, transmission, distribution and retail supply of electricity. Independent regulatory agencies and system- and market-operators are introduced. A competitive wholesale market is established for large customers, distributors and retailers who are connected at high and medium voltages. Open access to transmission and sub-transmission lines is necessary. This is the structure that would be more supportive of the transition of SAPP from shallow to deep regional integration.

- **Stage IV - Unbundled industry with retail competition:** This is similar to the previous structure with expansion of choice to retail customers. Open access to transmission, sub-transmission and distribution lines is necessary. This is the final stage of competition and is expressed in the SAPP Vision, which aims to give the end user a choice of supplier.

Although member states are at the second stage of having vertically integrated single buyer national utilities with IPPs and semi-independent regulatory agencies, the SAPP is at the third stage where there are several generators supplying a regional grid within an emerging competitive wholesale market. As already highlighted, the competitive wholesale market is currently operating under severe generation and transmission infrastructure constraints, which reflect shortcomings in the planning processes and financial structures for the power pool.

2.2.3.3 Planning Processes

Relationship between Regional and National Plans

The SADC Protocol on Energy promotes co-ordinated integrated resource planning for economies of scale and optimisation of investment and equitable sharing of benefits. The current SAPP mandate in the IGMOU allows countries to determine the level of autonomy and self-sufficiency they desire. Consistent with the IGMOU, the IUMOU provides for a regional integrated generation and transmission plan that is "purely indicative and shall not create an obligation upon the members to comply" (SAPP, 2007) (emphasis added).

It is important to understand the background to these provisions, which were influenced in part by negative historical experiences. The cases of South Africa and Zimbabwe are illustrative. In 1977/78 the largest hydropower station in SADC, the 2 075 MW Cahora Bassa Hydroelectric Project, was commissioned. The power station was developed by the Portuguese colonial government of Mozambique on the basis of a long-term power purchase agreement by Eskom of South Africa. Power was supplied through two HVDC power lines from Songo to Apollo Substations. In 1981 the HVDC power lines were sabotaged during the civil war in Mozambique, interrupting supply for 17 years. The impact on Eskom was mitigated by the surplus coal-fired capacity that it then had. National plans in South Africa and other importing countries have to factor this real risk of sabotage of transmission lines.

Zimbabwe has been interconnected to Zambia since the Kariba Hydroelectric Scheme was commissioned in 1960. The subsequent development of the Kafue Hydroelectric Power Station (900 MW) in the early 1970s and the Kariba North Bank Power Station (600 MW) in 1977 ensured secure and reliable power supply to both countries throughout Zimbabwe's war of independence. The pre-independence government in Zimbabwe initiated the development of the Hwange Coal Power Station (920 MW) to manage possible politically-motivated power supply interruptions. The station was commissioned after Zimbabwe's independence between 1983 and 1986. Teething problems on the power station were not felt by the Zimbabwean consumers due to the strong interconnection with Zambia, which was able to provide emergency support in addition to the long-term firm power supply contract.

Unfortunately this positive scenario came to an abrupt end in 1989 when a fire led to the extended total shutdown of Kafue Power Station. This was followed almost immediately thereafter by what turned out to be an extended drought period that severely curtailed the firm energy output from Kariba from the 10 000 GWh assumed from commissioning to just under 4 000 GWh. Zambia had no option but to declare force majeure and suspend the firm power exports to Zimbabwe. With no reserve capacity and increasing demand Zimbabwe had no option but to introduce severe load shedding. The country then adopted the following generation expansion planning criteria, recorded in unpublished internal planning documents of the utility:

- **Reliability:** The minimum reserve level to be carried shall be at least 10.6% of demand for thermal based power and 7.6% for hydro power and a weighted average for a combination of both.

- **Security:** The minimum level of internal generation shall be equal to or greater than 100% of demand. Internal generation shall be committed when existing reserve levels drop below the reliability margin.

- **Economy:** Firm imports may exceed the reserve margin as long as the security criterion is met and sources of energy are significantly diversified in both technology and geography and are cost-effective relative to local options.

These experiences introduce a clear division in focus for regional and national plans. Regional plans are focussed on reliability and economy while national plans are focussed on security. This is reflected in the SAPP and national plans that are described in the next section.

Historical and Current SAPP Plans

The development of SAPP regional master plans started in 2001 when Purdue University, with funding from the United States Agency for International Development (USAID), assisted with the development of models of the interconnected grid. The World Bank subsequently funded the latest SAPP master plan completed by Nexant Consultants in 2008/09, herein referred to as the SAPP 2009 Pool Plan. The objective of the 2009 Plan was to estimate the financial benefits of co-ordinated regional planning to meet projected demand over the period 2005-25 in contrast to individual national plans (Nexant, 2008).

The base case was developed as the sum of the individual national plans which had an undiscounted cost in 2006 of USD 138.6 billion. An alternative case, which assumed the development of the least cost regional projects with no funding or transmission constraints, was estimated to cost USD 89.3 billion, a saving of USD 47.5 billion. The cost savings were due to reduction of excess generation capacity inherent in uncoordinated planning throughout the region and to substitution of new nuclear generation in South Africa with large hydropower imports. This clearly demonstrated the potential economic benefits of co-ordinated planning and development on a regional basis.

The consultants qualified these findings by highlighting the need to undertake or update feasibility studies in order to provide more consistent and accurate data for capital costs, firm and average generation for hydro power plants and the availability and cost of fossil fuels and the forced outage rates of fossil fuel plants. For the short-term the recommendations were to give priority to increasing output from existing power stations by continuing with rehabilitations, de-mothballing and extensions.

With these qualifications, and in addition to the fact that regional plans are only indicative and non-binding on member states, the SAPP 2009 Pool Plan could therefore not be adopted as a guide for investment projects. There are plans to revise the regional plan using more accurate data and better assumptions. In the meantime selection of projects is guided by a multi-criteria prioritisation process. The criteria and relative weighting assigned are summarised in Table 14.

Table 14: SAPP Generation Project Prioritisation Criteria

Project Selection Criteria	Weight (%)	Best if	Weak if
Levelised Cost	20	Cost is low (<4USc/kWh)	>13 USc/kWh
Percentage of Regional Contribution	15	Contribution is high (>80%)	<20%
Economic impact (GDP & Jobs)	10	Regional	Localised impact
Size of Project	10	> 1 000 MW	<50 MW
Project lead time	10	Short (<2015)	> 2019
Percentage off take committed	10	High (>80%)	<20%
Climate Change Impact	10	Low or positive	High or negative
Cost of transmission	10	Existing infrastructure	>750 km
# of Participating Countries	5	>5	1
ALL	**100**	**Score >50%**	**Score < 50%**

Source: SAPP (2012b)

The criteria used reflect an optimum combination of cost, regional power generation and economic impact, project size, lead time, committed off-take, climate change impact, transmission cost and number of participating countries.

Each country, through its national utility, submits a government-approved generation and transmission plan to the SAPP Co-ordination Centre. The planning sub-committee, facilitated by the Co-ordination Centre, compiles a list of projects from the different national plans and ranks them on the basis of approved criteria. The projects that score above a defined level, currently 50%, are accepted as SAPP Priority Projects and recommended to the SADC energy ministers through the SADC Secretariat. The lists of the SAPP Priority Projects that are derived from this process are in Annex 4.

Table 15 provides an interesting contrast between the current SAPP priority projects and the recommended SAPP 2009 Pool Plan. The total proposed additional capacity is almost the same but the generation mix is very different.

Table 15: SAPP Priority Projects versus SAPP 2009 Pool Plan

Generation Technology of Capacity Addition	SAPP 2009 Pool Plan		SAPP 2012 Priority Projects	
	MW	%	MW	%
Hydro	18 045	32	14 646	26
Coal	23 883	42	9 650	17
Nuclear	-	-	9 600	17
Gas & distillate	14 758	26	7 620	14
Non-hydro renewable	-	-	14 100	26
TOTAL	**56 686**	**100**	**55 616**	**100**

Source: Nexant, (2008), SAPP (2012c)

It is also interesting to see the contrast between national and regional plans in terms of import dependency and self-sufficiency (Table 16).

Table 16: Self-Sufficiency versus Import Dependency in National and Regional Plans

Country (Utility)	2010 Actual	2025 National Plan	2025 Pool Plan
Angola (ENE)	Self-sufficient	Self-sufficient	Self-sufficient
Botswana (BPC)	Importer	Self-sufficient	Importer
DRC (SNEL)	Exporter	Self-sufficient	Exporter
Lesotho (LEC)	Importer	Self-sufficient	Importer
Malawi (ESCOM)	Self-sufficient	Exporter	Exporter
Mozambique (EDM& HCB)	Exporter	Exporter	Exporter
Namibia (Nampower)	Importer	Self-sufficient	Exporter
South Africa (ESKOM)	Self-sufficient	Self-sufficient	Importer
Swaziland (SEC)	Importer	Importer	Importer
Tanzania (TANESCO)	Self-sufficient	Exporter	Importer
Zambia (ZESCO)	Self-sufficient	Exporter	Exporter
Zimbabwe (ZESA)	Importer	Exporter	Exporter
KEY	**Self-sufficient = import/export < 5% of own generation**		
	Importer = net imports > 5%of own generation		
	Exporter = net exports > 5% of own generation		

Source: Analysis based on Nexant (2008), Analysis based on SAPP (2010)

It is evident that countries are naturally risk-averse and prefer to be self-sufficient or net exporters. When they import they want to do so in their own currency, which may not be the same as the currency preferred by the seller. In SAPP the trading currencies are US dollar (USD) and South African rand (ZAR). Eskom prefers to purchase in ZAR while most exporting countries prefer to trade in USD.

Renewable Power Options in SAPP Plans

The SAPP 2009 Pool Plan does not recommend additional nuclear power and did not consider non-hydro renewables. Instead the plan relies heavily on coal and hydropower for base load and on gas and distillate for peaking capacity. South Africa's Integrated Resource Plan (IRP) of 2010 has a significant amount of non-hydro renewables. The South African selection criteria and their relative weights as used to develop the 2010 IRP are shown in Table 17.

Table 17: South Africa Generation Scenario Prioritisation Criteria

Country (Utility)	2010 Actual	2025 National Plan
CO2 emissions	21.74	Emissions are minimised
Investment and operational cost	21.74	Least cost
Technology uncertainty	19.57	Proven technology
Localisation potential (%value addition, jobs, etc.)	15.22	High
Water usage	10.87	Water use is minimised
Regional development	10.87	Imports are maximised
ALL	**100**	**Optimum balance**

Source: Republic of South Africa, Department of Energy (2010)

The recommended scenario on the basis of these criteria was one that provided an optimum balance of these criteria (hence the designation "Balanced or Revised Balanced Scenario"). That scenario was then adjusted to reflect policy decisions to accelerate new renewable energy technologies (wind and solar); commit to significant amounts of nuclear power for security of supply, delay the imposition of CO_2 emission constraint to 275 million tonnes per year (thereby bringing forward new clean coal projects) until 2025; and limit hydro imports to 6% of new capacity addition. Table 18 provides a summary of the policy-adjusted revised balanced scenario.

Table 18: South Africa Recommended IRP (2010-2030)

Generation Technology		New Capacity		Generation Mix (%)	
		Amount in GW	Share (%)	2010	2030
Coal		6.3	15	90	65
Nuclear		9.6	22	5	20
Renewables	Hydro import	2.6	6	5	5
	Solar	8.4	20	-	9
	Wind	8.4	20	-	
	CSP	1.0	2	-	
Other	Gas turbines	6.3	15	-	1
TOTAL		**42.6**	**100**	**100**	**100**

Source: Republic of South Africa, Department of Energy (2010)

South Africa accounts for four-fifths of SAPP's total generation and demand. Therefore the adoption of significant nuclear and non-hydro renewables in the IRP reduces the level of imports of hydropower from the region, which is contrary to the major assumption behind the SAPP 2009 Pool Plan.

2.2.3.4 Financial Structure of SAPP

SAPP is registered as a non-profit organisation incorporated in Zimbabwe, whose purpose is to co-ordinate the planning and development of electricity interconnections between SADC member states and expand electricity trading in the region. The power pool's main assets are land, buildings and computer equipment.

The operating budget of SAPP covers the cost of running the Co-ordination Centre and its activities in supporting the work of the sub-committees. This is shared among members in accordance with guidelines that are agreed from time to time. The formula that had been used since the inception of the power pool resulted in the largest utility (ESKOM) and the Co-ordination Centre (CC) host utility (ZESA) carrying half of the budget. This formula has been recently reviewed to make it more equitable (Table 19). IPPs, ITCs and other members are charged a flat 5% of the SAPP operating budget.

Table 19: SAPP Co-ordination Centre Operating Budget Sharing Formula

Operating budget sharing criteria	Old formula (to 2010) (Weight (%))	New formula (from 2011) (Weight (%))
Annual peak demand	10	5
Thermal Rating of interconnectors	10	10
Imported energy	15	10
Exported energy	15	10
Host member	10	5
General member	40	60
TOTAL	**100**	**100**
IPP; ITC; service providers	3	5

Source: SAPP (2011c)

The Co-ordination Centre is now also earning DAM administration and participation fees as the market operator. Support from international co-operating partners (ICPs) for operating expenses has been focussed on specific projects such as studies for the development and implementation of the competitive electricity market. Approved administrative capital expenditure is shared equally among the members or funded by special funds from ICPs.

Financing of the generation and transmission infrastructure is the responsibility of the governments, utilities and investors.

2.2.3.5 Role of Development Partners

ICPs have played the critical catalytic role that has made SAPP the most operationally advanced power pool in Africa, notwithstanding its restricted mandate with respect to development of new generation and transmission facilities. **They have assisted in two main roles: provision of technical assistance and provision of credit facilities for projects.** Due to limited public sector credit facilities the technical assistance from government agencies has been directed at creating an enabling environment to attract the more substantial private sector financial resources.

The most active partners for SAPP and renewable energy have been the Scandinavian countries (Denmark, Finland, Norway and Sweden), Canada, the United States of America, the European Union and the United Kingdom. Other partners include the World Bank, European Investment Bank and the Development Bank of Southern Africa (DBSA).

The specific role of the various partners and the assistance given is briefly summarised below:

a) **Norway (through the Norwegian Agency for Development Cooperation):** Norway provided support for the operation of the SADC Energy Sector Technical and Administrative Unit (TAU), which was based in Angola until its functions were transferred to the Directorate of Infrastructure and Services of the SADC Secretariat in Botswana. Through TAU, Norway also funded meetings of energy ministers and officials, as well as the first meeting of the SADC electricity sub-committee in 1990, which brought together relevant utilities. The utilities immediately decided to fund their own subsequent meetings, which accelerated the establishment of the power pool. Donor assistance was then extended towards feasibility studies, planning and implementation of transmission lines within Zimbabwe and Mozambique, including the interconnections to Cahora Bassa, which became the key building blocks for the SAPP grid, and the planning for the Mozambique backbone project. Current on-going assistance has centred on facilitating development of a competitive wholesale power market and capacity building of the SAPP in competitive market management and operations.

b) **Sweden (through the Swedish International Development Agency):** Sweden supported the feasibility studies and financing for the development of the Cahora Bassa-Zimbabwe Interconnector and has supported studies for transmission pricing and ancillary services market.

c) **Denmark (through the Danish International Development Agency):** Denmark helped achieve the synchronous operation of the SAPP grid by providing technical assistance to analyse and solve power swings on the 400 kV Zimbabwe-South Africa interconnector through Botswana.

d) **Finland (through the Ministry for Foreign Affairs of Finland):** Finland's support has come through the Energy and Environment Partnership (EEP) Programme, cofounded by the Austrian Development Agency (ADA) and the UK Department for International Development (DFID), supporting renewable energy and energy efficiency studies (pre-feasibility, feasibility, pilot and demonstration project) implemented in 13 southern and east African countries. Finland has provided technical assistance for renewable energy and energy efficiency strategy in the SADC, which includes support for the development of the SADC Renewable Energy Strategy and Action Plan (RESAP).

e) **United States of America (through the US Agency for International Development):** The United States supported secondment of a power pool expert from the New York Power Pool to provide advisory services to help establish and operate the Co-ordination Centre; supported the development of the SAPP regional grid planning model; and has been supporting capacity building through visits of subcommittees to American counterpart institutions.

f) **United Kingdom (through the Department for International Development)**: The United Kingdom supported studies for transmission wheeling and third party access to help develop competitive electricity trading.

g) **Canada (through the Canadian International Development Agency):** Canada supported the development of the 220 kV Zimbabwe-Botswana Interconnector.

h) **Austria (through the Austrian Development Agency):** Upon the recommendations of Finland's International Development Agency including support for the development of the RESAP, the United Nations Industrial Development Organisation and Austria are the main donors supporting the establishment of the SADC Renewable Energy and Energy Efficiency Centre (SACREEE). The establishment of SACREEE is still at initial stages but the Centre is expected to drive the development of energy efficiency and renewable energy in the region.

i) **World Bank:** The World Bank supported the SAPP telecommunication project to enable communication between the control centres. It also supported the SAPP 2009 Pool Plan studies.

j) **European Investment Bank (EIB):** The EIB supported development of the Zimbabwe-South Africa Interconnector.

k) **Other technical assistance partners:** The Development Bank of Southern Africa (DBSA), European Union Energy Initiative Partnership Dialogue Facility (EUEI-PDF), International Renewable Energy Agency (IRENA), Renewable Energy and Energy Efficiency Partnership (REEEP), and the UN Sustainable Energy for All (SE4ALL) provided technical assistance for supportive framework conditions to increase renewable and power sector investments in the SADC.

l) **Other project financing partners:** The Development Bank of Southern Africa (DBSA), French Development Agency (FDA), African Development Bank (AfDB), Government of China and China Export and Import Bank provided credit facilities for generation and transmission feasibility studies and project implementation for national and international projects with a regional impact and part of the SAPP priority projects.

The focus of the co-operating partners on technical assistance in order to unlock private sector investment is desirable but has so far not been very effective judging by the fact that the region and Africa in general, continues to lag behind in terms of attracting private funding for energy investments. The problem is caused in part by the limited involvement of the private sector in the policy and planning process. The history of the SAPP is a case study in the effectiveness of involving the target stakeholders. For 10 years the Government of Norway sponsored meetings of government officials to discuss power pooling. It was only necessary to sponsor one meeting in 1990 that brought together the electricity utilities to unlock the utility resources for further meetings. This accelerated the creation of the desired power pool.

3. INFRASTRUCTURE FOR RENEWABLE POWER DEVELOPMENT

3.1 Renewable Energy Resources and Potential

The renewable energy resource potential for many SADC countries has not been fully assessed. Although South Africa has committed to significant renewable energy in the country's IRP, there is recognition of the need to invest in research to reduce the uncertainties with respect to cost, lead times, capacity credits, capacity factors and durability of renewable energy technologies.

The non-hydro renewable resources, particularly wind and solar, are estimated to be several orders of magnitude greater than the hydropower potential (Tables 20) but countries still need to carry out more detailed and site specific resource assessments.

Table 20: Technical Potential for Renewable Energy for Power Generation

Technology	Potential TWh/year	Present Utilisation TWh/year
Hydro	660	~ 50
Wind	800	Negligible
Bioenergy	>11 000	~10
Geothermal	20-25	Negligible
Solar	>20 000	Negligible
General member	40	60

Source: SADC (2012b)

For large-scale hydropower potential in the major river basins in SAPP, namely, the Zambezi, Congo and Kwanza, the general estimates of potential are known (Table 21) but very few sites have had feasibility studies undertaken.

Table 21: Hydropower Potential of Main River Basins in the SAPP

River Basin	Operational MW	Planned MW	Potential MW
Congo	840	40 000-46 957	100 000-123 600
Zambezi	4 904	9 729	14 200-16 000
Kwanza		-	6 700
(Compare Nile Basin)	5 407	13 404	45 000

Source: Nexant (2008), AfDB (2012)

At present the focus of regional co-operation in SADC is not on renewable energy but to facilitate the development of the large hydropower potential in the region. The highest priority projects being the Cahora Bassa North Bank Extension and Mphanda Nkuwa both in Mozambique, Batoka Gorge (Zambia/Zimbabwe) and Inga 3 in the DRC.

a) **Cahora Bassa North Bank Extension, Mozambique:** This is a project that involves the installation of a minimum of 850 MW up to 1 245 MW and increasing the capacity of the spillway at the existing dam. While the project can no longer be commissioned by 2015, it could still be completed before 2020 with more serious development efforts.

b) **Mphanda Nkuwa, Mozambique:** This is a 1 500 MW project to be developed 61 km downstream of the Cahora Bassa Dam. Construction of a regulating reservoir further downstream can increase the capacity to 2 400 MW for mid-merit operation.

c) **Batoka Gorge, Zambia/Zimbabwe:** This is a 1 600 MW project 50 km downstream of the Victoria Falls on the Zambia/Zimbabwe border on the Zambezi River.

d) **Inga 3, DRC:** Up to 4 800 MW can be developed in two phases – 1 800 MW low head scheme which does not require a dam and a 3 000 MW scheme with a dam, which will be the initial phase of the Grand Inga Dam with potential capacity of 40 000 MW. South Africa and the DRC are already jointly conducting feasibility studies and a framework for the development of the project.

A key agenda item for the ACEC is technical assistance for countries to undertake renewable energy resource assessments and identify feasible project sites with sufficient environmental, economic and social cost information. Systematic measurements of river flows and wind and solar resources are needed on a continuing basis. SADC countries have started co-operating with IRENA in collecting data for the Global Solar and Wind Atlas and in undertaking renewable readiness assessments (RRA), which are a first level and high level assessment. The SADC Secretariat has been directed by the SADC Energy Ministers to finalise the framework for co-operation with IRENA. All but two member states (Botswana and Malawi) have signed the IRENA statute or deposited instruments to that effect.

Through its Energy Sector Management Assistance Program (ESMAP) in 2012, the World Bank launched an initiative to support resource mapping and geo-spatial planning at the country level. SADC member states Lesotho (wind), Madagascar (biomass, small hydropower, solar and wind), Tanzania (biomass, small hydropower, solar and wind) and Zambia (small hydropower, solar and wind) are involved in the initiative.

3.2 Filling the Gaps in Transmission Plans

Nine of the 12 SAPP member countries are interconnected through the national grids and interconnectors that were planned or developed before the establishment of the power pool. The current SAPP Priority Transmission Projects fall into three categories:

a) **Interconnecting the three non-operating members**

b) **Strengthening transmission corridors used for wheeling power through the grid**

c) **Evacuating power from new generation projects**

The different project categories and their current status are summarised in Table 22.

Table 22: SAPP 2012 Priority Transmission Projects

Project Category	Project Name	Planned Capacity (MW)	Planned Date	Status
1. Interconnecting non-operating members	Zambia-Tanzania-Kenya	400	2016	Feasibility study
	Mozambique-Malawi	300	2016	Implementation planning
	Namibia-Angola	400	2016	Feasibility study terms of reference
	DRC-Angola	600	2016	Feasibility study terms of reference
	Zambia-Tanzania-Kenya	400	2016	Work in progress on Zambia- Tanzania side. Feasibility study on Tanzania-Kenya side
2. Relieving congestion	Zimbabwe/Zambia/Botswana/ Namibia interconnector (ZIZABONA)	600	2017	Implementation planning
	Central Transmission Corridor (CTC), Zimbabwe	300	2016	Work in progress & feasibility study review
	Kafue-Livingstone upgrade, Zambia	600	2014	Work in progress
	North-west upgrade, Botswana	600	2016	Implementation planning
3. Evacuating power from new generation	Mozambique backbone (STE) Phase 1	3 100	2018	Implementation planning
	Mozambique backbone (STE) Phase 2	3 000		Implementation planning
	2nd Mozambique-Zimbabwe	500	2016	Feasibility study
	2nd Zimbabwe-South Africa	650	2016	Feasibility study
	2nd DRC-Zambia	600	2016	Feasibility study

Source: Analysis based on SAPP (2012d)

With respect to the second and third category projects, the SAPP has been considering the development of a "super grid" or "strategic network" to create a North-South Corridor that allows transfer of hydropower from the Zambezi, Kwanza and Congo basins to the south and transfer of thermal power from the south to the north. This would allow the power pool to provide greater reliability and economy during wet years and security during prolonged drought conditions.

The need for such a "super grid" was identified in the SAPP 2009 Pool Plan, which recommends a 765 kV HVAC system from the DRC-Zambia border to South Africa through Zambia and Zimbabwe as shown in Figure 9. The components of the super grid were defined as follows:

a) HVDC Reinforcement in the DRC: This entails increasing the capacity of the 500 kV HVDC link from Inga to the DRC-Zambia border. The use of alternating current thereafter is to allow for multiple injection and off-take points in order to support trading among many parties along the route.

b) A 765 kV Central Corridor: This corridor would take off from the HVDC terminal station and step down in the Zambian Copperbelt region, branching into two legs, one going to Kariba and linking to the Tete region in Mozambique (picking up the Cahora Bassa and Mphanda Nkuwa power stations) and another going towards Hwange in Zimbabwe. The two branches would then meet in Bulawayo, Zimbabwe before going to South Africa via Botswana to link up with South Africa's 765 kV internal grid that extends to the Western and Eastern Cape and KwaZulu Natal. The choice of voltage was based on the fact that South Africa has already built 765 kV lines that are currently operating at 400 kV.

c) A 400 kV Western Corridor (WESTCOR): This corridor exists from Inga through to Angola. The idea of this corridor was later extended by SAPP member countries to link up Namibia, Botswana and Western Cape.

d) A 400 kV Eastern Corridor: This corridor extends from Malawi, interconnecting to the 765 kV grid in the Tete region and then going through the rest of Mozambique to Maputo and then back to the 765 kV grid in South Africa. The Eastern Corridor would include the interconnection of Tanzania to the Zambian grid.

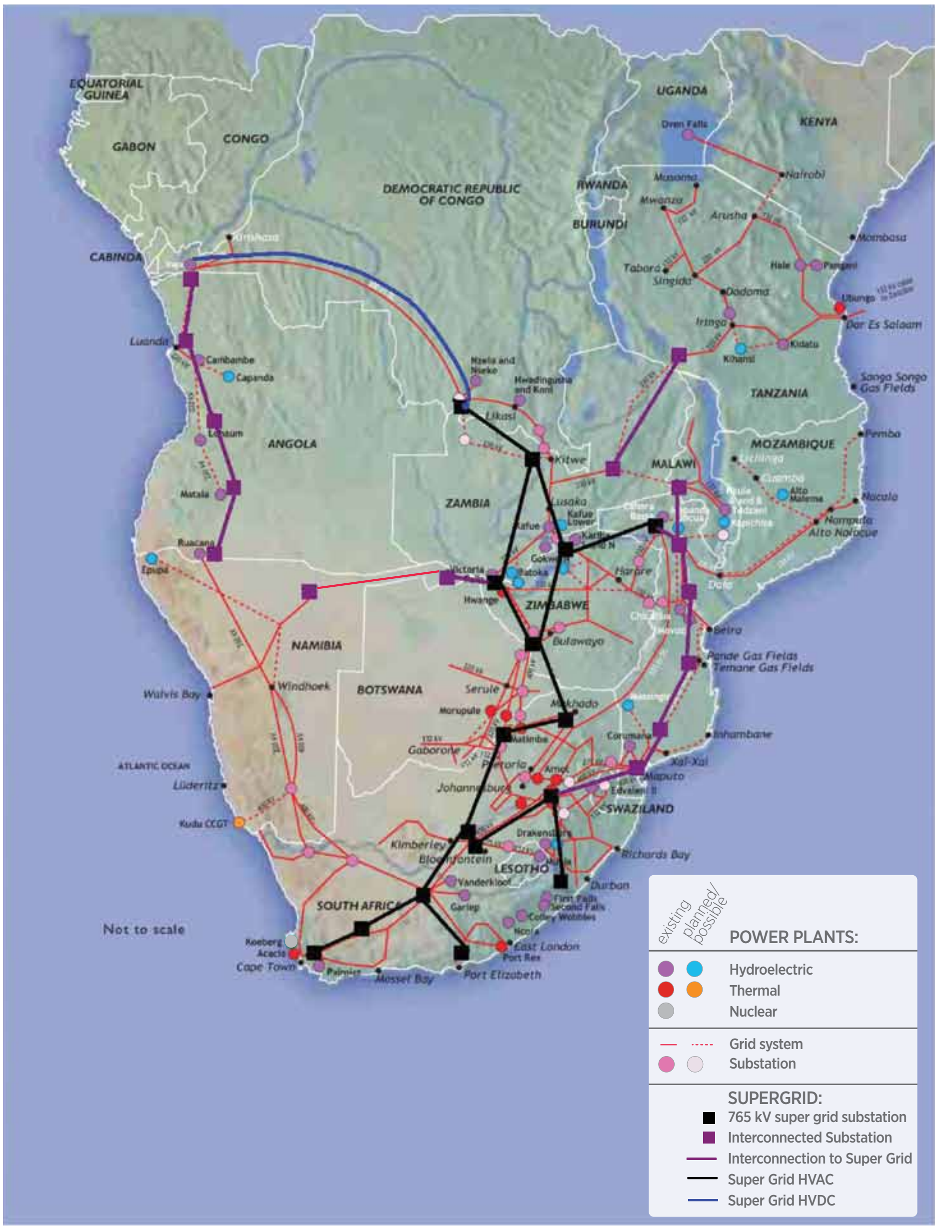
The identification of the gaps and corridors that need reinforcement is a relatively simple task compared to the preparation of bankable project proposals. Transmission projects that are associated with specific generation projects can easily be financed through long-term power purchase agreements between the identified sellers and buyers. The first and third category of projects – the interconnection of non-operating members and evacuating power from new generation projects – can be developed on this basis. Unfortunately this means that the projects can only be developed when long-term power purchase agreements can be entered into.

Merchant Transmission Investments

The challenge of developing the Africa Clean Energy Corridor requires a solution for the financing of projects to relieve congestion where it is difficult or impossible to get creditworthy buyers and sellers to underwrite the investments. These would have to be merchant investments that are developed in the hope of getting a market. This is where the zonal or nodal transmission pricing system can be of assistance.

When there is no congestion the whole system is one zone and has the same market clearing price. When there is congestion the system is split into separate zones with different clearing prices reflecting the supply and demand balance in the areas. In the case of SAPP the zones can be the three control areas under Eskom, ZESA and ZESCO respectively. Congestion on the Zambia-Zimbabwe, Mozambique-Zimbabwe and Zimbabwe-South Africa corridors results in higher market clearing prices in the Eskom area than in the ZESA area, which in turn will be higher than the ZESCO area prices. The price differentials represent "congestion income" that could accrue to a merchant transmission investor. The SAPP Co-ordination Centre is best placed to undertake such studies and use them at investment promotion conferences to attract merchant transmission investors.

Figure 9: Recommended Super Grid for 2009 Pool Plan

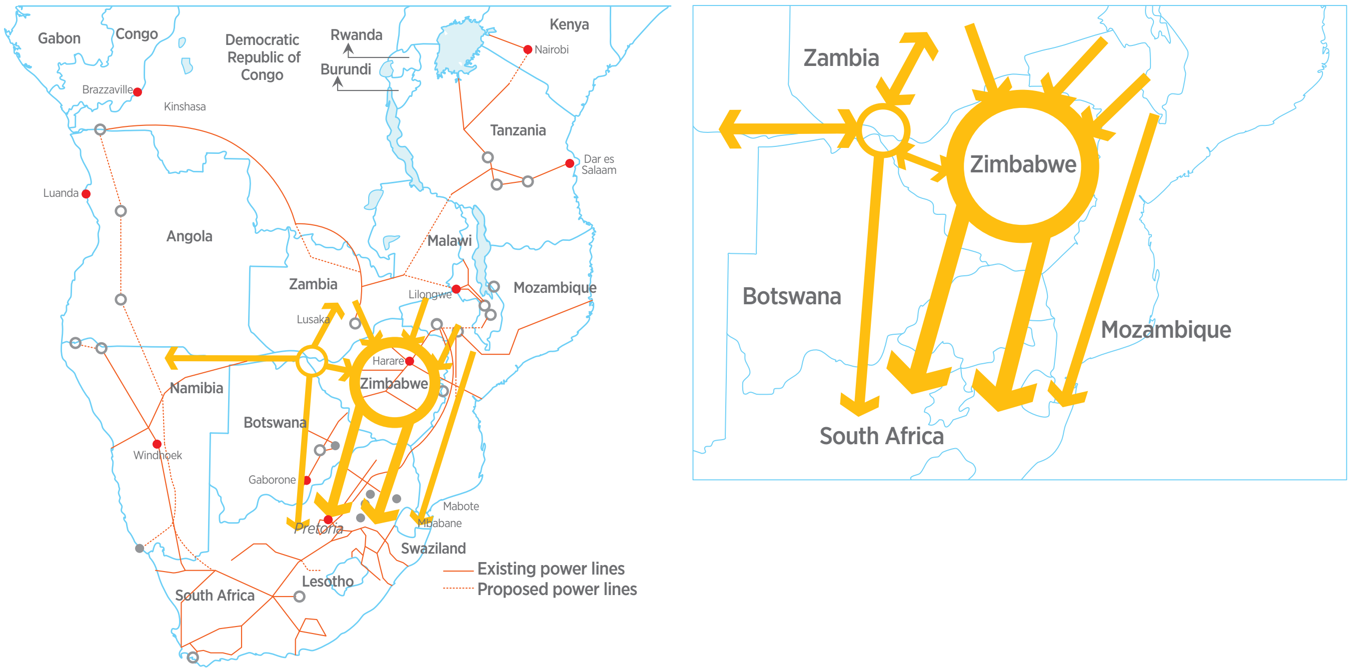


Source: Adapted from SAPP Regional Expansion Plan Study – Draft Final Report (Volume 2), November 2007

The 300 MW transfer capability that is the objective of the current projects within the Central Transmission Corridor in Zimbabwe is not adequate for the objectives of the strategic network, which require much higher transfer capability. A joint ZESA and ESKOM working group has therefore been established that is studying options for increasing transfer capacity through Zimbabwe to cater for existing and proposed generation projects according to the strategic network concept. Preliminary studies have identified the need for adding extra 400 kV lines along existing interconnectors to Cahora Bassa in Mozambique, Kariba North in Zambia and Matimba in South Africa via Botswana. In addition to a new direct 400 kV link between Zimbabwe and South Africa through the Limpopo province, a new 400 kV link between Mutare in Zimbabwe and the proposed HVAC backbone in Mozambique is also proposed. The 400 kV voltage level, which is much lower than the 765 kV proposed in the Draft 2009 SAPP Pool Plan Study, was found to be adequate for the level of trading expected in the pool.

These studies are guided by the need to evacuate power from the SAPP Priority Generation projects, which are concentrated in the Zambezi basin. A "super ring" centred in Zimbabwe, called the Central Transmission Corridor (CTC), indicated by the big red circle in Figure 10, serves to secure supplies to the major load centres in Zimbabwe while providing injection and off-take points to transfer power to any of the adjacent countries.

Figure 10: Strategic Network Concept



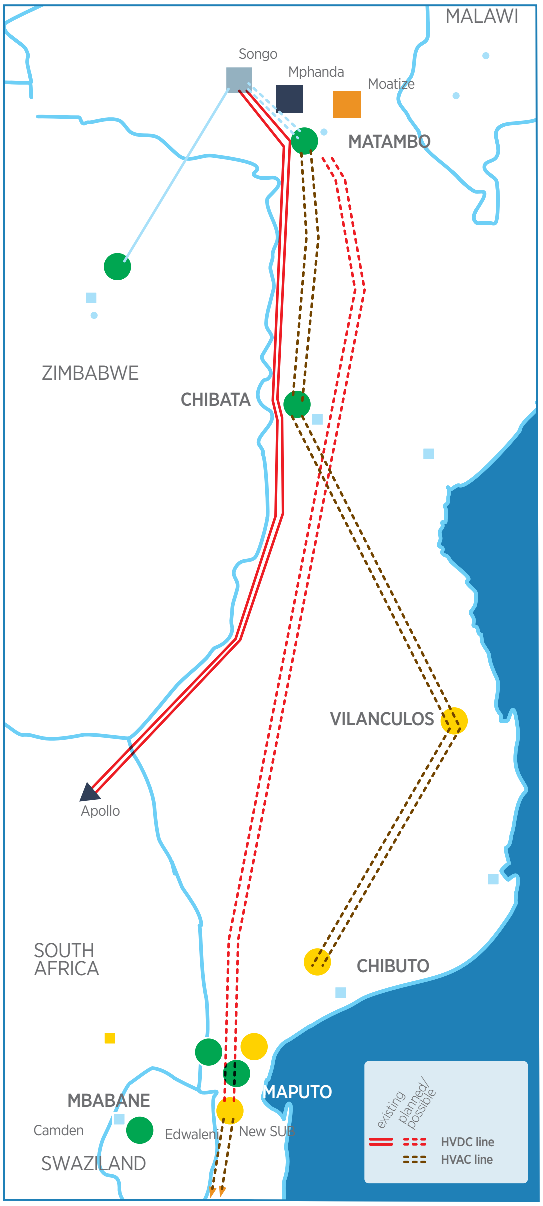
Source: Adapted from SAPP

The arrows on the north of the ring are corridors that facilitate injection of generation from Malawi, Mozambique, Zambia and the DRC. Projects are already proposed or in progress to upgrade the Kafue-Livingstone and North-West Botswana transmission lines. Two major power transfer routes into South Africa are provided from this central hub. The two routes would be designed to provide the redundancy required to improve reliability, stability and security.

A smaller ring in north-western Zimbabwe represents the integration of the Zimbabwe, Zambian, Botswana and Namibian grids that allows that region to exchange power with the central transmission corridor and to provide a Western Corridor into South Africa through Botswana in the event of a CTC contingency. There is a proposed project called Zimbabwe-Zambia-Botswana-Namibia Interconnector (ZIZABONA), a name that reflects the four participating countries, which will link this smaller ring to the existing Caprivi HVDC link to Namibia. The western corridor from this ring is a future proposed corridor with size and capacity requirements unknown at this stage. It is different from the Western Corridor (WESTCOR) project that is proposed to link the DRC, Namibia, Botswana and South Africa.

Another alternate power transfer route into South Africa is the eastern corridor, which is already proposed as the Mozambique (STE/CESUL) backbone project (Figure 11).

Figure 11: Proposed Mozambique Backbone Project HVDC (direct route) & HVAC



Source: SADC-SAPP-RERA Investment Conference Preparatory Workshop, Harare 18-19 June 2009

The SAPP priority transmission projects are the building blocks for a regional super grid and the Africa Clean Energy Corridor including links to Eastern African Power Pool. Since most of the projects are still at the feasibility study phase, the terms of reference can be reviewed by the SAPP Management Committee to incorporate the vision of the Africa Clean Energy Corridor concept.

3.3 Business Models and Financing

The business models for funding current and proposed transmission projects fall into the following categories:

a) **National utility:** The majority of transmission projects within SAPP have been developed by national utilities using commercial or concessional funding backed by government guarantees or power purchase agreements. The projects for relieving congestion are more suited to this model of funding and development.

b) **Special purpose vehicles (SPVs):** These are legal entities created by sponsors to carry out a specific purpose or a series of activities on behalf of the sponsors. Several utilities may partner through an SPV to develop a transmission project. The Mozambique Transmission Company (MOTRACO), a potential member of SAPP, is a model for a multi-lateral special purpose vehicle for developing a transmission project. MOTRACO is owned by the national utilities of Mozambique, Swaziland and South Africa and was created to supply power from ESKOM to an aluminium smelter near Maputo.

c) **Privatisation:** The CEC of Zambia owns and operates the transmission network in the Copperbelt. The network, originally developed by the mines, was then nationalised and taken over by the national utility ZESCO, before being re-privatised. The CEC is now also investing in renewable power generation projects.

d) **Public Private Partnerships (PPPs):** Although not yet implemented in practice, special purpose vehicles similar to MOTRACO could be created based on PPP model. This is a model being considered for the Mozambique backbone, Zimbabwe-Zambia-Botswana-Namibia Interconnector (ZIZABONA) and Western Corridor (WESTCOR) projects.

The national utility model works well with respect to bilateral trading on the basis of long term power purchase agreements. The main disadvantage is that most utilities in the region do not have investment grade credit ratings and have to rely on sovereign support and guarantees to access funding from bilateral and multilateral financial institutions and development banks. The study for the 2009 SAPP Pool Plan identified BPC, Eskom, NamPower and LEC as the only utilities with investment or near-investment grade credit ratings. Government-guaranteed funding can have concessionary terms but can take long to put in place.

Creditworthiness is dynamic. ESKOM has traditionally funded projects through domestic and international financial markets because it has a long history of charging cost-reflective tariffs and a good revenue collection and payment record. However, now that the costs are going up very steeply due to the new expansion projects, ESKOM is having problems getting approvals for cost-reflective prices. When the utility recently applied for a five-year tariff increase of 16% per annum the regulator approved only half of the increase proposed. On the other hand, ESKOM is purchasing power from IPPs at prices higher than its current selling price. Its 2012/13 annual report notes that the utility purchased 1 135 MW and 3 516 GWh from IPPs at an average price of 83.6 ZARc/kWh against revenue of 58.49 ZARc/kWh.

If this trend were to continue to a point where costs increase faster than prices, ESKOM would no longer be a creditworthy off-taker. Some credit rating agencies have already begun downgrading ESKOM from investment grade. To manage its exposure to exchange risk ESKOM prefers to sign power purchase agreements in South African rand while exporters prefer United States dollars or other internationally convertible currencies.

Increasing Private Sector Investment

The other models involve private sector investment resources, which can be significantly higher than the public sector funding sources. This approach is the recommended PIDA financing strategy, which involves the development of domestic capital markets and creation of conditions conducive to attracting foreign direct investment (UNECA/AUC, 2012). While it is important that countries create efficient financial and banking systems and attend to the legal and regulatory issues for attracting investment, the primary source of funding is from electricity customers and users. Except for limited grant funding from national governments and international donors who do not need to be paid back, equity and debt providers are a secondary source of funding motivated by the expectation of a return. That is why the forecasting of demand is such an important element of a transparent regional planning process in the Africa Clean Energy Corridor.

Accessing funding from private equity and debt requires a high level of predictability with respect to the policy, legal and regulatory framework for member utilities and the power pool. There is therefore a need for a paradigm shift with respect to the enabling institutional arrangements.

3.4 Enabling Institutional Arrangements

The only SAPP institutional arrangement for renewable power development is a renewable energy taskforce under the planning sub-committee whose work so far has been to produce terms of reference for a study to develop a framework for promoting renewable energy in the SADC.
The Renewable Energy Strategy and Action Plan should have defined such a framework but the draft report has a small section describing the institutional roles of various stakeholders such as the SADC Secretariat, national governments, development partners, financial institutions, private sector, research institutions, civil society and service providers. The energy division of the SADC Directorate of Infrastructure and Services, which is supposed to have an oversight and co-ordinating role, is severely understaffed as it has only two fulltime officers, one of whom is on a limited donor funded contract.

An institutional environment that supports renewable energy and other power sector investments can simply be described as one that has capacity to consistently achieve the following:

- Ability to plan, finance, construct, operate and maintain infrastructure projects and programmes to provide products and services on time, budget and specification;
- Sustained ability to charge cost-reflective but competitive prices to the primary providers of finance, namely the customers who pay for electricity services;
- Ability to collect revenue; and
- Ability to convert the revenue from domestic currencies to the currency required to pay equity returns and debt service.

The objective is to provide the predictability that is required by secondary financial providers, namely investors and financial institutions (equity and debt providers) both foreign and domestic. These provide the resources to create the products and services required by the customers.

This environment is lacking in the SAPP as demonstrated by the shortcomings quoted earlier from the Regional Infrastructure Development Master Plan (SADC, 2012a). The following recent experiences highlight capacity shortcomings in construction, operation and maintenance of generation and transmission infrastructure:

a) **Project implementation supervision is weak:** Two major generation projects [2] under construction in the region have exposed the lack of skills in supervision resulting in significant cost and time overruns and performance shortfalls.

b) **Operation and maintenance capacity for major import options is weak:** Assuming that projects are finally delivered to specification, the actual output can still be lower than expected due to capacity deficiencies during operation and maintenance. The latest annual report by ESKOM notes that imports from Cahora Bassa were reduced from 1 500 MW to 650 MW for four months due to prolonged outage of converter station after equipment failure (Eskom Holdings, 2013).

These shortcomings that have been experienced with conventional power systems did not augur well with renewable energy technologies which require new skill sets.

[2]The Morupule B Power Station in Botswana was due to have been completed in October 2012 but due to performance defects revealed at commissioning the contractors are still on site trying to resolve problems. The Government of Botswana has hired independent investigators to establish reasons. Medupi Power Station in South Africa was expected to cost ZAR 87 billion with first unit to reach commercial operation in 2013 but is now expected to cost ZAR 105 billion with its first unit to be commercially operative in mid-2014 (Sunday Times, 2013).

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Key Findings and Conclusions

4.1.1 Africa Clean Energy Corridor and Programme for Infrastructure Development in Africa

The ACEC is an initiative consistent with continental priorities:

a) The transmission backbone of the ACEC could be provided by the North-South Transmission Corridor under the PIDA being implemented by NEPAD. The corridor's implementation would benefit from the inclusion of all stakeholders involved in the planning and implementation of PIDA such as the African Union Commission, NEPAD Planning and Co-ordination Agency, United Nations Economic Commission for Africa and the African Development Bank.

b) The implementation framework should be guided by the Institutional Architecture for Infra structure Development in Africa (IAIDA) which is illustrated and described in Annex 5. IAIDA's objective is to streamline the institutional framework to avoid conflicts of interest and overlapping jurisdiction.

c) The SADC Protocol on Energy promotes electricity co-operation with non-SADC countries and therefore there is no legal barrier to the envisaged interconnection with the Eastern Africa Power Pool.

4.1.2 Renewable Resource Assessment

At present the focus of regional co-operation in SADC is to facilitate the development of the large hydropower potential in the region. The highest priority projects include the Cahora Bassa North Bank extension and Mphanda Nkuwa both in Mozambique, Batoka Gorge (Zambia/Zimbabwe) and Inga 3 in the DRC.

The corridor provides an opportunity to increase awareness of other abundant non-hydro renewables such as wind and solar and can help in efforts in generating credible data. There is a lack of credible data that can be used to review regional and national electricity master plans to include non-hydro renewables. Some countries in the region such as Mozambique, Tanzania and Zambia have started to work with IRENA to undertake high level renewable readiness assessments (RRAs) as well as the World Bank to conduct country-level resource mapping and geo-spatial planning.

4.1.3 Planning Challenges

SAPP faces a number of planning challenges the most significant of which are:

a) **Poor data quality:** Besides the limited range of renewable energy technologies, and on the top of the poor basic energy statistics, the input data needed for planning studies is based on information that is not supported by feasibility studies, or is based on outdated studies. Some of the input parameters that need to be reviewed are capital costs of projects; firm and average energy generation figures for hydro options; availability, cost and quality of fossil fuels; and forced outage rates and plant capacity factors.

b) **Inconsistent demand forecasts:** SAPP plans are based on forecasts that are an extrapolation of historical trends notwithstanding the regional and international targets for universal access, which call for policy based forecasts. There are many uncoordinated demand forecasts that need to be reconciled.

c) **Inconsistencies between regional and national plans:** SAPP's mandate defines regional plans as indicative and non-binding and therefore subordinate to national plans of member states. Regional plans focus on reliability and economy and have demonstrated that potential savings from co-ordinated development are substantial. National plans focus on security and reflect the fact that countries are risk averse, prefer to be self-sufficient or net exporters and to import using their own currencies, in contrast to sellers who need to be paid in currencies that enable the payment of equity returns and debt service.

d) **Historical experiences which have made national plans more risk-averse:** The sabotage of transmission lines as a result of civil war in Mozambique and the declaration of force majeure due to drought and catastrophic equipment failure in Zambia are some of the factors that have resulted in the subordination of regional plans to national priorities instead of the reverse.

e) **Variability and perceived uncertainty of renewable energy technologies:** Renewable energy technologies have daily and seasonal variations in power and energy output, impacted in part by uncertainties such as climatic conditions. There is limited technical knowhow and capacity by the SAPP and member states to integrate large amounts of renewable technologies in to the grid. The South African IRP demonstrates the effect of such technological uncertainties. The decision to commit 42% of new capacity addition to new renewable energy technologies increases the share of renewables in South Africa from 5% in 2010 to 14% in 2030 but introduces technological uncertainties with respect to validity of cost assumptions, lead times, life times and performance. Import options are restricted due to perceived risks associated with cost, construction delays, long transmission lines, and impacts of climatic conditions. To manage these perceived uncertainties, a nuclear powered generation fleet of 9 600 MW is included in the plan.

f) **Project selection and prioritisation criteria:** SAPP ranks projects in accordance with several selection and prioritisation criteria. The challenge is to seek consensus on the parameters that help to balance competing objectives.

4.1.4 Challenges to Creating an Enabling Market Environment

International experience shows that regional power sector integration evolves from interconnections, to shallow integration (sometimes called "loose power pool") and then to deep integration ("tight power pool"), where there are maximum benefits. The following is the current situation in SAPP:

a) SAPP is a loose power pool within a regional market structure characterised by vertically integrated single buyer utilities for IPPs under the oversight of semi-independent regulatory agencies.

b) There is a mismatch between the national and regional market structures. The regional structure is a competitive wholesale market with multiple buyers and sellers but without the oversight of an empowered regulatory authority.

c) Consistent with the status of SAPP as a loose pool, similarly RERA is the counterpart that aims to harmonise rules and regulations and to regulate inter-country issues that are not under the jurisdiction of the national regulators. The Regional Electricity Regulators Association (RERA), which comprises 10 out of the 12 member states, has developed cross-border trading guidelines and is promoting the adoption of cost-reflective tariffs to support new investment. Without the legal authority to enforce the guidelines and cost-reflective tariffs, there has been poor response by member countries to harmonise regulatory frameworks for cross-border trading.

d) Most utilities in SAPP have poor financial performance – low profitability and uncollected revenue. Sector reforms designed to achieve a turnaround of utility performance are not yet producing the desired results. Many of the utilities do not have investment-grade credit ratings.

e) The Protocol on Energy allows progression to deep integration but this is currently limited by the SAPP agreements that limit co-operation to a best-efforts basis.

4.1.5 Transmission Constraints Affecting Electricity Trading

Although SAPP is the most advanced power pool in Africa in terms of operating experience, the benefits have been limited due to limited interconnectivity and transmission congestion:

a) Nine out of twelve member states are part of the regional grid which was planned and developed before SAPP was established. Three have remained unconnected since SAPP was established and projects to interconnect them are still on the drawing board.

b) The bulk of the trading in SAPP is based on long-term bilateral contracts of one month to several years; a competitive DAM of 1 to 24 hour duration to optimise use of available generation, and an over-the-counter market of up to a month to cater to short-term supply and demand situations. Transmission constraints restrict trading to less than 30% of potential.

c) The congested corridors that are responsible for the bulk of lost trades are the Cahora Bassa-Zimbabwe Interconnector, the Central Transmission Corridor through Zimbabwe and the Zimbabwe-Botswana-South Africa Interconnector. Without transmission constraints the potential market is higher as there is an emerging post-DAM market where suppliers and buyers are willing to revise their bids to the declared market prices.

d) The SAPP Co-ordination Centre could promote the development of merchant transmission lines on the basis of congestion income arising from transmission constraints.

4.1.6 SAPP Strategic Network or "Super Grid"

The SAPP has started to plan for a strategic network or "super grid" designed to increase the north-south power transfer capacity on the interconnected grid, thereby relieving the congestion that now limits electricity trading. A working group has been established to study and recommend a phased programme for the strategic network. SAPP's objective to promote the development of a strategic network in the region is supportive of the broader network proposed by ACEC.

4.2 Recommendations

The IRENA-convened Executive Strategy Workshop of June 2013 suggested that an action agenda for the Africa Clean Energy Corridor should include elements related to zoning (identification of hydro and non-hydro renewable resources and zones known as hot spots) for renewable power development), planning (improved generation and transmission expansion planning at country level and more co-ordinated regional planning), and enabling (market opening and lower-cost financing for renewable power projects). The recommendations are designed to address these three pillars.

4.2.1 Zoning of Renewable Energy Resource Potential

There is need to increase stakeholder awareness in the SADC and SAPP of renewable energy resource potential beyond the current focus on large hydro. IRENA is the organisation that is best placed to assist countries in the region by facilitating the RRA and detailed mapping or zoning of areas for the development of different renewable energy resources. The focus must be to develop bankable data that allows both hydro and non-hydro renewable energy options to be included in the regional and national electricity master plans.

4.2.2 Planning for More Renewable Power

It would be useful for SAPP to create an Africa Clean Energy Corridor Strategic Network Working Group under its planning sub-committee. This working group will co-ordinate its work with a similar one for the EAPP, preferably working through current inter-power pool co-ordination mechanisms managed by the Association of Power Utilities of Africa (APUA). This mainstreaming approach is recommended to enhance ownership.

The working group could support the planning pillar of the ACEC in several ways:

a) **Harmonised demand forecasting approach:** Work towards region-wide adoption of a forecasting approach based on common goals for moving towards universal access to electricity. A common vision is required to harmonise the diverse views of SAPP, PIDA, SE4ALL, COMESA, IRENA, African Energy Commission (AFREC) and others.

b) **Generation selection and ranking criteria:** Work towards the adoption of agreed criteria for ranking and selection of national and regional generation projects taking account of diverse stakeholder expectations as well as improved processes for generation expansion planning. The criteria and process must address the expectations of four key stakeholder groups – policy makers, regulators, implementation agencies and investors.

c) **Reducing information asymmetry for project options**: Undertake renewable energy resource assessments and feasibility studies and research on identified site specific project options to reduce renewable energy technology uncertainties with respect to such issues as cost, lifetime, lead time, and performance, environmental and social impacts.

d) **Stakeholder consensus on priority generation projects:** Achieving consensus on the optimum generation mix based on the agreed selection and ranking criteria.

e) **Strategic regional network plan:** Develop the "super grid" transmission plan that compliments the generation mix. This involves developing and validating the regional planning model and carrying out the full range of transmission studies to address normal and emergency operating situations.

f) **National plans:** Provide assistance for countries to align national plans to the regional plan.

g) **Project implementation:** Select the appropriate financing and business models to ensure project bankability, development, operation and maintenance to meet specifications, time and budget targets.

4.2.3 Enabling More Renewable Power Investment

International experience shows that an enabling environment for renewable power development can be created through institutional arrangements that avoid or minimise conflicts of interest in policy making, regulation and implementation. Roles of policy making, regulatory and implementation agencies at continental, regional and national levels must be complimentary.

The Institutional Architecture for Infrastructure Development in Africa (IAIDA) (Annex 5) designates the NEPAD Planning and Co-ordinating Agency as the institution to facilitate and co-ordinate the implementation of continental and regional priority projects. Streamlining the institutional framework by identifying lead organisations for each stakeholder group should be part of its facilitating role because of the multiplicity of uncoordinated and overlapping initiatives addressing the same issue of regional integration of the power and other infrastructural sectors. The institutional arrangements could be organised according to the following guidelines:

a) **Policy makers:** At their 2013 meeting, SADC energy ministers were advised that the Conference of Energy Ministers of Africa (CEMA), established in November 2010 by the African Union Ministers Responsible for Energy, would be the sole continental organ for the co-ordination and development of energy in Africa. This must therefore be the forum for establishing political consensus on the ACEC concept and to report to the Heads of State on progress. Ministers from the SADC and COMESA regions, advised by their REC secretariats would need to motivate such consensus.

b) **Regulators:** African Forum for Utility Regulators (AFUR) and the regional regulators associations of the SADC and COMESA regions should take the lead in the harmonisation of regulations and standards for cross-border electricity projects. RERA has developed its Guidelines for Regulating Cross-Border Power Trading in Southern Africa, approved by the SADC energy ministers in 2010 and adopted at the national level by several countries, which could be applied for inter-regional projects. Established interconnected systems such as those in Europe and North America, have created regional regulators to deal with cross-border issues to compliment national or state regulators. In the US the Federal Energy Regulatory Commission (FERC) has oversight over inter-state energy issues while state regulators have oversight within their states. In Europe the Agency for the Co-operation of Energy Regulators provides similar functions. A similar structure is required to support the development of the ACEC. In the SADC, the mandate of the Regional Electricity Regulators Association could be changed to make it the regional regulator empowered to have authority and oversight within the entire region.

c) **Implementation Agencies:** Power pools, national utilities, universities, and research institutions are the implementation agencies that provide technical and administrative skills to develop master plans at national and regional levels. The APUA, which has been promoting inter-regional interaction among the different power pools, could co-ordinate the technical assistance required to develop skills for demand forecasting, generation and transmission planning, transmission pricing, cross-border project negotiations, project development, operation and maintenance.

d) **NEPAD Planning and Co-ordinating Agency:** The ACEC is part of the North-South Transmission Corridor of the Programme for Infrastructure Development in Africa. The continental institutions that need to be co-ordinated are those that have ACEC-related programmes, information and data. These include the CEMA, East African Community (EAC), COMESA, SADC, African Energy Commission (AFREC), APUA and African Forum for Utility Regulators (AFUR).

e) **Investors:** The African Development Bank's promotion of PIDA places the bank as the logical lead institution for organising debt, grants and private equity providers to support the planning, project preparation and building of projects along the Africa Clean Energy Corridor.

The streamlined institutional framework will increase the effectiveness of the supporting role of development partners.

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ANNEX 1: OVERVIEW OF APPROACH AND METHODOLOGY

Project and consultant objective

The study project was commissioned by the International Renewable Energy Agency (IRENA) with a view towards the creation of a clean energy corridor between the Eastern African Power Pool and the Southern African Power Pool, in order to achieve the following objectives:

- To raise the profile of cost-effective investments with governments, multilateral development banks and financial institutions, in particular by helping countries within the Eastern and Southern African regions to map out and cost out their renewable energy resources and power systems; and

- To develop an action agenda for the Africa Clean Energy Corridor (ACEC) together with all major stakeholders in the regions.

The role of the consultant for the SAPP region in meeting these project objectives is broken down into six key tasks:

1. Assess the readiness of the SAPP to embrace the objectives of the ACEC.
2. Assess the critical transmission and interconnection gaps in the SAPP that impact the ACEC.
3. Collaborate with the ACEC consultant for the EAPP region to harmonise findings.
4. Build associates and recommend networks for the development of the ACEC.
5. Outline projects within the CEC that are ready for investment and development.
6. Assess and recommend capacity-building requirements for the ACEC.

Methodology and approach

Input for the report was obtained through a desk study and engagement with relevant stakeholders, in particular the power pool secretariats. A workshop convened by IRENA in Abu Dhabi on 22-23 June 2013 to discuss relevant issues related to the ACEC provided an opportunity for preliminary consultation with many of the stakeholders who are expected to play a major role in the development of the corridor.

The primary source of information for the desk studies were recent SAPP annual reports, reports of the SAPP sub-committees (especially those of the planning, operations and market subcommittees), published and unpublished national generation and transmission policy and planning reports, and AfDB, World Bank, IRENA and NEPAD publications on renewable energy and infrastructure development in Africa and developing countries in general. Some of the reports were collected from the SAPP Co-ordination Centre in Harare and IRENA head office in Abu Dhabi, while other reports were obtained from internet searches of government and utility websites.

The specific activities that were, and are intended to be, undertaken in fulfilment of the six tasks are summarised in the following table:

Table 23: Activities to Fulfil the Study Tasks and Objectives

Project Category	Project Name	Planned Capacity (MW)
1. Assessment of the readiness (willingness and ability) of the power sector in SAPP to embrace the objectives of the ACEC	Assessment of the readiness (willingness and ability) of the power sector in SAPP to embrace the objectives of the ACEC	Desktop study on the relative costs of renewable and conventional energy generation being considered in the Pool
	To determine current and projected electricity demand and planning criteria within the SAPP	Collection of planning documents and analysis of electricity demand and economic growth forecasts
		Analysis of the costing of new generation planned for the power pool
		Review of the supply and demand characteristics and trends of SAPP and of 2-3 countries (South Africa included)
	To identify the availability of commercially viable renewable energy resources	Review of resource assessment reports for renewable energy resources in SAPP region
	To determine the capacity to plan, build and operate the grid necessary for the ACEC	Review of the planning, building and operation of energy generation and transmission projects to assess impact on the transfer limits and the state of current regional capabilities
		Review and analyse the relationship in system planning between SAPP and member countries
2. Assess critical transmission and interconnection gaps in the SAPP that impact the CEC	Assess critical transmission and interconnection gaps in the SAPP that impact the CEC	Study proposals for strategic grid network for SAPP that can serve as part of the ACEC network
		Review the current SAPP network for comparison with the strategic network
3. Collaborate with the ACEC consultant for the EAPP to harmonise findings	Collaborate with the ACEC consultant for the EAPP to harmonise findings	Discussed and agreed with EAPP consultants the project report outline, which was then modified by IRENA to the current outline
	Identify ACEC project priorities common to both EAPP and SAPP	Review SAPP transmission and interconnection gaps with EAPP transmission and interconnection gaps given an agreed target ACEC network for the SAPP and EAPP
4. Build associates and recommend networks for the development of the ACEC	Build associates and recommend networks for the development of the ACEC	Identification and invitation of relevant individuals and institutional representatives to stakeholder workshops to discuss preliminary and final reports
		Prepare PowerPoint presentations summarising findings and present to stakeholder workshop
	Integrate the ACEC's creation into existing regional energy and economic planning to ensure stakeholder buy-in	Identify current regional and continental energy and economic development initiatives that are consistent with the objectives of the ACEC with a view to proposing a unification of any fragmented efforts
		Attended IRENA strategy workshop on the ACEC and established relevant contacts for ACEC development

Project Category	Project Name	Planned Capacity (MW)
5. Outline projects within the ACEC that are ready for investment and development	Outline projects within the ACEC that are ready for investment and development	Study of SAPP planning and operating reports and specific project reports
		Discussion with SAPP management, governments and utility officials
6. Assess and recommend capacity building requirements for the ACEC	Assess and recommend capacity building requirements for the ACEC	Identification of skills and capacity gaps
		Propose capacity building initiatives to bridge gaps as part of the ACEC agenda

ANNEX 2: DETAILED LIST OF COMMITTED GENERATION PROJECTS (2012-2016)

GENERATION PROJECTS - 2012 TARGET						
No	Utility	Country	Name	Type	Capacity [MW]	Approximate Cost, MUSD
	ENE	Angola	Cambambe II	Hydro	180	382
2	BPC	Botswana	Morupule B	Thermal	600	1570
3	DRC	SNEL	Inga 1	Hydro	110	78
4	DRC	SNEL	Inga 2	Hydro	320	452
5	Namibia	NamPower	Ruacana	Hydro	92	150
6	Tanzania	TANESCO	Ubungo	Gas	100	75
7	Tanzania	TANESCO	Mwanza	HFO	60	60
8	IPP	Zambia	Ndola Energy	Gas	50	50
9	LHPC	Zambia	Hydro	Hydro	6	10
10	Eskom	South Africa	Komati	Thermal	303	330
11	ZESA	Zimbabwe	Chisumbanje	Co-gen	30	50
TOTAL					**1 851**	**3 207**

GENERATION PROJECTS - 2013 TARGET						
No	Utility	Country	Name	Type	Capacity [MW]	Approximate Cost, MUSD
1	DRC	SNEL	Nzilo	Hydro	25	28
2	ESCOM	Malawi	Kapichira	Hydro	64	50
3	Eskom	South Africa	Medupi	Thermal	722	1 600
4	Eskom	South Africa	Ingula	Hydro	333	350
5	Eskom	South Africa	OCGT IPP	Gas	1c050	420
6	Eskom	South Africa	OCGT IPP	Gas	800	320
7	Eskom	South Africa	Eskom South	Wind	100	141
8	Eskom	South Africa	Eskom Solar	Solar	100	400
9	Eskom	South Africa	Komati RTS	Thermal	101	225
10	ZESCO	Zambia	Kariba North	Hydro	360	200

GENERATION PROJECTS - 2013 TARGET						
11	NamPower	Namibia	Wind	Wind	60	90
TOTAL					**3 715**	**3 824**

Source: SAPP (2011a)

GENERATION PROJECTS - 2014 TARGET						
No	Utility	Country	Name	Type	Capacity [MW]	Approximate Cost, MUSD
1	ENE	Angola	Cambambe II	Hydro	80	140
2	SNEL	DRC	Zongo 2	Hydro	150	40
3	Eskom	RSA	Co-Gen	Thermal	100	230
4	Eskom	RSA	Medupi	Thermal	722	1 600
5	Eskom	RSA	Ingula	Hydro	999	1 052
6	ZESA	Zimbabwe	Chisumbanje	Co-gen	60	140
7	ZESA	Zimbabwe	Small Thermals	Thermal	80	20
8	ZESCO	Zambia	Itezhi-Tezhi	Hydro	120	200
9	IPP	Zambia	Lunzua	Hydro	15	30
10	EMCO	Zambia	IPP	Hydro	300	510
11	IPP	Zambia	Maamba	Thermal	300	670
12	IPP	Mozambique	Ressano Garcia	Gas	150	340
13	IPP	Mozambique	Gigawatt	Gas	115	250
TOTAL					**3 191**	**5 222**

GENERATION PROJECTS - 2015 TARGET						
No	Utility	Country	Name	Type	Capacity [MW]	Approximate Cost, MUSD
1	IPP	Mozambique	Moatize	Thermal	300	670
2	Eskom	RSA	Medupi	Thermal	1 444	3 210
3	Eskom	RSA	Kusile	Thermal	1 446	2 110
4	IPP	RSA	Cogen	Thermal	100	222
5	ZESCO	Zambia	Kabompo	Hydro	40	60
TOTAL					**3 330**	**6 272**

Source: SAPP (2011a)

GENERATION PROJECTS - 2016 TARGET						
No	Utility	Country	Name	Type	Capacity [MW]	Approximate Cost, MUSD
1	DRC	SNEL	Busanga	Hydro	240	300
2	ESCOM	Malawi	Lower Fufu	Hydro	100	170
3	Eskom	RSA	Kusile	Thermal	723	1 590
4	Eskom	RSA	Medupi	Thermal	722	1 590
5	Eskom	RSA	Coal	Thermal	600	1 020
6	LHPC	Zambia	LHPC	Hydro	160	272
7	ZESCO	Zambia	Lusiwasi	Hydro	84	142
TOTAL					**2 529**	**4 914**

Source: SAPP (2011a)

ANNEX 3: DETAILED LIST OF PLANNED GENERATION PROJECTS (2015-2025)

No.	Country	Project Name	Capacity [MW]	Technology	Estimated Project Cost USD million	Expected Commissioning Date
1	Botswana	Mookane	300	Thermal	400	2015
2	DRC	Zongo 2	120	Hydro	142	2016
3	DRC	Inga 3	4 320	Hydro	4 000	2018
4	DRC	Busanga	240	Hydro	300	2016
5	Malawi	Lower Fufu	100	Hydro	170	2015
6	Malawi	Lilongwe	20	Hydro	13	2013
7	Malawi / Tanzania	Songwe	340	Hydro	425	2024
8	Malawi	Mpatamanga	260	Hydro	404	2020
9	Malawi	Kholombizo	240	Hydro	392	2025
10	Mozambique	HCB North Bank	1 245	Hydro	771	2015
11	Mozambique	Mphanda Nkuwa (Phase I)	1 500	Hydro	2 000	2017
12	Mozambique	Moatize	600	Thermal	1 300	2015
13	Mozambique	Benga	600	Thermal	1 300	2015
14	Mozambique	Lurio	180	Thermal	340	2021
15	Lesotho	Wind Site	300	Wind	600	2015
16	Lesotho	Kobong Pumped Storage	800	Hydro	800	2017
17	Namibia	Baynes	360	Hydro	642	2018
18	Namibia	Kudu	800	Gas	640	2016
19	South Africa	OCGT	5 750	Distillate	2 012	2022-2030
20	South Africa	Generic Coal	3 850	Coal	8 555	2027
21	South Africa	Generic Pumped Storage	1 484	Hydro	3 124	2019-25
22	Tanzania	Kinyerezi	200	Hydro	190	2015
23	Tanzania	Kiwira	200	Hydro	342	2014
24	Tanzania	Ruhudji	358	Hydro	611	2017
25	Tanzania	Rumakali	520	Hydro	600	2018

No.	Country	Project Name	Capacity [MW]	Technology	Estimated Project Cost USD million	Expected Commissioning Date
26	Zimbabwe	Kariba South Extension	300	Hydro	300	2016
27	Zimbabwe	Batoka	800	Hydro	2 200	2022
28	Zimbabwe	Hwange 7 & 8	600	Thermal	1 080	2015
29	Zimbabwe	Lupane	300	Thermal	368	2017
30	Zimbabwe	Gokwe North	1 400	Thermal	2 240	2017
31	Zambia	Kalungwishi	220	Hydro	210	2016
32	Zambia	Mambilima Falls site 1	124	Hydro	272	2019
33	Zambia	Mambilima Falls site 2	301	Hydro	384	2019
34	Zambia	Lunsemfwa	55	Hydro	230	2016
35	Zambia	Mkushi	65	Hydro	119	2017
36	Zambia	Devils Gorge	500	Hydro	1 338	2023
37	Zambia	Mpata Gorge	543	Hydro	1 807	2023
38	Zambia	Batoka	800	Hydro	2 200	2022
TOTAL			**30 695**		**42 821**	

Source: SAPP (2011a)

ANNEX 4: SAPP PRIORITY GENERATION PROJECTS

SAPP 2012 High Priority Generation Projects >1000 MW & Score >50%

Rank	Country	Project Name	MW	Type	Cost (USD)		Date
					million	$/kW	
1	Mozambique	HCB North Bank	1 245	Hydro	771	619	2015
2	Mozambique	MphandaNkuwa	1 500	Hydro	2 000	1 333	2017
3	Zambia/ Zimbabwe	Batoka	1 600	Hydro	4 400	2 750	2022
4	DRC	Inga 3	4 320	Hydro	4 000	926	2018
5	Zimbabwe	Gokwe North	1 400	Thermal	2 240	1 600	2017
6	South Africa	New Clean Coal	6 250	Thermal	13 750	2 200	2026
7	South Africa	Nuclear	9 600	Thermal	24 000	2 500	2023
TOTAL			**25 915**		**51 161**	**1 974**	

Source: SAPP (2012c)

SAPP 2012 High Priority Generation Projects <1000 MW& Score >50%

Rank	Country	Project Name	MW	Type	Cost (USD)		Date
					million	$/kW	
1	Zimbabwe	Kariba S. 7 & 8	300	Hydro	300	1 000	2016
2	Namibia	Kudu	800	Gas	640	800	2016
3	Botswana	Morupule 5 & 6	300	Coal	400	1 333	2015
4	Namibia	Baynes	360	Hydro	642	1 783	2018
5	Mozambique	Benga	600	Coal	1 300	2 167	2015
6	Zimbabwe	Hwange 7 & 8	600	Coal	1 080	1 800	2015
7	Zambia	Lusemfwa lower	255	Hydro	230	902	2016
8	DRC	Busanga	240	Hydro	300	1 250	2016
9	Zambia	Kalungwishi	220	Hydro	210	955	2016
10	DRC	Zongo 2	120	Hydro	142	1 183	2016
11	Tanzania	Kiwira	200	Coal	342	1 710	2015
12	Tanzania	Kinyerezi	240	Gas	190	792	2016
13	Tanzania	Rumakali	520	Hydro	600	1 154	2018
14	Mozambique	Moatize	300	Coal	650	2 167	2018
15	Zambia	Mambilima Falls 1 & 2	425	Hydro	656	1 543	2019
16	Zambia	Mpata Gorge	543	Hydro	1 807	3 328	2023

Rank	Country	Project Name	MW	Type	Cost (USD)		Date
					million	$/kW	
17	Malawi	Lower Fufu	100	Hydro	170	1 700	2015
18	Tanzania	Ruhudji	358	Hydro	611	1 707	2017
TOTAL			**6 481**		**10 270**	**1 585**	

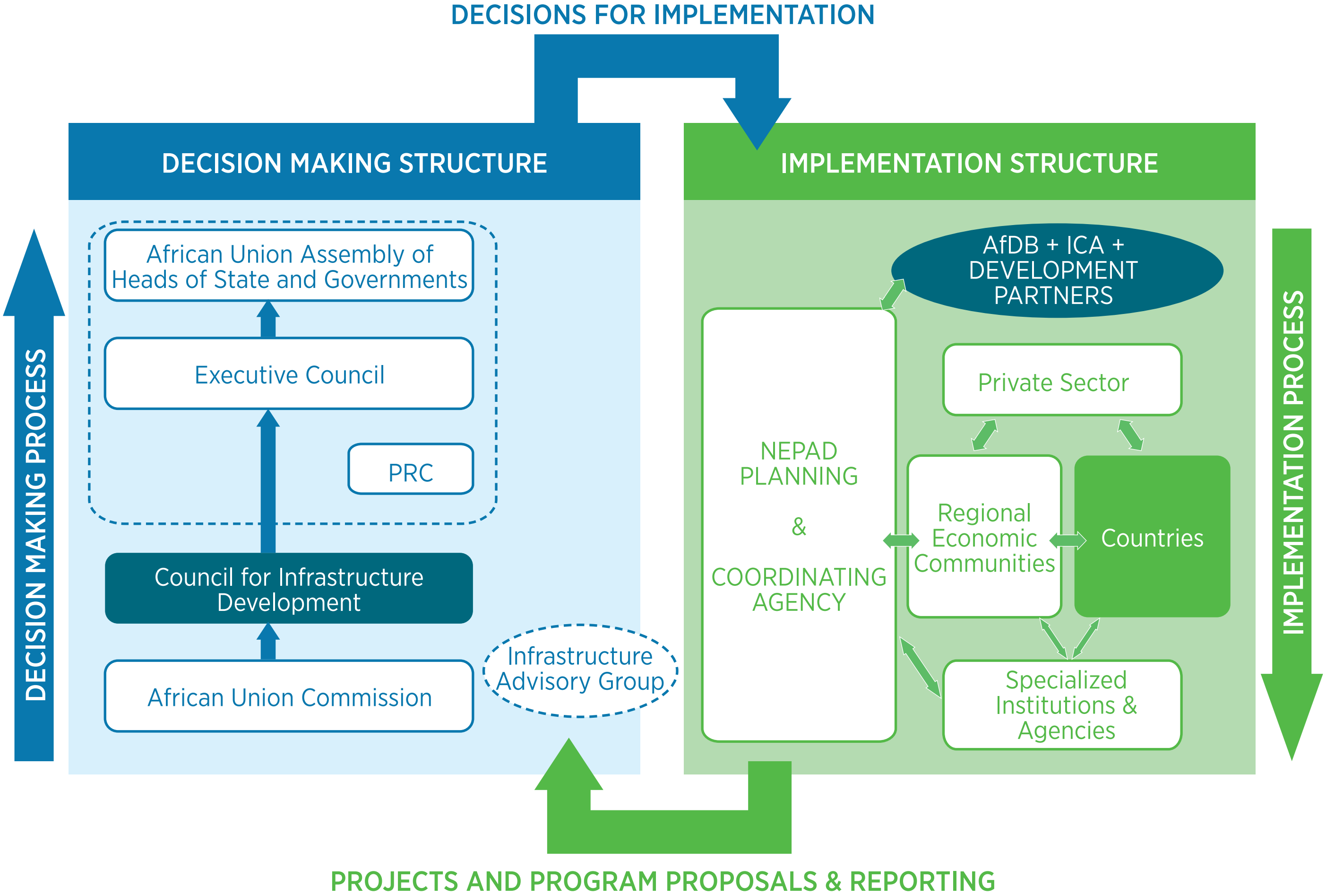
Source: SAPP (2012c)

Low Ranked SAPP Projects Scoring Less Than 50% (March 2012)

Rank	Country	Project Name	MW	Type	Cost (USD)		Date
					million	$/kW	
1	Lesotho	Kobong P.S.	1 200	Hydro	1 400	1 167	2017
2	Zambia	Devil's Gorge	500	Hydro	1 338	2 676	2023
3	Malawi	Mpatamanga	260	Hydro	404	1 554	2020
4	Malawi/Tanzania	Songwe	340	Hydro	425	1 250	2024
5	Malawi	Kholombizo	240	Hydro	392	1 633	2025
6	South Africa	OCGT	2 370	Gas	5 214	2 200	2019
7	South Africa	CCGT Gas	3 910	Gas	8 602	2 200	2022-25
8	South Africa	New Wind	7 200	Wind	10 080	1 400	2016-19
9	South Africa	Solar PV	6 900	Solar	27 600	4 000	2020
10	Zimbabwe	Lupane	300	Gas	368	1 227	2017
TOTAL			**23 220**		**55 823**	**2 404**	

Source: SAPP (2012c)

ANNEX 5: INSTITUTIONAL ARCHITECTURE FOR INFRASTRUCTURE DEVELOPMENT IN AFRICA



1. The NEPAD Planning and Co-ordinating Agency (NCPA) is responsible for monitoring and advocating the implementation process as well as updating PIDA every five years. It keeps the decision-making structures informed through the African Union Commission.

2. RECs, through their agencies, are responsible for developing regional master plans, which in turn are the basis for PIDA. RECs also monitor and report project implementation progress to the NEPAD Planning and Coordinating Agency.

3. Because RECs are not structured as implementing agencies, the responsibility for actual project implementation rests with countries, which need to marshal the resources and build the capacity to finance, develop, operate and maintain projects.

4. Actions at all levels should be complimentary with decision-making being delegated to the lowest level possible, where accountability should also rest. This implies that there must be strong local ownership. PIDA projects are aligned with regional priorities, which in turn should be aligned to member state priorities.

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