Africa Clean Energy Corridor

IRENA
International Renewable Energy Agency

Analysis of Infrastructure for Renewable Power in

Eastern and 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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Africa Clean Energy Corridor:

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FOREWORD
from the IRENA Director-General

Africa's impressive economic growth in recent years, reflecting its growing population as well as rapid economic development and diversification, calls for massive investment 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 has the potential to supply both its concentrated urban centres and its remotest, most dispersed rural areas with clean, sustainable energy, based on its indigenous renewable resources.

The Africa Clean Energy Corridor initiative, whose action agenda was endorsed through a ministerial communiqué in January 2013 at the Fourth 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 including the countries of the eastern and southern African power pools, links more than 20 countries in a combined endeavour to optimise their grid infrastructure and operations to be able to support high shares of renewable energy. As the costs of renewable energy technologies continue to fall, the economic logic for this 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 get ahead quickly with the latest on- and off-grid renewable energy solutions.

This report, examining the infrastructure of the Eastern Africa Power Pool and the Southern African Power Pool, represents an 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
Director-General, IRENA

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ABBREVIATIONS

ACEC	Africa Clean Energy Corridor
ACER	Agency for the Co-operation of Energy Regulators
AFDB	African Development Bank
BPC	Botswana Power Corporation
CBWS	Comprehensive Basin Wide Study
CCGT	Combined Cycle Gas Turbine
COMESA	Common Market of Eastern and Southern Africa
CSP	Concentrated Solar Power
DRC	Democratic Republic of the Congo
EAC	East African Community
EAPP	Eastern Africa Power Pool
EDM	Electricidade de Mozambique (Electricity of Mozambique)
EEPCO	Ethiopian Electric Power Corporation
ENE	Empresa Nacional de Electricidade, Angola (National Electricity Company)
ESKOM	National Utility of South Africa
EU	European Union
FiT	Feed-in Tariff
GECOL	General Electricity Company of Libya
HCB	Hidroelectrica de Cahora Bassa, Mozambique (Cahora Bassa Hydroelectric)
HVAC	high voltage alternating current
HVDC	high voltage direct current
IGMOU	Intergovernmental Memorandum of Understanding
IPP	Independent Power Producer
IRB	Independent Regulatory Board
IRENA	International Renewable Energy Agency
ITC	Independent Transmission Company
IUMOU	Inter-Utility Memorandum of Understanding
kV	kilovolt
kW/MW/GW/TW	kilowatt/megawatt/gigawatt/terrawatt
MOTRACO	Mozambique Transmission Company
NamPower	Namibia Power Corporation
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NEPAD	New Partnership for Africa's Development
PIDA	Programme for Infrastructure Development in Africa
PPA	Power Purchase Agreement
PV	Photovoltaic
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme (South Africa)
RERA	Regional Electricity Regulators Association of Southern Africa
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SINELAC	Société International d'Electricité des Pays des Grands Lacs (the International Electrical Society of the Great Lakes)
SNEL	Société Nationale d'Electricité (DRC) (National Electric Company)
STE	Sociedade Nacional de Transporte de Energia, Mozambique
TANESCO	Tanzania Electric Supply Company
UNECA	United Nations Economic Commission for Africa
USD/USc	United States Dollar/United States cent
WESTCOR	Western Power Corridor Company
ZAR	South African Rand (national currency of the Republic of South Africa)
ZESA	National Utility of Zimbabwe (formerly Zimbabwe Electricity Supply Authority)
ZESCO	National Utility of Zambia (formerly Zambia Electricity Supply Corporation)
ZIZABONA	Zimbabwe-Zambia-Botswana-Namibia Interconnector

EXECUTIVE SUMMARY

Africa is endowed with abundant renewable and non-renewable energy resources. Nevertheless, about two-thirds of its population still lacks access to modern energy services, such as electricity and non-solid cooking fuels. Fortunately, rapid advances in the reliability, efficiency and cost-competitiveness of renewable energy technologies provide the continent with the opportunity to increase energy access and security. This can be done without the environmental and economic costs associated with an energy development path based on fossil fuels. Regional and inter-regional power sector integration provides opportunities for exploiting the economies of scale of large hydropower, geothermal, wind, solar and biomass projects. This saves billions of dollars in development, operation and maintenance costs.

In 2012, African heads of state adopted the Programme for Infrastructure Development in Africa (PIDA). This is a framework for addressing the infrastructure deficit in Africa through the co-ordinated regional and inter-regional development of large-scale energy, water, transport and information and communication technology projects. PIDA energy projects include the North-South electricity transmission corridor, which extends from Egypt through countries in eastern and southern Africa to South 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 a complementary initiative. This is the Africa Clean Energy Corridor (ACEC). It has the following key objectives:

- accelerated development of renewable energy resources within Eastern Africa Power Pool (EAPP) and Southern African Power Pool (SAPP) member countries, the region for the proposed North-South corridor
- co-ordinated planning and development of regional electricity infrastructure and markets
- enhanced legal, technical and institutional capacity to plan, build and operate an interconnected grid with a high share of renewables

An executive strategy workshop convened by IRENA in June 2013 brought together regional institutions, power pools, utilities, independent power producers (IPPs), government ministries, multilateral financial organisations and development partners. They recommended an action agenda to put the corridor in place. The ministers and heads of delegation of Angola, Botswana, Burundi, the Democratic Republic of Congo (DRC), Djibouti, Egypt, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, Namibia, South Africa, Sudan, Swaziland, Uganda, the United Republic of Tanzania, Zambia and Zimbabwe endorsed a communiqué on 17January 2014, Abu Dhabi. This outlined the action agenda.

They endorsed renewable power development zoning, planning processes, enabling mechanisms, capacity building and public information. These are explained below.

Zoning

It is important to identify areas of high-capacity transmission networks to load centres and renewable power development zones in areas of high resource potential. This ensures the cost-effective development of renewable power resources. At present, both the long-range master plans of EAPP and SAPP 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. However, the detailed resource assessments needed to foster investment in renewable power projects are costly. Thus, it was recommended that IRENA work with these countries to help them produce credible data on renewable energy resources while identifying suitable zones for their concentrated development.

Planning

Effective co-ordinated and integrated energy planning is essential at both national and regional level. This takes advantage of the most cost-effective renewable power options available and ensures that these options are compared fairly with fossil fuel and nuclear power. Co-ordinated planning of generation and transmission facilities in eastern and southern Africa could provide significant cost economies. At the moment, generation expansion plans are independently formulated by each country in the power pools. The power pools base their new generation and transmission enhancements on an aggregation of national plans.

Enabling mechanisms

The entry of IPPs in the power market is vital if private capital is to be mobilised. Facilitating finance by reducing real and perceived risks in turn cuts the cost of capital. Renewable power investments are met with a perception of risk that does not reflect the current state of technology development. Effective national policies are therefore critical to create the kind of fair and open markets attractive to investors and financiers. Thus, it was recommended that IRENA provide advice and expertise on renewable energy strategies that aim to harmonise policy and regulatory frameworks of the countries in the region. This creates an effective regional power market. It was also recommended that IRENA expand its work with multilateral financial institutions to introduce innovative financing structures. These would reduce the risks to renewable power investments and support business models for renewable power projects adapted to local conditions.

Capacity building

This is needed to develop the human skills and supporting frameworks to build, plan, operate, maintain and govern power grids and markets with higher shares of renewable generation.

Public information

Public awareness initiatives are needed to promote the benefits of the corridor in providing secure, sustainable and affordable energy to meet rising energy demand.

EAPP and SAPP are expected to play a major role in implementing ACEC. This is because their principal mandate is to facilitate the development of regional electricity markets based on co-ordinated development and operation of generation and transmission systems. This report is intended to assess the current state of the power sector and the power pool readiness to embrace the objectives of the initiative. It also aims to identify the critical transmission gaps, and to raise the profile of projects ready for investment. Another objective is to identify capacity building requirements that support the planning, financing, development, operation and maintenance of these projects. The initiative provides an opportunity for EAPP and SAPP to learn from each other's experiences of harmonising national and regional policy and regulatory frameworks, as well as project planning and development.

The major challenges, findings, conclusions and recommendations of the study are summarised below.

The availability and quality of energy information and data needs great improvement in both regions. It is difficult to get up-to-date information in most EAPP countries on present power and energy demand and utility financial and operational performance. The SAPP co-ordination centre publishes data in its annual reports but the quality of the information varies significantly from country to country. Member countries and EAPP and SAPP secretariats need technical help to institutionalise and standardise timely data collection and communication through websites and other media. Countries need agreed templates for information to feed into accessible national and regional databases. Many types of critical operational data are required. These include installed and available public and private sector electricity generation plant capacity, transmission and distribution network lengths and transfer capacities, and transmission and distribution network losses. Other important information needed includes plant and network costs, electricity energy and maximum demand statistics, and electricity access statistics (national, urban and rural). Information on electricity tariffs and utility financial performance (particularly revenue collection, solvency and profitability) is also needed, as are demand forecasts, resource assessments, and feasibility studies for projects of national and regional significance.

The mandate and priorities for regional integration within the power pools are biased at present towards hydropower and fossil fuels. This bias is historical. It reflects the fact that the nations with the greatest electricity consumption (Egypt and Libya in EAPP and South Africa in SAPP) are largely dependent on gas, oil and coal-fired power plants. Most countries are also generally biased towards national self-sufficiency or net exporter status. Generation projects in the short to medium term therefore include significant fossil fuel and nuclear capacity. These countries need to adequately provide for the risks associated with import dependency, principally through physical and contractual security of transactions, and this drives their development approach. Non-conventional renewable energy sources such as utility-scale wind and solar are associated with technological limitations. The physical security of facilities can only be guaranteed through peace and stability within the region. This is an important issue that requires political judgment. The harmonisation of cross-border trading policies and regulations will help reduce contractual uncertainties. The ACEC initiative provides an opportunity to review the regional and national electricity master plans to include non-hydropower renewable resources and to incorporate the risk assessment associated with regional power markets. In partnership with the Lawrence Berkeley National Laboratory, IRENA is mapping eastern and southern African zones showing high-potential for developing cost-effective utility-scale wind and solar power plants. By taking part in such projects, member states need to improve their capability to undertake renewable energy resource assessments to generate bankable data. This allows a fair and serious evaluation of generation options using hydropower and non-hydropower resources.

The EAPP competitive electricity market is still at the planning and preparatory phase. A pilot training programme was launched in April 2014 for Ethiopia, Sudan, Kenya and Uganda for a short-term power trading market based on daily/hourly electricity production and consumption bids. The priority generation projects identified in the EAPP master plan (under review) that can facilitate increased regional power trade are summarised in the table below.

In addition to the projects highlighted, Ethiopia has embarked on another much bigger hydropower project, the 6 000 megawatts (MW) Grand Renaissance.

The complementary key interconnectors required to establish and operate the EAPP interconnected grid are outlined below.

- Ethiopia – Kenya: 500 kilovolt (kV) bipolar high voltage direct current (HVDC) with 2 000 MW transfer capacity originally scheduled for completion in 2015, but now expected to be completed in 2016.

- Ethiopia – Sudan: 500 kV double circuit high voltage alternating current (HVAC) with 2 x 1600 MW transfer capacity scheduled for 2016.

- Egypt – Sudan: 600 kV HVDC with 2 000 MW transfer capacity scheduled for completion in 2016.

- Kenya – Tanzania: 400 kV HVAC with 1 520 MW transfer capacity scheduled for completion in 2015.

SAPP has been operational since 1995 on the basis of historical interconnections between 9 of the 12 member countries. The slow introduction of new generation and transmission interconnectors means the region faces generation deficits and transmission constraints that are limiting electricity trading. Priority generation projects from a regional perspective include the following large (over 1 000 MW) hydropower projects in the Zambezi river and Congo river basins:

- Cahora Bassa North Bank extension, Mozambique. This project involves installing 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 as originally planned, it could still be completed before 2020 with more serious development efforts.

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

- Batoka Gorge, Zambia/Zimbabwe. This 1600 MW project is 50 km downstream from the Victoria Falls on the Zambia/Zimbabwe border on the Zambezi River. A joint project steering committee comprising officials from both countries appointed a consultant in early 2014 to update the feasibility and environmental studies done in 1993. It has also shortlisted potential project developers.

- Inga 3, DRC. Up to 4 800 MW to be developed in two phases – a 1 800 MW low head scheme, which does not require a dam, and a 3 000 MW scheme with a dam. This will be the initial phase of the Grand Inga Dam with a potential capacity of 40 000 MW. South Africa and DRC are already jointly conducting feasibility studies and a framework for the development of the project. The transfer of power from the project was originally planned via the Western Power Corridor (WESTCOR) project from DRC through Angola, Namibia and Botswana to South Africa. Having abandoned WESTCOR, the present plan is to follow the central corridor through Zambia, Zimbabwe and Botswana to South Africa.

The priority transmission projects are designed to interconnect non-operating members, relieve congestion that limits energy trading and evacuate newly generated power. The implementation status of projects is summarised in the tables below.

Considerable work is still in progress to establish effective institutional frameworks for policy and regulatory harmonisation and regional planning and project development in both regions. Where institutions have been set up, there is need to attract and retain adequate in-house skills to maintain policy and regulatory stability and to plan, manage, construct, run and maintain projects. Capacity building to increase renewable energy investment in the region is particularly needed in several areas. These include finance (long-term finance and risk mitigation to lower financing costs and increase private sector funding sources) and renewable energy resource assessment. Other major areas are project management, system planning, research and development (R&D), and local value addition (including the safe integration of these technologies in the regional and national grids). Development of standardised power purchase contracts and other project agreements should help to minimise project transaction costs and time. Concern specifically affecting and processes followed in these regions are outlined below.

- EAPP requires technical assistance to be able to co-ordinate all regional power sector integration activities currently undertaken by a range of organisations with overlapping mandates. This will optimise the use of scarce human and material resources in the region. The organisations concerned are those developing master plans for power generation and transmission and regional power trade, and also involved in project analysis and development. These include EAPP, the East African Community (EAC) and the Nile Basin Initiative. Similar organisations include those harmonising regulations, like the EAPP Independent Regulatory Board (IRB) and the Regional Association of Energy Regulators of East and Southern Africa of the Common Market of Eastern and Southern Africa (COMESA).

- Capacity building and staff retention strategies are needed for the SAPP co-ordination centre, Regional Electricity Regulators Association of Southern Africa (RERA), Southern African Development Community (SADC) secretariat and member countries. This will allow policy, regulatory, planning, development and operating institutions to adequately discharge their mandates. The SADC Directorate of Infrastructure and Services (DIS) has an energy division. However, it is too short-staffed to effectively discharge its mandate of monitoring and facilitating progress in harmonising policies and regulations and implementing regional projects. RERA needs to be transformed into a regional regulatory board similar to the EAPP IRB. However, it needs to report directly to the energy ministers and have a mandate to enforce regulations for cross-border trading. Recent power generation projects in South Africa and Botswana have experienced significant cost and time overruns. This indicates a need for project management skills to ensure projects are developed within planned budgets and timelines.

- The adoption of cyclical planning processes using multi-criteria analysis balancing national and regional priorities. National plans are developed on the basis of planning with horizons. These are used as inputs into the development of optimised regional generation and transmission plans. This quantifies the benefits of regional integration. National plans are revisited to incorporate regional options consistent with national interests. A list of regional priority projects is adopted that reflects a balance between regional and national interests. The process is repeated at agreed intervals to take account of major changes in planning assumptions. This approach, although it is not optimal, is likely to be the most politically feasible and hence the most practical.

The role of development partners has been essential in supporting the planning and preparatory phases of the power pools. Development partners will continue to be required to help draw on private sector funding that is needed for major project development. Development partners have provided technical assistance and credit facilities mainly from limited public sector sources to fund the packaging and preparation of generation and transmission projects. Forecast demand and corresponding investment requirements in the two regions are much higher than historical trends. Funding through public sector monopoly utilities is the traditional business model, but this will not be sufficient to manage projected investment requirements. Co-operation should now emphasise more private sector investment, and this could be achieved by engaging the private sector in policy formulation and planning. A co-ordinated public private partnership approach in which governments facilitate risk mitigation to attract long-term low-cost private finance is essential. The development partners have a long experience in regional power sector integration. This means they can assist in reducing political risk (such as policy and regulatory uncertainty), leveraging funding from commercial sources and building capacity. They can also help with issues outlined below.

a. technical assistance on resource assessments, providing reliable information that allows hydropower and non-hydropower renewables to act as candidate projects in national and regional master plans

b. innovative funding support for transmission corridor reinforcements and strategic networks difficult to finance on traditional non-recourse project finance.

c. power sector reform to create a financially viable and efficient power sector that can attract funding.

EAPP: Priority generation projects identified in regional master plan

Country	Plant name	Type	Installed capacity (MW)	Date
Eastern DRC	Ruzizi III	Hydro	125	2014
	Ruzizi II	Hydro	287	2027
Ethiopia	Mandaya	Hydro	2 000	2031
	Gibe III	Hydro	1 870	2013
	Gibe IV	Hydro	1 468	2016
	Karadobi	Hydro	1 600	2036
Rwanda	Kivu I	Methane	100	2013
	Kivu II	Methane	200	2033
Tanzania	Stieglers Gorge (I, II, III)	Hydro	1 200	2020;2023;2026
Uganda	Karuma	Hydro	700	2016
	Ayago	Hydro	550	2023
	Murchison Falls	Hydro	750	2032

Source: EAPP and East African Community (EAC) (2011)

SAPP: Status of priority transmission projects

Project category	Project name	Planned capacity (MW)	Estimated project costs (USD* million)	Planned year	Status
1. Interconnecting non-operating members	Mozambique-Malawi	300	94	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	1 116	2016	Work in progress on Zambia-Tanzania side. Feasibility study on Tanzania-Kenya side
2. Relieving congestion	Zimbabwe/Zambia/Botswana/ Namibia interconnector	600	225	2017	Implementation planning
	Central transmission corridor, Zimbabwe	300	100	2016	Work in progress and feasibility study review
	Kafue-Livingstone upgrade, Zambia	600		2014	Has been commissioned
	North-west upgrade, Botswana	600		2016	Implementation planning
3. Evacuating power from new generation	Mozambique backbone (STE) Phase 1	3 100	2 800	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	Under implementation

*United States Dollar
Source: analysis based on SAPP (2012a)

Olkaria geothermal power plant in Kenya.

1. INTRODUCTION

1.1 ACEC objectives

The International Energy Agency and United Nations predict a population of 2 billion in Africa by 2050. Of this, 40% will live in the countryside and 60% in cities. Most will have no access to electricity and clean cooking fuels if energy access trends continue unchanged (IRENA, 2013a). Energy access estimates commissioned by Programme for Infrastructure Development in Africa (PIDA) indicate that only 37% of the eastern African and 25% of the southern African population had access to electricity in 2010 (SOFRECO, *et al.*, 2011).

PIDA is an initiative adopted in 2012 by African heads of state to promote the co-ordinated development of large-scale energy, water, transport, information and communication technology projects. These are necessary to support a vision of accelerated economic and social development across the continent. 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). It provides a framework for cutting the infrastructure deficit in Africa through integrated planning and development at regional and inter-regional levels. Regional integration is essential to achieve the economies of scale required to develop infrastructure at the lowest cost.

IRENA, whose mandate is to promote the accelerated adoption and sustainable use of all forms of renewable energy, has observed that Africa has abundant renewable energy resources. These are enough to help reach the goal of universal access to modern energy services without the negative environmental impacts of fossil fuels. Lower cost and rapidly improving renewable energy technologies provide a unique opportunity for Africa to meet future growth in an environmentally and economically sustainable manner. Renewable power sources can be quickly deployed and scaled up to match growing demand. They could also create new jobs for Africa's rapidly growing population. Off-grid renewable energy technologies now provide more competitive solutions for rural energy access than fossil fuels, traditional energy sources and main-grid extension.

As part of its African programme, IRENA has identified a tremendous opportunity for renewable energy in the ACEC stretching from Egypt to South Africa. This is shown in figure 1. There are future prospects for broader integration. ACEC is an IRENA initiative. It seeks to promote a regional approach to developing a greater share of clean, indigenous, cost-effective renewable power in the energy mix. This would support African economic development based on the immense potential of the continent's renewable energy resources. This approach could have far-reaching implications for a clean and secure energy future in Africa. Countries forming Eastern Africa Power Pool (EAPP) and Southern African Power Pool (SAPP) are pioneering the corridor, which is congruent with the North-South transmission corridor identified by PIDA. The two will link up.

ACEC is expected to provide the following benefits:

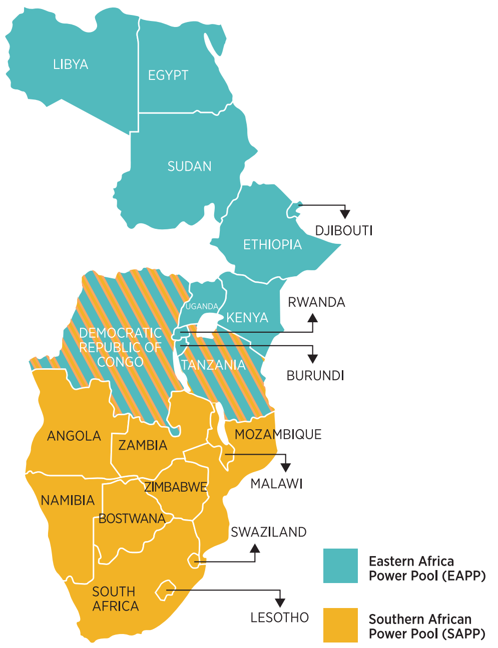
- **Identified cost-effective, high potential and high density renewable energy zones for utility-scale wind, solar photovoltaic (PV) and concentrated solar power (CSP) plants in EAPP and SAPP.** The renewable energy zones will incorporate existing and proposed geothermal and hydroelectric power plants and will facilitate planning and implementation of ACEC.

- **Accelerated development of renewable energy resources within EAPP and SAPP member countries.** A greater share of clean, indigenous and cost-effective renewable energy technologies will provide greater security of supply compared imported and volatile fossil fuels.

- **Co-ordinated planning and development of regional electricity infrastructure and markets.** The establishment of a competitive electricity market based on renewable energy sources will benefit consumers. As estimates indicate, regional power trade at full potential can save billions of dollars in investment and operational costs (EAPP and EAC, 2011; SAPP, 2008).

- **Enhanced local legal, technical and institutional capacity to plan, build and operate interconnected grids with a high share of renewables.** Renewable energy technologies offer the opportunity for a local manufacturing industry to develop, creating jobs and building technical skills and capacity.

Figure 1: map showing countries in the ACEC



Boundaries and names shown on this map do not imply official endorsement by the International Renewable Energy Agency.

Source: IRENA (2013b)

1.2 ACEC action agenda

An executive strategy workshop was convened by IRENA in Abu Dhabi on 22-23 June 2013, to work out an action agenda for ACEC. The workshop brought together a broad range of stakeholders, including representatives of regional institutions, power pools, utilities, independent power producers (IPPs), ministries, multilateral financial organisations and development partners. This agenda was subsequently endorsed in January 2014 by ministers from 19 EAPP and SAPP countries[1] through the IRENA Communiqué on ACEC.

Elements of the action agenda include zoning renewable power developments to identify areas with very good renewable power potential (hotspots) and allowing more cost-effective transmission links with load centres. Also included are planning processes that consider renewable power options in a more systematic fashion and enabling mechanisms supporting the development of renewable power options. These improve their access to electricity markets and financing, capacity building and public information.

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 two power pools 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 energy resource potential. However, detailed resource assessments are needed to foster investment in renewable power projects and these assessments are costly. Thus, it was recommended that IRENA work with countries to help produce credible data on renewable energy resources and identify suitable zones for their concentrated development.

Planning processes

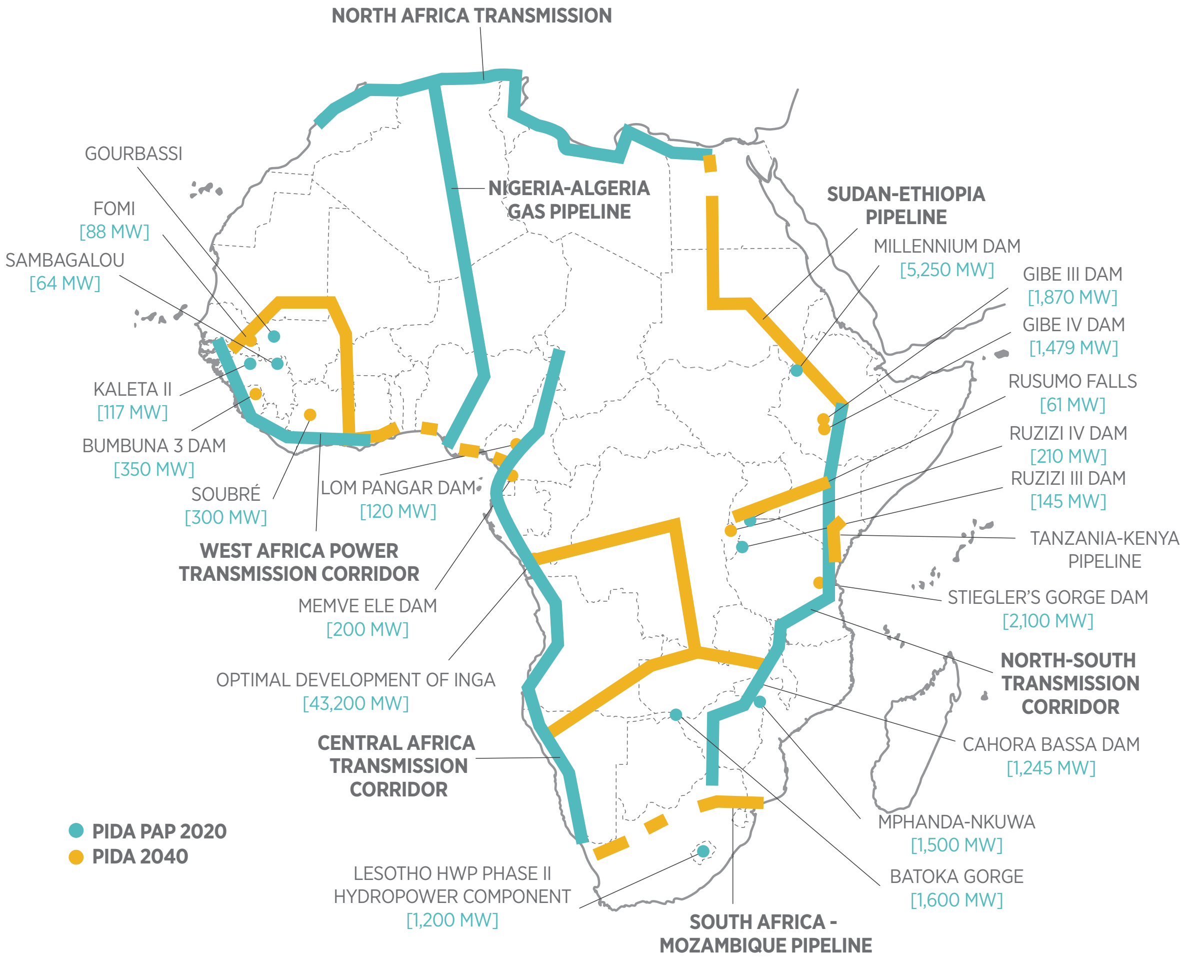
It is essential to have effective integrated energy planning at both country and regional levels. This takes advantage of the most cost-effective renewable power options, and ensures renewable power is compared fairly with fossil fuel and nuclear. Co-ordinated generation and transmission planning in eastern and southern Africa could provide significant cost economies. At the moment, generation expansion plans are formulated independently by each country in the power pools. The power pools plan new generation and transmission enhancements based on an aggregation of national plans. The best generation projects are grouped together and then optimised to select those costing the least to the region when carried through as regional projects. The EAPP 2011 master plan found that joint regional optimisation of generation and transmission plans could save USD 7.3 billion over 25 ears. This was in addition to USD 25.2 billion savings from separate optimisation by each country (EAPP and EAC, 2011). The 2009 SAPP pool plan found that co-ordinated planning could save USD 47.5 billion over 20 years (SAPP, 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 mean agreeing a range of demand scenarios, the costs of competing supply options to meet demand and the optimal mix of renewables.

Enabling mechanisms

To help mobilise private capital, it is vital to enable market entry by IPPs and encourage financing through reducing real and perceived risks. This in turn cuts capital costs. Renewable power investments are met with a perception of risk that does not reflect the current state of technology development. Effective national policies are therefore critical to create the kind of fair and open markets attractive to investors and financiers. 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. This creates an effective regional power market.

[1] Ministers and heads of delegations of Angola, Botswana, Burundi, Democratic Republic of Congo, Djibouti, Egypt, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, Namibia, South Africa, Sudan, Swaziland, Uganda, United Republic of Tanzania, Zambia and Zimbabwe gathered in Abu Dhabi, United Arab Emirates.

Figure 2: priority PIDA energy projects



Boundaries and names shown on this map do not imply official endorsement by the International Renewable Energy Agency.

Source: AfDB, 2012

- **Shallow integration stage**
  This involves integrating interconnections to create a regional grid that links together several neighbouring countries. A multilateral technical organisation is needed to ensure the reliable and secure operation of the interconnected grid by harmonising 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 PPAs. The maximum benefits of regional integration are achieved at this stage of co-operation.

It is important to highlight that the transition between stages of regional integration requires a high degree of mutual trust and operational experience. It can take several decades to reach this point. It takes time for countries with different policies, laws and institutional frameworks to create an integrated regional organisation with harmonised rules and regulations legally binding for all participating entities. The European Network of Transmission System Operators for Electricity (ENTSO-E) (www.entsoe.eu) is an example of such an integrated regional organisation. It is responsible for the co-ordinated development and operation of the electricity grids in 34 European countries, and represents probably the most advanced integration stage for multinational networks. This can provide a model for the development of ACEC. The Federal Energy Regulatory Commission of the USA is another model. However, this is more appropriate when the level of regional integration has reached a stage where countries are practically states within a federal governance structure.

It was also recommended that IRENA expand its work with multilateral financial institutions to introduce innovative financing structures. These would reduce risks to renewable power investments and support business models for renewable power projects adapted to local conditions. Other enabling mechanisms include capacity building for regional economic community and policy, regulatory and utility bodies.

Capacity Building

Capacity building is needed to develop the human skills and supporting frameworks to build, plan, run, maintain and govern power grids and markets with higher shares of renewable generation. Public awareness initiatives are needed to promote the benefits of the corridor in providing secure, sustainable and affordable energy to meet rising energy demand.

This report elaborates on the action agenda as it relates to the specific situation in the eastern and southern African regions. It assesses the status of the power sector and the readiness of the power pools EAPP and SAPP to embrace the ACEC objectives. It identifies the clean energy technologies and power systems within the corridor that are ready for investment and development and reviews critical transmission and interconnection gaps. It also assesses the enabling institutions and their capacity for planning, financing, construction, operation and maintenance of interconnected generation and transmission infrastructure.

1.3 Power pool role in corridor construction

The ACEC will rely on the development of a strong high-voltage transmission corridor from Egypt to South Africa. This will facilitate the transfer of large amounts of power from renewable energy sources to load centres. As highlighted in section 1.1, a key building block would be the North-South transmission corridor identified under PIDA (shown in figure 2).

The North-South transmission corridor consists of 8 000 km of power lines from Egypt through Sudan, South Sudan, Ethiopia, Kenya, Tanzania, Malawi, Zambia, Mozambique and Zimbabwe to South Africa. The portion from Ethiopia to South Africa is a priority action plan project, to be completed by 2020. A similar high-priority project is the Central Africa transmission corridor. This is a 3 800 kilometres (km) line linking Democratic Republic of Congo (DRC) to South Africa through Angola and Namibia and to Chad in the North through Equatorial Guinea, Gabon and Cameron. The next stage of the development up to 2040 is to involve the completion and interconnection of the corridors.

Power pools will play a central role in building ACEC by facilitating intra-regional and inter-regional co-ordinated development and operation of the power generation and transmission networks. ACEC provides the framework to guide collaboration between EAPP and SAPP.

To assess the power pool readiness to embrace ACEC objectives, it is necessary to consider international experience in regional power sector integration. 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"

(Energy Sector Management Assistance Program, 2010).

These observations arise from a study of 12 regional power sector integration schemes from different parts of the world, including 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 cooperation in the power sector evolves. These are outlined below.

- **Interconnection stage**
  This typically involves two countries building interconnections on the basis of long-term bilateral Power Purchase Agreements (PPAs) with a joint technical committee supervising simple rules for operating the interconnector. Where interconnections involve a third country, third party access and wheeling agreements are needed. Projects are derived from national plans.

ENTSO-E was created in 2009 out of six predecessor organisations. These were the Union for the Co-ordination of Transmission of Electricity for continental Europe, Nordic Electricity for Nordic countries, United Kingdom Transmission System Operators Association for Great Britain, Association of Transmission System Operators of Ireland, European Transmission System Operators, and Baltic Transmission System Operators. The European Transmission System Operators was an early model for ENTSO-E. It was made up of the Association of Transmission System Operators of Ireland, Nordic Electricity, United Kingdom Transmission System Operators Association and Union for the Co-ordination of Transmission of Electricity.

ENTSO-E operates through committees organised into continental and regional structures. These cover legal and regulatory issues, system development, system operations, market and R&D. The work of the committees is monitored by the Agency for the Co-operation of Energy Regulators (ACER) (www.acer.europa.eu), a European Union (EU) body. Created in 2010, its mandate is to ensure the harmonisation of regulatory frameworks to facilitate the achievement of a single EU energy market for electricity and natural gas. Its present work schedule includes harmonising network codes (rules for network connection and system, and market operations) and planning processes (like cost-benefit analyses methodologies and the ten-year network development plans).

Power sector integration in Europe is facilitated by legally binding EU directives and regulations. The regulations are progressively moving towards deeper integration. For example, upon its establishment in 2009, ENTSO-E was required by Regulation (EC) 714/2009 to "adopt a non-binding community-wide ten-year network development plan." This included a European generation adequacy outlook. The objective was to identify investment gaps and ensure greater transparency concerning the entire electricity transmission network in the community (ENTSO-E, 2013a). A new regulation (EU 347/2013) on guidelines for a trans-European energy infrastructure entered into force on 15 May 2013. It now requires the ten-year plan to also form the sole basis for selecting projects of common interest (ENTSOE, 2013b). ACER 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, ENTSO-E and ACER have created an institutional framework that will allow European countries to move towards it. This provides an appropriate model for SAPP and EAPP as ENTSO-E has demonstrated how co-ordination across countries and power pools can be achieved. Examples are outlined below.

Pan-European political co-operation and commitment. This is demonstrated by the adoption of co-ordinated energy policies and binding medium- to long-term targets for increased renewable energy generation, energy security, efficiency and market competitiveness. The EU 20/20/20 agenda for the year 2020 aims to reduce carbon emissions by 20% compared to 1990 levels. It also aims to raise the share of renewables in the EU energy mix to 20% and increase energy efficiency by 20%. The 2050 energy road map and 2050 supergrid vision outline scenarios for a transition toward a low carbon economy, assuming greenhouse gas emission reductions of at least 80% (Bompard, *et al.*, 2014).

Physical unbundling of the vertically integrated utilities in the member countries to establish specialised transmission system operators. These entities are responsible for long-term system planning, system and market operations, and R&D. R&D is necessary because of the challenges of dealing with the increased variability and uncertainty of non-conventional renewable energy, such as wind and solar and distributed energy generation. There is also a need to deal with the increased vulnerability to blackouts due to the interdependence of grids. The transmission system operators must also have expertise to deal with the legal and regulatory issues involved in cross-border facilities and trading.

Legally binding and harmonised regulations monitored and enforced by an independent regulatory body help speed up the approval and facilitate the financing and implementation of projects of common interest. Effective stakeholder consultation is particularly important given the difficulty that utilities are facing in building new high voltage transmission infrastructure due to environmental and social concerns.

The readiness of EAPP and SAPP in advancing the ACEC objectives largely depends on the power pools' stage of integration. As will be explained in more detail, SAPP is at the shallow integration stage. However, it still has to complete the interconnection of three[2] of its 12 member countries. EAPP is at the interconnection stage. The power pools may be at an immature stage compared to organisations like those in ENTSO-E. Nevertheless, initiatives like ACEC can help accelerate their progression by learning from each other's experience as well as international best practice. The role of development partners will be particularly important in facilitating the learning process.

[2] Angola, Malawi and Tanzania are not connected to the other SAPP member countries

1.4 EAPP organisation structure and mandate

EAPP (www.eappool.org) was established in 2005 by seven East African countries. These were Burundi, DRC, Egypt, Ethiopia, Kenya, Rwanda and Sudan. It was adopted in 2006 as the specialised electric power institution for COMESA.

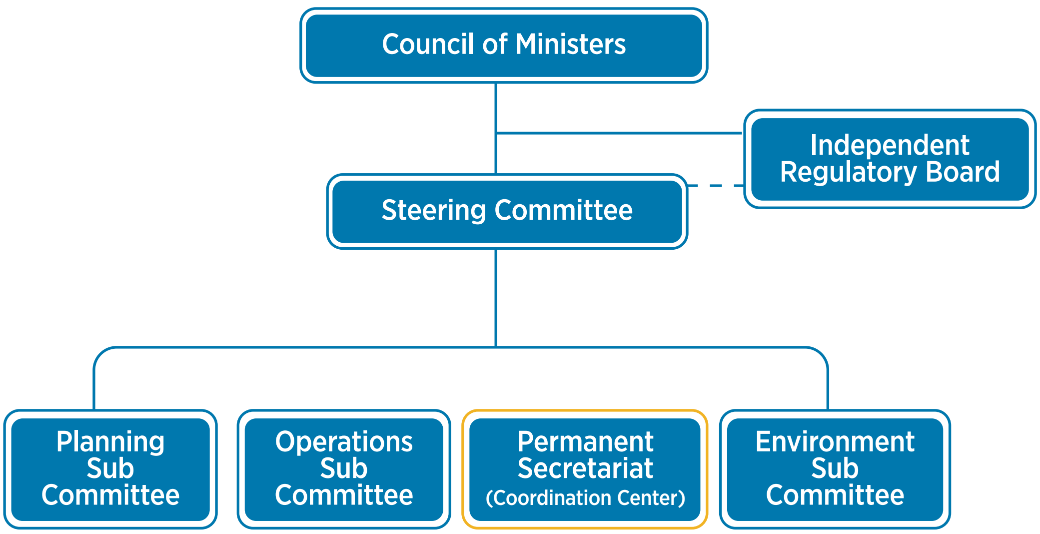
After Tanzania, Libya, and Uganda joined in 2010-2012, EAPP now has ten member [3] countries (shown in figure 1). Djibouti is in the process of joining while Eritrea and South Sudan are potential members. The participating countries and utilities from the member countries are listed in table 1.

Table 1: Participating countries and utilities from EAPP member countries

Nº	Country	Organisation
1	Burundi	Régie de Production des Eaux et de l'Electricité (REGIDESO)
2	DRC	Société Nationale d'Electricité (SNEL)
3	Egypt	Egyptian Electricity Holding Company (EEHC)
4	Ethiopia	Ethiopian Electric Power Corporation (EEPCO)
5	Kenya	Kenya Electricity Generation Company (KenGen)
		Kenya Electricity Transmission Company (KETRACO)
		Kenya Power and Lighting Company (KPLC)
6	Libya	General Electricity Company of Libya (GECOL)
	Rwanda	Electricity Water and Sanitation Agency (EWSA)
7	Sudan	National Electricity Corporation (NEC)
		Sudanese Electricity Transmission Company (SETCO)
8	Tanzania	Tanzania Electric Supply Company (TANESCO)
9	DRC – Rwanda – Burundi	Société International d›Electricité des Pays des Grands Lacs (SINELAC)
10	Uganda	Uganda Electricity Transmission Company Limited (UETCL)

Source: EAPP, n.d.

Figure 3: EAPP administrative structure



Source: Kintamo (2013a)

[3] DRC and Tanzania also belong to SAPP

The EAPP's administrative structure is shown in figure 3.

The composition and role of the different entities are outlined as follows:

- **The Council of Ministers** is made up of ministers responsible for electricity in the EAPP member states. This is the decision-making authority for policy and strategy including membership.

- **The steering committee** consists of the chief executives of each national power utility. The committee recommends policies and strategic issues for approval by ministers and oversees the execution of approved policies and strategies.

- **Technical subcommittees** report to the steering committee and comprise senior officials of the member utilities with the relevant expertise. Three of these are in place at the moment, working on planning, operations and environment. There are plans to set up a co-ordination centre to operate under the guidance of the operations subcommittee. Its objective is to facilitate system and market operations in the interconnected regional grid.

- **Independent Regulatory Board (IRB)**, which consists of nominees of the national electricity regulatory agencies of the member countries. It will oversee the harmonisation and implementation of cross-border trade regulations including dispute resolution. The initial proposal was to have it report to the steering committee but the current plan is to create a parallel regulatory forum reporting directly to ministers.

- **Permanent Secretariat** based in Addis Ababa, Ethiopia, handles the day-to-day activities. It is led by an executive secretary appointed by the Council of Ministers on the steering committee's recommendation. The host country agreement with Ethiopia gives EAPP the privileges and immunities of an international organisation.

- **Regional Co-ordination Centre** shown in the EAPP corporate plan for 2012-14 and the EAPP/EAC master plan studies as a separate entity from the permanent secretariat. It is now expected to be part of the secretariat as is the SAPP structure. The centre will be the regional market operator.

The founding governing documents are the Intergovernmental Memorandum of Understanding (IGMOU) signed by energy ministers in February 2005 and Inter-utility Memorandum of Understanding (IUMOU). This was signed in May 2005 by the chief executives of the national utilities. The mission and high level objectives of EAPP as outlined on its website can be summarised as follows on the basis of these documents:

- **to optimise the development and use of the eastern Africa region's energy resources** in an economically and environmentally sustainable manner through the efficient co-ordination and development of regional master plans and grid codes.

- **to increase the electricity access rate for the region's population** through an interconnected grid and regional power market that ensures provision of adequate, secure and affordable quality power.

- **to facilitate financing of integration projects** in power generation and transmission.

Getting interconnected grid operations up and running has taken longer than expected. A strategic road map for EAPP had envisaged the establishment of an interconnected grid in time for EAPP competitive market operations to begin in 2013 (Mercados, 2010). The initial trading was to be based on a bilateral market with the introduction of a day-ahead market scheduled for 2016. A pilot training programme for a short-term power trading market based on daily/hourly bids on production and consumption of electricity was launched in April 2014. This related to Ethiopia, Sudan, Kenya and Uganda. It is also encouraging to note that EAPP has initiated contacts with sister power pools in order to speed up capacity development by learning from others' experiences.

1.5 SAPP organisation structure and mandate

SAPP is a subsidiary institution of Southern African Development Community (SADC), which comprises 15 member countries. Twelve are on the African continent. It also includes the three island nations of Mauritius, Seychelles and Madagascar. The SAPP members are the 12 countries on the continent (see figure 1).

SAPP was established in August 1995 after an IGMOU was signed by SADC member countries excluding Mauritius. The other two island nations and Democratic Republic of Congo (DRC) were not yet SADC members. The IUMOU was signed in December 1995. The IGMOU was updated in 2006 to allow for expanded membership from new SADC member countries. It also allowed for new electricity supply enterprises arising out of the power sector restructuring in member countries. The IUMOU was also updated in 2007 to align with changes introduced by the revised IGMOU. In addition to designated national power utilities, membership is now open to IPPs, Independent Transmission Companies (ITCs) and other relevant service providers (see current list of member countries and utilities in table 2). In addition to the national utility, Mozambique has two observer members - the IPP Hidroelectrica de Cahora Bassa (HCB) and the ITC Mozambique Transmission

Company (MOTRACO). Non-operating members are utilities not yet connected to the regional grid.

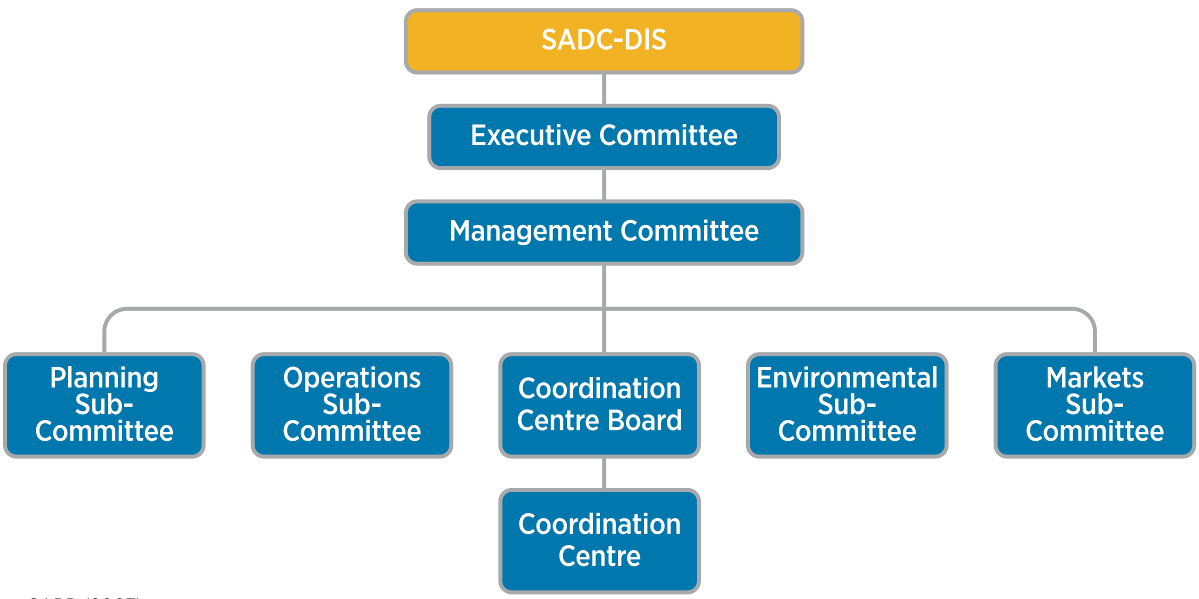
The operation of the interconnected grid is split into three control areas run by three different system operators. These are the national utility of South Africa, Eskom, whose area covers Botswana, Lesotho, southern Mozambique, Namibia, Swaziland and South Africa. The other two system operators are ZESA (covering Zimbabwe and northern Mozambique) and ZESCO (covering the Democratic Republic of Congo 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.

Table 2: Participating countries and utilities from SAPP member countries

Nº	Country	Organisation	Membership status
1	Angola	Empressa Nacional de Electricidade (ENE)	Non-operating
2	Botswana	Botswana Power Corporation (BPC)	Operating
3	DRC	Société Nationale d'Electricité (SNEL)	Operating
4	Lesotho	Lesotho Electricity Corporation (LEC)	Operating
5	Malawi	Electricity Supply Commission of Malawi (ESCOM)	Non-operating
6	Mozambique	Electricidade de Moçambique (EDM)	Operating
		Hidroelectrica de Cahora Bassa (HCB)	Observer
		Mozambique Transmission Company (MOTRACO)	Observer
7	Namibia	Namibia Power Corporation (NamPower)	Operating
8	South Africa	Eskom	Operating
9	Swaziland	Swaziland Electricity Company (SEC)	Operating
10	Tanzania	Tanzania Electric Supply Company (TANESCO)	Non-operating
11	Zambia	ZESCO Ltd.	Operating
		Copperbelt Energy Corporation (CEC)	IPP & ITC
		Lunsemfwa Hydro Power Company (LHPC)	IPP
12	Zimbabwe	ZESA Holdings	Operating

Source: SAPP (2012b and 2013a), www.sapp.co.zw

Figure 4: SAPP administrative structure



Source: SAPP (2007)

SAPP reports to the SADC secretariat through the Directorate of Infrastructure and Services (DIS) (figure 4).

The role of the different entities is as follows:

- **SADC DIS**
  This is a department of the SADC secretariat based in Gaborone, Botswana. It reports to the SADC energy ministers and officials on all energy matters, including those submitted by the SAPP executive committee. The SADC energy ministers provide policy guidance and approve SAPP priority projects and programmes on the recommendation of the executive committee.

- **Executive committee**
  This comprises the chief executives or managing directors of the member electricity supply enterprises. This is the governing authority of the power pool, which formulates SAPP objectives. It also approves or amends the governance structure, establishes committees and workgroups as needed and approves SAPP operational budgets. The chair rotates among the operating members of the national power utilities, and they hold 70% of the votes. The remaining members have 30% of the votes. Effective control is therefore vested in the chief executives/managing directors of the enterprises designated as the national power utilities of the member countries. The executive committee's decision-making authority includes admission of electricity supply enterprises to SAPP membership if they are situated in a SADC member country. Non-SADC utilities can be admitted to membership subject to approval by SADC governance structures.

- **Management committee**
  This is made up of senior officials from members with the ability to make decisions on planning and operating the power pool. They also need to be sufficiently senior to act as alternate members of the executive committee. The planning and operational functions of the power pool are vested in the management committee supported by relevant subcommittees and a co-ordination centre board. The co-ordination centre management reports to this board. The management committee decides all operational matters, but reports to the executive committee on non-routine and policy matters. These may include recommendations for new member admission, introduction of new service schedules, issues for approval by SADC energy ministers and operating budgets.

- **Subcommittees**
  Together with any working groups, these are established as needed by the management committee with the approval of the executive committee. They consist of senior officials with the relevant technical expertise to contribute to the objectives of the subcommittees. Four subcommittees are operational at present on planning, operations, environment, and markets. They are responsible for regional integrated generation and transmission planning as well as ancillary services. These include, for instance, communication and control, operation of the interconnected grid, monitoring compliance with environmental regulations and developing and operating regional power markets.

- **Co-ordination Centre**
  This is managed by a board made up of members nominated by the national power utilities and is based in Harare, Zimbabwe. It is a central point for convening all committee, subcommittee and workgroup meetings and is the secretariat and repository of all minutes, documents, information and power pool data. The centre also manages energy trading and helps co-ordinate feasibility studies and multinational project development. The co-ordination centre is responsible for administrating dispute resolution procedures.

Committees and subcommittees select their own chairpersons, and meetings are held at least once or twice a year.

The principal document governing SAPP is the IGMOU. Other supporting documents, in order of importance, are the IUMOU, the Agreement between Operating Members, operating guidelines and any other approved guidelines.

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

- co-ordinate and co-operate in planning, developing and running their systems to minimise costs while maintaining reliability, autonomy and self-sufficiency to the degree they desire

- fully recover their costs and share the resulting benefits equitably, including reductions in required generating capacity, fuel costs and improved use of hydropower

- co-ordinate and co-operate in planning, developing and running a regional electricity market based on the SADC member state requirements

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

The SAPP mandate elevates the national plans above regional plans because the IGMOU explicitly grants countries the right to choose the degree of autonomy and self-sufficiency they desire. The SAPP Inter-Utility MOU 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).

Operational experience before and after the power pool was set up has demonstrated the security of supply risks of import dependence. Adequate domestic reserves are needed to cope with interruptions due to human or natural causes. Countries are reluctant to honour firm foreign contractual obligations to export power when they are faced with supply constraints to satisfy their domestic demand. Physical damage to transmission interconnectors during extreme weather conditions, war or criminal activity are some of the reasons why countries sometimes fail to fulfil firm power commitments. The response is to adopt a cautious approach to dependence on power imports (see example in box 1).

These criteria imply that countries are willing to embrace regional co-operation as long as they have adequate domestic reserves. Regional plans should therefore focus on reliability and economy while national plans should focus on security. It is interesting to note that the 2011 EAPP master plan recommended the approach through which countries determine their own optimum generation plans and use interconnections to minimise operating costs. While the master plan recognised that an optimised regional generation as well as transmission plan would create investment cost savings, it noted that this was probably not a politically feasible scenario.

1.6 Power pool mandates and ACEC objectives

SAPP was established ten years before EAPP and is at a more advanced operational phase. The most visible operational EAPP structure at present is the permanent secretariat in Addis Ababa. This has been facilitating committee meetings and undertaking several studies and training programmes to prepare for the full operation of the power pool (EAPP, 2012).

The power pools have similar mandates. They are consistent with the ACEC objective of promoting regional power sector integration through co-ordinated generation and transmission infrastructure and regional electricity market structure planning and development. ACEC has the explicit objective of promoting both conventional and non-conventional renewable energy sources such as large hydropower, wind, solar and geothermal. The power pools share this objective implicitly through the commitment to hydropower and environmentally friendly development. The ACEC initiative requires policy makers to adopt explicit renewable energy targets fulfilled through the full range of renewable energy technologies.

The EAPP and SAPP organisation structures are similar in form but have the following important differences:

- In SAPP, decisions on membership, operational budgets and other governance issues are delegated to lower level structures like the executive and management committees. In EAPP the same decisions are made at the Council of Ministers and steering committee level. The EAPP structure can lead to delays in key decisions of an operational nature because ministers and chief executives cannot meet as frequently as lower level technical professionals.

- EAPP has a permanent secretariat in Addis Ababa. It had plans to set up a co-ordination centre whose location was still to be decided, according to the 2011 EAPP/ East African Community (EAC) master plan studies of 2011 and the 2012 EAPP corporate plan. As highlighted in the revised organisation chart above, the EAPP permanent secretariat will also host the co-ordination centre. SAPP has a co ordination centre that also serves as the permanent secretariat. SAPP is therefore able to make better use of scarce human and financial resources.

- EAPP has established an IRB, unlike SAPP. However, Regional Electricity Regulators Association of Southern Africa (RERA) currently operates as a forum for sharing experiences and capacity building. There are plans to transform RERA into a regional regulatory body. The EAPP IRB could provide lessons on how to do this. The European organisation ACER could be considered by regulatory bodies as an appropriate model for a multinational regulatory co-ordinating framework. The US Federal Energy Regulatory Commission supervises interstate transactions. It is a potential model when regional integration has reached a stage where countries are practically operating on a federal level.

The power pools could start co-operating in on ACEC development by obtaining the appropriate political endorsement. This is needed at the head of state level of COMESA and the regional economic communities to facilitate the creation of an ACEC planning working group. This would be drawn from members of the power pool planning subcommittees.

Box 1: Example of criteria reflecting national versus regional focus

Zimbabwe's generation expansion planning criteria reflect the balance countries try to achieve between reliability and economy through regional co-operation and the security of having adequate domestic reserve capacity.

- Reliability: the minimum reserve level to be carried shall be at least 10.6% of demand for thermal power and 7.6% for hydropower, 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 fall 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. They also need to be cost-effective relative to local options.

Solar photovoltaic power plant in Egypt.

2. STATE OF THE ELECTRICITY SECTOR IN EASTERN AND SOUTHERN AFRICA

2.1 Present and forecast electricity supply and demand

PIDA is based on present and projected electricity demand statistics that assume a 6% average annual economic growth rate for Africa for 2010-40. It is estimated that this translates into electricity energy consumption growth of 5.7% per year (table 3).

The present installed capacity and annual energy consumption in Africa is estimated at 125 gigawatts (GW) and 600 terawatt-hours (TWh) respectively. It is projected to increase by nearly 700 GW to support energy consumption in excess of 3 100 TWh by 2040. In the proposed North-South transmission corridor in eastern and southern Africa, an additional 140 GW is required in EAPP and 129 GW in SAPP. This corridor is congruous with ACEC. With this additional capacity it is estimated that the population with access to electricity would increase to about two-thirds by 2040.

PIDA presents a significantly different vision from other views on proposed plans for the future. Some of the alternative forecasts or targets are outlined below.

- The United Nations Sustainable Energy for All initiative is targeting universal access by 2030 (much more ambitious than PIDA, which does not project universal access before 2050).

- The COMESA integrated planning strategy estimates a 7% annual growth rate. This is higher than the PIDA estimate for the power pools in the COMESA region, EAPP and SAPP, for which it forecasts 6.5% and 4.4% respectively (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 analysis, based on International Energy Agency statistics, estimates an additional 900 TWh to bring the total to 1500 TWh required for full electricity access in Africa by 2030 (IRENA, 2013).

These conflicting views on demand forecasts and targets need to be reconciled because projected demand is the most important assumption for generation and transmission expansion planning. These differences arise from the diversity of the institutions and also whether they are a projection of historical trends or of a strategy to achieve regional and international access targets.

Regardless of the differences in forecasts there is a consistent and clear message. The region has to raise electricity consumption at very high and unprecedented growth rates to achieve increased economic growth and social development consistent with the expectations of the growing population. This emerges from a more detailed analysis of present and projected consumption statistics in the two ACEC regions.

Table 3: 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	8.9	45	67	90 000
Central African Power Pool	7.3	21	63	26 000
Eastern Africa Power Pool	6.5	37	68	140 000
Maghreb Committee on Electricity	6.0	>95	>99	298 000
Southern African Power Pool	4.4	25	64	129 000
Total	**5.7**			**683 000**

*gigawatt hours (GWh)
Source: Sofreco, *et al.* (2011)

Eastern Africa

Given the embryonic stage of EAPP, there is no readily available up-to-date information on individual EAPP country electricity supply and demand. Both EAPP and the utility websites do not have the information or it is outdated. A 2009 study by Mercados to assess the power sector in each member country observed that data gathering was a major difficulty. This needs to be overcome to have a functional power pool in eastern Africa. The consultants for the EAPP and EAC regional master plan (EAPP and EAC, 2011)[4] and the Comprehensive Basin Wide Study (CBWS) under the Nile Basin Initiative strategic action plan for power development and trade also noted this. They have reported that the data currently available were of poor quality and contained many gaps. Nevertheless it has been necessary to make do with the most recently available studies to provide a reasonable picture of present installed capacity compared to present and projected demand (table 4).

Table 4: EAPP generation and demand statistics (2011/2012 or latest available)

Country	Installed capacity		Peak demand	Energy sent out	Energy sales	Planned peak demand (MW)			Demand growth rate % p.a.	
	MW	% total	MW	GWh	GWh	2013	2023	2038	2013-2023	2023-2038
Burundi	50.9	0.1	n/a	198	170	56	204	667	13.8	8.2
Djibouti*	116	0.3	n/a	754	663	116	173	232	4.1	2.0
DRC East[5]	106	0.2	n/a	465	303	72	121	276	5.3	5.7
Egypt	29 074	64.4	25 705	157 406	133 969	28 383	49 034	102 282	5.6	5.0
Ethiopia	2275	5.1	1 600	8 207	7 000	1 964	4 912	15 783	9.6	8.1
Kenya	1 533	3.4	1 308	9 681	8 000	1 958	4 537	13 852	8.8	7.7
Libya	6 940**	15.4	5 981***	33 980	12 994[6]	n/a	n/a	n/a	n/a	n/a
Rwanda	97	0.2	n/a	650	497	94	276	806	11.3	7.4
Sudan	2 723	6.0	n/a	20 905	10 733	2 019	5 956	19 827	11.4	8.3
Tanzania	1 380	3.1	1 444	5 879	7 081	1 213	2 479	6 344	7.4	6.5
Uganda	829	1.8	n/a	4 314	3 560	715	1 310	2 650	6.2	4.8
Total	**45 126**	**100.0**								
Total (Non-coincident)						**38 025**	**80 616**			
Total (coincident)						**36 982**	**78 406**			

n/a = not available
Note: Energy demand figures are 2013 estimates.
* The EAPP report provides inconsistent statistics for Djibouti.
** Received from a compilation by EAPP for the review of the EAPP master plan.
*** Obtained from GECOL (2012). The different studies consulted did not include Libya, nor did they have the data required hence demand forecasts are not available.
**** obtained from EAPP/EAC Regional PSMP and grid code study

Sources: utility websites or contacts; Mercados (2009), EAPP and EAC (2011), Nile Basin Initiative (2011), SAPP (2013a), Regional Centre for Renewable Energy and Energy Efficiency (RCREEE) country profiles (Egypt, Libya, Sudan).

[4] The EAPP and EAC master plan is under review
[5] East DRC is connected to EAPP and isolated from the rest of the country
[6] Libya reported a significant decline in recorded energy unit sales of approximately 12 994 GWh in 2012 compared to about 20 602 GWh in 2010. However, energy produced increased from 32 558 GWh in 2010 to 33 980 GWh in 2012.

Table 4 highlights the following:

- The region has an installed capacity of just over 45 GW. It has a total individual maximum demand or non-coincident demand of 38 GW. The coincident or simultaneous maximum demand is 37 GW. The ratio of non-coincident to coincident demand is an indicator of diversity which is an opportunity to reduce reserve capacity for a given level of reliability. The size of the electricity systems varies significantly, with Egypt and Libya accounting for 80% of installed capacity. At the other extreme are small countries such as Burundi, Djibouti and Rwanda, whose individual installed capacity is less than 0.5% of the regional total.

- With the exception of Tanzania, the countries with available information on peak demand for 2013 have significant reserve capacity. In the absence of statistics on available capacity it is, however, difficult to judge the adequacy of the reserves.

- Very high growth rates are forecast for the first ten years of the plan. Actual and planned figures for 2013 appear to indicate that the demand projections may be too optimistic. Beyond the ten years, growth is projected to slow down.

The demand forecasts were derived from the most recent national forecasts adjusted and extended by the consultants to cover the 25-year study horizon of 2013-2038. These forecasts were completed before the adoption of the United Nations Sustainable Energy for All initiative launched in 2012. This aims to achieve universal access to electricity and clean cooking fuels by 2030.

Southern Africa

The latest available statistics for the year ending 31 March 2013 published in the SAPP annual report are summarised in table 5 and table 6 below.

Statistics in table 5 show the following:

- 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 sent out and sales were 276.7 TWh and 268.2 TWh respectively. The peak demand figures include a target reserve margin of 15%. The region has an installed capacity of 57 GW, of which nearly 53.7 GW is interconnected. As in eastern Africa, there are large differences in system sizes, with South Africa accounting for nearly 80% of total capacity, while the smallest systems in Lesotho and Swaziland are just over 0.1%.

- The available capacity in all but one country, Angola, falls short of requirements. 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.

- An analysis of the production and sales statistics suggests that some countries have high transmission losses and even higher distribution losses. These may reflect the reality on the ground or the poor quality of data.

The current demand forecasts for the power pool published in the SAPP annual reports were originally created as part of the studies for the SAPP 2009 pool plan (SAPP, 2008). Most utilities prepared their own forecasts while others used consultants. Table 6 provides a summary of the projected power and energy demand and compares this to the observed trends since the forecasts were made. For most utilities, it can be observed that the forecast growth rates are much lower than required to support higher economic growth rates. These are needed to keep pace with population growth and greater industrialisation. The actual demand growth in 2006-13 has generally been higher than forecast.

It is interesting to note the inconsistencies in the information reported by Tanzania to EAPP and to SAPP. For EAPP, Tanzania's projected demand for 2023 is 2 479 MW (table 4) but for SAPP, it is only 1 566 MW for 2025 (table 6). This is an example of underlying data problems encountered in this and other studies. SAPP has now decided to cross-check information with EAPP in order to get consistency.

Implications for ACEC

From the statistics for both regions, the concerns that need to be resolved with respect to information on present and projected demand are outlined below.

- There is a clear need to improve the availability and quality of information on installed capacity and present demand. The planning subcommittees need to define standardised templates for the required information. They also need to provide technical assistance to enable utilities to provide timely and accurate statistics on a regular basis. In addition, utilities need to co-ordinate within their organisations to ensure that information given out to different entities is consistent.

- Both regions are characterised by large disparities in system sizes. Egypt and Libya are the dominant systems in EAPP, and South Africa is the dominant system in SAPP. The dominance of these countries relative to the rest implies that most regional strategies and projects on them. They would become net importers of renewable energy generation output from other countries.

- A major weakness in the demand forecasts is the inconsistency with regional and national electricity access policies and targets. The power pools need to take a more active role in co-ordinating demand forecasting at national and regional levels. Power pools should become the common source of information on demand forecasts. This avoids the current situation where there is a multiplicity of conflicting forecasts by different organisations. The United Nations Sustainable Energy for All initiative could provide the framework for this type of co-ordination.

Table 5: SAPP 2013 generation statistics

Country (utility)	Installed capacity	Peak demand*	Available capacity		Energy sent out	Energy sales	Transmission losses
	MW	MW	MW	% peak demand	GWh	GWh	%
Angola (ENE)	1 793	1 341	1 480	110	5 613	3 427	10
Botswana (BPC)	352	604	322	53	372	3 118	3.7
DRC (SNEL)	2 442	1 398	1 170	84	7 641	6 323	9.3
Lesotho (LEC)	72	138	72	52	486	488	11
Malawi (ESCOM)	287	412	287	70	1 809	1 476	9
Mozambique (EDM)	233	636	204	32	390	2 380	6.4
Mozambique (HCB)	2 075		2 075		**		
Namibia (NamPower)	393	635	360	57	1 305	3 648	3.2
South Africa (Eskom)	44 170	42 416	41 074	97	237 430	224 446	3.3
Swaziland (SEC)	70	255	70	27	288.1	1 018.6	6
Tanzania (TANESCO)	1 380	1 444	1 143	79	3 034	3 770	6.1
Zambia (ZESCO)	1 870	2 287	1 845	81	11 381	10 688	4.6
Zimbabwe (ZESA)	2 045	2 267	1 600	71	6 951	7 367	4
Total	**57 182**	**53 833**	**51 702**	**96**	**276 700**	**268 149.6**	
Interconnected	**53 722**	**50 636**	**48 792**	**96**			

* Figures include estimates of suppressed demand. Energy sales for net importers are higher than energy sent out.

** HCB figures are accounted for under EDM, Eskom and ZESA sales.

Source: analysis based on SAPP (2013a).

Table 6: 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
Total	**41 406**	**71 698**	**272 196**	**472 447**	**2.9**	**53 833**	**3.8**

Source: calculations based on SAPP (2013a) and SAPP (2008).

2.2 EAPP and SAPP infrastructure

This section covers present generation and transmission infrastructure as well as the institutional structures for system planning and operation.

Present power generating capacity in Eastern Africa

The generation mix in EAPP in 2014 is predominantly thermal (78.6%). Egypt and Libya have most of the natural gas and oil-fired plants. Hydropower generation (18.8%) is to be found mostly in Egypt, Ethiopia, DRC and Sudan (see table 7). Hydropower is also significant in the national generation mix for Burundi, Rwanda, Uganda, Kenya and Tanzania. Wind and geothermal are the other significant generation options from a country perspective but are insignificant at regional level.

When compared to table 4, table 7 contains gaps as well as discrepancies in some figures. This is due to the weaknesses already described in compiling data or statistically insignificant data. The differences in the generation capacity statistics are most significant for Libya, Sudan and Tanzania. Tanzania and DRC belong to both pools but provide different information to the pools.

The generation mix of the new short to medium-term projects scheduled to 2020 from a national and regional perspective is highlighted in table 8. Nearly 85% of the new generation in the countries highlighted in the table is renewable energy. The bulk of this is conventional hydropower in Ethiopia followed by wind and geothermal mainly in Egypt, Ethiopia, Kenya, Sudan and Uganda. Solar and biomass remain insignificant. One country, Ethiopia, is building more than half the new generation of biomass energy. A review of the EAPP master plan is in progress and should be used as the opportunity to consider a greater share of both hydropower and non-hydropower renewable energy technologies.

Table 7: EAPP generation mix (MW), 2014

Country (utility)	Thermal	Hydro	Wind	Solar	Geothermal	Biomass	Total	%
Burundi	17	39					56	0.1
Djibouti	123						123	0.3
DRC	18	61					79	0.7
Egypt	26 336	2 800	547	140			29 823	65.9
Ethiopia	89	1 948	171		12		2 220	4.9
Kenya	595	770	5		199	26	1 595	3.5
Libya	6 940						6 940	15.3
Rwanda	49	49					98	0.2
Sudan	835	1 565					2 400	5.3
Tanzania	518	565				24	1 107	2.4
Uganda	100	691				32	823	1.8
Total	**35 620**	**8 488**	**723**	**140**	**211**	**82**	**45 264**	**100**
% of total	**78.6**	**18.8**	**1.6**	**0.3**	**0.5**	**0.2**	**100**	

Source: Personal communication with EAPP (May 2014).

Table 8: summary of EAPP generation mix for new short to medium-term (up to 5 years) projects (MW)

Country	Thermal	Hydro	Wind	Solar	Geothermal	Biomass	Total	% of total
Egypt	1 950		2 570	140			**4 660**	**22.7**
Ethiopia		9 275	641		771	154	**10 841**	**52.7**
Kenya	600	38	534		1 027	18	**2 217**	**10.8**
Libya			60	14			**74**	**0.3**
Rwanda		145					**145**	**0.7**
Sudan			320	20			**340**	**1.7**
Tanzania	900	500					**1 400**	**6.8**
Uganda		600		75	150	60	**885**	**4.3**
Total	**3 050**	**10 958**	**4 125**	**249**	**1 948**	**232**	**20 562**	**100**
% of total	**14.8**	**53.3**	**20.1**	**1.2**	**9.5**	**1.1**	**100**	

Sources: compiled from EAPP and EAC (2011); NBI (2011); Government of Kenya (2011b); Government of Tanzania (2013); RCREEE (2012)

Present power generating capacity in Southern Africa

The bulk of the 57 GW of current power generation capacity in SADC is from coal (70%), mainly in South Africa. Hydropower (21%) comes mainly from the Zambezi river and Congo river basins. Distillate oil (5%), nuclear (3%) and gas (1%) make up the rest. Details by country are illustrated in table 9. As with EAPP the bulk of the generation is based on fossil fuels and located in the country with the highest demand.

The discrepancies between some of the figures in table 9 and those in table 5 reflect the need for an audit of records kept by utilities and the SAPP co-ordination centre. Several countries are rehabilitating and starting up new generation projects. Almost 1 100 MW additional capacity became available in 2012 and 1 361 MW in 2013. Another 6 026 MW is expected in 2014. South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) is contributing 1 982 MW of non-conventional renewables (solar and wind) to this new capacity (SAPP, 2014a). Renewable energy comprised 32% of the capacity addition for 2013 and 59% of the capacity addition expected for 2014. A review of the regional master plan is scheduled. This should provide an opportunity to consider more renewable energy options.

The region expects to reach its target reserve margin of at least 15% by 2017 when a total of over 21 000 MW will have been added (table 10).

Table 9: SAPP generation mix, 2012-2013

Country (utility)	Coal		Hydropower		Nuclear		CCGT*		Distillate		Total
	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 and 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**

* combined cycle gas turbine

Source: analysis based on SAPP (2013a)

Table 10: SAPP - committed generation projects (MW), 2014

Country	2014	2015	2016	2017	Total	
	MW	MW	MW	MW	MW	%
Angola	204	0	1 280	2 271	3 771	18
Botswana	150	0	0	0	150	1
DRC	0	580	0	240	820	4
Lesotho	0	0	35	0	35	
Malawi	0	0	0	34	34	
Mozambique	175	0	40	300	515	2
Namibia	0	0	15	0	15	
South Africa	4 836	1 805	3 717	1 918	12 276	57
Swaziland	0	0	0	0	0	
Tanzania	450	240	660	250	1 600	8
Zambia	195	735	40	126	1 096	5
Zimbabwe	0	15	0	1 140	1 155	5
Total	**6 026**	**3 375**	**5 787**	**6 279**	**21 467**	**100**

Source: SAPP (2014a)

Cost of conventional power generation

Cost information from generation projects now running is generally not published. Financial and operational reports would have helped but these are either not available or so highly abbreviated that it is not possible to calculate the costs. However, reasonable indicative costs are available from master plan studies and published trading prices.

For East Africa an indication of the cost of conventional generation in EAPP member countries is summarised in table 11. This was established during studies for the EAPP and EAC master plan. The assumed plant capacity factor averages 75%-80% except for nuclear and large hydropower whose capacity factor is assumed to average 90%.

Fossil fuel dependency for Kenya comprises 17% of energy consumption and accounts for half the energy costs at USD 260 million per year (World Economic Forum, 2012).

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 were USD 0.046-0.21/kWh, as reflected in table 12. The average annual market clearing prices on the day-ahead market have been steadily rising since 2009 when this market was introduced.

Table 11: conventional generation costs by country and plant type (mid-2009 prices)

Country	Type of generation	Capacity (MW)	Unit cost (USD/kW*)	Total cost (USc/kWh**)	Fixed O&M (USD/kW/yr)	Variable cost (USc/kWh)	Fixed cost (%)	Variable cost (%)
Egypt	Natural gas -steam	1 300	1 196	3.47			59	41
	Natural gas - closed cycle	1 000	1 020	3.47	20	0.4	59	41
	Nuclear	1 000	4 420	9.4	75		90	10
Ethiopia	Geothermal	75/100	3 501	8.48			79	21
Kenya	Geothermal	140	4 434	10.13			83	17
	Imported coal - steam	300	3 110	10.97	50-70	0.65	54	46
Rwanda	Diesel/methane	100	1 444	8.74				
Sudan	Oil – steam	250	2 033	13.43	30-35	0.45	77	23
Tanzania	Coal – steam	400	3 483	9.42	50-70	0.65	30	70
	Natural gas – open cycle	240	1 000	7.13	10	0.5	72	28
Uganda	Gasoil – closed cycle	185	1 361	24.41	20	0.4	28	72
	Heavy fuel oil - steam	60	2 033	18.90			11	89
General	Medium speed diesel				20	1.2		
	Low speed diesel				9	1		
	Cogeneration				70	0.65		
	Hydroelectric				10	0		

* kilowatt (kW)
** kilowatt-hour (kWh)
Sources: EAPP and EAC (2011)

Table 12: SAPP - market trading prices

Group	Country	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 (06:00-11:00) & (17:00-21:00)	46.47	12.38	25.90	55.55	58.93
	DRC (SNEL)						
	Lesotho (LEC)						
	Namibia (NamPower)	Standard (11:00-17:00)	46.47				
	Mozambique (HCB)						
	Swaziland (SEC)	Off-peak (21:00-06:00)	46.47				
	Zambia (CEC and 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 South African Rand (ZAR) to USD at 10:1; emergency rate with no time of use: USD 46.47/MWh							

*megawatt-hours
Source: Musaba (2013), SAPP (2010 and 2013a)

SAPP has compiled a list of candidate projects for 2012-2025 complied from the input data used for the SAPP 2009 pool plan study (SAPP, 2008). The costs for the different technologies are summarised in table 13. The consultants noted inconsistencies in the data because many of the projects either lacked feasibility studies or had outdated studies in need of revision.

Interviews with some utility officials revealed that PPAs based on new coal-fired projects in the region are averaging 10-12 (United States cents) USc/kWh. In revising the regional master plan it will be necessary to invest human and material resources. This will ensure that all candidate projects are based on a similar level of economic, environmental and social cost data. Other key assumptions needing investigation include firm and average generation figures for hydropower projects, plant capacity factors, forced outage rates, quantity and quality of fuel for fossil fuel projects.

Table 13: SAPP – technology and estimated costs for new generation

Generation technology	2012-2016				2015-2025			
	MW	% of total MW	USD million	USD/kW	MW	% of total MW	USD million	USD/kW
Conventional hydropower	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	60		60	1 000				
Cogeneration	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**	**23 195**	**1 603**	**30 695**	**100**	**42 821**	**1 395**

Source: analysis based on SAPP (2011a)

Costs of renewable electricity generation

Table 14 summarises typical costs in Ethiopia, Kenya and South Africa of hydropower and non-hydropower renewables assumed in master plans or obtained from competitive bidding. The 2012 Ethiopian programme to scale up renewable energy states that the levelised cost of power generation based on the Ethiopian expansion plan to 2030 is 4.55 USc/kWh. Most of Ethiopia's neighbours were at the time estimated to have average generation costs of 15-24 USc/kWh. This gives Ethiopia the opportunity to build an export market for electricity.

The latest Ethiopian plan, based on an expansion plan to 2037, gives a levelised cost of power generation at 7.8 USc/kWh (EEPCO, 2014). The candidate hydropower projects for the most recent plan have a combined total of 12 406 MW. This comprises 4 821 MW with levelised costs below 5 USc/kWh, 5 637 MW below 10 USc/kWh and 1 948 MW above 10 USc/kWh.

The 2011 master plan studies show Ethiopia and Kenya represent the low and high end of the renewable energy costs in the eastern Africa region. Sudan is in the middle range at 4-8 USc/kWh (Kintamo, 2013). Investment costs are around USD 1 000-8 500/kW, with an average of about USD 4 000/kW.

From the initial competitive REIPPPP bidding rounds, South Africa provides indicative investment costs averaging USD 2 000/kW for wind. They average USD 3 000/kW for solar PV and USD 8 000/kW for CSP with 3-15 hour storage (Modise, 2013).

Table 14: indicative cost of renewables in Ethiopia, Kenya and South Africa

Country	Hydro (USc/kWh)	Wind (USc/kWh)	Geothermal (USc/kWh)	Solar thermal (USc/kWh)	Solar PV (USc/kWh)	Biomass/ biogas (USc/kWh)	Levelised cost (USc/kWh)
Ethiopia	4.02		7.0				4.55
Kenya	14.0	8.8	7.0	30	35	8.0	9.2
South Africa		9-12.5		25.1-26.7	16.5-27.6		

Sources: Government of Ethiopia (2012), Government of Kenya (2011a), Modise (2013)

Existing EAPP and SAPP electricity transmission and interconnections

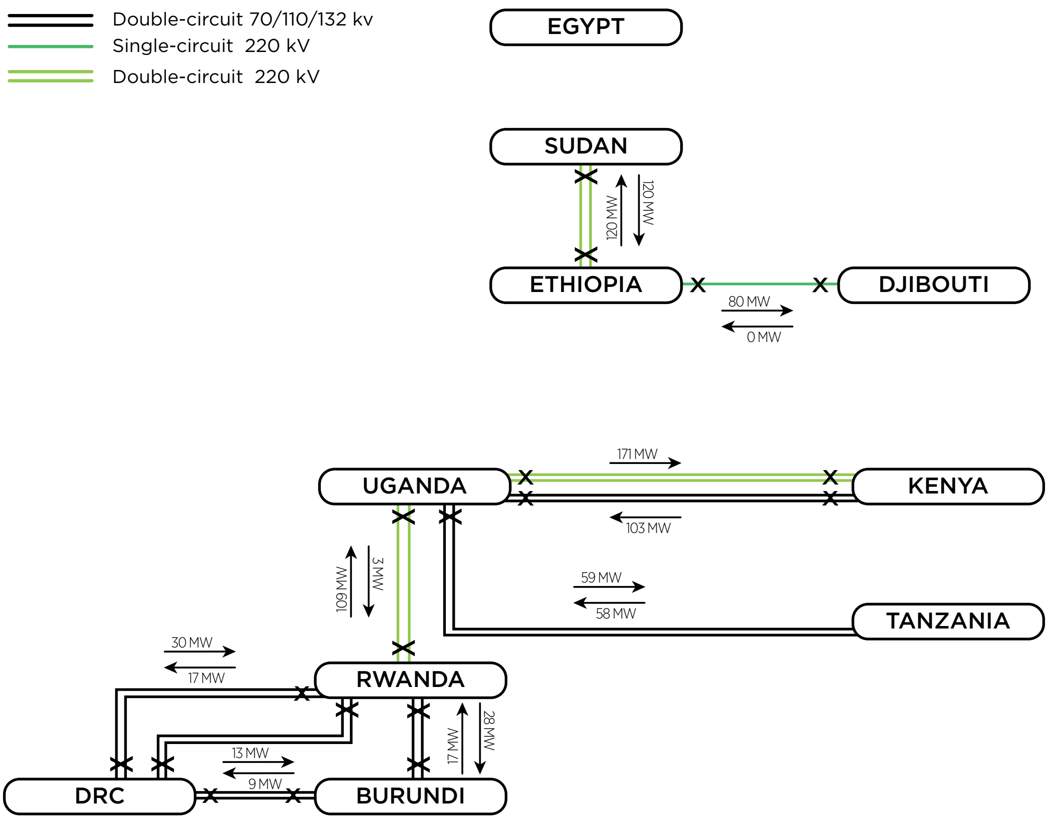
The existing regional interconnections in both regions mainly consist of those developed through bilateral transactions before the power pools were created. Figure 5 illustrates the existing interconnections and transfer capacities in EAPP.

The existing power interconnections are listed below.

- DRC, Burundi, and Rwanda interconnected at 110 kilovolt (kV) from a jointly developed hydropower station Ruzizi II (45 MW capacity) operated by joint utility (SINELAC).
- Kenya – Uganda 132 kV and 220 kV double circuit lines
- Ethiopia- Sudan double circuit 220 kV line
- Ethiopia – Djibouti 220 kV single circuit
- Egyptian power system interconnection through Libya (200 kV) to other Maghreb countries and southern Europe (400 kV and 500 kV) and through Jordan to the eastern Mediterranean (400 kV).

Within the national grids, the highest transmission voltages are 400 kV and 500 kV high voltage alternating current (HVAC) in Egypt, 400 kV in Ethiopia and 500 kV high voltage direct current (HVDC) in DRC. These are the voltages being adopted for planned interconnections.

Figure 5: existing EAPP interconnections



Source: EAPP and EAC (2011)

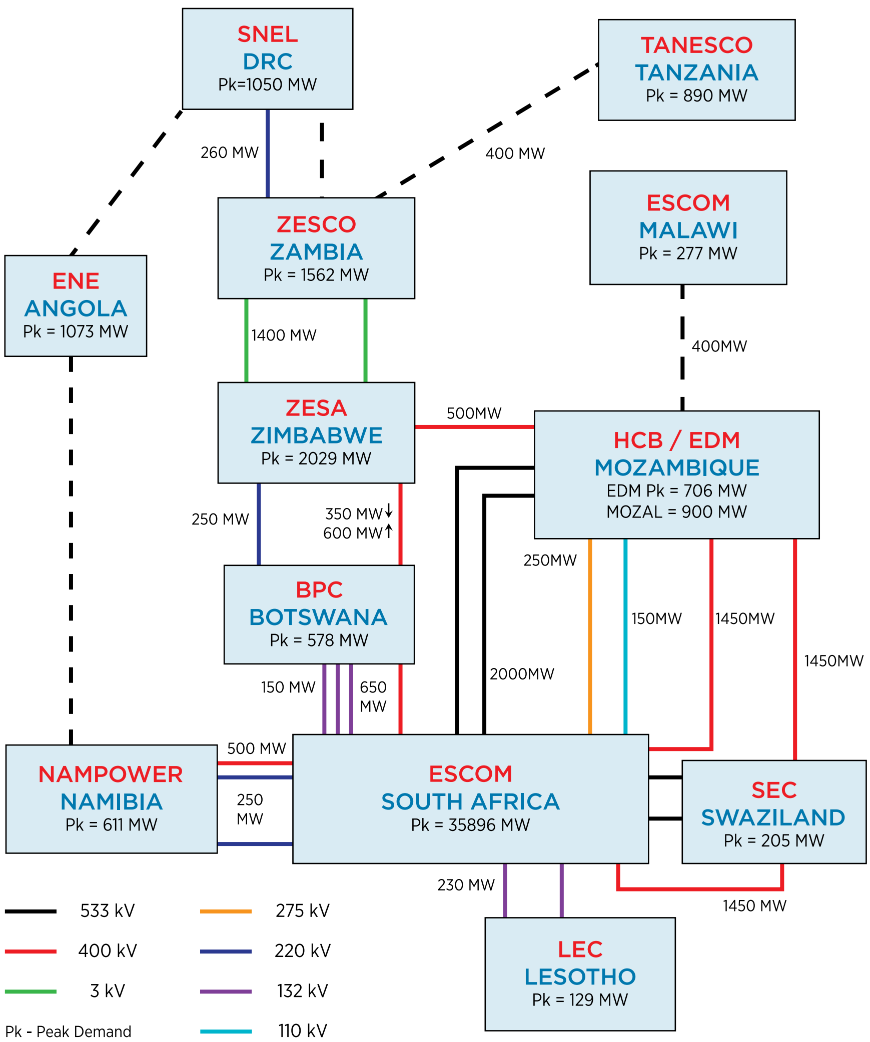
Existing SAPP interconnections are shown in figure 6. The diagram highlights the thermal capacity of the interconnectors. The operational transfer limits that take account of the voltage and stability limits are highlighted in the following table 15 for 2011 and 2013. The operational transfer limit will depend on several factors such as thermal rating of the conductor or associated terminal equipment, length of the line, number of circuits, ambient temperature and conductor temperature. The latest figures show a significant decline in operational transfer capacity on several interconnectors.

The differences in the peak demand figures in figure 6 and those in table 15 show the estimates of suppressed demand and the reserves required in each country.

The impact of the transmission constraints is illustrated by day-ahead market, the competitive market administered by the SAPP co-ordination centre. The sale and buy bids received are matched to establish a market clearing price but the actual trading depends on the available transmission capacity. Between the day-ahead market introduction in December 2009 and March 2013 there was a total of 230 131 MWh of matched sale and buy bids. However, only 62 154 MWh (27%) could be traded.

The existing power interconnections cover nine of the 12 member countries. The most tightly interconnected country is South Africa. The highest transmission voltages are 533 kV HVDC (South Africa to Mozambique and within DRC and Namibia), 400 kV (between and within South Africa, Botswana, Namibia, Zimbabwe, Swaziland and Mozambique) and 330 kV (between and within Zimbabwe and Zambia). Recent 330 kV projects are designed for ease of upgrading to 400 kV. South Africa has some lines designed for 765 kV, but still operating at 400 kV.

Figure 6: existing SAPP interconnections



Source: SAPP (2013a)

Table 15: SAPP interconnection capacity – 2011 and 2013

Flow direction		Number of lines and voltage	Thermal limit	Operational transfer limits			
				2011		2013	
From	To	kV	MW	MW flow direction	MW reverse	MW flow direction	MW reverse
DRC	Zambia	1x220	310	260	310	247	200
Southbound through Zambia			**500**	**210**	**260**	**325**	**200**
Zambia	Namibia	1x220	200			120	120
Zambia	Zimbabwe	2x330	700	700	450-700	428	570
Zimbabwe	Mozambique	1x110	70	40-70	70	38	35
Mozambique	Zimbabwe	1x330/400	700	350	150	220	142
Southbound through Zimbabwe			**700**	**300**		**220**	**400**
Zimbabwe	South Africa	1x132	70	20		0	0
Zimbabwe	Botswana	1x220	250	250	250	200	209
Zimbabwe	Botswana	1x400	700	300	450	220	300
Botswana	South Africa	1x400	650	300	270	190	256
Botswana	South Africa	2x132	300	150	225	245	213
Botswana	South Africa	1x132	300	75	225	70	213
Southbound through South Africa			**2 600**	**1800-1900**	**1800-1900**	**1710-1805**	**1710-1790**
South Africa	Lesotho	2x132	200	100	100	90	95
South Africa	Namibia	2x220	500	225	500	195	475
South Africa	Namibia	1x400 (2x400)*	630	410	500	380	
South Africa	Mozambique	1x275	210	165	210	133	170
South Africa	Swaziland	1x132	100	70	85	76	80
South Africa	Swaziland	1x400	1300	1200	1300	1000	1045
Swaziland	Mozambique	1x400	1300	1100	1300	1000	1045
Mozambique	South Africa	2x533 HVDC		1500		1500	

Note: Unexplained 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.
* The 2nd line was completed in 2013.

Source: adapted from SAPP (2011b) and SAPP (2014b)

Transmission and interconnection costs

As is the case for generation costs, present transmission costs are not published but master plan studies are used to get estimates. The 2012 Scaling Up Renewable Energy Program for Ethiopia estimated the levelised generation cost at 4.55 USc/kWh for generation. It also estimated 0.7 USc/kWh for transmission and 1.4 USc/kWh for distribution. This adds up to a total supply cost of 6.7 USc/kWh. The latest estimates are a levelised cost of 7.8 USc/kWh for generation, 1.8 USc/kWh for transmission and 4.2 USc/kWh for distribution. This means a total supply cost of 13.8 USc/kWh (EEPCO, 2014). New transmission costs are therefore estimated in the studies at about 15%-25% of generation costs if constructed to evacuate power from new generation stations.

The SAPP experience may be relevant in providing an indication of the actual relative costs of transmission compared to generation costs. Since the introduction of the SAPP day-ahead market on 15 December 2009, the average market clearing price is 5.882 USc/kWh up to 31 March 2013. This is made up of 83% generation and 13% transmission (comprising wheeling, loss and congestion charges) as well as 4% administration costs (SAPP, 2013a). Congestion costs reflect the transmission bottlenecks that force the market operator to split the interconnected grid into different pricing zones. They are a signal to the market for transmission investment opportunities.

Because of its impact on transmission investment, transmission pricing is an important item on the agenda for the power pools and ACEC. SAPP uses the MW-km method where the purchaser pays a charge comprising a rental fee and reimbursement of costs for use of transmission assets on the wheeling path. The wheeling study on this methodology (SAPP, 2001) recommended rates of USD 1.4-28/kW per year. This reflects the big variations in the costs and lengths of transmission assets used for transactions. The study noted that these charges compared well to those in other international markets: USD 1-23/kW/year in England and Wales and USD 2-17/kW per year in Brazil. The negative price implies that the wheeling transaction results in a net benefit for the wheeler. This could occur if the power flows reduce losses.

The MW-km is a simple method that works well for a few transactions using existing assets but does not provide adequate incentives for investing in new facilities. It also loads all costs on the purchaser. For this reason SAPP is now considering adopting zone or nodal transmission pricing. Using this methodology, transmission costs are more equitably shared by sellers and buyers within a trading zone. When there are no transmission constraints in the power pool, the whole pool is a single trading zone. When transmission bottlenecks appear the pool is split into zones with different prices that reflect the zone costs.

The price differentials give a signal to the market of the potential benefits of investment to remove congestion.

2.3 Institutional structures for system planning and operation

As already highlighted in the introductory chapter, the power pool planning and operation subcommittees are the institutional structures for regional power system planning and operation. This section explains the interaction between regional and national policy, regulatory and electricity market structures and how the planning processes take place. The financing arrangements and role of development partners are also analysed.

It is important to note that EAPP, which is now the adopted regional electricity institution for COMESA, has an additional responsibility. This is to co-ordinate other regional institutions also involved in regional power project planning and development. These are described below.

- EAC comprises five countries: Burundi, Kenya, Rwanda, Tanzania and Uganda (half the EAPP membership). It was established to widen and deepen economic, social and cultural integration for the mutual benefit of the member states. The EAC secretariat, based in Arusha, Tanzania, initiated the development of the East African Power Master Plan in 2005 before EAPP was set up. The plan was updated in 2011 as a joint project with EAPP.

- Nile Basin states. In December 2009 the Nile Basin Regional Power Trade Project signed a memorandum of understanding with EAPP to facilitate data co-operation and sharing. This approach helped to co-ordinate the 2013-38 EAPP master plan update. It also helped update the CBWS, extending the horizon to 2045. Going forward, EAPP will focus on establishing the power market rules and regulatory framework. The Nile Basin Initiative will focus on helping countries implement hydropower projects of common interest. The Nile Basin Initiative is a water sector institution concerned with hydropower projects alone.

- Economic Community of the Great Lakes Countries was founded in 1976 by Burundi, DRC and Rwanda to promote co-operation and management of projects and programs of common interest. Through this organisation the three countries established a jointly owned utility, SINELAC. This operates the jointly-owned Ruzizi II hydropower project that supplies electricity to the three countries.

As well as co-ordinating national institutions, EAPP will have to be equipped to effectively co-ordinate these regional institutions with overlapping mandates. The aim is to avoid the inefficiencies and suboptimal use of scarce human and financial resources.

Policy and regulation

There is no policy or legal barrier to cross-border trading in any of the countries in electricity and in renewable energy project development. However, different interpretations of contractual obligations and the absence of explicit renewable energy policies and targets can be significant barriers in practice. They are a source of investor insecurity. This is where the role of the regional co-ordinating bodies is critical. It ensures that policy and regulatory frameworks are harmonised across borders.

The most common renewable energy policy instruments being adopted by countries in the region are renewable energy targets, feed-in tariffs (FiTs), net metering, import duty credits and tax credits. Most rural electrification funds also have a mandate for promoting renewable energy. These tend to be focussed on small projects.

The SADC Protocol on Energy, signed in Maseru on 24 August 1996, outlines the typical policies governing regional co-operation in the energy sector. The protocol defines the following guidelines.

- promote electricity trading and power pooling as described in the SAPP agreements adopted by member states.
- promote integrated resource planning to take advantage of economies of scale and investment optimisation and benefit sharing.
- co-ordinate the development and update 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 use 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.

It should be noted that the protocol gives SAPP the delegated authority to work with member countries in defining the details of the power pooling and trading agreements. At the moment, the countries in southern Africa have chosen to subordinate the regional master plans to the national plans. EAPP does not yet have the operational experience to establish the relative weight that member countries give between regional and national plans and projects.

At present four of the EAPP countries (Burundi, DRC, Libya and Sudan) and Djibouti, a potential member, have not yet established regulatory agencies. The relevant ministries and national utilities share the regulatory functions. Six of the ten EAPP member countries have semi-autonomous regulatory bodies accountable to the energy ministries. The utilities and regulatory agencies are summarised in table 16.

RERA has three strategic objectives listed below.

- Facilitate electricity regulatory capacity building among members at both a national and regional level through information sharing and skills training.
- Facilitate harmonised electricity supply industry policy, legislation and regulations for cross-border trading, focusing on terms and conditions for access to transmission capacity and cross-border tariffs.
- Regional regulatory co-operation. This means deliberating and making recommendations on issues affecting the economic efficiency of electricity interconnections and electricity trade among members that fall outside national jurisdiction. It also means exercising 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 concerns – guidelines for cross-border trading and adoption of cost-reflective tariffs. The guidelines for regulating cross-border power trading in SAPP were developed with support from the World Bank (RERA, 2010). This was the first concrete step towards the goal of harmonising 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. 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.

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

Regional guidelines are being adopted at a slow pace because regional priorities are being subordinated to national priorities.

Table 16: EAPP electricity market structure by country

Country	Structure	Regulation
Burundi	Vertically integrated utility, Regie de Production des Eaux et de l'Electricite.	Government /Ministry of Energy and Mines
DRC	Vertically integrated SNEL; open to IPPs.	Government / Ministry of Energy, draft law prepared to introduce regulator
Djibouti*	Vertically integrated utility.	Government
Ethiopia	Vertically integrated EEPCO unbundled into Ethiopian Electric Power (EEP), for generation and transmission, and Ethiopian Electric Service for distribution.	Ethiopian Electricity Agency, supervised by the Ministry of Water, Irrigation and Energy
Egypt	Egyptian Electricity Holding Company; single transmission system operator and buyer. State owns majority shares. Law permits up to 49% private ownership. Market competition foreseen in legislation.	Electric utility and consumer protection regulatory agency
Kenya	Unbundled generation from Kenya Electricity Generation Company (KenGen) with IPPs and some embedded generation spilling onto grid. Integrated transmission and distribution as single buyer, Kenya Power and Lighting Company.	Energy Regulatory Commission (ERC)
Libya	Vertically integrated utility, GECOL	Government /GECOL
Rwanda	Vertically integrated utility, Electricity Water and Sanitation Agency (EWSA). Unbundling in progress to separate energy from water and sanitation.	Rwanda Utilities Regulatory Agency (RURA)
Sudan	The former National Electricity Corporation unbundled into five separate state-owned companies.	Government
Tanzania	Vertically integrated utility, TANESCO.	Energy and Water Utilities Regulatory Authority (EWURA)
Uganda	Unbundled into generation, transmission by Uganda Electricity Transmission Company Limited and distribution with IPPs permitted. Single buyer.	Electricity Regulatory Authority (ERA)

*Djibouti is not yet a member of EAPP

Source: Mercados (2010), utility websites.

Table 17: SAPP electricity market structure by country

Country	Structure	Regulation
Angola	Vertically integrated state-owned utility ENE	Institute for Electricity Sector Regulation of Angola (IRSE)
Botswana	Vertically integrated state-owned utility BPC	Government
DRC	Vertically integrated state-owned utility SNEL	Government
Lesotho	Lesotho Electricity Company (LEC) - vertically integrated state-owned utility	Lesotho Electricity and Water Authority (LEWA)
Malawi	ESCOM - vertically integrated state-owned utility	Malawi Energy Regulatory Authority (MERA)
Mozambique	Electricidade de Mozambique (EDM) - vertically integrated state-owned utility	National Electricity Advisory Council of Mozambique (CNELEC)
	HCB – IPP	
	Mozambique Transmission Company (MOTRACO) - ITC	
Namibia (NamPower)	NamPower - vertically integrated state-owned utility	Electricity Control Board of Namibia (ECB)
South Africa	Eskom - vertically integrated state-owned utility	National Energy Regulator of South Africa (NERSA)
Swaziland	Swaziland Electricity Company (SEC) - vertically integrated state-owned utility	Swaziland Energy Regulatory Authority (SERA)
Tanzania	TANESCO - vertically integrated state-owned utility	Energy and Water Utilities Regulatory Authority of Tanzania (EWURA)
Zambia	ZESCO - vertically integrated state-owned utility	Energy Regulation Board of Zambia (ERB)
	Copperbelt Energy Corporation– ITC and IPP	
	Lunsemfwa – IPP	
Zimbabwe	ZESA Holdings – vertically integrated state-owned utility	Zimbabwe Energy Regulatory Authority (ZERA)

Source: SAPP co-ordination centre and utility websites.

Electricity market structure

Market structures in the region are summarised in tables 16 and 17 above. Internationally and regionally, electricity market structures have been evolving according to the models listed below.

- **Stage I - vertically integrated monopoly. A single entity is responsible for generation, transmission, distribution and retail.** The regulation function is jointly exercised with the energy ministry where the utility has the authority to make recommendations. This is a kind of self-regulation. The power pools were established when almost all countries had this traditional structure.

- **Stage II – vertically integrated single buyer with IPPs. Multiple generating companies compete to supply power to the vertically integrated utility.** The utility's regulatory powers are confiscated to avoid conflict of interest from its role both as 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 structure is now prevalent in most EAPP and SAPP member states (tables 16 and 17).

- **Stage III - unbundled industry with wholesale competition.** Separate entities are in place for generation, transmission, distribution and retail electricity supply. 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 structure would provide better support of the power pools as they move 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 already expressed in the SAPP vision statement.

Although member states are at the second stage, the power pools are planning to operate at the third stage by introducing wholesale competition at regional level. Countries could keep pace by ring-fencing their transmission, system and market operations and getting these to operate at arm's length from the generation and distribution businesses.

Planning processes

All countries have historically planned on the basis of satisfying their own national demand. The regional master plans are therefore used to demonstrate potential benefits of regional integration. Countries still develop projects that suit their national priorities.

The generic planning process at national or regional level follows the three stages outlined below.

- **Identification and prioritisation of needs or objectives**. For electricity planning, the power and energy demand forecasts identify the need to be met over a defined time horizon. The demand must reflect the ability and willingness to pay by the target beneficiaries. Policy interventions such as universal access targets help define the time horizon and interventions to influence ability and willingness to pay. Because of conflicting interests, selection and ranking criteria must be set using a needs identification process. Criteria such as security, reliability and affordability need to be clearly defined in order to guide the selection and ranking of options and plans.

- **Identification and prioritisation of options to fulfil needs.** Options are identified on the basis of several criteria such as size, energy technology (renewable, fossil, nuclear), geographical location (national or regional), environmental, social and economic impacts. Ideally the options must be evaluated on the basis of information derived from available feasibility studies of similar quality. Only acceptable options are used in the final stage as candidate projects.

- **Identification of the optimum plan (combination of options).** The selected plan must reflect the optimum combination of acceptable options identified on the basis of criteria that best fulfil the needs. The complementary transmission plan is then developed to facilitate the necessary power flows from generation to load centres.

National plans are completed first and used as inputs for the regional plan. Ideally the regional plan should in turn be used as input for a second iteration of the national plans so that the national plans are then aligned to the regional plans. The current master plans illustrate the actual planning processes that have been followed in the regions.

EAPP regional master plan and CBWS

The input data for the EAPP/EAC master plan and CBWS was derived from the national plans. The data included planning criteria, demand forecasts, generation supply options, existing and future thermal, hydropower and renewable energy projects, existing transmission network data and models. The national plans were completed without co-ordination, so they did not span the 2038 planning horizon (for the master plan) and 2050 planning horizon in the CBWS. The consultants had to make adjustments to the country data, noting that data available for many countries were of poor quality and contained many gaps. Some power generation options had information based on full feasibility studies while others were based on very preliminary reconnaissance surveys. To ensure the national plans were based on the same planning criteria as the regional plan, they were repeated or updated (EAPP and EAC, 2011).

The candidate projects for the EAPP and EAC master plan had significant inconsistencies in data. This highlights a need to invest significantly in feasibility studies in order to bring all candidate projects to similar levels of data quality. The CBWS adopted a screening and ranking process for generation options in an attempt to ensure that planning was based on projects with a similar level of data quality. It identified projects where feasibility studies needed to be prioritised for future planning.

Both studies identified optimum plans on the basis of least financial cost. The economic, social, environmental and other important factors like geographic equity in terms of development options were not considered. To ensure that regional and national plans are complementary there is need to invest considerable effort in a consensus on a set of criteria balancing the interests of all co-operating countries. Egypt is the region's largest electricity consumer and would need to prioritise imports from the other countries in order to increase the volume of power traded.

The EAPP/EAC master plan estimated the national generation plan capital and operating costs to 2038 at USD 355 billion. With USD 4.5 billion investment in transmission interconnectors the countries would reduce operating costs. The total cost was estimated at USD 325 billion, a saving of USD 25 billion. Optimising generation investments by deferring expensive thermal generation and advancing cheaper hydropower resulted in additional investment cost savings for both generation and transmission. These amounted to USD 319 billion and USD 3.8 billion respectively. The net benefit increased to USD 32 billion.

SAPP regional master plans

The creation of the regional master plans of 2001 and 2008/2009 used national plans as input data. Due to the different planning horizons for each country, consultants had to make adjustments to align national plans with the regional planning horizon. The objective of the 2008/2009 pool plan was to estimate the financial benefits of co-ordinated regional planning in 2005-2025 in contrast to individual national plans (SAPP, 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 at USD 89.3 billion. This provided a saving of USD 47.5 billion. The cost savings were due to reduced excess generation capacity inherent in unco-ordinated planning throughout the region. They were also due to the substitution of new nuclear generation in South Africa by large hydropower imports.

The SAPP pool plan of 2008/2009 clearly demonstrated the potential benefits of co-ordinated planning and development on a regional basis. However, this was not persuasive enough to influence South Africa's 2010 Integrated Resource Plan (IRP), which adopted a multi-criteria analysis to arrive at optimal development for the country. The criteria used for the IRP and their relative weights are shown in table 18.

South Africa accounts for four-fifths of SAPP total generation and demand. Therefore the introduction of significant nuclear and non-hydropower renewables in its IRP reduces import of hydropower from the region. This is contrary to the major assumption behind the SAPP 2009 pool plan. It is interesting to note that for South Africa, regional development does not carry the weight expected by the regional master plan. The recommended development programme to 2030 compared to the generation mix at the time of the plan preparation shows a marked increase in non-hydropower renewables like wind and solar. South Africa revised its IRP in 2013.

None of the other countries nor the power pool has adopted the master plan to identify priority regional projects, either. Instead SAPP has developed a multi-criteria prioritisation system to select and rank projects. The criteria reflect a need to consider an optimum combination of factors. These include cost, regional power generation and economic impact, project size, lead time, committed offtake, climate change impact, transmission cost and number of participating countries. The criteria and relative weighting assigned are summarised in table 20. Each country, through its national utility, submits a government-approved generation and transmission plan to the SAPP co-ordination centre. The planning subcommittee, 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 co-ordination centre helps utilities to undertake project readiness assessments. The projects that score above a defined level, currently 50%, are accepted as SAPP priority projects. They are recommended to the SADC energy ministers through the SADC secretariat.

Table 21 provides an interesting contrast between the SAPP 2008/2009 pool plan and the present SAPP priority projects. The latter reflect the multi-criteria analysis by SAPP and South Africa. The total proposed additional capacity is almost the same but the generation mix and its geographical location is very different.

Table 18: South Africa generation scenario prioritisation criteria

Project selection criteria	Weight (%)	Best if
CO_2 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
Total	**100**	**Optimum balance**

Source: Government of the Republic of South Africa (2010)

Table 19: 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		
	Wind	8.4	20		9
	CSP	1.0	2		
Gas		6.3	15		1
Total		**42.6**	**100**	**100**	**100**

Source: Government of the Republic of South Africa (2010)

Table 20: SAPP generation project prioritisation criteria

Project selection criteria	Weight (%)	Best if	Weak if
Levelised cost	20	Cost is low (<4 USc/kWh)	>13 USc/kWh
Percentage of regional contribution	15	Contribution is high (>80%)	<20%
Economic impact (GDP and jobs)	10	Regional	Localised impact
Size of project	10	> 1 000 MW	<50 MW
Project lead time	10	Short (<2015)	> 2019
Percentage offtake committed	10	High (>80%)	<20%
Climate change impact	10	Low or positive	High or negative
Cost of transmission	10	Existing infrastructure	>750 km
Number of participating countries	5	>5	1
Overall	**100**	**Score >50%**	**Score < 50%**

Source: SAPP (2012c)

Table 21: SAPP priority projects versus SAPP 2009 pool plan

Generation technology of capacity addition	SAPP 2009 pool plan		SAPP 2012 priority projects	
	MW	%	MW	%
Hydropower	18 045	32	14 646	26
Coal	23 883	42	9 650	17
Nuclear			9 600	17
Gas and distillate	14 758	26	7 620	14
Non-hydropower renewable			14 100	26
Total	**56 686**	**100**	**55 616**	**100**

Source: SAPP (2008), SAPP (2012d)

Lessons for master plan reviews

EAPP is reviewing its regional master plan while SAPP is planning to review and update its regional master plan. To ensure improved outcomes, the planning subcommittees should adopt the following approach based on the lessons from the previous studies.

- National plans need to adopt the same planning horizon for each country. They need to undertake demand forecasts consistent with national and regional policy targets such as the vision of universal access by 2030. In both regions the national plans of the dominant electricity consumers and the fastest growing consumers will have the greatest influence on the regional master plans. The major electricity consumers are Egypt and Libya in EAPP and South Africa in SAPP. The fastest growing consumers are Ethiopia ad Kenya in EAPP and Angola, Mozambique and Zambia in SAPP.

- Candidate projects for fulfilling demand must be more comprehensive, including both hydropower and non-hydropower renewables. Common project readiness assessment criteria should be used to prioritise projects for the short to medium term.

- Project optimisation must not only focus on least financial costs but must reflect a balance between the national security interests and the reliability and economic benefits of co-ordinated regional development.

- An iterative planning process is necessary that begins with national plans feeding into regional plans which in turn become the basis for revising national plans.

IRENA recreated[7] EAPP least cost planning scenarios with an update of renewable technology data from various IRENA databases. It did this by building on the same database used for the EAPP master plan based on the same least cost system planning approach. Similarly, IRENA developed a scenario modelling tool for SAPP, the System Planning Test[8] model for southern Africa. This was calibrated to the present status of each SADC country using the 2007 SAPP master plan. It was updated with South Africa's IRP, as well as the 2012 SAPP priority projects. Two studies emerged from this exercise. They are entitled 'IRENA Planning and Prospects for Renewable Energy Study for East African Power Pool' and 'Southern Africa Power Pool: Planning and Prospects for Renewable Energy.' They are a part of a series of five African power pool models and studies whose objective is to develop energy system planning tools accessible to interested member states. This work highlight the benefits of regional power trade and the prominent role renewable energy can play in the energy mix if planning incorporates the latest data in a more refined way.

Power pool financial structures

Since EAPP was set up in 2005 the financing employed to acquire and support the secretariat's operation is drawn primarily from grants from development partners. Member utilities also contribute to a lesser extent. According to the IUMOU, EAPP finance is sourced as follows.

- Pending the effectiveness of power exchanges involving a greater number of countries in the region, the permanent secretariat is to be financed in the ways listed below:

  - contributions of member utilities
  - service fees
  - grants and any other revenues

- Infrastructure and capacity building finance will be secured from private, public, bilateral and multilateral development partners under specific agreements in addition to member contributions (EAPP, 2005).

The current corporate plan published on the EAPP website estimates an average annual budget requirement for the secretariat of just under USD 9 million for 2013-2015 (EAPP, 2012). Two-thirds of the budget is for institutional development and capacity building. Contributions by member countries are expected to amount to just over USD 500 000 per year. This is not enough to sustain the operational expenses of the secretariat without funding from development partners.

SAPP is registered as a non-profit organisation incorporated in Zimbabwe. The power pool's main assets are land, buildings and computer equipment. The SAPP operating budget covers the cost of running the co-ordination centre and its activities in supporting the work of the subcommittees. This is shared among members in accordance with guidelines agreed from time to time. The formula originally used when the power pool was formed meant the largest utility (Eskom) and the co-ordination centre host utility (ZESA) carried half the budget. This has been recently reviewed to make it more equitable (table 22). Each IPP and ITC is charged a flat 5% of the SAPP operating budget. Each observer member pays 3%.

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[7] The 2011 EAPP master plan was based on the proprietary SDDP OptGEn software models (www.psr-inc.com.br). The current master plan update is using the open source Balmorel model (www.balmorel.com/). IRENA uses the MESSAGE model, also an open source software.

[8] This is based on the MESSAGE model and covers the following 11 African countries: Angola, Botswana, DRC, Lesotho, Malawi, Mozambique, Namibia, Swaziland, Tanzania, Zambia and Zimbabwe.

The co-ordination centre is now also earning administration fees as the market operator. Support from international co-operating partners for operating expenses has focussed on specific projects like 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 international co-operating partners. SAPP members finance all their meeting expenses as well as contributing to the operation of the co-ordination centre. For both power pools, the financing of the generation and transmission infrastructure is the responsibility of the governments, utilities and investors. Most funding is supported by international co-operating or development partners.

Long-term financing

The SAPP financial structure benefits from a much higher contribution towards core costs by member utilities. This is a more enduring finance structure than that of EAPP. Support from development partners has therefore focussed on various programmes rather than recurring operational expenditure. For example, for the year ending March 2013, it had an expenditure budget of USD 1.9 million. Out of this, USD 1.2 million was self-funded, covering all core costs. This left the grant of USD 0.7 million to be used for special programmes. EAPP needs to investigate how SAPP has achieved a great deal more with much less funding than that envisaged in the EAPP corporate plan. The 2012 and 2013 SAPP annual reports show that the co-ordination centre operated on USD 2-3 million per year where core costs were covered by contributions from member utilities. For financial sustainability, core costs must not be dependent on donors.

Role of development partners

Development partners have played a critical role in establishing the two power pools. They have provided grants and concessionary and commercial loans for technical assistance and infrastructure projects for countries in the region. The major partners and their areas of development support are described below.

- Bilateral donors such as the United States, UK, Germany, Japan, Norway, Sweden, Finland and Denmark have funded power pool establishment costs. These include stakeholder meetings, computer hardware and software and skills for regional power trading and operations. In addition, they have provided support for the development of transmission interconnectors and the creation of enabling environments for renewable energy development.

- Multilateral financial institutions have used multi-donor trust funds to support regional master plans and project feasibility studies. These include, for instance, the World Bank, European Investment Bank, European Commission and AfDB. They have also facilitated the strategic social and environmental assessments and development of pilot projects for scaling up renewable energy projects.

- Non-traditional development partners including the Development Bank of Southern Africa and China have been providing grant and concessionary funding for generation and interconnector project development.

Due to limited public sector funding, the development partners are now playing a leading role in helping countries create an environment for attracting increased private investment in the power sector. This is particularly aimed at infrastructure development in power generation. Given that most projects are funded through PPAs, there is merit in enhancing the PPA bankability by extending private sector participation to distribution and supply. Public sector utilities are still very weak in this area. The public sector can then concentrate on transmission infrastructure, system and market operations to provide a level playing field for private generation, distribution and supply businesses.

Table 22: SAPP priority projects versus SAPP 2009 pool plan

Operating budget sharing criteria	Old formula (to 2010) %	New formula (from 2011) %
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
Observer members		3

Source: SAPP (2008), SAPP (2012d)

Wind park in Western Cape, South Africa

3. INFRASTRUCTURE FOR RENEWABLE POWER DEVELOPMENT

3.1 Renewable energy resources and potential

Both the EAPP and SAPP regions offer considerable renewable energy potential. However, available estimates of potential and utilisation are not very reliable as there have been no systematic renewable energy resource assessments besides large hydropower and geothermal. The largest renewable energy resource utilised is biomass. This takes the form of firewood, charcoal and agricultural waste used to provide thermal energy. There is also very little information on potential and utilisation of this resource. For ACEC, the renewable energy resources of interest are those used for power generation.

Estimated potential and present utilisation is shown in table 23 for East Africa. Ethiopia has used less than 3% and DRC only 2% of its hydropower potential. Only Egypt has used 85% of its hydropower potential (Kadiayi, 2013). Less than 2% of geothermal potential in the region has been exploited so far by Kenya, which uses 248 MW (EEPCO, 2012; Government of Kenya, 2011). Only 633 MW wind and 20 MW solar capacity is in use. Egypt accounts for the largest share of this, hosting 86% of the wind and 100% of solar capacity.

Plans for renewable energy development in the region focus o n hydropower, as can be seen from table 24. This summarises the priority generation projects identified in the EAPP and EAC Regional Energy Master Plan. Annex 2 lists the priority projects for each country. Improved resource assessments should be able to identify cost-effective non-hydropower options that can be considered in future master plan revisions.

Table 23: renewable energy utilisation in EAPP

Country	Hydropower (MW)		Geothermal (MW)		Wind (MW)		Solar (MW)	
	Potential	Used	Potential	Used	Potential	Used	Potential	Used
Burundi	1 700	32	n/a	0	n/a	0	n/a	0
DRC	100 000	2 442	n/a	0	n/a	0	n/a	0
Egypt	3 664	85%	n/a	n/a	n/a	547	n/a	20
Ethiopia	45 000	<3%	5 000	7	n/a	81	n/a	0
Libya	0	0	n/a	0	n/a	0	n/a	0
Kenya	6 000	812	10 000	248	n/a	5.1	n/a	0
Rwanda	500	72	700	0	n/a	0	n/a	0
Sudan	4 920	2 542.6	400	0	n/a	0	n/a	0
Tanzania	3 800	382	650	0	n/a	0	n/a	0
Uganda	>4 500	477	450	0	n/a	0	n/a	0

n/a =not available
Source: Government of Kenya (2011a), EEPCO (2012), REEGLE, n.d.

Table 24: priority projects identified in EAPP master plan

Country	Plant name	Type	Installed capacity (MW)	Date
Eastern DRC	Ruzizi III	Hydro	125	2014
	Ruzizi II	Hydro	287	2027
Ethiopia	Mandaya	Hydro	2 000	2031
	Gibe III	Hydro	1 870	2013
	Gibe IV	Hydro	1 468	2016
	Karadobi	Hydro	1 600	2036
Rwanda	Kivu I	Methane	100	2013
	Kivu II	Methane	200	2033
Tanzania	Stieglers Gorge (I, II, III)	Hydro	1 200	2020; 2023; 2026
Uganda	Karuma	Hydro	700	2016
	Ayago	Hydro	550	2023
	Murchison Falls	Hydro	750	2032

Source: EAPP and EAC (2011).

The renewable energy resource potential for many SADC countries has also not been fully assessed. South Africa has committed to significant renewable power in its IRP. However, there is recognition of the need to invest in research to reduce uncertainties on cost, lead times, capacity credits, capacity factors and durability of renewable energy technologies. The non-hydropower renewable energy resources, particularly wind and solar, are estimated to be several orders of magnitude greater than the hydropower potential (tables 25). Nevertheless, countries still need to carry out more detailed and site specific resource assessments.

Table 25: technical potential for renewable energy for power generation in SADC

Technology	Potential (MW	Potential TWh/year	Operational (MW)	Present utilisation TWh/year
Hydropower	121 000-146 000 *	660	5 744	~ 50
Wind		800		Negligible
Bioenergy		>11 000		~10
Geothermal		20-25		Negligible
Solar		>20 000		Negligible

* These figures include the DRC 100 000 MW also included in EAPP

Source: SADC (2012b), SAPP (2008), AfDB (2012)

At present, the focus of regional co-operation in SADC is not on renewable energy in general but on facilitating the development of the large hydropower potential. The priority projects in SAPP are listed in annex 3. The highest priority projects are the Cahora Bassa North Bank Extension and Mphanda Nkuwa, both in Mozambique, Batoka Gorge in Zambia/Zimbabwe and Inga 3 in DRC.

- **Cahora Bassa North Bank Extension, Mozambique.** This project involves the installation of 850-1245 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.

- **Mphanda Nkuwa, Mozambique.** This is a 1500 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 2400 MW for mid-merit operation.

- **Batoka Gorge, Zambia/Zimbabwe.** This 1600 MW project is 50 km downstream from the Victoria Falls on the Zambia/Zimbabwe border on the Zambezi River. A joint project steering committee has been set up by the governments of Zambia and Zimbabwe to oversee feasibility study updates, project preparation and implementation.

- **Inga 3, DRC.** Up to 4800 MW can be developed in two phases – 1800 MW low head scheme which does not require a dam and a 3000 MW scheme with a dam. This will be the initial phase of the Grand Inga Dam with a potential capacity of 40000 MW. South Africa and DRC are already jointly conducting feasibility studies. A framework for developing the project has been agreed.

Given poor data on renewable energy resources, technical assistance is a key agenda item for ACEC. This is required for countries to undertake renewable energy resource assessments and identify feasible project sites with sufficient environmental, economic and social cost information. This will be used in national and regional power master plans. Systematic measurements of river flows and wind and solar resources are needed on a continuous basis.

SADC countries have started to co-operate with IRENA on data collection for the Global Solar and Wind Atlas and Renewable Readiness Assessments (RRA). These are first-stage and high-level assessments. The SADC secretariat has signed a framework for co-operation with IRENA. At the 2013 SADC energy ministers meeting it was noted that all but two member states (Botswana and Malawi) had signed the IRENA statute or deposited instruments to that effect.

Through its Energy Sector Management Assistance Program in 2012, the World Bank launched an initiative to support renewable energy resource mapping and geospatial planning at the national 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. In partnership with the Lawrence Berkeley National Laboratory of the USA, IRENA is identifying renewable energy zones for the ACEC countries. The focus is on solar and wind.

3.2 Filling the gaps in transmission plans

The transmission projects identified in the EAPP and SAPP current master plans relate to potential hydropower use. Ethiopia and DRC, the countries endowed with the largest hydropower resources, need strong transmission grids to the major load centres in the region, namely Egypt and South Africa. Since these countries are at the extremities of their respective regions, grids of this kind would automatically serve the relatively minor needs of countries along the route.

Zambia, Tanzania and Kenya are the countries at the centre of the interconnection between EAPP and SAPP.

By virtue of its low-cost hydropower system, Ethiopia would be a strategic nerve centre for the EAPP grid. Figure 7 below shows the possible interconnectors to Ethiopia.

The short-term projects necessary to get interconnectors in the regional grid up and running are listed below.

- **Ethiopia – Kenya:** 500 kV bipolar HVDC, with 2000 MW transfer capacity scheduled for completion in 2015.

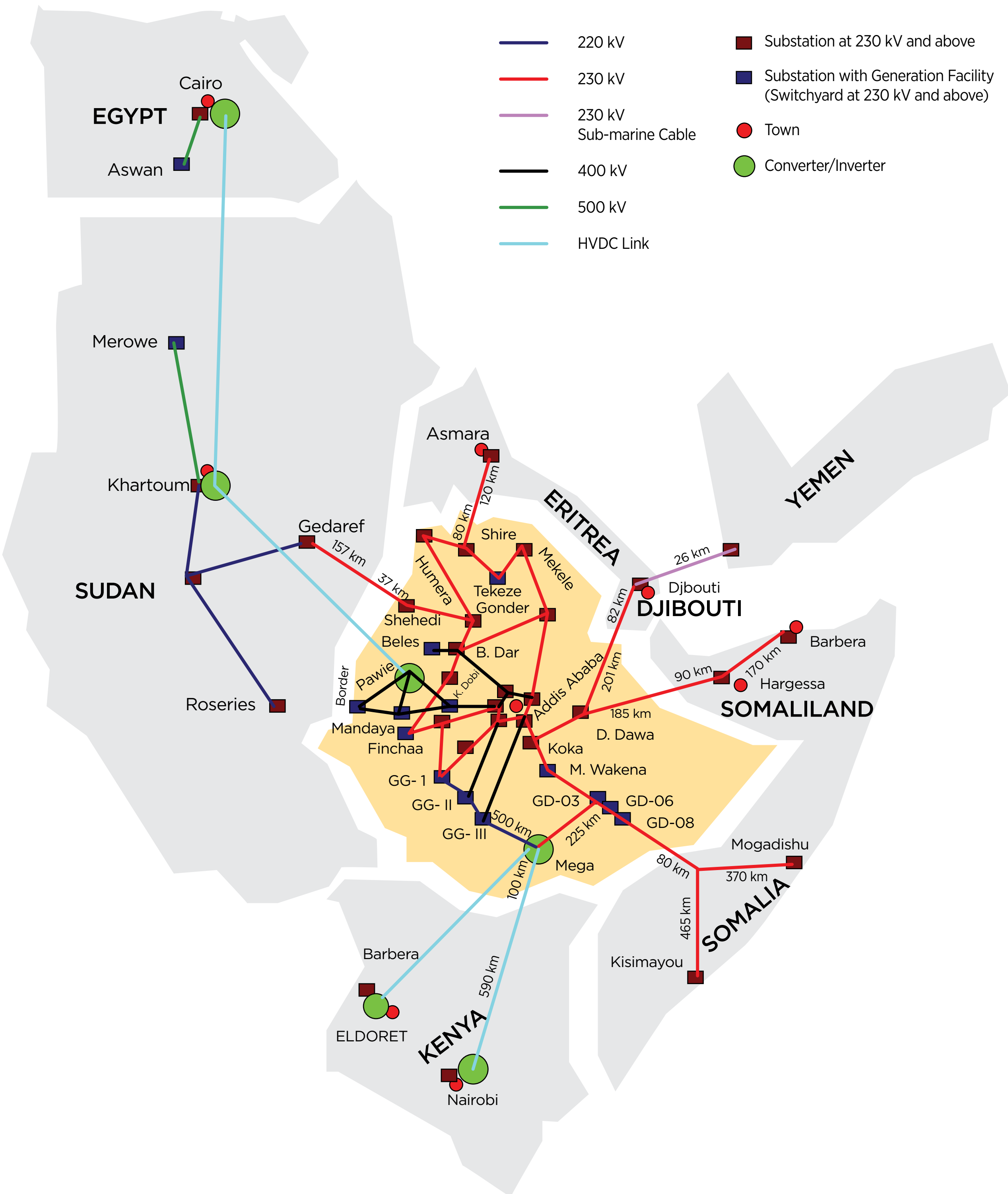
- **Ethiopia – Sudan:** 500 kV double circuit HVAC, with 2x1600 MW transfer capacity scheduled for 2016.

- **Egypt – Sudan:** 600 kV HVDC, with 2000 MW transfer capacity scheduled for completion in 2016.

- **Kenya – Tanzania:** 400 kV HVAC, with 1520 MW transfer capacity scheduled for completion in 2015.

The status of these and other short-term projects identified in the master plan is summarised in table 26.

Figure 7: possible Ethiopia interconnectors



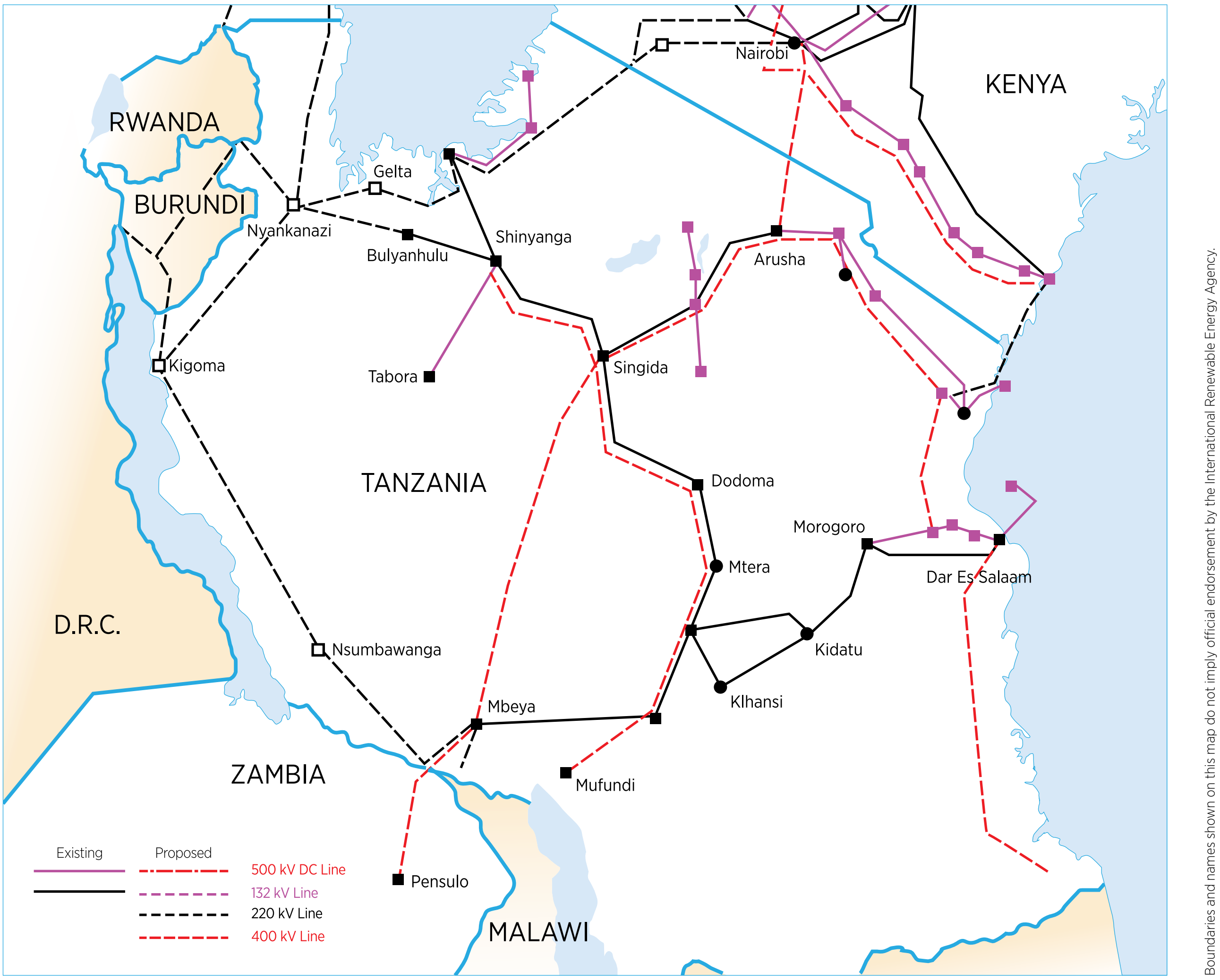
Source: Derbew (2013)

Table 26: status of interconnection projects in EAPP

From	To	Type/length	Capacity (MW)	Commission date	Status
Tanzania	Kenya	400 kV, 2 circuits, 260 km	1 520	2016	Negotiation stage for line construction
Rusumo	Rwanda	220 kV, 1 circuit, 115 km	320	2015	Discussions with financiers ongoing
Rusumo	Burundi	220 kV, 1 circuit, 158 km	280	2015	
Rusumo	Tanzania	220 kV, 1 circuit, 98 km	350	2015	
Ethiopia	Kenya	500 kV-DC, bi pole, 1 120 km	2 000	2018	Project officially launched May 2013
Ethiopia	Sudan	500 kV, 4 circuits, 570 km	3 200	2016	Negotiations with stakeholders ongoing
Egypt	Sudan	600 kV-DC, bi pole, 1 120 km	2 000	2016	Negotiations with stakeholders ongoing
Uganda	Kenya	400 kV, 2 circuits, 254 km	300	2015	Being implemented under NELSAP. Initially to be operated at 220 kV
Uganda	Rwanda	220 kV, 2 circuits, 172 km	250	2015	Being implemented under NELSAP
Rwanda	DRC	220 kV, 1 circuit, 68 km	370	2014	Being implemented under NELSAP
DRC	Burundi	220 kV, 1 circuit, 105 km	330	2014	Being implemented under NELSAP
Burundi	Rwanda	220 kV	330	2015	Being implemented under NELSAP

Source: EAPP and EAC (2011), discussions with utility stakeholders.

Figure 8: EAPP and SAPP interconnection



Map provided by EAPP.

The proposed Zambia-Tanzania-Kenya interconnector (figure 8) is expected to be the first realistic option for a link between EAPP and SAPP. The line route would be from Pensulo in Zambia to Mbeya, Singida and Arusha in Tanzania, and then to Nairobi, Kenya. AfDB is funding the project on the Zambian side where construction has commenced.

At a later stage the interconnection could be reinforced through a parallel HVDC route to enable greater power exchanges between the power pools.

Nine of the 12 SAPP member countries are interconnected through the national grids and dedicated interconnectors planned or developed before the establishment of the power pool. The present SAPP priority transmission projects fall into three categories outlined below:

- interconnecting the three non-operating members.
- strengthening transmission corridors used for wheeling power through the grid.
- evacuating power from new generation projects.

The different project categories and their present status are summarised in table 27.

Table 27: SAPP 2012 priority transmission projects

Project category	Project name	Planned capacity (MW)	Planned date	Status
1. Interconnecting non-operating members	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	600	2017	Implementation planning. A special purpose vehicle established and registered in Namibia
	Central transmission corridor, Zimbabwe	300	2016	Work in progress and feasibility study review
	Kafue-Livingstone upgrade, Zambia	600	2014	Line has been commissioned
	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 (2012a)

With respect to the second and third categories, SAPP has been considering the development of a super grid or strategic network. This would create a North-South corridor that allows hydropower transfer from the Zambezi and Congo basins to the South, and thermal power transfer 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 key components of the strategic network illustrated in figure 9 emphasise the importance of linking DRC to South Africa. DRC is the biggest potential source of hydropower in the region while South Africa is the largest consumer. In the 2008-09 master plan studies (SAPP, 2008) a link between these two countries was proposed. It is described below.

- **DRC HVDC reinforcement.** This entails increasing the capacity of the 500 kV HVDC link from Inga to the DRC-Zambia border. The use of 765 kV HVAC thereafter is to allow for multiple injection and offtake points to support trading among many different parties along the route.

- **A 765 kV central corridor.** This corridor would emerge from the HVDC terminal station and descend into the Zambian Copperbelt region, where it would fork. One branch would go to Kariba (Zambia-Zimbabwe border) and link to the Mozambique Tete region (picking up the Cahora Bassa and Mphanda Nkuwa power stations). The other would extend towards Hwange in Zimbabwe. The two would then meet in Bulawayo, Zimbabwe, before going to South Africa via Botswana. It would then link up with South Africa's 765 kV internal grid that extends to the Western and Eastern Cape and KwaZulu Natal. South Africa has already built 765 kV lines operating at present at 400 kV, and this explains the choice of voltage.

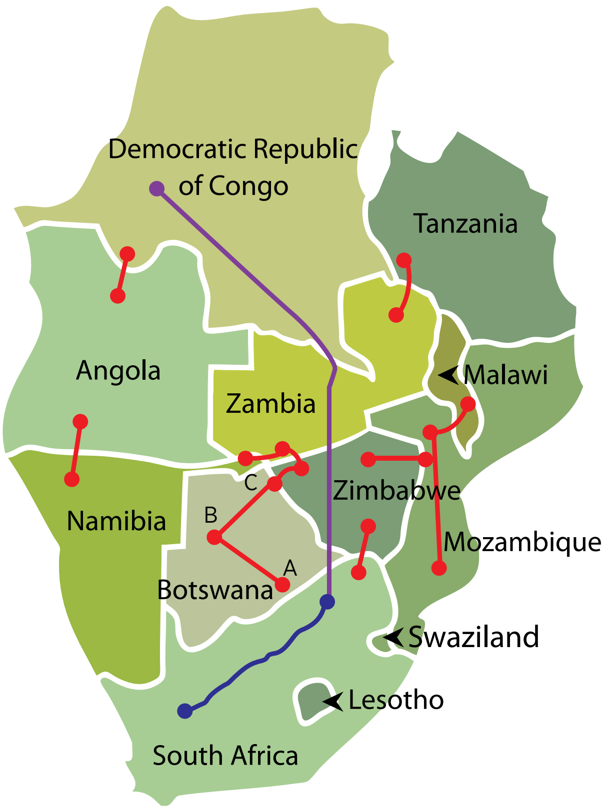
- **The 400 kV Western Power Corridor (WESTCOR) project.** This corridor exists from Inga through to Angola. The idea of this corridor was later extended by SAPP member countries to link up Namibia, Botswana and Western Cape.

- **A 400 kV eastern corridor.** This corridor extends from Malawi. It interconnects to the 765 kV grid in the Tete region and then goes through the rest of Mozambique to Maputo and back to the 765 kV grid in South Africa. The eastern corridor would include the interconnection of Tanzania to the Zambian grid.

Figure 9 shows the concept of this central corridor as a line that starts in DRC. It connects to the blue line within South Africa. Identifying the gaps and corridors that need reinforcement is a relatively simple task compared to actually making the projects happen. The WESTCOR project interconnecting the DRC Inga scheme to South Africa through Angola, Namibia and Botswana was initiated in 2003. Five countries signed IGMOUs and IUMOUs. A special purpose vehicle was agreed for the implementation of the project with a head office in Botswana. The project collapsed when the various countries were unable to agree on how to share expected benefits arising from the project.

Following the collapse of WESTCOR, attention has now switched to the central transmission corridor. This is designed to strengthen the transfer capacity of the grid in and around Zimbabwe as illustrated by the big red circle in figure 10. The immediate objective is to facilitate transfers from proposed projects in the Zambezi river basin. However, the ultimate objective is still to create a path for transfers from the Congo River basin. A joint ZESA and Eskom working group has been established. In consultation with other SAPP members, it is studying options for increasing transfer capacity through Zimbabwe to cater for existing and proposed generation projects according to the strategic network concept.

Figure 9: key SAPP interconnection priorities and expected year of completion

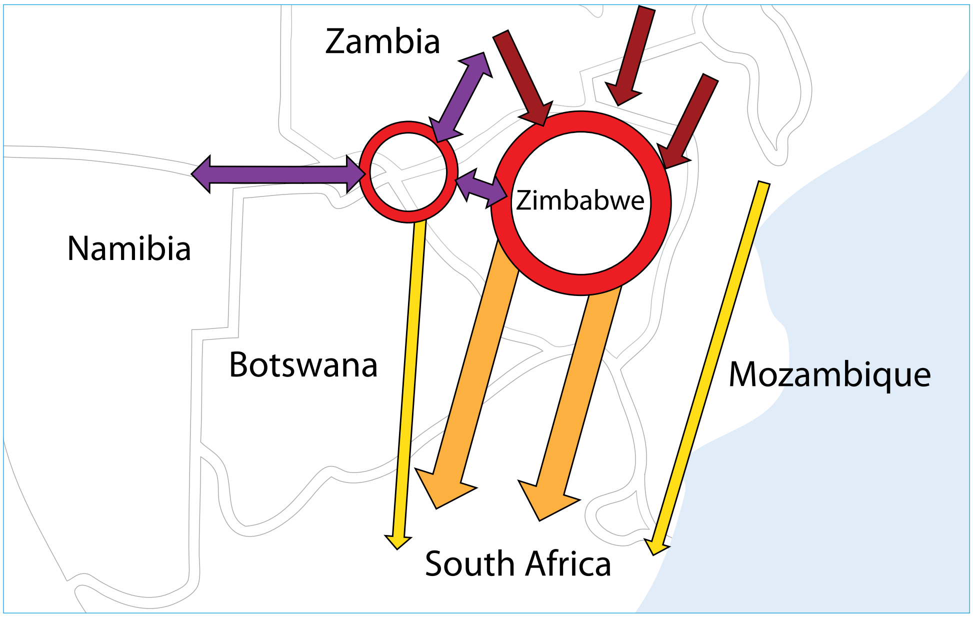


2017:	**ZIZABONA**
2017:	**Mozambique - Malawi**
2018:	**Zambia - Tanzania**
2018:	**DRC - Angola**
2022:	**Mozambique Backbone (STE)**
2017-2025:	**765 kV central corridor**
2018:	**Morupule (A) - Maun (B)**
2020:	**Maun - Pandamatenga (C)**

Boundaries and names shown on this map do not imply official endorsement by the International Renewable Energy Agency.

Source: SAPP (2014a)

Figure 10 strategic network concept for increasing transfer capacity through Zimbabwe



The arrows to the North of the ring are corridors that facilitate injection of generation from Malawi, Mozambique, Zambia and DRC. Projects are already proposed or in progress to upgrade the Kafue-Livingstone and North-West Botswana (Maun-Pandamatenga in figure 9) 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. It allows that region to exchange power with the central transmission corridor and to provide a western corridor into South Africa through Botswana (Maun to Morupule in figure 9) in the event of a central transmission corridor contingency. The proposed project, the Zimbabwe-Zambia-Botswana-Namibia Interconnector, commonly abbreviated as ZIZABONA, will connect this smaller ring to the existing Caprivi HVDC link to Namibia. The western corridor emerging from this ring is a future proposed corridor through Botswana with unknown size and capacity requirements at this stage. This is not the same project as WESTCOR.

An alternative power transfer route into South Africa is the eastern corridor, represented by the arrow down the middle of Mozambique in figure 10.

Preliminary studies have identified the need for the links outlined below.

- Adding extra 400 kV lines along existing interconnectors to Cahora Bassa in Mozambique, Kariba North in Zambia and Matimba in South Africa via Botswana.

- Introducing a new direct 400 kV link between Zimbabwe and South Africa through the Limpopo province.

- Introducing a new 400 kV link between Mutare in Zimbabwe and the proposed HVAC backbone in Mozambique. The 400 kV voltage is much lower than the 765 kV proposed in the draft 2009 SAPP pool plan study. However, it was considered adequate for the short to medium-term level of trading expected in the pool.

The EAPP and SAPP priority transmission projects are the building blocks for the ACEC. Most of the projects are still at the feasibility study phase. This means the terms of reference can be reviewed by the proposed EAPP and SAPP working group on ACEC in order to incorporate both hydropower and non-hydropower renewables.

3.3 Business models and financing

Funding generation and transmission projects will need to be very innovative. This is because these countries have never experienced the rate of demand and investment envisaged over the planning horizon. For example, the system in Kenya has been expanding at 4.2% per annum in 2002-2011. However, under the country's Vision 2030 Least Cost Power Development Plan, the ambition is to expand by 9.3 % per annum. This requires, among other initiatives, the development of 5 000 MW geothermal and 2 000 MW wind power. Around USD 45 billion will be required, USD 41.1 billion for generation and USD 3.9 billion for transmission. Out of these sums, USD 7.3 billion will be required over the next five years. Geothermal resource assessment by the Geothermal Development Corporation will require USD 1 billion. Kenya Electricity Generation Company and IPPs will need USD 3.6 billion for generation projects. USD 2 billion will be required for transmission projects by Kenya Electricity Transmission Company and the rest will be for distribution under Kenya Power and Lighting Company (WEF, 2012).

This vision of accelerated growth in electricity in tandem with economic growth is typical of all EAPP and SAPP countries. That is why it is necessary to consider business and financial models beyond the traditional state-owned utility.

Traditional utility financing model

This is the dominant and traditional financing model. Government budgetary allocations, donor grants and concessionary loans guaranteed by the state are extended to utilities. For relatively small projects, many of the countries in the region qualify for special official development assistance programmes such as the Global Energy Transfer FiT being trialled in Uganda and programmes for scaling up renewable energy. These are designed as pilots for attracting clean energy project private sector financing.

This model is probably the best for developing merchant generation and transmission projects and the civil structures of hydroelectric schemes. The private sector tends find these very risky. Merchant projects are necessary but their cash flows are not predictable enough for project finance on the basis of long-term PPAs. Examples are projects required for relieving congestion or performing a supplier of last resort function. These projects need to be funded from utility balance sheets or developer sovereign guarantees.

The region's state-owned utilities have a poor credit record, and national governments have limited financial capacity to subsidise their operations. This is the challenge of the traditional utility model. The financial weakness of EAPP utilities is reflected in their inability to meet the basic core costs of running the EAPP secretariat. The SAPP 2008/2009 master plan study and 2009 SAPP pool plan single out BPC, Eskom, NamPower and LEC. These, they note, are the only utilities with investment or near-investment grade credit ratings in southern Africa.

The creditworthiness of state enterprises can be unpredictable due to political risks. Some credit rating agencies have already begun downgrading Eskom from investment grade. This is because the utility is facing steeply rising costs from new projects and IPPs which are not being matched by approvals for tariff adjustments (Sunday Times, 2013). To manage its exposure to exchange risk, Eskom prefers to sign PPAs in ZAR. Exporters prefer to use USD or other international convertible currencies.

Private sector financing

The governments in the region have recognised the role the private sector can play to complement traditional public sector resources in meeting the huge finance requirements. Project financing is generally made on the basis of government guaranteed PPAs by state-owned utilities. In many countries, these are designated for offtake of power generated by IPPs. EAPP countries like Egypt, Kenya and Uganda have successfully used this approach for hydropower, geothermal, wind and solar projects. After three bidding rounds that started in August 2011, South Africa's REIPPPP has been able to mobilise private sector expertise and funding for 64 projects. They have a total capacity of 3 922 MW and USD 14 billion in committed private sector investment (www.ee.co.za/article/south-africa's-reipppp-programme-success-factors-lessons.html).

Apart from sovereign-guaranteed PPAs, governments have also introduced FiTs and provided land grants and other permits. They have also used rural and renewable energy funds/programmes to build the capacity of local banks to provide finance for projects. Zambia successfully used the privatisation of state assets, so that the Copperbelt Energy Corporation owns and operates a transmission system originally run by the state utility, ZESCO. The company has since extended its activities into IPP development within and outside Zambia.

Public private partnerships

One of the most recent successful public private partnership projects was established by the government of Uganda for the construction of the Bujagali hydro power plant project. It is called Bujagali Energy, and the plant has a capacity of 250 MW worth USD 860 million. The company will own the plant for a 30-year concessionary period before transferring it to the government. Multilateral lenders include the World Bank, the European Investment Bank and AfDB. They teamed up with private financiers such as Standard Chartered Bank and South Africa's ABSA capital. The dam was commissioned in August 2012.

Other successful public private partnerships include Ruzizi III, a USD 450 million, 145 MW hydropower plant located on the Ruzizi River flowing between Lake Kivu and Lake Tanganyika. It will provide electricity to Rwanda, Burundi and DRC. Another is MOTRACO. This is owned by the national power utilities of Mozambique, South Africa and Swaziland and supplies a privately-owned aluminium smelter in Maputo. The approach is to create a special purpose vehicle in which the public and private sectors allocate risks in accordance with the party best able to carry them.

Development of domestic capital markets

South Africa and Kenya have been able to mobilise funding by issuing stocks and bonds in their domestic markets. The development of domestic capital markets and creation of conditions conducive to attracting foreign direct investment is one of the key recommendations for financing PIDA projects (UNECA/AUC, 2012).

3.4 Enabling institutional arrangements for renewable energy development

Few countries in eastern and southern Africa have dedicated institutional arrangements for accelerating renewable energy development. Many countries manage renewable energy investments directly through energy departments. However, notwithstanding the institutional arrangements, supplying the relevant institutional capacity with the necessary human and financial resources is critical.

The role of regulators is crucial to the success of ACEC. These are the pillars of the corridor initiative, acting as enabling frameworks for investment. It is recommended that the approach to an enabling regulatory environment cover both regional and national power systems. The implementation process should include a high level strategy which provides general guidance on focus activities as well as the approaches for providing technical assistance.

To implement enabling regulatory environments, development partners should engage with stakeholders in SAPP and EAPP member countries. They need to identify areas which technical assistance projects make the greatest impact on national and regional decision-makers in supporting renewables. Action requiring immediate regulatory intervention at regional and national level is highlighted below.

Regional institutions

International trading carries physical and contractual risks. These need to be reduced by institutions that promote regional peace and stability and harmonisation and enforcement of laws governing the international transactions. The need for policy and regulatory framework harmonisation has influenced the establishment of RERA and IRB. It has also influenced the Energy Regulators Association of East Africa created in 2008 by EAC, as well as the Regional Association of Energy Regulators for Eastern and Southern Africa. This was created by COMESA in 2009.

The EAPP corporate plan (EAPP, 2012) has identified the need to build the skills of all national regulators as well as the regional body. In SADC, both RERA and the energy division of the SADC secretariat's DIS are grossly understaffed. One or two officers have to undertake both administrative and programme management work. The ability of regional bodies to carry out the necessary co-ordinating role is recognised as a key component of the PIDA Institutional Architecture for Infrastructure Development in Africa (annex 4).

National institutions

The weak human and financial capacity of regional institutions co-ordinating policy is replicated at national level. Governments and regulatory agencies require skills that include harmonising cross-border policies and regulations, building a culture of regulatory independence and dispute resolution.

A review of lessons learnt from South Africa's REIPPPP noted the critical importance of having a Department of Energy. It indicated this needs to have the institutional capacity to manage a transparent procurement process within a policy framework allowing developers to be profitable. It said that risks outside their control need to be assumed by governments (World Bank, 2014). The government-owned utility is sufficiently creditworthy to provide project offtake. It is also noted that South Africa has a strong domestic capital market that has complemented foreign funding. The first round bidding had less competition and produced prices close to FiT used as the price cap (table 28). Subsequent rounds were more competitive, and prices were reduced as local content also increased. This win-win situation boosts local employment. The reduction in costs through successive bidding rounds demonstrates the value of experience and investor confidence in a market in reducing risk perception.

Table 28: results of South Africa's REIPPPP bidding rounds 1, 2 and 3

Technology	Wind			Solar		
Bid dates	Nov 2011	Mar 2012	Aug 2013	Nov 2011	Mar 2012	Aug 2013
MW offered	1 850	650	654	1 450	450	401
MW awarded	634	562.5	787	631	417.1	435
USD awarded (million)	1 664	1 372	1 721	2 889	1 517	826
Average tariff USc/kWh	14.3	11.3	7.5	34.5	20.8	10

Note: Tariffs computed based on prevailing ZAR/USD exchange rates.

Source: adapted from World Bank, 2014

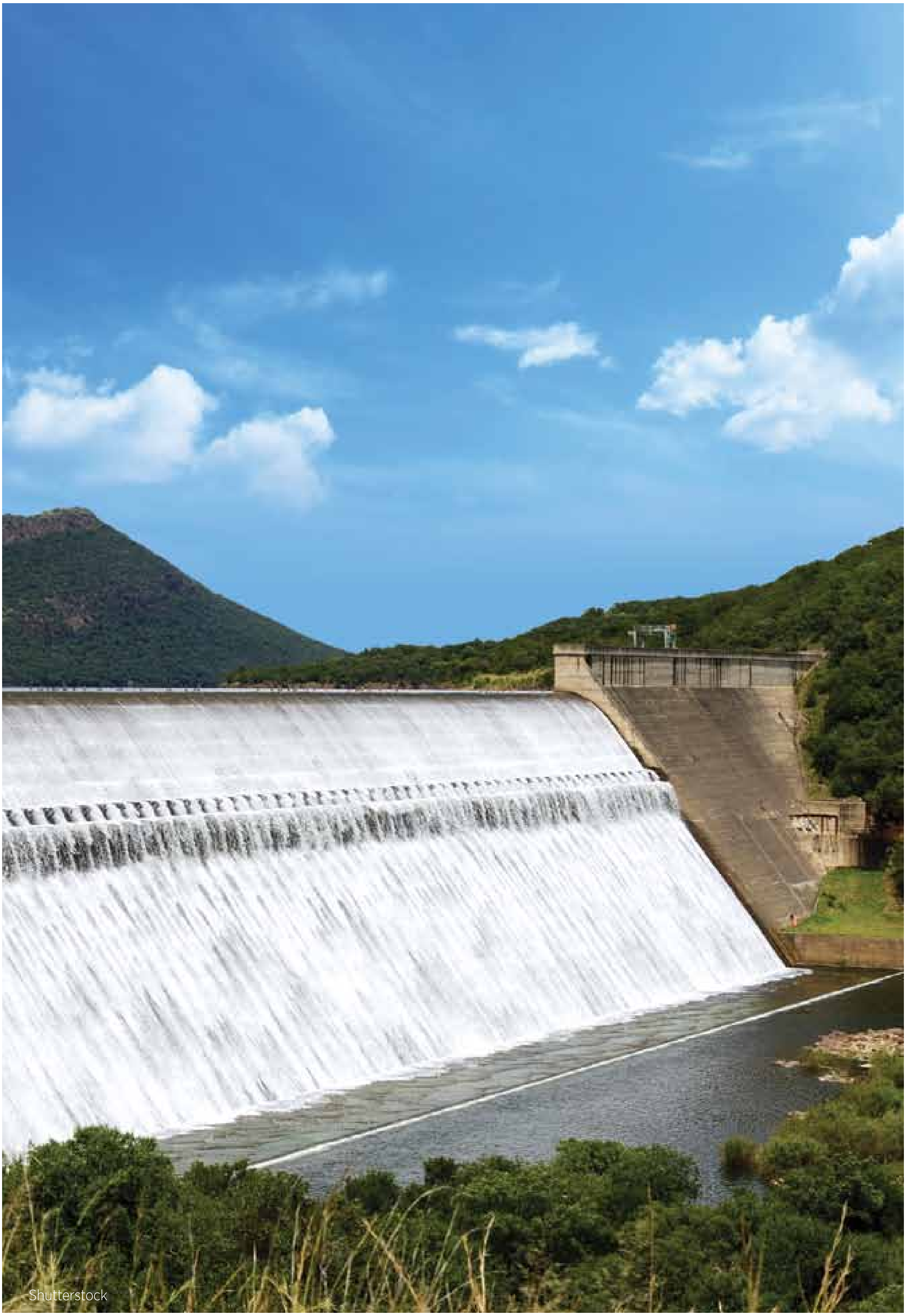
Egypt demonstrates the value of having a specialised agency for renewable energy development. Egypt's New Renewable Energy Authority was established in 1986 to undertake research and develop renewable sources of energy in Egypt on a commercial scale. Its role is also to implement energy conservation and efficiency programs (RCREEE, 2012). Under the direction of the New Renewable Energy Authority there has been considerable research into the feasibility of renewable energy systems in Egypt. This is most notably related to solar and wind power systems. Solar and wind atlases have been produced that have helped project developers identify the most favourable investment zones. Outside ACEC, Morocco has led in the deployment of renewables through a dedicated institution called Moroccan Agency for Solar Energy. This is a public company mandated to implement a programme for the development of integrated electricity production projects from solar energy with a minimum total capacity of 2 000 MW.

Summary of institutional capacity requirements

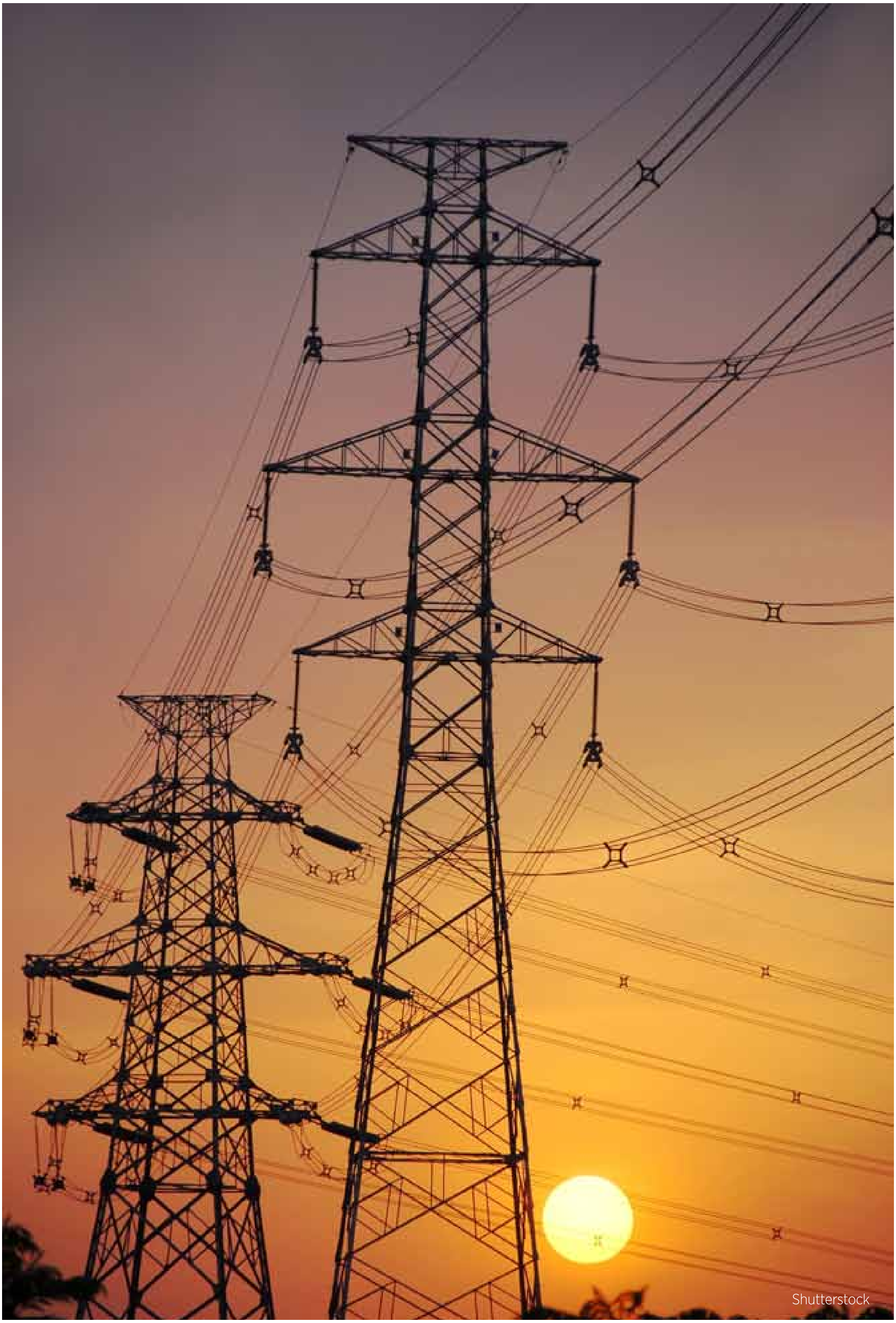
Lessons from successes and failures demonstrate the need for institutional capacity requirements for enabling institutions described below.

- Regional institutions need adequate administrative and technical staff to facilitate international policy and regulatory harmonisation. Developments of model agreements help reduce transaction costs and time.
- National institutions for implementing projects require additional skills. These include project preparation and management, harmonisation of planning and operational codes and system operation tools. They also need to be able to run competitive markets covering bilateral transactions, day ahead markets and ancillary services.
- A strong local private sector must provide advisory services and project funding. The two key issues are to get adequate financial sources to match demand and to reduce costs by reducing actual or perceived risks.
- R&D is needed to reduce uncertainties on resources and to ensure increasing amounts of renewables are safely integrated.

One of the root causes of institutional weakness is over-dependency on donor funding for core costs in a commercially-viable industry. For operations to last over the long term, the funding of such costs should not be dependent on ad hoc donor facilities but on contributions from member countries. It only takes a tiny percentage of energy industry revenues to support these institutions. Beyond the initial establishment costs, donor funds are best deployed towards specific programmes co-ordinated and supervised by regional and national institutions funded by revenues from the local energy industry.



Loskop Dam, Mpumalanga, South Africa



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4. CONCLUSIONS AND RECOMMENDATIONS

This study has assessed the readiness of the power pools to embrace the ACEC objectives. It has also identified renewable and other generation projects planned for the short to medium term. In addition, it has assessed and reviewed the critical transmission gaps and action being taken to resolve them. It has also reviewed the regional and national institutional capacity for enabling renewable energy development. The recommendations respond to the ACEC agenda.

4.1 Key findings and conclusions

a. Readiness of power pools to embrace ACEC objectives.

The ACEC initiative seeks to accelerate the development of renewable energy and co-ordinated regional planning and development to reduce energy costs and carbon emissions. It also seeks to improve institutional capacity for renewable energy development. Its findings are listed below.

- The EAPP and SAPP mandates support the ACEC regional co-operation objectives. However, their renewable energy focus is on large hydropower and to a lesser extent geothermal power in East Africa.

- SAPP is at a more advanced operational level than the EAPP. This has not yet developed enough interconnections and has missed its 2013 deadline for launching a competitive market. The SAPP co-ordination centre also acts as secretariat. It is therefore able to operate with a lower budget than that proposed for EAPP, which plans to separate the secretariat and co-ordination centre.

- SAPP has a mandate that explicitly subordinates regional plans to national plans and therefore limits the potential extent of regional integration.

- Both regions are characterised by a mix of very large public utilities that account for as much as four-fifths of total capacity. These operate alongside very small public utilities whose total demand is smaller than a single generating unit within the bigger countries. In practical terms, this means the national plans of the large countries override regional plans.

- The capacity of the regional and national policy and regulatory institutions is inadequate. This is partly due to over-dependency on donor funding in EAPP and the SADC secretariat. Another reason is the limited mandate of regional over national institutions.

b. Generation projects to meet current and planned demand.

It was difficult to get information from EAPP on the electricity sector so there was a reliance on consultant reports. The consultants for the EAPP master plan noted that information on the electricity sector in the member countries was either unreliable or not available. Some information was provided through contacts with individual utilities. The SAPP co-ordination centre publishes annual reports available on the website. These are very helpful in providing information from the national utilities. However, some of the utility information has gaps or inconsistencies. Notwithstanding these limitations a reasonable picture of present and planned supply is summarised below.

- Installed capacity at present is 45 GW for EAPP and 57 GW for SAPP. Of this, nearly 80% is thermal and concentrated in Egypt (gas) and Libya (oil) and South Africa (coal). The remaining capacity in the other countries is mainly hydropower, geothermal (mainly Kenya) with oil and gas for emergency power. The available or dependable SAPP capacity is 51.7 GW. This is less than peak demand including reserves of nearly 54 GW, which forces many countries to resort to load shedding. There was insufficient information to establish the dependable capacity in EAPP.

- Energy demand in SAPP is estimated at 268 TWh. The corresponding figure for EAPP was projected to reach 247 TWh by 2013. There was insufficient information to compute current energy demand for EAPP.

- Demand is projected to increase by wide-ranging margins. These are 4%-14% per year for EAPP and 2.5%-12.5% for SAPP. These projections are used in the master plan studies and were provided by the individual countries. These forecasts do not take account of global policy targets to achieve universal access by 2030.

- For EAPP, more than half (53%) of the planned and ongoing generation projects to meet demand in the short to medium term are hydropower. This is followed by wind (20%), thermal (15%) and geothermal (10%) with the balance being solar and biomass. Most hydropower is planned in Ethiopia. For SAPP, the generation mix for short to medium-term projects is 26% hydropower and 26% non-hydropower renewables (mostly wind and solar in South Africa). The balance is 17% coal, 17% nuclear and 14% oil and gas. In contrast the SAPP 2008/2009 regional master plan had identified a least cost regional plan without nuclear. This consisted of 32% hydropower, 42% coal and 26% oil and gas. A list of the projects is in annex 2 for EAPP and annex 3 for SAPP.

c. Critical transmission gaps

EAPP does not yet have an interconnected regional grid, while nine of the 12 SAPP member countries are interconnected. Transmission constraints in the SAPP interconnected grid are limiting energy trading. Priority transmission projects are therefore designed to create an interconnected grid for EAPP to start operations, to interconnect the three unconnected SAPP members and to relieve congestion. The critical transmission gaps to note are:

- key interconnectors in Ethiopia-Kenya, Ethiopia-Sudan, Egypt-Sudan and Kenya-Tanzania will get EAPP up and running for energy trading.
- the Zambia–Tanzania- Kenya interconnector will link the two power pools.
- interconnectors for the non-operating SAPP members are Mozambique-Malawi, Namibia-Angola, DRC-Angola and Zambia-Tanzania. The congested SAPP transmission corridors are Zimbabwe-Mozambique (Cahora Bassa) and Zimbabwe-Botswana-South Africa. Attempts to interconnect these countries have been made over the past 20 years without much progress.
- the most immediate impact of congestion in SAPP is the limit to trading on the competitive day-ahead market, currently standing at 27% of potential demand.
- the long-term SAPP plans are to create a supergrid or strategic network. This will run between DRC, the major source of hydropower, and South Africa, the major load centre. It is due to go through the central transmission corridor of Zambia, Zimbabwe and Botswana and through WESTCOR via Angola, Namibia and Botswana. WESTCOR has been shelved indefinitely.

d. Enabling institutional arrangements.

The current electricity market structure consists of vertically integrated state-owned utilities. Most of these are designated as the single buyer for power generated from IPPs. The information available shows that most of the utilities are not creditworthy without sovereign guarantees. Although more than half the countries have regulatory agencies, these are generally semi-autonomous and lack the track record of independent decision-making required to inspire investor confidence. There are, however, some success stories, listed below:

- REIPPPP is a competitive bidding programme for renewable energy projects managed by the Department of Energy. It has mobilised USD 14 billion for projects with a total capacity of nearly 4 000 MW.
- The 250 MW Bujagali hydropower project in Uganda was a successful public private partnership that raised USD 860 million. Another successful public private partnership is the 145 MW USD 450 million Ruzizi III hydropower project. This will provide electricity to Rwanda, Burundi and DRC.
- Successful ITCs include Copperbelt Energy Corporation of Zambia and MOTRACO.
- The successful mobilisation of funding from domestic equity and debt markets in Kenya and South Africa. The utilities in these countries have shares and bonds traded on the stock exchanges.

The ACEC initiative complements the North-South transmission corridor identified under PIDA. The implementation framework for PIDA is guided by the Institutional Architecture for Infrastructure Development in Africa illustrated and described in annex 4. This could provide a framework for ACEC. ENTSO-E is another model for EAPP and SAPP to learn how to implement the ACEC action agenda. (www.entsoe.eu). This is responsible for the co-ordinated development and operation of electricity grids in 34 countries in Europe.

4.2 Recommendations

The recommendations follow the proposed ACEC action agenda. They relate to renewable energy zoning, planning and enabling mechanisms (for attracting investment), capacity building and communications.

Zoning renewable energy resource potential

- **Resource assessments**
  Renewable energy resource assessments are

necessary to broaden the range of renewable energy technologies considered in EAPP and SAPP member countries beyond large hydropower schemes. They need to include both hydropower and non-hydropower resources. R&D institutions in the two power pools need to actively continue gathering, refining and analysing renewable energy resource data.

- **Feasibility studies**
  Project feasibility studies are needed in order to ensure equitable consideration in planning and development. These remove information inconsistencies between conventional fossil, nuclear and large hydropower projects and non-conventional renewables. Candidate projects must be fully described in terms of technical, financial, economic, environmental and social parameters.

- **Communications**
  To create a level playing field, all zoning information and feasibility studies funded from public resources must be easily accessible to potential investors, financing agencies and other stakeholders.

Planning for more renewable power

- **Policy harmonisation**
  Political co-operation is necessary to adopt co-ordinated renewable energy policies and targets and explicitly address the physical and contractual security risks arising from imported fossil fuel dependence.

- **Harmonisation of planning criteria and forecasts**
  Common planning horizons are needed to synchronise national and regional plans. For the same reason, demand needs to be forecast on the basis of similar scenarios. Multi-criteria analysis is also needed that balances the legitimate national interests of individual countries with the benefits of regional co-operation. To achieve harmonisation, a cyclical planning process needs to be adopted as follows:

  - national plans are prepared on the basis of the common criteria adopted
  - regional plans are then developed using input from national plans
  - national plans are then revised to achieve a desired balance between national and regional interests

- **Special attention to the inherent variability and uncertainty of renewable energy technologies**
  The safe integration of renewable energy in the interconnected and national grids needs appropriate analysis so that the reliability and stability of electricity supply is not compromised. This applies to both hydropower and non-hydropower renewables which can be affected by extreme weather conditions such as flooding and drought.

- **Special attention to transmission pricing**
  Transmission pricing is needed, especially for projects that need to be developed but have no quantifiable or predictable revenue stream (*e.g.,* to relieve congestion).

- **ACEC working group**
  A joint EAPP-SAPP working group on ACEC needs to be established by the planning subcommittees. This can work under the umbrella of existing inter-pool co-ordination through the Association of Power Utilities of Africa. Political endorsement through the SADC-EAC-COMESA tripartite framework and PIDA would help get the working group up and running.

Enabling more renewable power investment

- **Renewable energy policies and agencies**
  Dedicated policies and well-resourced institutions for renewable energy promotion have proved effective in accelerating renewable energy development. They a ddress barriers and constraints, carry out R&D and communicate information. For small countries, the renewable energy agencies could also be responsible for rural electrification. They would resolve concerns relating to off-grid technologies.

- **Market structure to facilitate private sector participation**
  Public utilities need to be unbundled to create separate regulated businesses for transmission system and market operation. Transmission operators will work at arm's length from the generators and distribution and supply divisions or companies. A multiple buyer wholesale market at national and regional level can mitigate the concentration risk of having a single buyer.

- **Minimising transaction time and costs**
  Standardised or model tariff methodologies and PPAs, technical standards, licences and approval guidelines and procedures minimise transaction costs. They also speed up the project development and financing process.

- **De-risking financing costs**
  Facilities from development partners are needed to minimise risk premiums on project funds and reduce policy and regulatory uncertainty.

Capacity building

- Build the human and financial capacity of national and regional policy, regulatory and project implementing institutions. If they are to endure, the core costs of institutions must not depend on donor payment but on energy sector revenues. It is essential that these institutions are able to attract and retain the necessary skilled people to plan, build and operate projects to specification, time and budgets.

- Learning from the experiences of others helps fast track capacity building. The EAPP secretariat could, for instance, learn from SAPP how to cost-effectively combine the functions of a co-ordination centre and secretariat. SAPP and RERA can learn from IRB for cross-border transactions. Both can learn from ENTSO-E. This organisation supervises the development and operation of grids in 34 European countries.

- It is worth building the necessary human skills and processes to plan for, integrate, operate and govern grids with increased renewable energy. These skills are essential across the value chain of the electricity supply industry.

Communications

Stakeholders, including international co-operating partners and civic society, need to be kept informed of ACEC developments.

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ANNEX 1: Overview of approach and methodology

Project and consultant objectives

The study project was commissioned by IRENA with the objectives listed below.

- To raise the profile of cost-effective investments with governments, multilateral development banks, financial institutions and others, in particular by helping countries within the eastern and southern African regions. This is to map and cost out their renewable energy resources and power systems.
- To develop an action agenda for ACEC together with all major stakeholders in the regions.
- The work was organised in two phases.

Phase 1

Preparation of two reports analysing the infrastructure for renewable power in eastern and southern Africa regions addressing the tasks outlined below.

1. Assessing the readiness of the power pools to embrace ACEC objectives.
2. Assessing the SAPP critical transmission and interconnection gaps that impact ACEC.
3. Collaboration to harmonise findings for the consolidated report.
4. Building associates and recommending networks for the development of ACEC.
5. Outlining projects within ACEC that are ready for investment and development.
6. Assessing and recommending capacity-building requirements for ACEC.

Phase 2

Preparation of consolidated report addressing the key tasks below.

1. Review of the phase 1 reports for EAPP and SAPP.
2. Strengthen the assessment and review of the critical transmission and interconnection gaps and action that affect ACEC, including both EAPP and SAPP viewpoints.
3. Prepare the final project report (unifying the EAPP and SAPP studies.)

Methodology and approach

Input for the reports was obtained through desk studies and engagement with relevant stakeholders, in particular the power pool secretariats. The primary sources of information for the desk studies were recent annual reports as well as published and unpublished national and regional generation and transmission policy, and planning reports. Other primary sources were AfDB, World Bank, IRENA and NEPAD publications on renewable energy and infrastructure development in Africa, and developing countries in general. Some reports were collected from the IRENA head office in Abu Dhabi, while others were obtained from internet searches of government and utility websites. It was generally much easier to get information on SAPP, which has an operational co-ordination centre in Harare.

A workshop was convened by IRENA in Abu Dhabi on 22-23 June 2013, to discuss relevant issues related to ACEC. It provided an opportunity for preliminary consultation with many of the stakeholders expected to play a major role in the development of the corridor.

The specific activities undertaken to fulfil tasks are summarised in the table below.

Key Tasks	Intermediate goals	Activities
1. Assessment of the readiness (willingness and ability) of the SAPP power sector to embrace ACEC objectives	To identify the cost-effectiveness of renewable energy considered in the pool	Desktop study on the relative costs of renewable and conventional energy generation considered in the pool
	To determine current and projected electricity demand and planning criteria within 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)

Key Tasks	Intermediate goals	Activities
1. Assessment of the readiness (willingness and ability) of the SAPP power sector to embrace ACEC objectives	To identify the availability of commercially-viable renewable energy resources	Review of resource assessment reports for renewable energy resources in SAPP
	To determine the capacity necessary for ACEC to plan, build and operate the grid	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 analysis of the relationship in system planning between the power pools and member countries
2. Assess critical transmission and interconnection gaps in EAPP and SAPP that impact ACEC	Determine the target ACEC network	Study proposals for strategic grid networks for SAPP that can serve as part of the ACEC network; study proposals for establishing an EAPP interconnected grid
		Review the present EAPP and SAPP network for comparison with the strategic networks
3. Collaborate with the ACEC consultant for EAPP to harmonise findings	Agree report formtat with EAPP consultant and IRENA	Discuss and agree with IRENA the project report outline
	Identify ACEC project priorities common to both EAPP and SAPP	Review EAPP and SAPP transmission and interconnection gaps given the target ACEC network
4. Build associates and recommend networks for the development of ACEC	Bring relevant stakeholders together to discuss ACEC creation	Identify and invite relevant individuals and institutional representatives to stakeholder workshops to discuss preliminary and final reports
		Prepare presentations summarising findings and present to stakeholder workshop
	Integrate ACEC creation into existing regional energy and economic planning to ensure stakeholder buy-in	Identify current regional and continental energy and economic development initiatives consistent with ACEC objectives with a view to proposing a unification of any fragmented efforts
		Attend IRENA strategy workshops on ACEC and establish relevant contacts for ACEC development
5. Outline projects within ACEC that are ready for investment and development	Identify projects with completed feasibility studies or secured funding	Study of EAPP and SAPP planning and operating reports and specific project reports
		Discussion with EAPP and SAPP management, governments and utility officials
6. Assess and recommend capacity building requirements for ACEC	Identify skills gaps in planning, building and operating grid and renewable energy generation projects as basis for recommendation of capacity building requirements	Identification of skills and capacity gaps
		Propose capacity building initiatives to bridge gaps as part of ACEC agenda

ANNEX 2: Key EAPP generation projects for short to medium term

Country	Project	Technology	Capacity (MW)	Developer	Status
Egypt	Helwan South	Gas	1 950		To be completed in 2018
	Gulf of Al-Zayat	Wind	200	Public	To be commissioned in 2014
	Italgen	Wind	120	Private	To be commissioned in 2014
	Western Nile Bank	Wind	200	Public	Proposal stage
	Gulf of Suez	Wind	720	Public	Proposal stage
	Gulf of Suez	Wind	1 350	Private	Proposal stage
	Komobo	CSP	100	Public	Proposal stage
	Komobo	PV	20	Public	Proposal stage
	Hurghada	PV	20	Public	Proposal stage
Ethiopia	Gibe 3	Hydro	1 875	Public	To be commissioned in 2014
	Grand Renaissance	Hydro	6 000	Public	Done in stages, 25% completed
	Border	Hydro	1 400	Public	Pre-feasibility study completed
	Ashegoda	Wind	90	Public	To be commissioned in 2013
	Ayisha	Wind	300	Public	To be commissioned in 2015
	Debre Birhan	Wind	100	Public	To be commissioned in 2015
	Asela	Wind	100	Public	To be commissioned in 2015
	Adama II	Wind	51	Public	To be commissioned in 2015
	Repi Waste Energy	Biomass	50	Public	To be commissioned in 2015
	Fincha sugar	Biomass	6	Public	To be commissioned in 2014
	Wonji sugar	Biomass	20	Public	To be commissioned in 2014
	Tendaho sugar	Biomass	78	Public	To be commissioned in 2015
	Tendaho	Geothermal	701	Public	Proposal stage
	Aluto Langano II	Geothermal	70	Public	To be commissioned in 2015
Kenya	Olkaria	Geothermal	910	Public	To be completed in 2013-16
	Wellhead units	Geothermal	65	Public	To be commissioned in 2013-14
	Orpower4	Geothermal	52	Private	To be commissioned in 2013-14
	Kenya coal plants	Coal	600	Not stated	To be completed in 2018
	Lake Turkana	Wind	300	Private	To be completed in 2018
	Ngong phase II	Wind	20.4	Public	To be commissioned in 2014
	Aeolus	Wind	60	Private	To be commissioned in 2015
	Kipeto	Wind	100	Private	To be commissioned in 2015
	Prunus	Wind	50	Private	To be commissioned in 2015

Country	Project	Technology	Capacity (mw)	Developer	Status
Kenya	Kindaruma 3	Hydro	32	Public	To be commissioned in 2013
	S.H (Genoproand Gura)	Hydro	6	Private	To be commissioned in 2015
	Kwale Sugar	Biomass	18	Private	To be commissioned in 2014
Libya	Darnah	Wind	60	Public	To be commissioned in 2014
	Al-Jofra	PV	14	Public	To be commissioned in 2014
Rwanda	Ruzzi III	Hydro	145	Public	Feasibility study completed in 2010
Sudan	Nyala	Wind	20	Public	Proposal stage
	Dongola	Wind	100	Public	Proposal stage
	Red Sea	Wind	180	Public	Proposal stage
	Khartoum	Wind	20	Public	Proposal stage
	Khartoum	PV	10	Public	Proposal stage
	Nyala	PV	5	Public	Proposal stage
	Al Fashir	PV	3	Public	Proposal stage
	Al Geneina	PV	2	Public	Proposal stage
Tanzania	Rusumo falls	Hydro	900	Not stated	To be completed in 2015
	Mtwara	Gas	400	Not stated	To be completed in2016
	Symbion 205	Gas	100	Not stated	To be completed in 2014
Uganda	Kakira II & Kinyara	Biomass	60	Public	To be commissioned in 2013-15
	Karuma dam	Hydro	600	Not stated	To be completed in 2019
	Namugoga	Solar	50-100	Private	To be completed in 2013-15
	Namugoga	Geothermal	150	Private	To be completed in 2014-16

Source: Compiled from EAPP and EAC (2011), NBI (2011), Government of Kenya (2011b), Government of Tanzania (2013)

ANNEX 3: SAPP priority generation projects

SAPP 2012 high priority generation projects >1 000 MW and score >50%

Rank	Country	Project name	MW	Type	USD million	USD million/kW	Date
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 (2012d)

SAPP 2012 high priority generation projects <1 000 MW and score >50%

Rank	Country	Project name	MW	Type	USD million	USD million/kW	Date
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
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**	

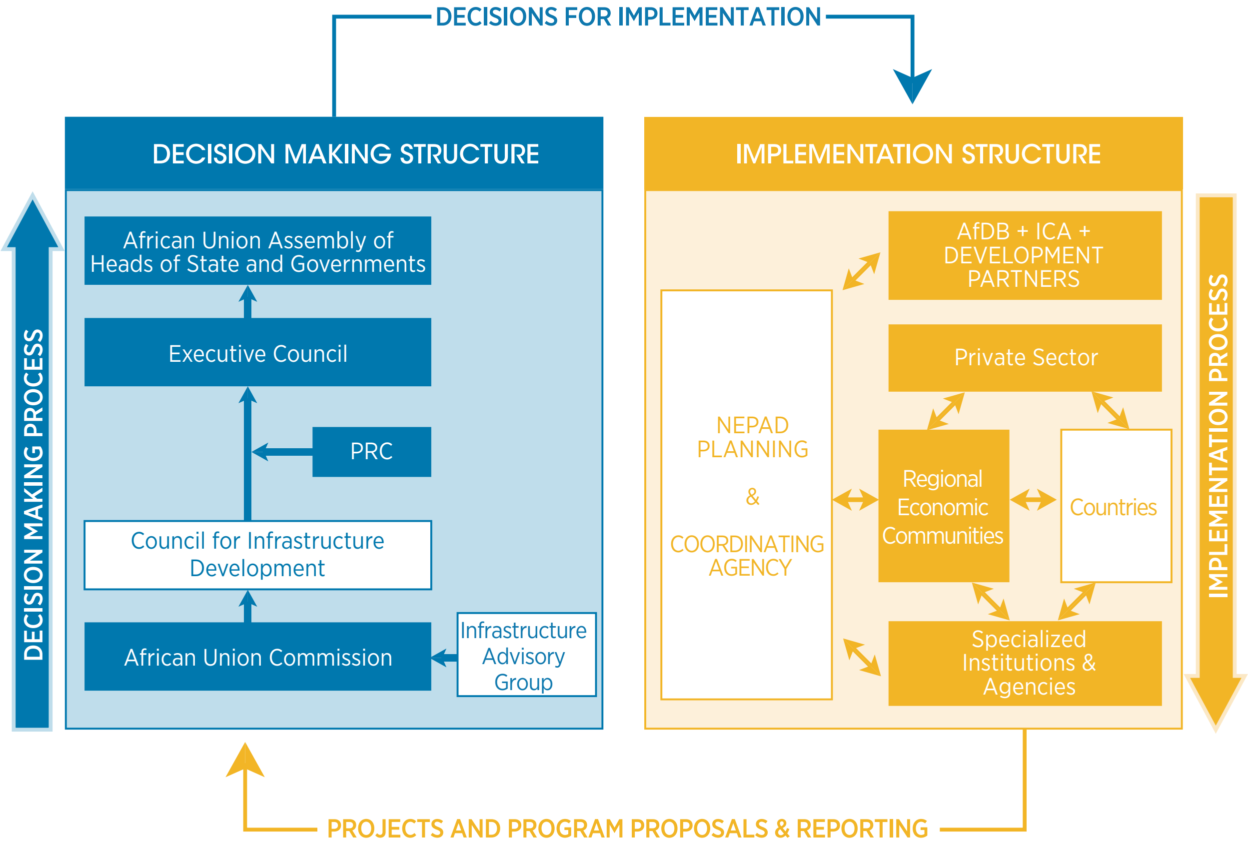
Source: SAPP (2012d)

Low ranked SAPP projects scoring less than 50% (March 2012)

Rank	Country	Project name	MW	Type	USD million	USD million/kW	Date
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	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 (2012d)
*open cycle gas turbine

ANNEX 4: Institutional Architecture for Infrastructure Development in Africa (IAIDA)



The implementation architecture can be summarised simply as follows:

- The NEPAD Planning and Co-ordinating Agency 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.

- Through their agencies, regional economic communities are responsible for developing regional master plans, which in turn are the basis for PIDA. Regional economic communities also monitor and report project implementation progress to the NEPAD Planning and Co-ordinating Agency.

- Since regional economic communities are not structured as implementing agencies, the responsibility for actual project implementation rests with countries. These need to marshal the resources and build the capacity to finance, develop, operate and maintain projects.

- Action at all levels should complement decision-making and be delegated to the lowest possible level, where accountability should also rest. This incentivises strong local ownership. PIDA projects are aligned with regional priorities, which in turn should be aligned to member state priorities.

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