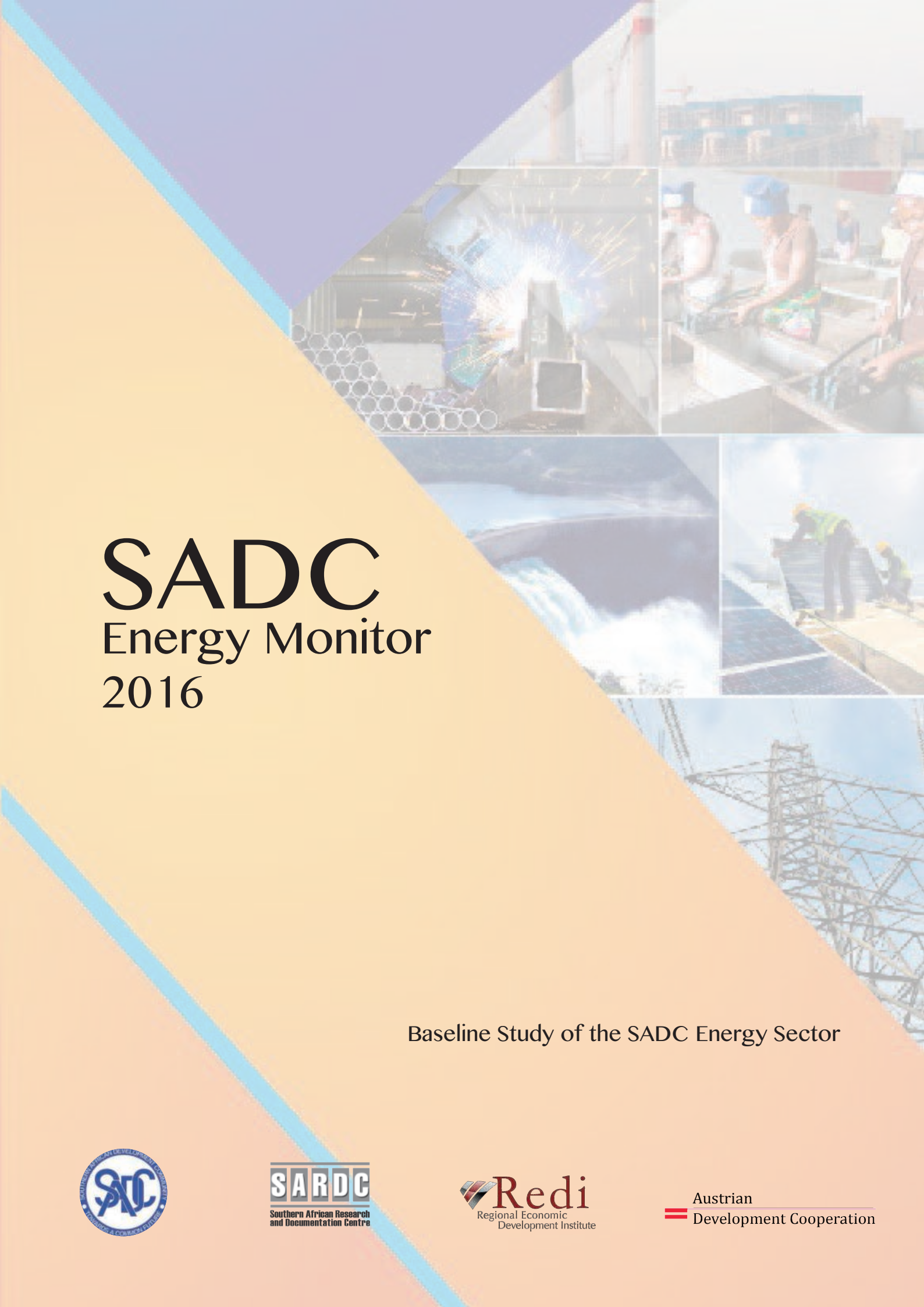
SADC
Energy Monitor 2016

Baseline Study of the SADC Energy Sector



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FOREWORD

Energy infrastructure development in the SADC region has been guided by instruments that include the Regional Indicative Strategic Development Plan (RISDP) – first adopted in 2003 and revised in 2015; the SADC Protocol on Energy; the Energy Cooperation Policy and Strategy of 1996 and the SADC Energy Action Plan (1997). In addition to these, cooperation in the SADC energy sector is captured in various other regional policy documents. These include the SADC Energy Activity Plan (2000), and the recently approved SADC Regional Infrastructure Development Master Plan and its Energy Sector Plan (2012). Energy is a critical area of Priority B of the Revised RISDP 2015-2020, which focuses on provision and improvement of infrastructure support for regional integration and industrialisation. Considerable preparatory work has been undertaken in this area to develop enabling policies, systems and processes such as Regional Energy Access Strategy and Action Plan of 2010 in support of the SADC Industrialization Strategy and Roadmap 2015-2063. The environment created will help to attract private sector investment and further promote public-private partnerships.

The emphasis from these instruments is largely to harmonise national and regional policies and regulatory frameworks; cooperation in energy development and trading through development of the necessary infrastructure as well as exploitation of the abundant energy resources in the region, particularly hydropower and put into place coordinated planning and institutional arrangements. The instruments were all developed prior to 2001 will be updated to take into account emerging issues such as biofuels, energy efficiency and climate change. Other issues coming to the fore are the crucial role of renewable energy (RE) for heating and cooling; RE in the transport sector; and RE in the manufacturing sector.

It is worth noting that energy issues transcend borders and, therefore, demand the cooperation of all Member States. In this regard, the signing of the Protocol on Energy on 24 August 1996, and its subsequent coming into force two years later on 17 April 1998, represented a significant milestone towards promoting a more coherent system of transboundary cooperation in energy development in the region. The Protocol acknowledges the importance of energy in pursuit of the SADC vision of economic well-being and poverty eradication in southern Africa. To best achieve these ends, the Protocol invites SADC Member States to cooperate on energy development by harmonising policies and promoting joint implementation of projects in the region. It also advises that these policies ensure the security, reliability, and sustainability of the energy supply, with Member States cooperating on research and development of low-cost energy sources applicable to Southern Africa.

Such cooperation is best exemplified by the work of the Southern African Power Pool (SAPP), which coordinates the planning, generation, transmission and marketing of electricity on behalf of Member State utilities in the SADC region. All the 12 mainland SADC countries, namely Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, United Republic of Tanzania, Zambia and Zimbabwe, are SAPP members. However, Angola, Malawi and Tanzania are not yet connected to the regional grid and efforts are at an advanced stage to link the three countries to the power pool. Similarly, SADC has established the Regional Electricity Regulatory Association (RERA), which has helped in harmonising the region's regulatory policies on energy and its subsectors.

The region, therefore, has to capitalise on the available resources to move forward the energy agenda to guarantee the much-needed energy security. The provision of reliable and sustainable energy continues to be a priority for Southern Africa's development agenda. If

SADC implements the agreed short, medium to long term generation projects as well as some rehabilitation projects on time, the region could meet its medium-term energy demand by 2020. We are confident that this target is attainable, and we call on everyone to play their part in making it a reality.

We must do more to use and develop renewable energy sources. This could be accomplished by addressing some of the challenges that continue to hinder and limit the levels of renewable energy penetration and use across the region. These challenges include inadequacies of effective legislative and regulatory frameworks that would support market development. The 34th SADC Energy Ministers meeting that was held in July 2015 in South Africa has set the motion towards renewable energy by making a landmark decision to establish a SADC Centre for Renewable Energy and Energy Efficiency (SACREEE).

We are excited to present the first edition of the *SADC Energy Monitor*, which presents a comprehensive regional perspective of the progress made towards implementation of various SADC energy policies. We sincerely hope that the first edition of this report will provide a solid reference source on energy development in the SADC region.

The main objective of the publication is to ensure that progress made towards the implementation of the SADC energy commitments in line with the SADC Protocol on Energy and other regional strategies and policies are documented and widely distributed. The publication also tracks implementation by Member States of the various energy commitments they have made at the regional level. It focuses on the three main energy sectors of relevance to SADC – electricity, renewable and energy efficiency, and oil and gas. It is my hope that the publication will assist Member States and other players in the energy sector to track implementation of commitments made at the regional level pursuant to the broad objectives of regional integration in Southern Africa.

I applaud the long-standing partnership of the SADC Secretariat, through its Energy Division, with the Southern African Research and Documentation Centre (SARDC) in producing this unique publication. I take this opportunity to thank the Austrian Development Agency for their consistent support and contribution to sustainable development in Southern Africa through funding this important initiative.

This publication reflects the spirit of cooperation and partnership that strengthens our efforts to raise the standard of living of people in Southern Africa and achieve SADC's vision of a shared future within a regional community.

Dr Stergomena Lawrence Tax
SADC Executive Secretary
July 2016

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ACRONYMS

ADA	Austrian Development Agency
AfDB	African Development Bank
AU	African Union
AUC	African Union Commission
BEST	Biomass Energy Strategies
BOO	Build-Own-Operate
BOOT	Build-Own-Operate-and-Transfer
BOT	Build-Operate-Transfer
BPC	Botswana Power Corporation
CDM	Clean Development Mechanism
CEC	Copperbelt Energy Corporation
CL	Commercial Lighting
CFLs	Compact Fluorescent Lamps
CNELEC	National Electricity Advisory Council of Mozambique
CRT	Cost Reflective Tariffs
CSP	Concentrated Solar Power
CTC	Central Transmission Corridor
DAM	Day Ahead Market
DBSA	Development Bank of Southern Africa
DFI	Development Finance Investment
DMP	Demand Market Participation
DRC	Democratic Republic of Congo
DRE	Distributed Renewable Energy
DSM	Demand Side Management
ECB	Electricity Control Board of Namibia
EDM	*Electricidade de Moçambique*
EEP	Energy and Environment Partnership
EIA	Energy Information Administration
ENE	*Empresa Nacional de Electricidade de Angola*
ENTSO-E	European Network of Transmission System Operators for Electricity
ERB	Energy Regulation Board of Zambia
ETG	Energy Thematic Group
ESCOM	Electricity Supply Corporation of Malawi
ESI	Electricity Supply Industry
ESIA	Environmental and Social Impact Assessment
ESP	Energy Sector Plan
EU	European Union
EWURA	Energy and Water Utilities Regulatory Authority of Tanzania
FDI	Foreign Direct Investment
FERC	Federal Energy Regulatory Commission
FINESSE	Financing Energy Services for Small-Scale Energy Users Conservation
FIT	Feed In Tariff
FTA	Free Trade Area
FPM	Forward Physical Market
GDP	Gross Domestic Product
GIZ	*Deutsche Gesellschaft für Zusammenarbeit*
GW	GigaWatt
GWh	GigaWatt hours
HCB	*Hidroeléctrica de Cahora Bassa*

HFO	Heavy Fuel Oil
HWLC	Hot Water Load Control
ICT	Information Communication Technology
ICPs	International Cooperating Partners
IDA	International Development Association
IDM	Intra-Day Market
IEA	International Energy Agency
IGMOU	Intergovernmental Memorandum of Understanding
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
IRPs	Integrated Resource Plans
IRSE	Institute for Electricity Regulation of Angola
kV	kiloVolt
kVA	kiloVolt-Amp
kW	kiloWatt
kWh	kiloWatt hour
LEC	Lesotho Electricity Company
LED	Light Emitting Diode
LEWA	Lesotho Electricity and Water Authority
LHPC	Lunsemfwa Hydro Power Company
LNG	Liquefied Natural Gas
LPG	Liquid Petroleum Gas
MDGs	Millennium Development Goals
MERA	Malawi Energy Regulatory Authority
MJ	Megajoule
MGJ/a	Megajoules per annum
MOTRACO	Mozambique Transmission Company
MoZiSa	Mozambique-Zimbabwe-South Africa
MoU	Memorandum of Understanding
MTP	Market Trading Platform
MVA	MegaVolt-Amp
MW	MegaWatt
MWh	MegaWatt hours
NamPower	Namibia Power Corporation
NBI	Nile Basin Initiative
NEEA	National Energy Efficiency Agency
NEPAD	New Partnership for Africa's Development
NERSA	National Energy Regulator of South Africa
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OGJ	Oil and Gas Journal
OPPPI	Office for Promoting Private Power Investment
ORE	Office of the Electricity Regulator
PBMR	Pebble Bed Modular Reactor
PCP	Power Conservation Programme
PIDA	Programme for Infrastructure Development in Africa
PJ	Petajoule
PPAs	Power Purchase Agreements
PPDF	Project Preparation & Development Facility
PPPs	Public Private Partnerships
PSA	Production Sharing Agreement
ProBEC	Programme for Biomass Energy Conservation
PV	PhotoVoltaic

RAP	Resettlement Action Plan
RE	Renewable Energy
REA	Rural Energy Agency
RECs	Regional Economic Communities
REF	Rural Electrification Fund
REFIT	Renewable Energy Feed In Tariff
REIPPPP	Renewable Energy Independent Power Producers Procurement Programme
REN21	Renewable Energy Policy Network for the 21st Century
REPGA	Regional Petroleum and Gas Association
RERA	Regional Electricity Regulators Association of Southern Africa
REASAP	Regional Energy Access Strategy and Action Plan
RESAP	Renewable Energy Strategy and Action Plan
RIDMP	Regional Infrastructure Development Master Plan
RISDP	Regional Indicative Strategic Development Plan
RRAs	Renewable Energy Readiness Assessments
RSA	Republic of South Africa
SACREEE	SADC Centre for Renewable Energy and Energy Efficiency
SADC	Southern African Development Community
SADC PPDF	SADC Project Preparation and Development Facility
SADCC	Southern Africa Development Coordination Conferenc
SAPP	Southern African Power Pool
SARDC	Southern African Research and Documentation Centre
SDGs	Sustainable Development Goals
SE4All	Sustainable Energy for All
SEC	Swaziland Electricity Company
SERA	Swaziland Energy Regulatory Authority
SMEs	Small to Medium Enterprises
SNEL	*Société nationale d'électricité*
SOLTRAIN	Southern African Solar Thermal Training and Demonstration Initiative
SPP	Small Projects Programme
STEM	Short Term Energy Market
SWHs	Solar Water Heaters
TANESCO	Tanzania Electricity Supply Company
TW	TeraWatt
TWh	TeraWatt hours
UNECA	United Nations Economic Commission for Africa
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USAID	United States Agency for International Development
VPS	Virtual Power Station
VPP	Virtual Power Plant
ZAMCOM	Zambezi Watercourse Commission
ZERA	Zimbabwe Energy Regulatory Authority
ZEO	Zambezi Environment Outlook
ZESA	Zimbabwe Electricity Supply Authority
ZESCO	Zambia Electricity Supply Corporation

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Production of the *SADC Energy Monitor* has been a collaborative effort. The Regional Economic Development Institute (REDI) of the Southern African Research and Documentation Centre (SARDC) worked with various organizations, experts and individuals in producing this publication. Key among them is the SADC Secretariat through its Energy Division.

We want to pay special tribute here to the late Dr Lawrence Musaba, who until his passing was the Coordination Centre Manager of the Southern African Power Pool (SAPP) and an icon of the regional energy sector. Dr Musaba was instrumental in establishing a regional energy market that allows countries in SADC to share surplus power to address their energy challenges. His contribution to the SADC energy sector over many years of dedicated service was extraordinary. He also contributed a great deal to our understanding of the issues, as a SAPP partner, and was an inspirational, humble figure whose guidance will be greatly missed. We dedicate this first edition of the SADC Energy Monitor to his work and his memory.

The process of producing this publication was informed and guided by the valuable support of SADC Member States through their timely submission of questionnaires that have informed the *SADC Energy Monitor* – the first of its kind in the SADC region.

For the development of the publication, SARDC REDI headed by Joseph Ngwawi contracted a number of authors, contributors and reviewers. The team of authors and reviewers, comprising Professor Godfrey Dzinomwa, Leonard Chitongo, Engineer Shadreck Mandiopera, Charles Murove, Nelson Magombo, Egline Tauya, Admire Ndlovu, Kizito Sikuka, Neto Nengomasha and Danai Majaha, worked hard to put together this publication.

We also acknowledge with deep appreciation the guidance and support of the SARDC Executive Director Munetsi Madakufamba, who supported the process throughout, from conceptualising the initiative through ideas and informed analysis, and Phyllis Johnson, SARDC Founding Director and Special Projects for the active engagement through technical review and knowledgeable eye for accuracy that made this publication a cut above the rest.

Special thanks also goes to the creative work of the SARDC design and publishing team, comprising Tonely Ngwenya, Anisha Madanhi and Shirley Pisirai, who worked tirelessly to ensure an engaging product that is presented in an attractive and accessible manner.

We express our gratitude to the Austrian Development Agency for its generous financial assistance offered for the research, development and publication of the *SADC Energy Monitor*.

Last but not least, the contribution and pivotal role of all institutions and individuals who supported the preparation of this publication, and may not have been credited by name is gratefully acknowledged. We say thank you for your essential support.

SARDC
July 2016

INTRODUCTION

Energy plays a pivotal enabling role in the overall development agenda of any region. Without access to modern energy services, vulnerable members of society spend most of their time on basic tasks that are time consuming, non-remunerative and highly laborious, such as collecting biomass fuels. Beyond its use in daily life, energy catalyses infrastructure projects that drive both national and regional development.

At the continental and global levels, energy has been identified as critical to the attainment of the global development agenda. The African Union, in its Agenda 2063, has identified energy as one of the key infrastructure pillars for connecting the continent. Energy was also regarded as the missing link in the attainment of the United Nations Millennium Development Goals (MDGs) that ended in 2015. The UN Sustainable Development Goals (SDGs) that replaced the MDGS in 2015 include access to affordable, reliable, sustainable and clean energy as one of the goals. The SDGs, officially known as "Transforming Our World: The 2030 Agenda for Sustainable Development", are an intergovernmental set of goals with 169 specific targets. Cognisant of the importance of energy in socio-economic development, the post-2015 global agenda also includes such initiatives as Sustainable Energy for All (SE4ALL), which seeks to attain universal access to sustainable and environmentally friendly energy services by 2030.

The existing SADC energy policy framework is comprehensive and places emphasis on the availability of sufficient, reliable and least costly energy services. The main challenge with the framework is that most of the policy documents, such as the SADC Protocol on Energy approved in 1996, are outdated and fall short of the region's stated objectives. Further, successful implementation of these policies depends on the commitment of Member States and other players in the regional energy sector.

The *SADC Energy Monitor* is a reference source and baseline publication that presents a picture of the progress made towards implementation of the SADC energy policies. The main objective of the publication is to ensure that progress made towards the implementation of the SADC energy commitments in line with the SADC Protocol on Energy and other regional strategies and policies are documented and tracked.

The publication was compiled using mostly secondary data obtained through literature review and through consultations with the SADC Secretariat, subsidiary organisations and other key players in the SADC energy sector. The framework of analysis took the driver, pressure, state, impacts and response approach.

The publication focuses on the three priority energy sub-sectors as currently defined by SADC– electricity, renewables, and oil and gas. In these chapters the publication gives a sectoral analysis of key developments, state, trends and projections.

Chapter 6, on Investment and Funding of Energy, analyses the current state of funding of energy projects. This includes an analysis of investment made so far as well as the available source of funding for future projects. It also focuses on related institutional and policy frameworks in place to promote investment in the energy sector.

Chapter 7 discusses the key trends in the various sub-sectors and possible scenarios in the event that the region takes action to address its energy challenges or it adopts a business-as-usual approach. This is crucial in flagging the key issues that the region should focus on as it moves to ensure that energy plays its role as a "key enabler" for socio-economic development.

The last chapter provides recommendations on how the region can attain energy self-sustenance, including policy considerations for Member States and the Community as a whole.

Cross-cutting issues such as gender, and climate change, are mainstreamed throughout the publication.

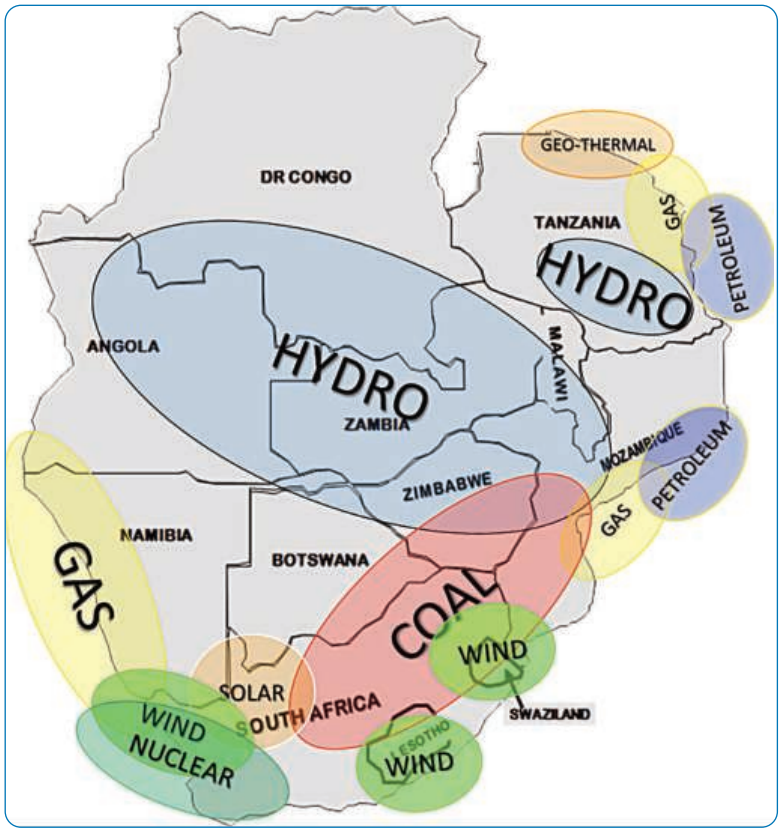
The target audiences for the publication are SADC Member States, their governments and policy makers, the SADC Secretariat and its subsidiary organisations, international cooperating partners, private sector and investors, researchers and academic institutions, as well as media houses.

Chapter 1

ENERGY OVERVIEW IN SADC

Southern Africa is relatively well-endowed with energy resources. Figure 1.1 gives an overview of the various energy resources available in mainland SADC Member States.

Figure 1.1 **Energy Resources, Mainland Countries**



Source SAPP Presentation at RISDP Review Researchers Workshop, May 2013

The SADC region has vast energy potential from solar, wind, nuclear, hydro, thermal, gas and petroleum sources in several countries, as shown in Figure 1.1. However, biomass is by far the major source of energy in most SADC Member States. Traditional biomass such as wood and charcoal accounts for more than 45 percent of final energy consumption in the region, according to a report by the Renewable Energy Policy Network for the 21st Century (REN21, 2015). The report notes that if modern biomass, such as bagasse for boilers in the sugar industry, is included, the overall biomass share reaches more than 57 percent. The use of biomass, however, varies by country, with some Member States exceeding 70 percent in terms of the contribution of traditional biomass to energy consumption. This is the case for the Democratic Republic of Congo (DRC). Biomass is also a significant source of energy in Mozambique, Tanzania and Zambia, where it accounts for at least 60 percent of energy consumption, according to the report.

The high share of biomass in total energy consumption in SADC can be attributed to the low proportion of urban dwellers. According to the SADC Secretariat, the total population in the region was about 294 million in 2013 (SADC, 2014), however only 39 percent of the population lives in urban areas where there is greater access to electricity. It is estimated that SADC's population is growing at a rate of 1.7 percent per annum and is likely to reach over 350 million by 2027, according to the SADC Regional Infrastructure Master Plan.

Electricity in SADC is generated mainly through thermal or hydroelectric resources. The coal industry so far is the backbone of power generation in the region and a significant share of the resource

is allocated for export. Coal exports are an opportunity that can yield economic benefits to the region if carefully planned so as not to prejudice the local demand. Both mining and transport infrastructure are needed for coal redistribution and export.

The region has a large reserve of low-cost hydroelectricity in the north (especially Inga Reservoir in the DRC and Kariba Dam on the Zambia/Zimbabwe border in the middle of the regional system, as well as large reserves of cheap coal in Botswana, Mozambique, South Africa and Zimbabwe.

Natural gas is becoming more significant to the region's energy sector, as Mozambique, Namibia, South Africa and United Republic of Tanzania develop natural gas fields in their respective countries (SARDC, 2010). New natural gas discoveries by international oil companies in Mozambique and Tanzania during the past decade have ignited investor interest in this previously under-explored region. The nascent petroleum and gas sub-sector is, however, plagued by volatile prices and although the region is endowed with some petroleum and gas resources, these are not directly available to the region either due to foreign commitments or the lack of necessary infrastructure to exploit, process, store and distribute throughout the region.

The SADC region has some of the most significant known reserves of uranium and the mineral is being mined in Namibia and South Africa for use as fuel for nuclear power plants while exploration is underway in Botswana and Zimbabwe. Nuclear technology is included in the electricity sub-sector but what is required is to demonstrate that nuclear power can be a safe electricity generation option and win the confidence of the population and governments to endorse nuclear energy deployment in the SADC region. Only South Africa has nuclear capacity, with plans for a new nuclear programme.

The region has a large potential for renewable energy, including hydropower which is already being exploited on a commercial scale. However, the necessary infrastructure for grid connection is poor. The prices for most renewable energy technologies are coming down but more needs to be done in the form of innovative financing.

A key factor of the SADC energy sector is the fact that the region has faced an electricity deficit since 2007 due to a combination of factors that have contributed to a diminishing generation surplus capacity against increasing growth in demand. In recent years, the sub-region has experienced a power deficit situation due to a number of reasons, including growing demand against limited expansion in generation capacity.

The prevailing instability in the sector is compounded by many other factors that include the current reality where access to energy takes a national rather than regional approach; tariff levels that are not cost-reflective and caught between the viability and access conundrum; capacity issues at both national and regional levels; and energy sector reforms that are generally perceived to be moving at a sluggish pace. In addition to the impact of lack of investment in new infrastructure over the years, the region's generation capacity is likely to suffer from the

effects of climate change and the stronger El Nino-induced weather conditions that have seen dam levels in most countries dropping. This situation has prompted most Member States to resort to various coping mechanisms that include load shedding as well as other Demand Side Management (DSM) measures while longer term solutions are being sought to remedy the situation through improved supply.

The Southern African region has a low access to electricity of about 42 percent compared to around 36 percent for the East African Community and 44 percent for the Economic Community of West African States, with some SADC countries having below five percent rural access to electricity.

Investment and financing are hampered by a number of barriers, which include low tariffs and poor project preparation, as well as limited off-takers that can sign power purchasing agreements under single buyer models and other required policy/regulatory frameworks. The petroleum and gas sub-sector is plagued by volatile prices and although the region is endowed with coastal petroleum and gas resources, these are not directly available to the region, either due to foreign commitments or the lack of necessary infrastructure to exploit, process, store and distribute throughout the region.

Southern Africa is also affected by the volatile and often ever-rising fluctuation in world prices of petroleum fuels, and yet little comparative, cross-border pricing data is available in the public domain although shortages have been felt in a number of countries. High prices of hydrocarbon oils relative to prices of biofuels have created a strong incentive to expand production of biofuels in the SADC region. Ethanol from sugar cane is produced and blended with petrol in several SADC member countries that produce sugar. The other biofuel that is produced in the SADC region is biodiesel, which is made from vegetable oils. Only South Africa and Zimbabwe are producing biodiesel at present. So far, the production of biofuels in the SADC region has not had a serious impact on the production of food because cereal food crops have not been used as the relevant feed, and because production has been on a small scale, thus avoiding competition for land with food crop production. But the situation could change in future as biofuel production increases.

While SADC attaches significant importance to all energy sources, whether renewable or non-renewable, the electricity sector is the one area where regional cooperation has advanced significantly. The quest for regional energy security in SADC has always involved a delicate balance between national and regional interests. Amid acute shortages, Member States have tended to take the sovereign route of attempting to attain national self-sufficiency, rather than depending on imports from other countries. In a Pool Plan with a planning horizon stretching from 2010 to 2020, the SAPP has revealed that the region stands to make huge cost savings of up to US$48 billion as well as enjoy better coordination if they pursued their projects collectively as a region rather than as individual Member States (SARDC, 2011).

Chapter 2

LEGAL, POLICY AND INSTITUTIONAL FRAMEWORK

2.1 Introduction

The overall goal of the SADC energy sector is to ensure the availability of sufficient, reliable, least-cost energy services that will assist in the attainment of economic efficiency and the eradication of poverty while ensuring the environmentally sustainable use of energy resources. To achieve these broad and ambitious goals, SADC has put in place a number of legal documents, policies and institutional frameworks through the adoption of various instruments such as protocols, strategic guidelines and regulatory frameworks. The main legal document on energy development is the SADC Protocol on Energy of 1996, which entered into force on 17 April 1998 after ratification by two-thirds of Member States. This provides a framework for cooperation on energy policy among SADC Member States.

Other key supporting governance instruments include the Revised RISDP, Energy Sector Cooperation Policy and Strategy and the Activity Plan, which outline the region's strategic development priorities for the energy sector. These frameworks are all premised on the SADC Treaty that sets the SADC agenda and is intended to create an enabling environment for economic cooperation among SADC Member States. In addition, the 15 SADC Member States have crafted various national energy documents to spur developments in the energy sector with the creation of national agencies to coordinate implementation of agreed activities, projects and programmes.

At the regional level, to ensure smooth implementation of regional energy instruments, the Directorate for Infrastructure and Services (DIS) was established at the SADC Secretariat to coordinate developments in the sector. The Directorate focuses on the development and quality of strategic infrastructure in the region through the six thematic sectors of: Energy; Transport; Water; ICT); Meteorology and Climate Service Centre, and Tourism (SADC, 2015). Box 2.1 provides a summary of the vision and objectives of the sectors that fall under DIS, including Energy.

Box 2.1

SADC Directorate for Infrastructure and Services

Vision
A world class facilitation of Regional Integration and sustainable development through provision of, and universal access to, infrastructure and services.

Sectors	Objectives
Energy	To ensure the availability of sufficient, least cost, environmentally sustainable energy services in the region
Transport	To provide adequate, integrated, safe and efficient infrastructure services in roads, railways, and civil aviation, maritime and inland waterways services
Water	To facilitate the development of a framework for sustainable, efficient and effective shared watercourses planning and management, through development of strategic water infrastructure and promotion of good water governance in the region
Information Communication Technology (ICT)	To ensure access to affordable, modern, efficient, reliable high quality and fully integrated ICT services to all citizens of SADC
Meteorology & Climate Service Centre	To generate and disseminate timely and credible meteorological and climate information products to stakeholders to support planning for socio-economic development, weather-related disaster risk management and the rational use, conservation and protection of natural resources
Tourism	To market the region as a single multifaceted tourism destination

Source SADC, 2015

In furtherance of economic integration in the energy sector, SADC has also established subsidiary organizations to implement various energy programmes, projects and activities. These organizations are the Southern African Power Pool (SAPP), Regional Electricity Regulators Association of Southern Africa (RERA) and the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE) which will soon be operational.

2.2 Institutional Framework

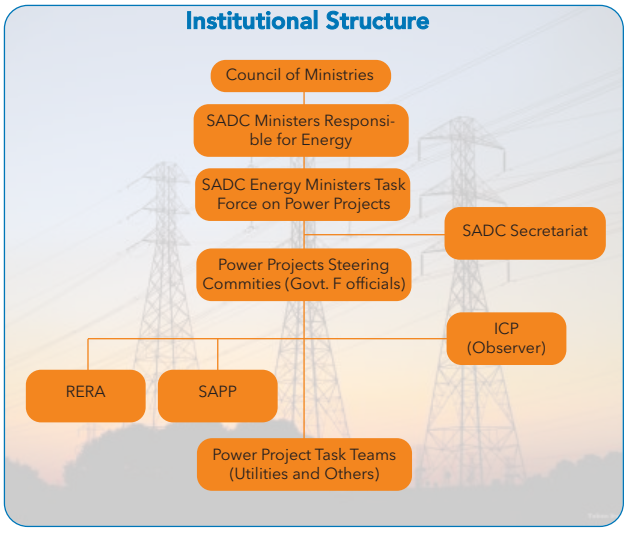
2.2.1 Governance structure

Establishment of appropriate and affective institutional frameworks and structures has been identified as one of the critical priorities for SADC to ensure that all regional programmes, projects and activities are fully executed to promote deeper integration and socio-economic development. To this end, various measures have been taken by SADC, including a Review and Rationalisation of the SADC Programme of Action in 1997, and a directive by the SADC Heads of States and Government in 1999 to the SADC Council of Ministers to initiate a comprehensive review of the operations of all SADC institutions. Similar review exercises are still being undertaken by SADC to ensure that the regional integration agenda is a success. One such institutional reform in the energy sector has been the recent approval by SADC to establish SACREEE to spearhead the uptake of renewable energy and energy efficiency technologies in the region.

In terms of institutional arrangements in the energy sector, the Ministers responsible for Energy is the apex policy body in the overall energy sector. It meets annually, reporting to the SADC Council of Ministers which in turn reports to SADC Summit Heads of State and Government. Below the Ministers responsible for Energy is the SADC Energy Ministerial Taskforce on Power Projects (comprising ministers from Botswana, Mozambique Namibia (Chair), South Africa and Zimbabwe), which was constituted in 2004 in response to the then impending power shortages and was therefore given the mandate to develop a roadmap to address the shortages in consultation with all Member States. Below the task force is the Power Projects Steering Committees made up of government officials, which ensure that energy projects are realized. Subsidiary organisations such as SAPP and RERA report to the steering committees as do the International Cooperating Partners (ICPs). The SADC Secretariat provides technical assistance to the ministerial committees. The institutional structure for managing the regional energy sector roadmap and projects is depicted in Figure 2.1.

The institutional structure depicted above will change to incorporate SACREEE, which was established as a specialist institution of SADC under the provisions of a subsidiary organization guided by the particular instruments set out in the Guidelines

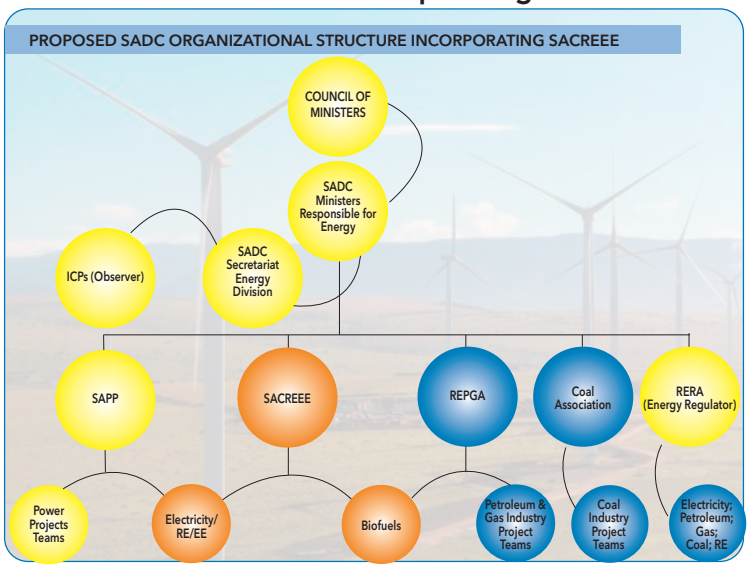
Figure 2.1 **Institutional Framework for Project Implementation**



Source SADC website www.sadc.int

Governing Relations between SADC and the Organizations Executing SADC Projects and Programmes under the Principle of Subsidiarity. Figure 2.2 shows the proposed new SADC organizational structure incorporating SACREEE.

Figure 2.2 **Proposed SADC Organisational Structure incorporating SACREEE**



Source SACREEE background booklet, 2014

2.2.2 SAPP

An Intergovernmental Memorandum of Understanding (IGMOU) signed by Member States in August 1995 gave birth to the Southern African Power Pool (SAPP), a 16-member regional body that coordinates the planning, generation, transmission and marketing of electricity on behalf of utilities in SADC Member States. According to SAPP, all utilities participating in the power pool have equal rights and obligations, and have agreed to act in solidarity without taking advantage of one another. In this regard, members have undertaken to share information and knowledge, be politically neutral, and develop common planning and operating criteria and procedures and to accept wheeling on behalf of other members when this is technically and economically feasible. Power utilities in mainland SADC – with the exception of Angola, Malawi and Tanzania – are interconnected through SAPP, allowing them to trade electricity with one another through a competitive market. SAPP member utilities are listed in Table 2.1.

Table 2.1 **SAPP Member Utilities**

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

Source SAPP

OP Operating Member NP Non-Operating Member ITC Independent Transmission Company IPP Independent Power Producer

The IGMOU of 1995 was reviewed in 2006 by SADC Energy Ministers in order to allow IPPs to be members of SAPP. At its formation SAPP had only 12 member utilities but the number has risen following the signing of the IGMOU, which is one of four agreements that govern SAPP operations. The others are the:

- Inter-Utility Memorandum of Understanding that established the basic management and operating principles for SAPP;
- Agreement between Operating Members which established the specific rules of operation and pricing; and
- Operating Guidelines that provide standards and operating guidelines.

In this regard, SAPP operations are based mainly on a set of agreements among the member utilities as opposed to formal laws, which would, among other things, allow the regional body to have greater authority on issues of energy in the region. Figure 2.3 shows the SAPP structure.

Figure 2.3 **SAPP Organisational Structure**

Source SAPP website

SAPP was created with the primary aim to provide reliable and economical electricity supply to the consumers of each of the SAPP members, consistent with the reasonable utilisation of natural resources and the effect on the environment. The regional power pool has also coordinated efforts to exploit for electricity generation the numerous energy resources that are in abundance in the region. For example, SAPP has identified a number of priority energy projects for commissioning over the next few years to address energy shortages in the region. Between 2015 and 2019, SAPP plans to commission a total of 23,585MW. If this is achieved, SADC will finally be able to meet most of its power needs after several years of shortages.

The current role of SAPP has been limited to facilitating energy trading and coordinating energy projects. However, there have been calls for reviewing the role and functions of SAPP to allow the regional power pool to have more authority on issues of energy development in region, and thus ensure that SAPP has the power to enforce decisions made by Member States (SARDC, 2012).

Despite its limited role and functions, SAPP is regarded as the most advanced power pool on the African continent. SAPP was the first formal international power pool outside of North America and Europe. It was also the first power pool in Africa to establish a competitive power market that allows countries connected to the regional grid to trade surpluses. During the early years of the power pool, the trading was confined to bilateral contracts among member utilities. The bulk of cross-border trading in electricity was governed by fixed co-operative bilateral contracts, which accounted for between 90 and 95 percent of

total regional energy traded. The contracts generally covered a period from one to five years although they could be longer. They provided for assurance of security of supply but were not flexible to accommodate varying demand profiles and prices. The pricing of electricity depended on the consumption period – peak, standard or off-peak.

Recognising the importance of regional electricity trading, SAPP then operated the Short Term Energy Market (STEM) from 2001 until 2007 when the region ran out of surplus capacity. The STEM market catered for about five percent of SADC energy trade. It comprised daily and hourly contracts, mainly covering off-peak periods. STEM was a precursor to the full competitive electricity market that was successfully developed for the region in the form of the Day Ahead Market (DAM). The development of the DAM started in 2003 and the trading platform was delivered towards the end of 2006.

From February 2007, SAPP has been running market trials that enabled the SAPP members to gain much-needed experience to operate such a market. See Box 2.2 on Market Development and Performance. This market went live in December 2009.

Box 2.2

Market development and performance

In its business plan of 2013 on the competitive market, SAPP noted the need to reduce support and maintenance costs for its future trading platform. As a way forward, a decision was made to develop a new trading platform with reduced support and maintenance costs, while at the same time giving the SAPP the option to add other trading products that will assist in increasing liquidity on the competitive market. Development of the SAPP-MTP trading system was completed and the following modules are now in place:

Day Ahead Market (DAM)
The competitive electricity market, commonly known as the Day Ahead Market (DAM), was commissioned in December 2009 and is administered by the SAPP. The DAM sets prices as of 11am the previous day, thus the term "day ahead", based on generation and energy transaction bids that are offered in advance to the SAPP. DAM prices are determined on an hourly basis for each of the power pool's operating members. This, therefore, means that the seller will only sell their electricity at a price they have set or even higher since there are some buyers who would have expressed bids for the same quantity at a higher rate. On the other hand, the buyer can also only buy the electricity at their desired price or even less as some sellers will be selling the same quantity of electricity at a lower rate. This system is now used for live trading since 1 April 2015.

Forward Physical Market (FPM)
The FPM is open for market participants for trade of monthly and weekly products. The market is based on physical delivery of the traded power volume. The principle of the FPM is that all participants trade on equal terms and that they have a physical grid point in a given market area for delivery of production or withdrawal of consumption. The objective of the FPM is to facilitate trading of longer term physical contracts. The FPM is an auction-trading model just as the DAM. It was commissioned in August 2015, with live trading expected to start on 1 April 2016.

Intra-Day Market (IDM)
IDM is open for trading of power after DAM and up to a configurable time before real-time – typically one hour ahead. The IDM supplements DAM and helps participants to secure their balance between supply and demand on an hourly basis. The role of the IDM is to allow each individual market participant to adjust the power balance and be a tool for them to manage incidents and failures in the power system between the closing of the DAM and delivery the next day. IDM is a continuous market, and trading takes place 24/7 on every day until [one hour] before delivery. It is based on a continuous trading model that means a continuing matching of the orders submitted to the market. The orders can be of type Bid (sales order) or Ask (purchase order). The orders are either matched automatically by the system on price or a buyer / seller can accept and "hit" an order in the market. The market contracts are settled at the matched price. Trading is based on a first-come, first-served principle. This was commissioned in October 2015, with full operation expected from 1 March 2016.

Energy Imbalance, Bilateral Wheeling and Losses Settlement
Calculations – commissioned in January 2016. Implementation was targeted for 1 April 2016

Market Book of Rules and Transmission Capacity Allocation criteria revised to accommodate new markets.

Source SAPP presentation at ETG meeting, February 2016

The auction-type market allows for sellers and buyers to input their requirements for trade in the power pool a day ahead and trade or bid for excess capacity on a real-time basis. Volumes of power traded on the DAM have increased significantly, from less than 50,000 megawatt hours (MWh) when the market started in December 2009 to around 450,000 MWh as of February 2015.

The objective of shifting to the power pool was to create a more efficient regional market. SAPP is modelled on the "loose" pool concept that emphasises constant exchange of information to maximise the cost and reliability benefits from trading and system autonomy. Each Member State is also obliged to cover emergency energy up to several hours a day to provide automatic generation control and other facilities in its control area, and to allow "wheeling" through its system (i.e. transmission of sales between two other partners) where this is technically and economically feasible.

To achieve sustainable power supply in the short, medium to long term, SAPP has developed with a pool plan covering the period 2008 to 2020. The plan underscores the benefits arising from pursuing projects collectively as a region rather than as individual Member States. It forecast that by going this route, the region would not only attain better coordination and optimization of available energy resources but achieve total cost savings of about US$48 billion over the planning horizon. The pool plan also urges SADC Member States to accelerate the interconnection of Malawi and Tanzania to the regional grid. It further advocates for what it calls a Central Transmission Corridor from the DRC to South Africa through Zambia and Zimbabwe to ease congestion and widen options.

To be accountable for the preparation and implementation of selected and agreed priority regional electricity projects in the power pool, SAPP has set up a Projects Advisory Unit (PAU) with grant funding from the World Bank. Among other responsibilities, PAU will conduct regional analytical work, and screen, select, prepare and monitor the implementation of regional priority projects.

RERA

SADC Energy Ministers approved the establishment of the Regional Electricity Regulators Association of Southern Africa (RERA) on 12 July 2002 in Maseru, Lesotho and it was formally launched on 26 September 2002 in Windhoek, Namibia – the seat of the RERA Secretariat. The association was established with the following objectives:

- ***Capacity building and information sharing***: Facilitate electricity regulatory capacity-building among members at both a national and regional level through information sharing and skills training;
- ***Facilitation of Electricity Supply Industry (ESI) policy, legislation and regulations***: Facilitate harmonized ESI policy, legislation and regulations for cross-border trading, focusing on terms and conditions for access to transmission capacity and cross-border tariffs; and
- ***Regional regulation cooperation***: Deliberate and make recommendations on issues that affect the economic efficiency of electricity interconnections and electricity trade among members

that fall outside national jurisdiction, and to exercise such powers as may be conferred on RERA through the SADC Energy Protocol.

RERA is a formal association of electricity regulators which provides a platform for cooperation between independent electricity regulators within the SADC region. Its membership is open to all electricity regulatory bodies in SADC. See Figure 2.4.

A total of 12 of the 15 SADC countries have energy or electricity regulators. These 12 are Angola, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. However, only 10 are members of RERA. Office of the Electricity Regulator (ORE) of Madagascar and the Energy Commission of Seychelles are not yet members of the association. Botswana, DRC and Mauritius do not have regulators. They are however at various stages of sector reform (RERA, 2015). According to RERA, four of the 12 are electricity regulators while six are energy regulators and two are multi-sector regulators, covering both energy/water issues. See Table 2.2 for a list of the 10 members of RERA.

Among other functions, RERA was established to monitor and evaluate electricity regulatory practises among members to determine regional training needs; develop, conduct or manage information and capacity-building programmes; promote and support the development of independent electricity regulators in Member States where these are not presently established; and source funding for the implementation of programmes and projects.

Figure 2.4 **RERA Membership**

- 12/15 SADC countries have energy/electricity regulators - 80%
- 10/12 are Members of RERA
- 0RE of Madagascar & Energy Commission of Seychelles are not yet members of RERA
- 4 are electricity regulators, 6 are energy regulators & 2 are multi-sector (energy/water) regulators
- Remaining 3 countries (Botswana, DRC & Mauritius) are at various sector reform stages

Source RERA, September 2015

Table 2.2 **RERA Members**

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

Source RERA presentation at ETG meeting, September 2015

Other functions are to facilitate coordination of development in the areas of regional regulatory policies, legislation and regulations as well as electricity market structures in the region; promote research and prepare position papers on key aspects of regional regulation, including but not limited to examination of policies, strategies and legislation in the energy sector of the region in comparison with international trends and best practices; and investigate and deliberate on issues referred to it by members or emanating from any other source, relating to matters which impact on the development of integrated electricity supply systems in the southern African region.

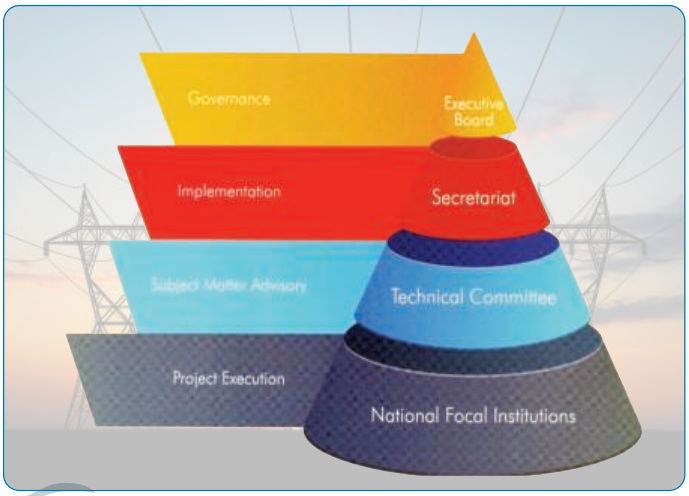
2.2.4 SACREEE

A new SADC subsidiary organization on energy called SACREEE was approved by SADC Energy Ministers at their 34th meeting in July 2015. SACREEE will be hosted by Namibia with a mandate to support the achievements of the sustainable development objectives of SADC Member States by promoting the use of renewable energy and energy efficient technologies and energy services. The centre is expected to become operational in the second half of 2016. SACREEE is expected to work closely with other SADC energy subsidiary organisations such as SAPP and RERA.

Once operational, the centre is expected to focus on the promotion of renewable energy and energy efficiency technologies and the development of markets, through sharing information and best practices, developing sound policy, regulatory, and legal frameworks, and building the capacity within SADC Member States for renewable energy and energy efficiency.

SACREEE will be governed through an executive board constituted from various members as agreed by the Member States. See proposed SACREEE governance structure and responsibilities below. The content of SACREEE thematic areas will be guided by a technical committee of the board. The management team of SACREEE will be headed by an executive director appointed by the board. The management is expected implement and execute an approved annual budget and work plan. The SACREE governance structure is shown in Figure 2.5.

Figure 2.5 **SACREEE Governance Structure**



Source SACREEE background booklet, 2014

The rational for establishing SACREEE is that the region has the capacity to address its energy challenges if its vast renewable energy sources such as hydro, wind and solar are fully harnessed. According to the African Development Bank, the total hydropower potential in SADC countries is estimated at about 1,080 terawatt hours per year (TWh/year) but capacity being utilised at present is just under 31 TWh/year. A terawatt is equal to one million megawatts (MW). The region also has an abundance of watercourses such as the Congo and Zambezi, with the Inga Dam situated on the Congo River having the potential to produce about 40,000 MW of electricity, according to the Southern African Power Pool (SAPP). With regard to geothermal, the United Nations

Environment Programme and the Global Environment Facility estimate that about 4,000MW of electricity is available along the Rift Valley in the United Republic of Tanzania, Malawi, Mozambique and Zimbabwe. More work is required to complete the process of quantifying the available geothermal reserves in the region.

However, at present there are low levels of renewable energy penetration and use across the region. This is attributed to a number of factors, including lack of effective legislative and regulatory frameworks to support market development. The establishment of SACREEE is, therefore, expected to change the "landscape of energy development in SADC". An increase in the uptake of renewables will also allow the region to achieve a renewable energy mix of at least 32 percent by 2020, which should rise to 35 percent by 2030. Currently, SADC generates about 74 percent of its electricity from thermal stations.

2.2.5 International Cooperating Partners (ICPs)/ Energy Thematic Group (ETG)

Another important institutional structure in the SADC energy sector is the ICP/ETG, which consists of representatives of the SADC Secretariat, SADC subsidiary organisations, International Cooperating Partners (ICPs) and a knowledge partner, the Southern African Research and Documentation Centre (SARDC). Other target groups also participate in the ETG as associate members. These include the private sector, civil society, multilateral and bilateral financial institutions. Participation in ETG is voluntary, and the ICP/ETG meets twice a year. Austria is currently the lead ICP for the energy sector.

The purpose of the ETG is to promote SADC's regional potential and ability to utilise its energy resources to fuel its future sustainable growth in line with the SADC Protocol on Energy, and the Energy Sector Plan of the SADC Regional Infrastructure Development Master Plan. As a part of the SADC-ICP dialogue structure, the ETG serves as the technical coordination and advisory group for the partnership between the two sides in the energy sector. It acts as a forum for dialogue, networking and creation of shared understanding between SADC Secretariat, the ICPs and main regional SADC partners; and a platform for coordinating energy related assistance at the regional level.

The role of the ICPs is to assist SADC in facilitating coordination of the ICPs involved or interested in a specific thematic area. Other roles include building partnerships for implementation of the Revised RISDP and other key regional documents and strategies, promoting and coordinating thematic areas or programmatic approaches to implementation of regional programmes, activities and projects, as well as assisting SADC in validating and/or identifying pertinence of programmes, projects or other activities requiring intervention of ICPs; and, facilitating coordinated consultations among ICPs and assist SADC in its endeavours towards coordinated consultations with ICPs in a thematic area.

The partnership between SADC and the ICPs is based on the recommendations of a review of the 2006 Windhoek Declaration on a New Partnership, which recommended the designing of effective dialogue between the two sides. The Windhoek Declaration called for the establishment of thematic groups as a platform to give attention to

specific priorities in SADC on a sector basis. It was envisaged that the thematic groups would provide an opportunity to pool resources towards the realization of the main SADC priorities.

2.3 Policy Instruments and Legal Framework

As highlighted in the introduction to this chapter, SADC has put in place a number of legal documents and policies to guide and spur development in the energy sector. The main legal document on energy development in the region is the SADC Energy Protocol. Other key supporting governance instruments are the Revised RISDP, and the recently adopted SADC Industrialisation Strategy and Roadmap which identifies energy as a "key enabler" for industrial development in the region.

Most energy documents and policies are comprehensive and place great emphasis on the availability of sufficient, reliable and least-cost energy services. This is meant to address the broader SADC objectives that include attracting investment and promoting competitiveness and trade as a means for eradicating poverty, bearing in mind the need for the environmentally sustainable use of energy resources. The policy documents are also supportive and responsive to the SADC's strategic priorities that are targeted at industrialisation, the promotion of economic and social infrastructure, developing agriculture, gender mainstreaming, human resources development and improving social welfare.

However, a major concern that has been raised at various fora, including the meetings of SADC Energy Ministers, is that regional energy policies and other documents have not been updated to reflect developments in the sector. This has now received ministerial attention and a decision has since been reached to review the guiding principles. In this regard, the process to review some of the policies, including the SADC Protocol on Energy, has commenced.

The SADC Directorate for Infrastructure and Services contends that in line with the guiding vision of the SADC Treaty as well as the principles of the SADC Protocol on Energy and the Revised RISDP, SADC Member States are committed to developing and using energy to support economic growth and development, poverty alleviation and improvement of the standard and quality of life throughout the region.

Table 2.3 **Summary of Status of the Policy Framework of SADC Member States**

Country	Energy Policy/Strategies	Energy Master Plan	Energy/ Electricity Regulator
Angola	-	-	√
Botswana	Draft	√	In progress
DRC	-	-	In progress
Lesotho	-	-	√
Madagascar	n/a	n/a	√
Malawi	-	-	√
Mauritius	√	√	In progress
Mozambique	√	√	√
Namibia	√	-	√
Seychelles	-	-	-
South Africa	√	√	√
Swaziland	√	-	√
Tanzania	√	-	√
Zambia	√	√	√
Zimbabwe	√	√	√
SADC	√	√	√

Source SADC Regional Infrastructure Development Master Plan, 2012
Details for Madagascar and Seychelles were not available/included in the master plan
There is, however, an energy regulator in Madagascar although the body is not a member of RERA

In addition to this, SADC also aligns its policy instruments and legal framework to other regional and international documents. These include the United Nations' Sustainable Energy for All Initiative – one of whose objectives is to ensure universal energy access. Another international commitment relevant for SADC is the newly adopted Sustainable Development Goals (SDGs), as well as the Programme for Infrastructure Development in Africa (PIDA), which provides a framework for addressing the infrastructure deficit in Africa through integrated planning and development at regional and inter-regional levels. PIDA was developed by the African Union Commission together 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). Of the 16 strategic and regionally balanced PIDA projects approved in 2012, seven are in the SADC region.

2.3.1 SADC Protocol on Energy

The SADC Protocol on Energy is the main legal document on energy development in the region that provides the broad legal and policy framework for cooperation in the energy sector. The protocol was signed in August 1996 and entered into force in April 1998 after receiving the required number of ratifications (two-thirds). The protocol aims at harmonising national and regional energy policies; strengthening cooperation in the development of energy and energy pooling; and ensuring the provision of reliable, continued and sustainable energy services in the most efficient and cost-effective manner. It also promotes joint development of human resources and organisational capacity building; as well as the strengthening of regional cooperation in research, development, adaptation, dissemination and transfer of low-cost energy technologies.

Through the Protocol, the processes of sharing of energy data and information and co-operating with non-SADC states and organisations are clearly defined. The protocol was operationalised through the SADC Energy Cooperation Policy and Strategy and the SADC Energy Sector Action Plan approved by the SADC Council of Ministers in 1996 and 1997, respectively. The Action Plan identified four priority areas – energy trade, information and experience exchange, training and organisational capacity building, and investment and funding. The SADC Energy Activity Plan (approved by Council in 2000) further elaborated the four priority areas into a detailed programme of activities to be implemented.

Article 3(3) states that energy cooperation in the SADC region shall involve working together in the development and utilization of energy in the sub-region in the following subsectors: wood fuel, petroleum and natural gas, electricity, coal, new and renewable energy sources, energy efficiency and conservation and other crosscutting themes of interest to Member States. According to Article 6(1) of the protocol, Member States are supposed to make energy data freely available in the region to assist in planning for the sector.

Cooperation in the sector has continued to flourish since the signing of the protocol. Notable sub-regional projects implemented in line with the SADC Energy Protocol included the Programme for Biomass Energy Conservation (ProBEC) and a United Nations Development Programme

(UNDP)-supported Financing Energy Services for Small-Scale Energy Users (ECA-SA, 2006). Another important development is that the protocol was instrumental in the establishment of a regional power grid, where a total of nine Member States have merged their electricity grids into the SAPP, reducing costs and creating a competitive common market for electricity in the region. Similarly, SADC has established the RERA, which has helped in harmonising the region's regulatory policies on energy and its subsectors.

2.3.2 Revised RISDP

The Revised Regional Indicative Strategic Development Plan (Revised RISDP) 2015-2020 was endorsed by the SADC Extraordinary Summit of Heads and State and Government held in April 2015 in Harare, Zimbabwe, as the new blueprint that will guide the implementation of SADC programmes during the next five years. Before this latest revision, the RISDP was developed and approved by Summit in 2003 for a 15-year period, but was effectively implemented from 2005, thus giving an implementation timeframe of 2005-2020. The RISDP is built on the premise that good political, economic and corporate governance are prerequisites for sustainable socio-economic development, and that SADC's objectives for poverty eradication and deeper levels of integration will not be realised if these are not in place.

Since its approval in 2003, the RISDP has guided SADC and its partners in planning the implementation of the cooperation and integration agenda. Two assessments of the RISDP were carried out in 2011 and 2012/13. Based on their findings and the recommendation of Council in 2013, a Revised RISDP has been produced for the remaining duration of the Plan. The Revised RISDP provides a guiding framework for the last phase of the RISDP that is 2015-2020. The scope and purpose of the Revised RISDP remain unchanged from those of the original document, except that emphasis has been placed on re-aligning existing priorities with resources allocation in terms of their relative importance and greater impact on regional integration. It defines specific results and timeframes in the various areas of cooperation and integration in order to facilitate monitoring and evaluation. The purpose of the Revised RISDP is to deepen regional integration in SADC and it provides SADC Member States with a consistent and comprehensive programme of medium-term economic and social policies. It also provides the Secretariat and other SADC institutions with a clear view of SADC's approved economic and social policies and priorities.

The Revised RISDP has four major priority areas. These are Industrial Development and Market Integration; Infrastructure in Support of Regional Integration; Peace and Security Cooperation as a prerequisite for regional integration; and Special Programmes of regional dimension. Energy development is under Priority B on Infrastructure in Support of Regional Integration, which seeks to promote the facilitation of infrastructure to support regional integration, including investment in energy, transport (surface, air and intermodal), tourism, information communication technology, meteorology and water. The major intervention for energy in the RISDP is: "Energy to support regional economic development, trade and investment", and this guided the selection of the intervention components that are being evaluated. The four pillars of the Revised RISDP are illustrated in Figure 2.6.

Since the Revised RISDP is one of the latest policy documents for SADC, stakeholders in the energy sector have begun the process to align all their activities, programmes and projects to the Revised RISDP. Alignment of support to the two regional documents is critical as it ensures the smooth implementation of agreed activities and programmes, thereby promoting socio-economic development and deeper integration.

It should be noted that the RISDP was the first effort by SADC to set specific quantitative targets for infrastructure development (including energy) for a 15-year period, 2004-2018. On the energy side, for example, the target was for at least 70 percent of rural communities within southern Africa to have access to "modern forms of energy supplies". More specifically, the Plan advocated "Improving access to affordable energy services to rural communities through rural electrification and development of new and renewable energy sources", and proposed doing so through "development of renewable and low cost energy sources including solar, biomass, and wind-generated energy".

Figure 2.6 **Four Pillars of the Revised RISDP**

Source SADC, 2015

2.3.3 SADC Industrialisation Strategy and Roadmap

Another latest policy development critical to the SADC energy sector is the 2015 SADC Industrialisation Strategy and Roadmap that was approved by the SADC Extraordinary Summit of Heads and State and Government held in April 2015 in Harare, Zimbabwe. The Strategy and Roadmap, which aims at accelerating the momentum towards strengthening the comparative and competitive advantages of economies of the region, as well as allow the region to leverage its vast natural resources endowment such as energy resources, identifies energy as a "key enabler" for industrial development in the region."

Anchoring on three pillars, namely Industrialisation, Competitiveness and Regional Integration, the strategy covers the period 2015-2063 and is aligned to the African Union's Agenda 2063 – a continental strategy that aims to optimize the use of Africa's resources for the benefit of all Africans. During the period 2015-2020, SADC will strive to progress from being factor-driven to being investment-driven. From 2021-2050, the region will aim to advance to being an innovation-driven economy, while the period 2051-2063, the target for SADC is to achieve high levels of economic growth, competitiveness, incomes and employment.

On the role of energy, the strategy acknowledges that "efficient and affordable infrastructural services (consisting of energy supply) are critical inputs for reducing transaction costs for industry and trade, as well as for enhancing the economic and social wellbeing of society at large" (SADC, 2015). To address the crippling energy deficit being faced by the region, and ensure the smooth implementation of the industrialization, the strategy advocates a variety of measures, including the following:

- Member States should increase public investment in energy provision both for domestic use and export to regional partners through the Southern African Power Pool.
- Attention should be paid to the reliability, efficiency and cost effectiveness of energy supply.
- Simultaneously, governments should step up the involvement of

independent power providers to ease the burden on government investment spending.
- Alternative sources of energy should be exploited with a particular focus on renewables.
- The region should adopt energy efficient technologies to reduce the cost of production and minimise greenhouse gas emissions that contribute to climate change.
- Attention should be paid to greater energy pricing efficiency within the context of deeper regional co-operation. Cheap energy is a necessary condition for industrial competitiveness and to that end, Member States should draw on lower cost regional supplies where practicable, rather than focusing on national self-sufficiency.
- Current plans for hydropower network connectivity and proposed new generation and transmission projects should be fast-tracked including regional joint-ventures. Member States should accelerate the design and implementation of an appropriate institutional framework for the early development of the Inga Dam project which has enormous potential for the supply of low-cost electricity to the SADC region.

2.3.4 Regional Infrastructure Development Master Plan: Energy Sector Plan (ESP)

In August 2012, SADC approved the Regional Infrastructure Development Master Plan (RIDMP). The RIDMP defines regional infrastructure requirements and conditions to facilitate the realisation of key infrastructure in the energy, water, transport, tourism, meteorology and telecommunications sectors by 2027. The master plan is based on the SADC Vision 2027, which caters for implementation over three phases, the short term (2013-2017), the medium term (2017-2022) and the long term (2022-2027).

In the energy sector, the plan is expected to address four key areas of energy security — improving access to modern energy services, tapping the abundant energy resources and up-scaling financial investment while enhancing environmental sustainability. It defines regional infrastructure requirements and conditions to facilitate the realisation of key infrastructure in the energy, water, transport, tourism, meteorology and telecommunications sectors by 2027. Such infrastructure would enable the SADC region to attain regional integration, economic growth and poverty eradication. The ESP defines the main areas of consideration relating to the implementation of:

- "Hard" infrastructure projects that include electricity generation plants, transmission lines; petroleum and gas refineries, pipelines, storage reserves, coal depots and port facilities, and nuclear demonstration plants.
- "Soft" interventions entail the required policies/strategies and regulatory frameworks, institutional frameworks and capacity building, financing and cooperation/collaboration arrangements that enable "hard" projects to be realised.

The ESP highlights the status of the sector, projections and gap analysis as well as its infrastructure needs. Investments and intervention needed are explored, including monitoring an evaluation of the implementation and a way forward is discussed within the plan.

2.3.5 Regional Energy Access Strategy and Action Plan

At their meeting in Angola in April 2010, the SADC Energy Ministers agreed to undertake a comprehensive review and rationalisation of the entire energy sector governing instruments and also adopted a new SADC Regional Energy Access Strategy and Action Plan. The plan aims to combine regional energy resources as a means of ensuring the entire SADC region has access to affordable, sustainable electricity. The plan's goal is to within 10 years (i.e. by 2020) reduce by half the number of people in the region without access to energy, and then halve it again every five years until the region has universal access.

The overall objective of the SADC Energy Access Strategy and Action Plan are at the strategic level to harness regional energy resources to ensure, through national and regional action, that all the people of the SADC region have access to adequate, reliable, least cost, environmentally sustainable energy services, and at the operational level that the proportion of people without such access is halved within 10 years for each end-user and halved again in successive five-year periods until there is universal access for all end-users.

2.3.6 AU Agenda 2063

SADC aligns its policy instruments and legal framework to other regional and international commitments. These include the African Union's Agenda 2063, which is a strategic framework for socio-economic transformation of the continent over the next 50 years, initiated at the 50th anniversary Summit of AU Heads of State and Government on 25 May 2013. They committed to accelerate actions on a number of strategic areas including how to connect Africa through world-class infrastructure, with a concerted push to finance and implement the major infrastructure projects.

Energy is one of the areas identified as a priority under the AU Agenda 2063. AU members agreed to harness all "African energy resources to ensure modern, efficient, reliable, cost-effective, renewable and environmentally friendly energy to all African households, businesses, industries and institutions, through building the national and regional energy pools and grids, and PIDA energy projects."

2.4 Conclusion and Recommendations

Although implementation of various legal documents, policies, institutional frameworks and strategies has been slow, the region has made significant progress in developing its energy sector. Cooperation among SADC Member States has allowed countries in the region to share surplus energy through the SAPP competitive market. In this regard, full implementation of all agreed instruments will enable SADC to develop its energy sector.

Another important observation is that a number of various legal documents, policies, institutional frameworks and strategies are outdated and need to be reviewed in line with the changing environment for them to remain relevant and useful. As a recommendation, SADC Member States need to speed up energy sector reforms, including adopting friendlier regulatory environments as well as adopting pricing structures that can attract private capital.

Chapter 3

ELECTRICITY SUPPLY IN THE SADC REGION

3.1 Introduction

The SADC region enjoyed a surplus electricity-generation capacity for many years until 2007. The Southern African Power Pool (SAPP) warned the region as far back as in 1999 that it would run out of generation surplus capacity by 2007 unless new investments in the energy sector were put in place. Not much generation and transmission investment was actioned to alleviate the anticipated generation capacity shortfall, resulting in electricity demand outstripping supply in 2007, as per the SAPP forecast. This was evidenced particularly in South Africa where load shedding had to be implemented as early as 2008. In addition to lack of new generation capacity, other key drivers of the shortages included the rapid economic and population growth. According to SAPP, regional average electricity demand growth is estimated at around three percent per annum against a low off-take of projects to boost power generation. It was once pegged at 4.6 percent ahead of the 2010 FIFA World Cup hosted by South Africa.

Based on global best practices, SAPP requires a 10.2 percent reserve margin at any time. This desired reserve margin is required to guarantee system reliability and allow for unexpected surges in demand for power that may occur from time to time. Adequate reserve margins also allow for the much-needed plant maintenance to be undertaken without putting the operating system under pressure.

Besides Demand Side Management (DSM) measures, SADC has pushed for energy infrastructure investment and development over the past few years. As discussed in Chapter 6, the main hurdle to implementation of most of the identified infrastructure projects is not necessarily a lack of funding but absence of bankable projects. A number of long-planned projects have failed to take off as the private sector appears reluctant to engage in partnerships with governments due to various challenges. Private players often cite the poor returns, a function of tariff regimes that are not cost reflective, inappropriate financing formulas and poor governance as key factors in limiting their participation.

Over the decade or so, Botswana, Namibia, South Africa, Zambia and Zimbabwe (and more recently Tanzania too) have had to resort to load-shedding as a stop-gap measure in order to conserve energy. South Africa, the region's economic powerhouse, has been particularly badly hit by energy shortages with its mining industry, the mainstay of its economy, temporarily shutting down operations in January 2008 to allow for the power supply situation to be stabilised. Mining accounts for about 15 percent of South Africa's electricity demand. The diminishing generation surplus capacity is largely due to the rise in

power demand, coupled with aged power generation assets that are not always properly maintained. The deficit is caused by:

- ***An increase in the population of most SADC Member States*** The total population of the region is expected to grow by 1.7 percent per annum from approximately 294 million in 2013, according to the SADC Secretariat (SADC, 2014), to reach 350 million by 2030, as projected in the SADC Regional Infrastructure Development Master Plan;
- ***Economic expansion in most Member States*** requiring more power to supply new industries;
- ***Non-economic tariffs*** in some cases that do not support re-investment in power generation, but allow for large energy-intensive users to come into the region and set up operations;
- ***No significant capital injection into generation projects*** from either the private or the public sector; and
- ***Poor plant performance*** especially the thermal power plants that are characterised by high downtimes, with Eskom and Zimbabwe Electricity Supply Authority (ZESA) as cases in point.

Although the electricity shortage is expected to be corrected by 2020, projects intended to address the shortage lag behind the deadline due to failure to package projects for funding, below-cost tariffs, poor project preparation, issues with Power Purchase Agreements (PPAs), and absence of regulatory frameworks, among other constraints.

Massive investment in generation, transmission and distribution infrastructure will be required to sustain the projected increase in power demand in the region. The SADC region is estimated to require between US$93 billion and US$212 billion on short- and long-term projects to boost power supplies between 2015 and 2027 (SADC, 2012).

This chapter looks at developments in the electricity sub-sector in the past decade.

3.2 Current Generation Status

Electricity in the region is generated mainly from coal and hydro resources. South Africa accounts for more than 83 percent of the total regional electricity production, followed by Mozambique, Zambia and Zimbabwe.

There are power generation projects in nearly all Member States which are at various stages of development in order to meet or surpass demand. Other than Mozambique and DRC, most of the countries have a supply deficit that they are struggling to manage. It goes without saying that the above picture gives investors a great opportunity of investing their money into power generation and transmission projects in the SADC region.

As of November 2015, the installed generation capacity in the Southern African Power Pool stood at 61,859MW. However available generation was only 46,910MW. Peak demand for the same period, including reserves, stood at 55,157MW, giving a shortfall of 8,427MW, as shown in Table 3.1. The shortfall was slightly lower at 7,921MW if only SAPP operating members are considered. As mentioned in Chapter 2, only nine of the 16 SAPP members are operating members.

Table 3.1 **Demand and Supply Balance with Current Peak Demand 2015**

Country	Utility	Installed Capacity (MW)	Operating Capacity (MW)	Current Peak Demand (MW)	Peak Demand Plus Reserve (MW)	Capacity Excess/ Shortfall including Reserves (MW)
Angola	ENE	2 210	1 772	1 599	1 829	(57)
Botswana	BPC	892	410	610	698	(288)
DRC	SNEL	2 442	1 066	1 381	1 580	(514)
Lesotho	LEC	74	70	10	172	(102)
Malawi	ESCOM	352	351	326	373	(22)
Mozambique	EDM/HCB	2 724	2 279	830	949	1 330
Namibia	NamPower	501	354	629	720	(366)
South Africa	Eskom	46 963	36 000	37 661	43 080	(7 080)
Swaziland	SEC	70	55	219	251	(196)
Tanzania	TANESCO	1 380	823	935	1 070	(247)
Zambia	ZESCO/CEC/LHPC	2 206	2 175	2 287	2 616	(441)
Zimbabwe	ZESA	2 045	1 555	1 589	1 818	(263)
TOTAL ALL		**61 859**	**46 910**	**48 216**	**55 157**	**(8 247)**
TOTAL Operating Members Only		**57 917**	**43 964**	**45 356**	**51 885**	**(7 921)**

Source SAPP, November 2015

Table 3.2 **SAPP Utility Generation Mix (MW and %) 2014**

SAPP UTILITY GENERATION MIX, MW

Technology/ Utility	BPC	EDM	ENE	ESCOM	Eskom	LEC	Nam Power	SEC	SNEL	TANESCO	ZESA	ZESCO	Total
Base Load Hydro	-	2 157	1 346	350	2 000	72	348	61	2 442	717	750	2 118	12 361
Coal	732	-	492	-	37 831	-	132	9	-	-	1295	-	40 491
Nuclear	-	-	-	-	1 930	-	-	-	-	-	-	-	1 930
CCGT	-	-	190	1	-	-	-	-	-	585	-	-	776
Distillate	160	151	-	-	2 409	-	21	-	-	78	-	10	2 829
Total	**892**	**2 308**	**2 028**	**351**	**44 170**	**72**	**501**	**70**	**2 442**	**1 380**	**2 045**	**2 128**	**58 387**

Technology/ Utility	BPC	EDM	ENE	ESCOM	Eskom	LEC	Nam Power	SEC	SNEL	TANESCO	ZESA	ZESCO	Total
Base Load Hydro	0%	93%	66%	100%	5%	100%	69%	87%	100%	52%	37%	100%	21.2%
Coal	82%	0%	24%	0%	86%	0%	26%	13%	0%	0%	63%	0%	69.3%
Nuclear	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	3.3%
CCGT	0%	0%	9%	0%	0%	0%	0%	0%	0%	42%	0%	0%	1.3%
Distillate	18%	7%	0%	0%	5%	0%	4%	0%	0%	6%	0%	0%	4.8%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source SAPP, March 2014

Table 3.2 shows the existing generation capacity mix of the 12 SAPP member utilities by technology, as of March 2015.

3.2.1 Coal power generation

Given the dominance of South Africa in terms of power generation – accounting for almost 76 percent of the overall generation capacity in mainland SADC – coal is the most dominant source of electricity in the region. More than two-thirds of all the electricity produced in the region comes from coal-fired plants. At least 86 percent of South Africa's total generation capacity of 44,170MW (as of March 2015) came from coal-fired plants, while 82 percent of Botswana's electricity was produced from coal and 63 percent for Zimbabwe.

3.2.2 Hydropower generation

Hydropower is the sole source of electricity generation in four SAPP member countries – DRC, Lesotho, Malawi and Zambia – while hydropower also accounts for a sizeable proportion of capacity in Angola, Mozambique, Namibia, Swaziland and Tanzania (Table 3.2).

3.2.3 Distillate generation

This is the third largest contributor to power generation in the SADC region, accounting for close to five percent of total generation. Distillate power plants generate electricity using diesel fuel. These are available in Botswana, Mozambique, Namibia, South Africa and Tanzania, and account for more than 2,800MW.

3.2.4 Nuclear power generation

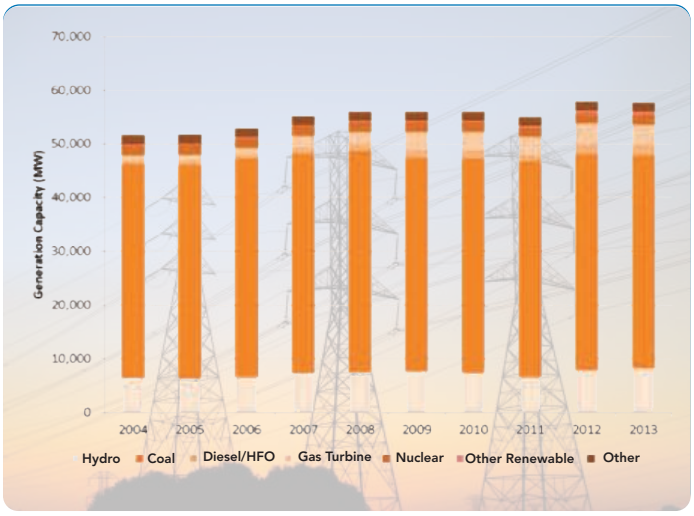
South Africa is the only SADC Member State that has a nuclear power station. In fact, the Koeberg Nuclear Power Station near Cape Town is the only nuclear power station in Africa. It contains two uranium pressurised water reactors, and supplies power to the national grid so that over-capacity can be redistributed to the rest of the country on a needs basis. The power station has generation capacity of 1,800 MW and has two large turbine generators, each producing 900MW. The Koeberg nuclear power station is owned and operated by the national utility in South Africa, Eskom.

3.2.5 Combined-cycle gas turbine power generation

Combined-cycle gas turbine power plants use both gas and steam turbines to produce up to 50 percent more electricity from the same fuel than a traditional simple-cycle plant. However, these are not common in SADC as they only account for a mere 1.3 percent of the total power generation mix. They are in use in DRC, Malawi and Tanzania.

The trend in the overall generation mix for the SADC region is shown in Figure 3.1.

Figure 3.1 **Installed Generation Capacity Breakdown by Type**



Source RERA Publication on Electricity Tariffs & Selected Performance Indicators, 2015

As discussed above, coal accounts for most of installed capacity, followed by hydro. While total installed capacity increased from about 52,000MW to about 58,000MW between 2004 and 2013, coal's contribution has remained somewhat constant at around 40,000MW.

Available data shows a material reduction in the relative contribution of coal-fired generation over the past decade, from around 77 percent in 2004 to 69 percent in 2013 (RERA, 2015). However, the commissioning of coal plants at Kusile (4,800MW) and Medupi (4,764MW) in South Africa could change this picture drastically, given that Eskom reported the design capacity for these two complexes to be almost 9,600MW. The completion of Morupule B in Botswana, at 600 MW, would also have an important impact. Hydropower has gained little prominence in the region, but the fastest growth rates are observed in diesel-fired generation and gas turbines, which had a combined 10 percent contribution to regional capacity in 2013, compared to three percent in 2004.

3.3 Progress in Implementation of Generation Projects

The SAPP has during the last decade implemented a number of projects to boost electricity generation and transmission. As highlighted in Table 3.3, a total of 13,200MW was commissioned between 2004 and 2014 against a target of 19,600MW that was planned over the period. The largest amount of new generation capacity commissioned was in 2009 when 2,187MW was added to the regional grid. This could be attributed to the preparation for the hosting of the 2010 FIFA World Cup by South Africa.

As discussed in Chapter 6, a major challenge for the SADC energy sector is that most of the proposed regional projects are poorly structured and packaged and therefore fail to attract investment. A number of long-planned projects have failed to take off as the private sector has been reluctant to engage in partnerships with governments mainly due to inappropriate financing formulas. Most SADC Member States have been slow in putting in place mechanisms that promote private sector participation in the energy sector and therefore improve the attractiveness of the industry for investors. The policy environment in most SADC countries does not encourage private sector participation in the energy sector. Save for a few countries such as Zambia, the majority of SADC Member States are yet to fully embrace the concept of Public Private Partnerships (PPPs) despite being party to SAPP Inter-Utility Memorandum of Understanding that for-

Table 3.3 **Commissioned Generation Projects**

Year	Planned Capacity (MW)	Actual Capacity Commissioned (MW)
2004	260	320
2005	520	490
2006	1 041	375
2007	2 441	1 696
2008	2 014	1 747
2009	2 400	2 187
2010	908	848
2011	1 751	1 230
2012	3 552	1 099
2013	1 992	1 210
2014	2 737	1 999
TOTAL	**19 616**	13 201

Source SAPP, March 2015

Box 3.1

Zambia sets the pace for private sector participation

The Office for the Promotion of Private Power Investors (OPPPI) is a dedicated unit in the Zambian Ministry of Energy whose role is to promote new players to the electricity market. It is one of two institutions formed following the liberalisation of the Zambian power sector to attract private sector participation in the generation, transmission and distribution of electricity in the country. The other institution is the Energy Regulation Board whose responsibility is to regulate operations and pricing in the Zambian Electricity Supply Industry (ESI). The OPPPI interfaces directly with investors and champions support for private-sector hydropower generation and transmission projects. The creation of OPPPI has eased the process of investing in the Zambian ESI and has seen several private players entering the industry.

Source SAPP presentation at ETG meeting, February 2016

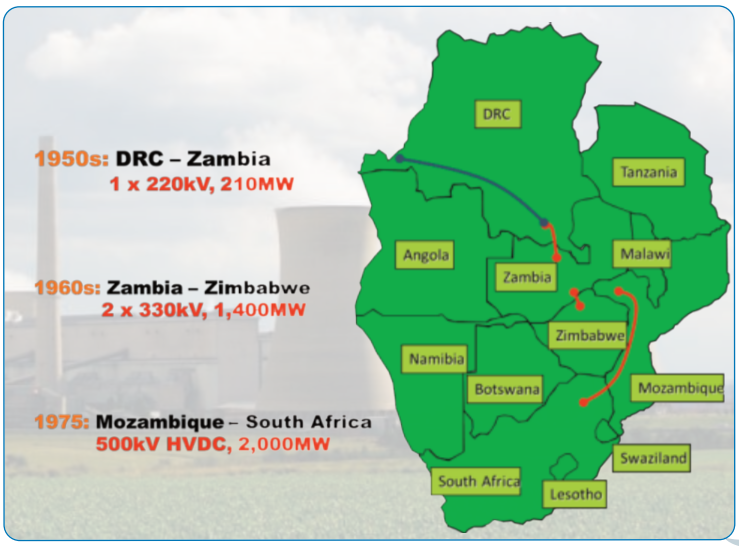
mally allowed private players in the region's energy sector. Zambia has established a public institution, Office for Promoting Private Power Investment (OPPPI), which facilitates and promotes the implementation of PPPs.

Except for South Africa the capacity constraints have also seen most SADC Member States failing to fully embrace renewable energy and energy efficiency technologies such as solar and wind power. For instance, solar thermal-electric systems have the long-term potential to provide a significant fraction of SADC's electricity and energy needs. Research has shown that most countries in southern Africa receive more than 2,500 hours of sunshine per year. Knowledge on solar energy technology is widespread in the SADC region but its use is still limited partly due to the prohibitive initial set-up costs involved and capacity constraints.

3.4 Electricity Transmission Projects

SADC has prioritised the implementation of cross-border transmission projects in an effort to link the power systems of all SADC Member States. The history of energy cooperation in the region dates back to the 1950s when the DRC partnered with Zambia to construct a 200kiloVolts (kV) line connecting the two countries. This allowed the two neighbours to trade 210MW of electricity. This was followed by a similar interconnector project between Zambia and Zimbabwe in the 1960s, and the 500kV interconnector linking Mozambique to South Africa in 1975. (See Figure 3.2)

Figure 3.2 **Origins of SAPP Electricity Transmission Projects**



Source SAPP, November 2015

Figure 3.3 **Existing SAPP Transmission Lines**

Source SAPP, 2015

Figure 3.3 shows the existing SAPP electricity transmission grid. The dotted lines show planned transmission projects linking the various countries.

Table 3.4 shows the transmission interconnectors that have been commissioned since the formation of the SAPP in 1995.

The above achievements notwithstanding, southern Africa continues to be engaged in a number of projects to ensure that all countries are interconnected to the SAPP power grid that allows Member States to trade surplus electricity on a competitive market. Non-connection of Angola, Malawi and Tanzania in the regional power grid means that any new generation capacity installed in any of the three countries is not enjoyed by the nine other mainland SADC Member States — Botswana, DRC, Lesotho, Mozambique, Namibia, Swaziland, South Africa, Zambia and Zimbabwe.

Similarly, surplus power in the nine interconnected countries cannot be exported to the three Member States which are not connected to the regional power grid. This situation has created challenges for most countries particularly when they shut down some of their power generation plants for rehabilitation and cannot import power from neighbouring countries to meet their local demand. In order to achieve full in-

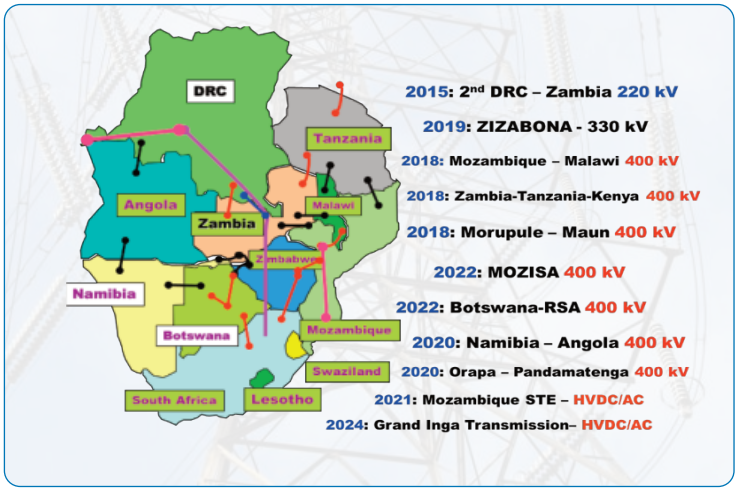
Table 3.4 **Transmission Interconnectors Commissioned since 1995**

Interconnector	Capacity, kiloVolt	Countries Connected	Year Completed
Matimba-Insukamini	400	South Africa and Zimbabwe	1995
Songo-Bindura	400	Mozambique and Zimbabwe	1997
Phokoje substation-Matimba	400	Botswana and South Africa	1998
Upgrade of line between Cahora Bassa-Apollo substation	533	Mozambique and South Africa	1998
Camden-Edwaleni-Maputo	400	South Africa, Swaziland, Mozambique	2000
Arnot-Maputo	400	South Africa and Mozambique	2001
Aggeneis-Kookerboom	400	South Africa and Namibia	2001
Zambia-Namibia	220	Zambia and Namibia	2007
Caprivi Link	350	Namibia	2010
Kafue-Livingstone upgrade (from 220-330kV)	330kV	Zambia	2013

Source SAPP

terconnectivity, SAPP is therefore pursuing a number of transmission projects that are at various stages of development.

Figure 3.4 **Proposed SAPP Transmission Lines**



Source SAPP, February 2016

3.4.1 Angola interconnection

Angola is a special case owing to the unique nature of the country's power system. Angola's priority is to connect its northern, central and southern power systems, which have until now been separated. The 300km Capanda-Luanda 400 kV line was commissioned in December 2009. Several other projects have been commissioned since then, including the 80km-long Gove-Huambo 220kV line; the 212km Lucala-Uige 220kV line; and the 191km Uige-Maquela do Zombo 220kV line. The 242km Gabela-Kileva 220kV interconnector connects the northern and central systems in Angola. In addition to this progress in internal interconnections, there are plans to link Angola to the SAPP power grid through the proposed Namibia-Angola and DRC-Angola interconnector projects.

3.4.2 Central Transmission Corridor

The Central Transmission Corridor (CTC) project involves upgrading of the transmission networks in Zambia, Zimbabwe and Botswana to enable the transfer of power from the North to countries in the South and vice versa. This is regarded as a priority project for the SAPP as it alleviates transmission congestion in Zimbabwe to benefit other countries in the South.

3.4.3 Malawi-Mozambique interconnector

This planned interconnector will enable Malawi to access the regional power market through Mozambique, whose grid is interconnected with South Africa and Zimbabwe. Utility Project Teams have been formed and communication protocol has been set up. Expression of interest has been launched for update of feasibility studies. The environmental impact assessment studies will be sponsored by the World Bank. There is also an option to link Malawi to the SAPP grid through Zambia.

3.4.4 Mozambique Backbone Project

The Mozambique Regional Transmission Backbone project (STE) will consist of a double transmission line from Tete Province in central Mozambique to the capital Maputo in southern Mozambique and to the SAPP interconnected power network. It will transport the electricity generated in new hydropower plants from Mphanda Nkuwa (1500MW) and Cahora Bassa (North Bank, 1245MW) to the markets (SANF, March 2014). The backbone will comprise a 400kV high-voltage alternating current (HVAC) 800km line to supply the major consumption zones within Mozambique and link with the South African market. Its estimated cost is US$2.8 billion. The pre-feasibility system planning studies were concluded.

3.4.5 Zambia-Tanzania-Kenya

This interconnector is intended to link Tanzania and Kenya to the SAPP grid through Zambia, and also link SAPP to the East African Power Pool, thus improving the overall access to energy in southern and eastern Africa. Zambia, Kenya and Tanzania signed an agreement in December 2014 under which they committed to start their interconnector project in December 2015 and ensure that it is completed by December 2018 (SARDC, 2015). The project was placed under the Nile Basin Initiative (NBI) and consultants were engaged for a technical feasibility and economic viability study, conceptual design and tender documents. Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) Final Inception Report has been compiled. The documents are to be used to source funding. Feasibility and environmental studies for the Mbeya-Kasama (400kV) leg are underway.

3.4.6 Namibia-Angola interconnector

This will enable Angola to be connected to the SAPP grid through Namibia. Terms of reference for the project have been agreed between ENE and NamPower and a consultant has been engaged by the Government of Angola for technical feasibility studies. Another option that has been considered is to construct the Angola-DRC interconnector.

3.4.7 ZIZABONA interconnector

Work on an interconnector linking the electricity transmission of four countries in the region was initiated in 2008 for Zimbabwe, Zambia, Botswana and Namibia. Its objective is to provide an alternative electrical power transmission in the region and de-congest the existing central transmission corridor that passes through Zimbabwe, thus boosting electricity trading among Member States (SARDC, 2015). This involves the construction of 120km transmission line with a voltage capacity of 330kV from Hwange Power Station in Zimbabwe through Victoria Falls to a substation at Livingstone in Zambia, and the construction of a 300km transmission line of similar voltage rating from Livingstone to Katima Mulilo in northern Namibia. Technical and financial proposals were evaluated for the three packages that were advertised as follows: Transaction and Technical Advisory Services; Environmental and Social Impact Assessment (ESIA) for the Zambian leg of the transmission line; and Project Coordination and Supervision. ESIAs were completed in Botswana, Namibia and Zimbabwe. Fichtner, a German engineering consultancy firm, was appointed to provide transaction and technical advisory services, while Swedish company, SWECO, was awarded the contract to undertake the Environmental and Social Impact Assessment for the Zambian leg. Project coordination and supervision will be undertaken by PhD Capital of South Africa. The consultants are being funded by the African Development Bank (AfDB).

3.4.8 MOZISA interconnector

Construction of a new power transmission line linking Mozambique, South Africa and Zimbabwe is expected to improve connectivity and electricity trading in Southern Africa. Commonly referred to as MoZiSa Transmission Project, the venture involves the three countries

that are linked to the regional grid. According to SAPP, the MoZiSa project is being supported by the respective utilities of the three countries, namely *Electricicade de Moçambique* (EDM), Eskom of South Africa and the Zimbabwe Electricity Supply Authority (ZESA). The three utilities have since entered into a memorandum of understanding to develop the interconnector and have formed three joint project development teams – a steering committee, technical committee and commercial committee – which have been tasked with spearheading the implementation process being coordinated by SAPP.

As part of the MoZiSa project, there is a need for various separate developments in each of the countries involved to complement the project to ensure that the MoZiSa interconnector is a success. For example, in Zimbabwe there is a plan to install a new substation at Triangle in the south of the country and another one at Orange Grove near Mutare in the east. Between Zimbabwe and South Africa, the Triangle-Nzhelele interconnector will be built with a 400kV line that stretches 275km. Plans are also in place for a new 400/220kV substation to be established in Mozambique, and a 360km-long 400kV Inchope-Matambo line as well as a 400kV Matambo-Songo line that stretches 115km.

SAPP received funding from the Project Preparation Feasibility Study Fund (PPFS) to be used to carry out a scoping study for the preparation of the MoZiSa transmission project. The PPFS is jointly funded by the Development Bank of Southern Africa and *Agence Française de Development*.

3.4.9 Morupule B-Maun transmission line

This is part of Botswana's North West Transmission Grid Project. It involves the construction of a backbone transmission network of about 500km, consisting of a 400kV line from Morupule B to Maun via Orapa, with 400kV substations at Orapa and Maun. The transmission line is expected to be completed by 2018 (BPC, September 2015).

3.4.10 Orapa-Pandamatenga transmission line

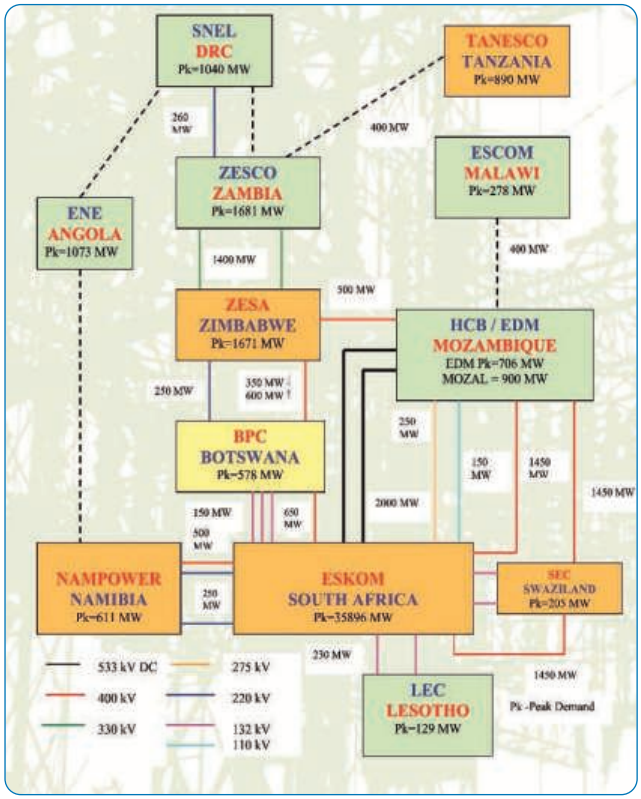
This will involve the construction of a 400kV line from Orapa in central Botswana through Dukwi to Pandamatenga in the northwest of the country close to the borders with Namibia, Zambia and Zimbabwe. The purpose of the interconnector is to strengthen the transmission system and enable greater power trading between Botswana and other SADC Member States.

3.5 Power Trading

Once completed, the new interconnectors are expected to promote regional electricity trade, enhance security of electricity supply as well as foster regional trade. Further, the interconnectors will decongest existing transmission corridors, and provide another wheeling path that will fully integrate all mainland SADC countries to the regional power grid.

As mentioned earlier in this chapter, cross-border cooperation in the SADC power sector is not a new phenomenon. Cooperation among Member States began as early as 1958, with the construction of a line

Figure 3.5 **SAPP Grid 2013/14 (showing capacity of transmission lines)**



Source SAPP Annual Report 2015

between Nseke in the DRC and Kitwe in Zambia to supply electricity to the Zambian copper mines. This laid the foundation for bilateral cooperative projects in the power sector and was immediately followed by the construction of Kariba Dam in the 1960s with its associated hydroelectric power stations (one each in Zambia and Zimbabwe).

Regional cooperation in the power sector has expanded over the past 50 years, especially during the last 15 years as southern Africa moved to restore energy self-sufficiency. The SADC region has experienced unprecedented economic growth during the last decade but investment in electricity infrastructure has lagged far behind regional demand, necessitating greater regional cooperation to share the available power. Cross-border power trading in SADC is facilitated by SAPP and the trading allows countries to buy and sell electricity through an existing network of transmission lines and relay substations. This enables the exchange of power from those countries that are energy resource-rich to those that suffer energy vulnerability.

3.5.1 State of play in SADC power trading

SADC power trading platforms have evolved since the formation of the Southern African Power Pool in 1995. During the pool's early years, trading was confined to bilateral contracts among member utilities. All power utilities in mainland SADC, except Angola, Malawi and the United Republic of Tanzania, are interconnected to the regional grid through SAPP, allowing them to sell electricity to one another. According to SAPP, the main trading options are bilateral contracts between member utilities which are intended to meet long-term security of supplies and are negotiated on a bilateral basis.

The Day Ahead Market (DAM) is an auction-type market. It allows utilities to weight their options and ensure that when it is cheap to get power from the market, utilities will buy it rather than generate power. This helps SAPP members to bid on and sell electricity a day before the transactions are made. In 2014, SAPP, with the help of Enerweb of South Africa, developed a new trading platform, Post-DAM, with the aim of reducing trading operating costs and also to add other trading products. The new trading platform will offer month, week and hour ahead trading options in addition to the current day-ahead option.

SAPP says power trading has increased significantly over the years. It soared to more than 450,000 megawatt hours (MWhr) in February 2015 compared to just 50,000 MWhr in 2009. More than US$3 million is exchanged on the DAM each month, and about six percent of all energy traded in southern Africa is accessed through the competitive market.

It is hoped that the creation of a competitive market will help to optimise the use of regional electricity resources, assisting in determining

the correct electricity price in the pool and sending signals for investments and real time utilization of existing assets. It is also worth noting that the SAPP membership is no longer a preserve of national power utilities following the amendments to the Inter-Governmental Memorandum of Understanding (IGMOU) and the Inter-Utility Memorandum of Understanding (IUMOU) that allow Independent Power Producers (IPPs) to become members of SAPP. IPPs have taken advantage of this positive development to become members of the SAPP.

A unique feature of SADC's power-trading architecture is that SAPP is based on agreements rather than law. The pool was formed after the signing of the IGMOU by a majority of the SADC members. The IGMOU and its subsidiary agreements—the IUMOU, the Agreement between Operating Members and the Operating Guidelines — have now been signed by all the SADC members and their national power utilities. The IGMOU establishes that the SAPP agreements must be interpreted in a manner consistent with the SADC Treaty and that the final and binding dispute resolution forum is the SADC Tribunal.

3.5.2 Electricity trade pricing

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

3.6 Electricity Regulatory Environment

Although a regional energy market is operational through the SAPP, power trading within SADC takes place between utility members only. Ten SADC Member States have national regulators that oversee energy issues in the respective countries and are members of RERA. However, as the national regulatory agencies develop and begin to assert their authority, there is a risk that they have not been sufficiently attuned to the needs of the regional market. Experience in other countries shows that although a pool can operate where regulatory regimes differ, as they do among SAPP countries, possibilities for gaming or unfair advantage created by differences in regulatory systems can undermine members' willingness to participate.

RERA has responded to regulatory impediments to cross-border power trading by developing "regulatory guidelines" that were approved by the SADC Energy Ministers in April 2010 to ensure that efficient cross-border deals are not constrained by unclear or complicated processes for making regulatory decisions. More specifically, the "regulatory guidelines" seek to:

- Clarify how regulators will carry out their powers and duties in regulating cross-border electricity transactions in order to minimise regulatory risks for power investors and electricity consumers;

- Promote efficient and sustainable cross-border electricity transactions that are fair to selling and buying entities that are consistent with least-cost sector development and can help to ensure security of supply; and
- Promote transparency, consistency and predictability in regulatory decision-making.

The regulatory guidelines represent a first concrete step towards harmonisation of national regulatory systems to encourage large cross-border transactions by ensuring that regulatory arrangements in the region are compatible. However, these only apply to long-term cross-border transactions. It is expected that regulatory conditions of small cross-border transactions (for example, those involving less than 20MW of power and having agreements providing for trading for less than one year) would be more streamlined and less extensive than provided for in the guidelines. The rationale for focusing on larger and longer-term transactions is that such transactions are likely to have a more direct impact on decisions to invest in new generation and transmission facilities.

Similarly, given their focus on major, long-term cross-border transactions, the RERA guidelines do not apply to trading on the SAPP DAM. They are also written in the form of principles, rules and procedures that could be adopted for reviewing major, long-term imports and exports of power. However, as a RERA document, they do not have a formal legal status over the decisions of individual national regulators. To give the regulations legal effect, national regulators will need to implement the guidelines in their respective countries.

Another issue is that most, if not all, of the SAPP Member States have a regulatory framework in place as part of the Electricity Supply Industry (ESI). The regulators have the RERA, a forum through which they share their experiences in their areas of operation. There is, however, a general view that while their effectiveness is incumbent upon independence or autonomous operation, many if not all of them, suffer from general lack of independence in exercising their mandate in particular when it comes to determination of tariffs and reigning in on errant ESI players. They are answerable to their Governments so they get their approval from the shareholder who may derail or slow down their effectiveness in order to satisfy their constituents from a political perspective.

In addition, the SADC energy sector lacks the capacity to carry out proper planning due to staff shortages. Most of the SAPP member utilities have lost a number of senior staff over the past few years through migration and resignations. This trend needs to be addressed through appropriate policy incentives. A RERA survey done in 2008 with support from the USAID Trade Hub to review current status of the Electricity Supply Industry (ESI) revealed that although most countries have energy policies, these need to be reviewed and updated in line with best practices. Capacity to implement policies is inadequate in some of the countries while ESI reforms are, in most cases, incomplete and need to be finalised in line with adopted policies.

3.7 Emerging Issues

There are moves in some countries to establish independent system operators that are separate from the national utilities. In most cases, the national fully integrated utility is the generator of electricity and transmitter and distributor thereof. However, South Africa, for example, has said the procurement of electricity will in future be done by an independent and neutral entity. This is an important step to level the playing field for private producers of electricity because Eskom's "single buyer" monopoly has been a major deterrent to new investment in the generation market.

The lengthy negotiations for Power Purchase Agreements (PPAs) have also been seriously affecting the speedy implementation of some important projects, thus affecting electricity trading in the region.

The quest for regional energy security in SADC has always involved a delicate balance between national and regional interests. Member States have tended to take the sovereign route of attempting to attain national self-sufficiency, rather than depending on supply from another country. The attraction is usually the shorter gestation period for national projects compared to the larger regional energy facilities that often include several countries and involve elaborate negotiations among the beneficiary states and with potential funders.

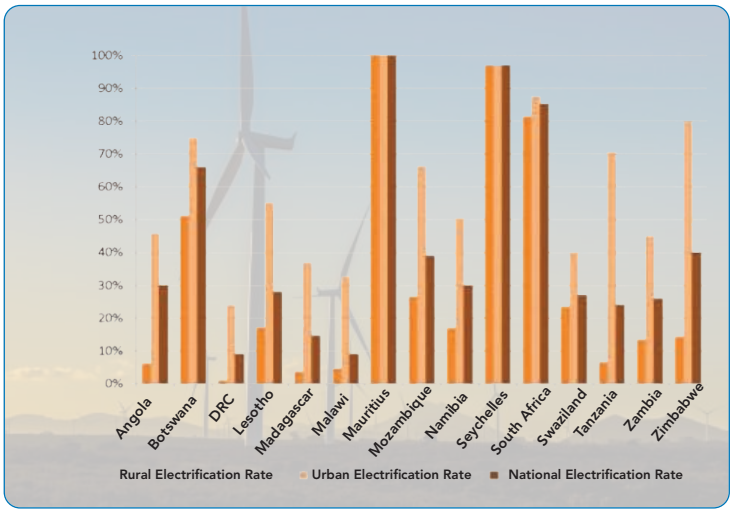
A case in point is the Mmamabula Power Station in Botswana. Initially meant to be a regional initiative, the project was expected to add 2,100 MW of power to the SAPP grid through the construction of a coal-fired plant near the border between Botswana and South Africa. Stung by power shortages at home, Botswana then decided to go solo on the project rather than wait for the long process of regional negotiations to take place. Another example is the Westcor Power Project which had been initiated by five Member States to draw power from the DRC to Angola, Botswana, Namibia and South Africa, but the initiative is now moribund due to a number of factors including concerns over security of supply.

Some Member States have raised genuine concerns in terms of both physical security of transmission infrastructure as well as contract security, particularly in the absence of a regional regulatory framework. Electricity-deficient countries usually have no control over the transmission infrastructure in other Member States through which their own imports pass. For example, South Africa cannot control what happens along the regional grid when it imports electricity from the DRC. The current regional regulatory framework is silent on measures to regulate pilferage of power imports meant for another country. The challenge to ensure electricity security is further compounded by emerging policy concerns that link energy security to climate change. Climate change experts have confirmed that current and future changes in the atmosphere not only pose the greatest economic, social and environmental challenge the world has ever faced, but, more importantly, demand greater regional efforts to ensure long-term energy security.

3.8 Electrification Rate

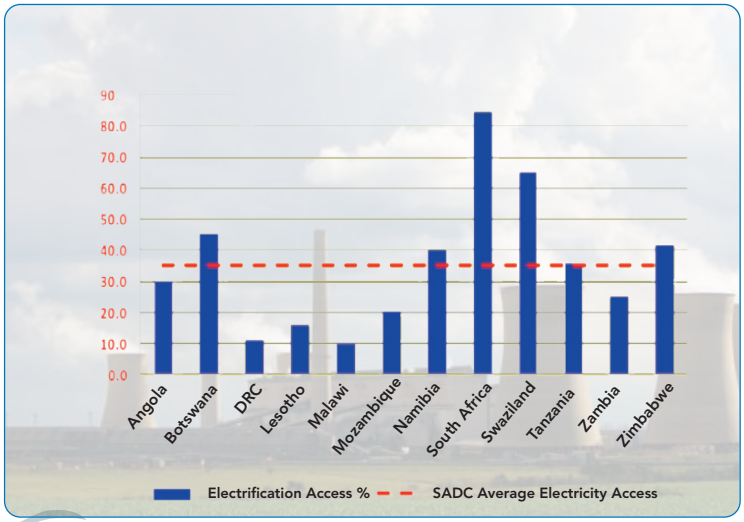
National electrification rates, which can be defined as the percentage of households with an electricity connection, vary significantly among SADC countries, with Mauritius being fully electrified and Seychelles very close to full electrification (RERA, 2015). In contrast, Malawi has the lowest national electrification rate at around nine percent. Other countries with low levels of national electrification include the DRC and Madagascar, both with electrification rates below 20 percent.

Figure 3.6 **Electrification Rate in Southern Africa 2012)**



Source RERA Publication on Electricity Tariffs & Selected Performance Indicators for the SADC Region 2012 and 2013, 2015

Figure 3.7 **Electricity Access in SAPP Countries %**



Source SAPP Annual Report 2014

3.9 Access and Affordability

Access to electricity in most SAPP countries, which refers to the percentage of people in a given area that have stable access to electricity, is still very low irrespective of the massive rural electrification programmes being done by most utilities through their electrification agencies. The average electrification access level is 36 percent and this low level tends to affect women and children disproportionately.

Figure 3.7 shows that South Africa is leading the SADC region in terms of access while Malawi and the DRC have the lowest electrification level, at 10 percent.

Member States are urged to promote the use of local resources in particular renewable energy to enable access to electricity by the generality of the population through affordable tariffs and implementation of industries in communities in order to provide employment. More often than not it becomes cost effective if electricity infrastructure is developed to serve community industries after which communities in particular the residential customers will then find it easy to access and afford electricity.

3.9.1 Electricity pricing

It has long been recognized by SADC Member States, regulators, utilities and developers that the electricity supply challenges faced by the region are partly due to the inadequate investment in electricity infrastructure – especially in the generation and transmission sectors – largely as a result of low tariffs that did not provide adequate incentives to promote new investments (RERA, 2015). To this end, the SADC Ministers responsible for en-

ergy decided in July 2004 in Namibia to adopt the principles of cost-reflective tariffs in the region. This decision was reaffirmed at another meeting of the Ministers of Energy held in Zimbabwe in April 2007. At its meeting in Zambia in February 2008, the SADC Council of Ministers resolved that Member States should endeavour to reach cost-reflective tariffs within a period of five years, that is, by 2013.

To implement the resolutions by the SADC Ministers of Energy and the Council of Ministers, SAPP, with the support from the Development Bank of Southern Africa (DBSA), reviewed and documented the electricity tariff-setting principles, approaches and pricing applied in the SADC region. The recommendations resulting from the study were presented and approved at the meeting of the SADC Ministers responsible for Energy in Mozambique in April 2009. At that meeting, the ministers directed RERA to start producing, on an annual basis, a publication on the annual developments in electricity tariffs and their cost-reflectivity in Member States and to provide a comparative analysis of such tariffs for the SADC region.

Only Namibia and Tanzania have reached Cost Reflective Tariffs (CRT) and therefore the ministers adjusted the timeframe of their previous decisions and reaffirmed their commitment to ensure that the SADC as a region reached full CRTs by 2019.

Table 3.5 shows that only Namibia, South Africa and Zambia have cost-reflective tariffs covering the entire electricity supply sector, from generation until the power reaches the final consumer. They are also among the only six countries with agreed plans on the attainment of cost-reflective tariffs.

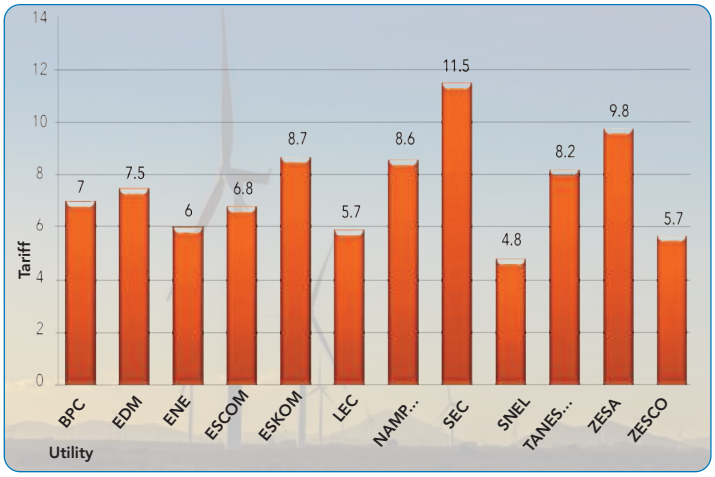
Table 3.5 **Progress Towards Cost Reflective Tariffs**

Country	Distribution		Transmission		Generation		Overall		Agreed Plan		Target Set	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Angola	x	x	x	x	x	x	x	x	√	x	√	x
Botswana	-	x	-	x	-	x	-	v	-	-	-	v
DRC	-	-	-	-	-	-	-	-	-	-	-	-
Lesotho	√	√	√	√	√	√	√	√	x	x	x	x
Madagascar	-	x	-	x	-	x	-	√	-	x	-	x
Malawi	x	x	X	x	x	x	x	x	-	-	x	x
Mauritius	-	√	-	√	-	√	-	√	-	x	-	x
Mozambique	-	-	-	-	-	-	-	-	-	-	-	-
Namibia	√	√	√	√	√	√	√	√	√	√	√	√
RSA	√	v	v	√	√	√	√	√	√	√	√	√
Seychelles	-	-	-	-	-	-	-	-	-	-	-	-
Swaziland	x	x	x	x	x	x	√	x	√	-	x	x
Tanzania	x	√	x	√	x	√	x	√	x	√	x	√
Zambia	√	√	√	√	√	√	√	√	√	√	√	√
Zimbabwe	X	x	x	x	x	x	x	x	x	x	x	x
Total	4	6	4	6	4	6	5	8	5	4	4	5

Source RERA Publication on Electricity Tariffs & Selected Performance Indicators, 2015

Although all Member States formally announced a policy to adopt cost-reflective tariffs by 2013, only five countries (Botswana, Namibia, South Africa, Tanzania, and Zambia) have set target dates for achieving cost reflectivity. The target dates range from 2012 to 2014 (RERA, 2015). Overall, while there has been progress, it is apparent that the original 2013 date adopted across the region has not been achieved by any Member State.

Figure 3.8 **Average Electricity Tariffs, USc/KWh**



Source RERA annual report, 2012

Electricity pricing varies widely from country to country, and may vary significantly from locality to locality within a particular country. There are many reasons that account for these differences in price. The price of power generation depends largely on the type and market price of the fuel used, government subsidies, government and industry regulation, and even local weather patterns. However countries with predominantly hydropower have competitive tariffs, such as Zambia and DRC, as shown in Figure 3.8.

3.10 Energy Efficiency and Conservation Initiatives

SAPP said as early as 1999 that demand for power in SADC was increasing faster than the growth in generation capacity. It warned that the region would face rolling blackouts by 2007 unless immediate action was taken to invest in new generation capacity. Regional average electricity demand growth is currently estimated at about 4.6 percent per annum against a low off-take of projects to boost power generation. This has resulted in load shedding in most SADC countries.

In addition to other energy conservation measures, including promotion of energy-saving or fluorescent lights and encouraging the use of solar water heaters in residential areas and promoting commercial energy-efficient lighting, there are a number of energy efficiency and conservation initiatives being pursued due to the capacity shortfalls that have affected nearly all countries in the region. These initiatives vary from one Member State to another, depending on the magnitude of the demand/supply imbalance. In Zambia and Zimbabwe in particular, the above initiatives have been exacerbated by the low lake level at Lake Kariba where the two neighbouring countries have had to endure a 40 percent reduction in electricity production in 2015/16. Zambia finds itself in a more difficult situation because it relies almost entirely on hydropower, unlike Zimbabwe where thermal power is produced at four coal-fired power plants which are Hwange Power Station, Harare Power Station, Munyati Power Stations and Bulawayo Power Station.

Box 3.2

Southern Africa targets Virtual Power Station

SAPP is actively pursuing the concept of a Virtual Power Station (VPS) as it seeks to augment ongoing efforts to increase electricity generation capacity to beat shortages in the region. A VPS, also known as Virtual Power Plant (VPP), is not a physical power station and makes extensive and sophisticated use of information technology, advanced metering, automated control capabilities, and electricity storage to match short-interval load fluctuations. The VPP integrates the operation of supply- and demand-side assets to meet customer demand for energy services in both the short- and long-term. The VPP concept also makes use of long-term load reduction achieved through energy efficiency investments, distributed generation, and verified demand response on an equal footing with supply expansion.

SAPP has taken significant steps in establishing a VPP and the various energy efficiency projects and DSM programmes being pursued by the power pool are the building blocks of this initiative. Faced with an electricity shortfall of about 8,000 megawatts (MW), the SAPP has been actively promoting energy efficiency technologies such as the replacement of incandescent bulbs with Compact Fluorescent Lamps (CFLs) and introduction of the Solar Water Heater (SWH) programme, Hot Water Load Control (HWLC) and the Commercial Lighting (CL) programme. Switching from traditional light bulbs to CFLs has been an effective programme by SAPP to reduce energy use at home and prevent greenhouse gas emissions that contribute to climate change.

Research shows that residential lighting accounts for about 20 percent of the average home electricity bill in the SADC region. However, compared to incandescent bulbs, CFLs have been shown to save up to 80 percent of electricity consumption. Similarly, the HWLC programme being pursued by SAPP has enabled consumers to install load control switches that automatically turn off power during peak periods or when appliances such as geysers have reached maximum demand. The energy efficiency measures have resulted in significant savings of about 4,500MW as of September 2015 since the launch of the initiative in 2011.

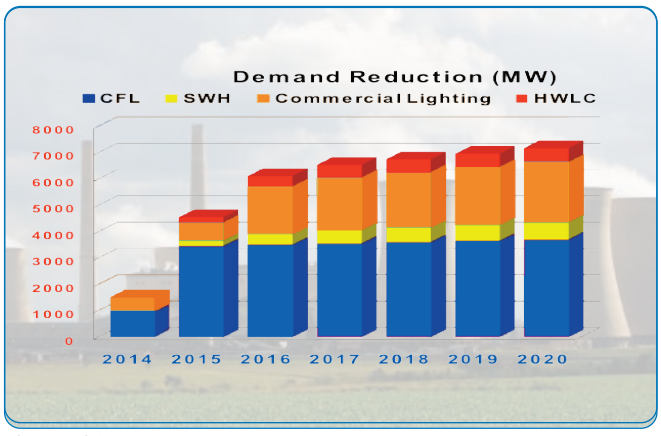
The power savings are expected to gradually increase to more than 6,000MW by 2018, by which time the use of incandescent bulbs would be banned in all Member States and a SAPP Energy Efficiency Framework Document would be in place. A taskforce has been formed to finalise the framework, which is expected to show how the power pool would roll out its energy efficiency programme. The framework will also define the private sector participation and role of energy service companies.

Source SADC Today, February 2014

To date, the majority of SAPP Member States have introduced the CFLs on a large scale. Other forms of energy efficiency and DSM programmes are at various levels of implementation. The target is to save 2,450MW of power this year using these four energy efficiency and DSM initiatives, according to SAPP.

The power savings are expected to gradually increase to 6,000MW by 2018, by which time the use of incandescent bulbs would have been completely banned in all Member States and a SAPP Energy Efficiency Framework Document would be in place. A task force has been formed to finalise framework, which is expected to spell out how the power pool would roll out its energy efficiency programme. The framework will also spell out the private sector participation and energy service companies.

Figure 3.9 **Projected Savings from DSM Initiatives**



Source SAPP, 2015

The SAPP has been implementing various initiatives for Demand Side Management that include:

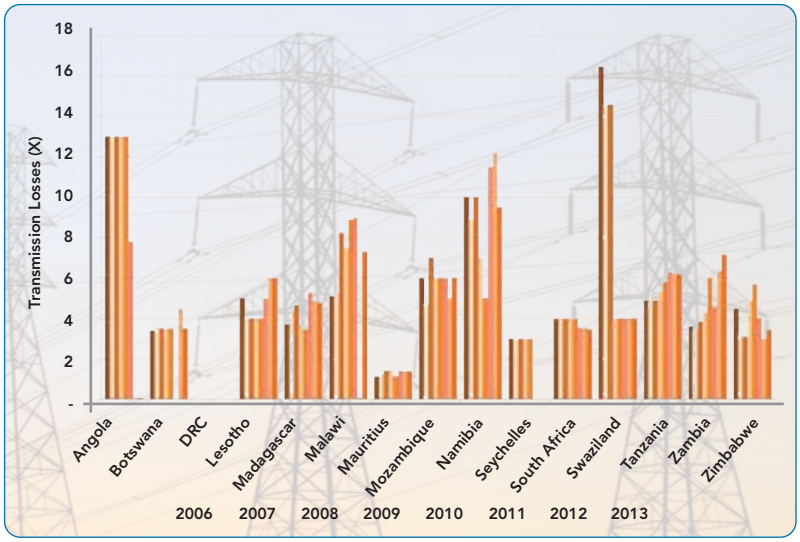
- Replacement of incandescent bulbs with Compact Fluorescent Lamps (CFLs);
- Commercial Lighting (CL);
- Hot Water Load Control (HWLC); and
- Solar Water Heater Geysers (SWH).

According to SAPP, the biggest savings have been realised from CFL installation, accounting for 3,285MW, or 73 percent, of the 4,500MW saved.

A Regional Light Emitting Diode (LED) roll-out business case has been developed. Promotion of LEDs has started in most countries. Some countries have started LED installation as well. Pilot programmes implemented at utility offices resulting in 60 percent savings. Zimbabwe has approved legislation for the banning of incandescent bulbs to join other countries which are at various stages of migration towards the banning of incandescent bulbs. South Africa has led the way by establishing the National Energy Efficiency Agency (NEEA) immediately after the power shortages began in 2006. The agency promotes energy efficiency throughout the South African economy by supporting projects for the public sector and targeted industrial end-users in the residential sector as well as public and commercial buildings.

The above initiatives, though noble, are capital-intensive to ensure benefits are realized. For example, some utilities procure energy-saving bulbs and give them out to customers free of charge in order to force them to embrace a change leading to reduction in consumption. Other utilities have solicited government support to enact laws which make it illegal to use electric geysers in order to cause domestic and other customer categories to use solar water-heaters. While the above initiatives are known to work, their implementation timeframe can be long due to the time it takes to enact relevant laws and the need to have reasonable time to allow phasing out of the old technology and usher in new energy-efficient initiatives.

Figure 3.10 **Transmission Losses in the SADC Region 2006-2013**



Source RERA Publication on Electricity Tariffs & Selected Performance Indicators, 2015

3.10.1 Transmission losses

Another topical issue with regard to energy efficiency and conservation is with respect to transmission losses. Transmission of electricity from generation points to load centres over long distances creates power losses. A major part of the energy losses comes from the joule effect in transformers and power lines and manifests as heat lost in the conductors. Transmission losses typically range from four to eight percent (RERA, 2015). However, they can be higher due to a multitude of reasons, such as poor management, inadequate investment in transmission, and poorly planned or haphazard growth of transmission subsystems and other power delivery infrastructure.

In the SADC region, transmission losses are strongly influenced by network length from generation points, energy intensity, loading of the network, as well as the age and condition of the power delivery system. According to the *RERA Publication on Electricity Tariffs & Selected Performance Indicators for the SADC Region 2012 and 2013*, the highest transmission losses in 2012 were reported by Namibia, at around 12 percent, followed by Malawi and Zambia at around seven percent. At the low-end, Mauritius, South Africa and Zimbabwe reported transmission losses of between 1.5 and 3.5 percent. For 2013, the highest transmission losses were reported in Angola at 13 percent and Namibia (improved) at 9.5 percent, followed by Malawi and Zambia at around seven percent and Mozambique, Tanzania and Lesotho at around six percent.

3.11 Projections and Scenarios

More than 24,000MW of new generation capacity is expected to be commissioned between 2014 and 2017. A number of rehabilitation and new generation projects are being undertaken to address the generation supply gap. The SAPP Pool Plan indicates that 57,000MW would need to be commissioned in the next 20 years.

The generation mix is expected to change in the future with more emphasis on renewable energy particularly hydropower development. Currently hydropower constitutes 21 percent of the generation mix and this would increase to at least 26 percent in the next 20 years. However, there is a need to diversify the energy source base in view of the experiences of Zambia and Zimbabwe, particularly in 2015, when hydropower generation dropped by nearly forty percent (40 percent) due to low water levels in the Zambezi river and hence Kariba Dam arising from poor rainfall. This, therefore, calls for the prioritization of solar and other renewable energy projects in line with climate change efforts being pursued internationally. Nearly all the SAPP Member States have high solar penetration levels which provide a great potential and meaningful contribution of solar energy to the current power deficit. The total renewable energy contribution is expected to rise to at least 35 percent of the regional energy mix by 2030.

3.12 Conclusions and Recommendations

Electricity is a common challenge in SADC, with power cuts common in most countries. It is against this background that SAPP members should take a radical approach to ensure that solutions to the power challenges are pursued and implemented without undue delay. The access to and affordability of electricity cannot be over-emphasized as it has a key bearing on the socio-economic development of the region.

Accelerated implementation of power generation and transmission projects, including deliberate efforts to prioritise least-cost, power generation projects in the region such as the Great Inga and Batoka, is paramount due to the increased economic activity in the region.

DSM and energy-efficiency initiatives should be pursued vigorously in order to reduce demand and allow power and energy savings realised to be channelled to productive sectors and stimulate economic growth.

Member States are encouraged to take firm measures to ensure that investment agreements, such as provision of cost-reflective tariffs, approval times for generation licences and power purchase agreements are accelerated and/or are put in place to attract investors in power generation projects going forward.

It cannot be over-emphasized that the huge volumes of water that flow to the oceans through the Zambezi and Congo rivers every year remain an opportunity lost. The same can be said of the immense sunshine in the SADC region.

A deliberate focus on replacement of aged power plants – most of them with antiquated technology – is proposed for energy efficiency purposes and to improve reliability, ensure cost-effective tariffs and prevent possible opportunity losses aggravated by load-shedding when such assets fail to perform or become expensive to operate. The power generation mix has to be managed effectively to prevent possible economic challenges arising from load-shedding in some countries such as Zimbabwe, Zambia and to an extent South Africa due to the drought and ageing equipment which have affected production from hydro power plants.

The regulators are urged to ensure that system losses are measured and addressed going forward in order to reduce operational costs. There is little evidence to show that some SAPP members are giving the issue of system losses top priority. The same can be said of customers who have not taken interest in improving power supply quality by taking measures that can improve quality of supply from a customer's perspective.

There is no doubt that Africa in general, and southern Africa in particular, is endowed with natural resources that can be exploited to produce electricity cost-effectively. The production of power and the associated grid infrastructure projects should be viewed in the context of the production of surplus electricity, with a view to exporting it not only to SAPP members but to other countries and power pools in Africa and Europe.

The effect of global warming and the general desire by Member States to conform to the dictates of climate change should be championed as a matter of urgency. This should enable all member states to prioritise renewable energy such as solar, wind power and exploitation of biomass fuels with a sense of urgency.

RENEWABLE ENERGY IN SOUTHERN AFRICA

4.1 Introduction and Background

Southern Africa has great potential to meet its energy requirements through exploiting the vast renewable energy resources such as solar, wind, biomass and geothermal, and mini and micro hydros. The interest to increase renewable energy and energy efficiency initiatives in southern Africa has been driven largely by electricity supply shortages affecting several countries in the region (REN21, 2015). Furthermore, the changing economics of renewable energy and in particular wind and solar energy and the emergence of new policy concepts such as feed-in tariffs, net metering, auctioning of power supply from Independent Power Producers (IPPs) and clean energy certificates (known as CELs) have led to increase in renewable energy investments. The use of renewable energy has become popular as it is known to provide solutions to improve energy access and security, mitigate greenhouse gas emissions and lessen the region's carbon footprint, ensure sustainable development and significantly improve socio-economic development. In particular, improved access to electricity and modern fuels reduces the physical burden associated with carrying wood and frees up valuable time, especially for women, thereby widening their employment opportunities (SADC/SARDC 2012a). According to OECD/IEA 2014, renewables can be deployed in a decentralised manner, which is faster than centralised power plant system and can provide local employment for deployment and maintenance.

Although the main source of renewable energy in southern Africa is hydropower, interest in solar, particularly photovoltaic (PV) and wind energy technologies is growing. The technologies range from small-scale household PV panel arrays to large-scale operations such as the 96 MW solar array project at Jasper in the Northern Cape, South Africa and the 138MW Jeffrey's Bay wind farm in South Africa (REN21 2015). Countries such as Botswana, Malawi, Namibia and Tanzania are developing large scale solar PV projects, while Swaziland and Zimbabwe are following the trend (REN21 2015). With regard to geothermal, it is estimated that about 4,000 MW of electricity is available along the Rift Valley of Tanzania, Malawi and Mozambique (SADC/SARDC 2014a). Biomass for electricity generation as well as for industrial heating applications is growing in importance in southern Africa (REN21 2015). The potential for biomass-generated electricity is estimated at 9 500 MW, based on agricultural waste alone. In addition, the region has attracted interest in large scale biofuel investments due to its great potential in biofuel production processing and utilization.

4.2 Renewable Energy Policies in Southern Africa

4.2.1 Policy landscape

The main regional policy drivers have been and remain electricity supply shortages in several key countries. The changing economics of wind and solar energy emergence of new policy concepts have propelled developments in the Renewable Energy programming in SADC. Developing own targets and policies has helped to expedite the uptake of renewable energy and energy efficiency projects and is the aim to offset dependence on fossil fuels. SADC is also identifying targets and developing appropriate policies for sustainable energy and this is a relatively recent phenomenon in the region

Examples of new policy concepts include Feed-in Tariffs (FITs), net metering, auctioning of power supply to IPPs and renewable energy certificates. The 2003 SADC Regional Indicative Strategic Development Plan (RISDP) set specific quantitative targets for infrastructure development (including energy) for a 15-year period, 2004-2018. For the energy sector, the target was for at least 70 percent of rural communities within SADC to have access to "modern forms of energy supplies", rural electrification and development of new and renewable energy sources.

Several member states have developed specific policies that embody targeting as a key element in the policy. Generally, these focus exclusively on the use of renewable energy in the electricity sector and in a few cases on biofuels (for example, Zambia). Only three countries – Mauritius, Mozambique and South Africa – have developed targets for biomass energy use. SADC established a Framework for Sustainable Biofuels as well as a Decision Tool to guide biofuels development. With IRENA assistance, Mozambique, Zambia and Swaziland conducted Renewable Energy Readiness Assessments (RRAs).

The Revised Regional Indicative Strategic Development Plan (RISDP) 2015-2020 and the Industrialization Strategy and Roadmap call for "increased/efficient use of renewable and other low-cost energy sources (biomass, solar, wind etc.)" in order to ensure that "10% of rural communities have access to New and Renewable Energy Sources". The Southern African Power Pool (SAPP) has committed to achieving a renewable energy mix in the regional grid of at least 32 percent by 2020 and 35 percent by 2030.

At country level, Botswana, Malawi, Mozambique and Tanzania developed biomass energy strategies with support from a European Union funded regional programme. South Africa, Namibia and Zimbabwe have introduced national energy efficiency programmes.

4.2.2 SADC Energy Protocol

The SADC Energy Protocol is the legal document for cooperation in the energy sector in the region. Article 3(1) of the Protocol defines the objective of energy cooperation in southern Africa as to strive to harmonize national and regional energy policies, strategies and programmes on matters of common interest based on equity, balance and mutual benefit. Article 3(3) states that energy cooperation in the SADC region shall involve working together in the development and utilization of energy in the region in the following subsectors: woodfuel, petroleum and natural gas, electricity, coal, new and renewable energy sources, energy efficiency and conservation and other cross-cutting themes of interest to Member States. Notable projects implemented in the re-

gion in line with the SADC Energy Protocol include the Programme for Biomass Energy Conservation (ProBEC) and the United Nations Development Programme-supported Financing Energy Services for Small-Scale Energy Users Project.

4.2.3 SADC Regional Infrastructure Development Master Plan

The Energy Sector Plan (ESP) is part of the SADC Regional Infrastructure Development Master Plan (RIDMP) whose aim is to define regional infrastructure requirements and conditions to facilitate the realisation of key infrastructure in the energy, water, transport, tourism, meteorology and tele-communications sectors by 2027. The ESP is designed to address four key strategic objectives that are paramount in the energy sector of SADC namely, ensuring energy security, improving access to modern energy services, tapping the abundant energy resources and achieving financial investment and environmental sustainability.

The ESP covers electricity, petroleum and gas, coal, renewable energy, nuclear energy and energy efficiency sub-sectors covering both the SADC and Member State perspectives. The duration of the ESP in accordance with the RIDMP is for 15 years from 2012 to 2027. The deployment of projects has been divided into short-, medium- and long-term periods spanning five years to 2017, 2022 and 2027, respectively (SADC, 2012). The main objectives of the study in relation to the energy sector are to:

- Review the current energy supply-demand balance and future projections up to 2027;
- Assess the effectiveness and adequacy of the SADC energy policies/strategies and regulatory frameworks, institutional frameworks, capacity and financing opportunities to support energy infrastructure development; and
- Propose deployment of both "hard" and "soft" infrastructure to meet SADC energy vision and strategic and priority goals.

4.2.4 SADC Renewable Energy Strategy and Action Plan

In 2011, SADC started the process of developing a Renewable Energy and Energy Efficiency Strategy and Action Plan (REEESAP), which is still under development as officials and ministers need to ensure that the targets are achievable and appropriate to each Member State. REEESAP proposes reaching electricity savings of five percent by 2015, 10 percent by 2020 and 15 percent by 2030 of total in the sectors that use electricity compared to the established baseline. In 2010, SADC managed a saving of 750MW compared to a peak demand of 50GW which was barely 1.5 percent (SADC, 2012).The strategy is set to be approved in 2017.

4.2.5 Sustainable Energy for All

SADC Member States' efforts to develop targets and policies have been assisted by their involvement in the Sustainable Energy for All (SE4All) initiative of the United Nations. The principal objective of SE4All is to achieve universal energy access by 2030 through: ensuring access to modern energy services; doubling the rate of improvement in energy efficiency; and doubling the share of renewable energy in the global energy mix

(SADC/SARDC 2015). To date, 12 of the 15 SADC countries have joined SE4All and have expressed an interest in initiating rapid assessments to help determine the main challenges and opportunities in achieving the initiative's goals. In addition, 10 Member States that is, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe have carried out the SE4All gap analysis.

It is expected that the SE4All initiative will help SADC countries refine their energy policy frameworks and develop appropriate incentives for renewable energy and energy efficiency.

4.2.6 Revised Regional Indicative Strategic Development Plan (RISDP)

SADC Member States adopted the Revised Regional Indicative Strategic Development Plan (RISDP) in April 2015. The revised RISDP was adopted in response to concerns about the need to assess progress and make necessary adjustments. It establishes an Implementation Framework for the period 2015-2020 and an Industrialisation Strategy Roadmap, identifying energy as one of the main drivers of economic growth. It includes the original target of "increased/efficient use of renewable and other low cost energy sources (biomass, solar, wind)" in order to ensure that "10 percent of rural communities have access to new and renewable energy sources (REN21 2015).

Table 4.1 shows the renewable energy instruments in the region. As shown, most of the countries have national policies on energy with only three countries having developed renewable energy policies. These are Namibia, South Africa and Zambia. In addition, SADC data shows that only Mauritius, South Africa and Zambia have renewable energy strategies in

Table 4.1 **Renewable Energy Instruments in SADC**

Country	National Energy Policy	Energy Master Plan	RE Policy	RE Strategy	RE Master Plan/Action Plan	Integration of RE into Rural Electrification
Angola	✓					
Botswana	✓	✓				✓
DRC	✓					
Lesotho	✓					
Madagascar	✓					
Malawi	✓					
Mauritius	✓	✓		✓	✓	
Mozambique						
Namibia	✓		✓			✓
Seychelles	✓					
South Africa	✓	✓	✓	✓		
Swaziland						
Tanzania	✓					✓
Zambia	✓	✓	✓	✓		✓
Zimbabwe	✓	✓				✓

Source SADC Directorate of Infrastructure and Service Energy Division in SADC/SARDC 2012b

place while Mauritius is the only Member State with an existing renewable energy master plan.

As a result of the policies and strategies mentioned above, countries in southern Africa have each crafted their own national renewable energy targets to promote energy security. Table 4.2 summarises the targets for each Member State.

Table 4.2 **Renewable Energy Targets in SADC Member States**

Country	Sector/ Technology	Target
Angola	Electricity access Renewable energy (small-scale) Hydropower Biofuels	60 percent by 2025 (from 30 percent currently) Increased share in off-grid applications by 2025 500 MW added by 2025 (through rehabilitation) E10 for ethanol by 2025
Botswana	Energy access Renewable electricity Renewable energy	100 percent access by 2016 (from 82 percent currently) 43.5 MW capacity added from REFIT programme by 2030 1 percent of final energy by 2016
DRC	Energy access (non- renewable energy-specific)	60 percent by 2025 (from 9 percent currently)
Lesotho	Grid extension (non- renewable energy-specific)	288 MW by 2020
Madagascar	Renewable electricity	10 percent of generation by 2019
Malawi	Electricity access Energy-efficient devices Renewable energy Biofuels	30 percent by 2030 (from 9 percent currently) 10 percent of use by 2030 (from 1.5 percent currently) 6 percent in energy mix by 2030 (from 1 percent currently) E10 for ethanol by 2030
Mauritius	Renewable electricity	35 percent of electricity from renewables by 2025; generation shares of 17 percent bagasse, 8 percent wind, 4 percent waste, 2 percent solar, 2 percent geothermal by 2025 (under review)
Mozambique	Renewable electricity	By 2025, generation of: Solar: 23 TW potential, 597 MW priority Hydropower: about 18 GW potential, 5.4 GW priority Wind: about 4.5 GW potential, 1.1 GW priority Biomass: about 2 GW potential, 128 MW priority
Namibia	Renewable electricity	10 percent by 2011 (extended)
Seychelles	Renewable electricity	5 percent by 2020, 15 percent by 2030 (IRENA)
South Africa	Renewable electricity Transport	10 000 GWh by 2013 (White Paper); 17 800 MW by 2030 (Revised IRP) 15 percent reduction in final energy demand for transport by 2015
Swaziland	Renewable electricity	Increased contribution via hydropower and solar
Tanzania	Renewable electricity	2 000 GWh by 2020 (from 370 GWh currently)
Zambia	Electricity access Biofuels	40 percent by 2015 (from 22 percent currently) 40 million litres, E10 for ethanol by 2015; B5 for biodiesel by 2015
Zimbabwe	Electricity access Renewable energy Hydropower (small-scale) Biofuels	85 percent by 2020 300 MW added by 2020, including 100 MW from solar 150 MW by 2020 Import substitution to E10 for ethanol, B5 for biodiesel by 2020

Source SADC Renewable Energy Status Report 2015, REN21

4.3 State and Trends in Renewable Energy Initiatives

Biomass is a major source of energy in most SADC countries. Traditional biomass accounts for 45 percent of the final energy consumption and if bagasse for boilers in the sugar industry is included this figure rises to 57 percent. However, from a health perspective and negative impacts of energy use, more than 153,000 people die each year in the region from household air pollution resulting from indoor burning of solid fuels for cooking and heating (REN21 2015).

Energy access and energy security to allow for secure and reliable interconnections that permit exchange of power between the hydro-dominated north and fossil fuel-dominated south have been and remain major areas of concern and focus for SADC. In this context 6,000MW of trans-border connections were planned for completion in 2014-2015 alone.

Notably as the use of renewable energy continues to rise, it is expected that the increase in the uptake of renewables in SADC will allow the region to achieve a renewable energy mix of at least 32 percent by 2020, which should rise to 35 percent by 2030 (SADC/SARDC 2013). As shown in Table 4.3 there has been a clear upward trend in renewable capacity in the period 2000 to 2014 at an average of 26 per-

Table 4.3 **Renewable Energy Capacity in SADC Member States 2014**

	TECHNOLOGY TYPE (MW)									
	Large Scale Hydro	Medium Scale Hydro	Small Scale Hydro	Pumped Storage	Solar PV	Onshore Wind	Biomass /Waste	Biogas	Total	% Change 2000-2014
Country										
Angola	861	16	1	0	0	0	0	0	878	225
Botswana	0	0	0	0	1	0	0	0	1	100
DRC	2 360	50	6	0	0	0	0	0	2 416	1
Lesotho	72	3	2	0	0	0	0	0	77	0
Madagascar	130	34	1	0	3	1	1	0	169	55
Malawi	346	4	1	0	1	0	0	0	369	21
Mauritius	42	17	2	0	18	1	1	0	351	32
Mozambique	2 182	3	1	0	1	0	0	0	2 187	0
Namibia	332	0	0	0	5	0	0	0	337	35
Seychelles	0	0	0	0	0	6	6	0	6	600
South Africa	653	30	3	1 590	922	570	570	13	4 023	60
Swaziland	55	6	2	0	0	0	0	0	138	48
Tanzania	553	14	6	0	11	0	0	0	646	8
Zambia	2 244	11	2	0	2	0	0	0	2 302	26
Zimbabwe	680	6	2	0	5	0	0	0	790	6
SADC	10 510	194	29	1 590	969	578	578	13	14 690	26

• An entry of "0" means either that there is no use of the technology in that country, or that this use is very small and therefore not registered statistically.

Source SADC Renewable Energy Status Report 2015, REN21

cent for the region, and as high as 225 percent in Angola due to vastly increased hydro-capacity. The figures also reflect the huge disparity that still exists between hydropower and the other renewable energy resources (REN21 2015).

The trends and projections developed under the New Policies Scenario indicate that electricity generation and trade for bioenergy, solar PV and other renewables will increase with a compound average annual growth rate of 11.5 to 25.1 and 23.1 percent in the period 2012 to 2040 respectively. Again, although electricity generation and trade for bioenergy remained unchanged from 2000 and 2012, standing at 1TWh, it is projected to rise to 6 TWh in 2020 and 27 TWh in 2040 as shown in Table 4.4. The New Policies Scenario takes into account the broad policy commitments and plans that have been announced by countries, including national pledges to reduce greenhouse-gas emissions and plans to phase out fossil-energy subsidies, even if the measures to implement these commitments are yet to be identified or announced (OECD-IEA 2014).

Electricity capacity from bioenergy, solar PV and other renewables is expected to rise by compound average annual growth rates of 13.0, 24.6, and 29.7 percent between 2012 and 2040 as shown in Table 4.5.

Table 4.4 **Electricity Generation and Trade in Southern Africa under New Policies Scenario**

Electricity Generation and Trade (TWh)									Shares %		CAAGR* %
Year	2000	2012	2020	2025	2030	2030	2035	2040	2012	2040	2012-2040
Bioenergy	1	1	6	11	17	17	22	27	0	4	11.5
Solar PV	-	0	6	13	20	20	27	34	0	5	25.1
Other Renewables	-	0	8	16	25	25	34	42	0	6	23.1

* CAAGR is Compound Average Annual Growth Rate. This is the average annual growth rate over a specified period of time.

Source OECD/IED 2014

Table 4.5 **Electricity Capacity in Southern Africa under New Policies Scenario**

Electrical Capacity (GW)							Shares %		CAAGR* %
Year	2012	2020	2025	2030	2035	2040	2012	2040	2012-2040
Bioenergy	0	1	2	4	5	6	0	3	13.0
Solar PV	0	4	7	12	16	19	0	11	24.6
Other Renewables	0	3	6	9	12	15	0	8	29.7

* CAAGR is Compound Average Annual Growth Rate. This is the average annual growth rate over a specified period of time.

Source OECD/IED 2014

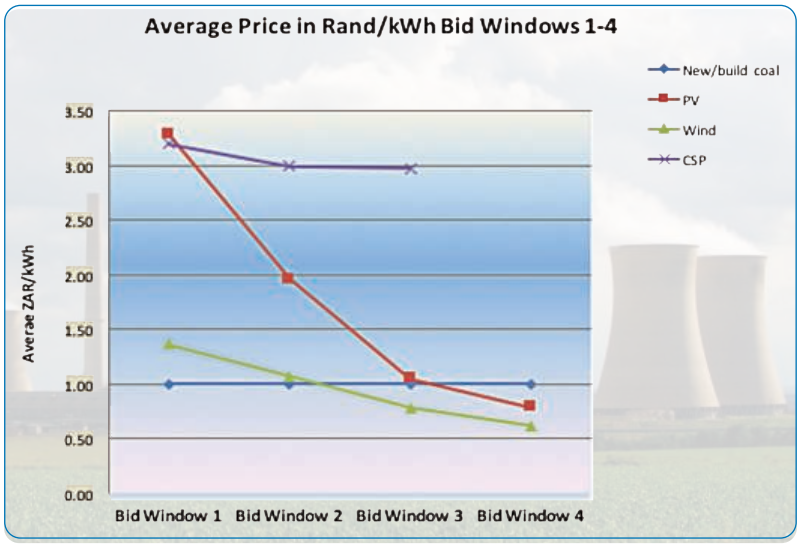
4.3.1 Solar

Of the estimated solar capacity for the region, only one percent of this capacity has been realised such that the revised RESAP target of 500MW by year 2020 has already been exceeded. Solar thermal-electric systems have potential to provide a significant portion of SADC's electricity and energy needs (SADC/SARDC 2012a). According to Chenje 2000, solar power provides clean energy and can improve the standard of living of those communities that have no access to grid electricity. Research has shown that most countries in southern Africa receive more than 2,500 hours of sunshine per year.

In its study of infrastructure requirements for the African Clean Energy Corridor, IRENA estimated that the SADC region has the potential to generate approximately 20,000 TWh of electricity from solar energy per year. The current installed solar capacity is less than one percent of this figure (REN21 2015). As earlier mentioned, the region's largest single solar PV project, the 96 MW Jasper project in the Northern Cape of South Africa was commissioned in 2014 and is just slightly smaller than the smallest hydro-project on the SAPP priority list that is the Lower Fufu in Malawi (REN21 2015).

There is evidence of increased and planned uptake especially in South Africa, Namibia and Swaziland and Zimbabwe where there are plans to build more solar PV plants. Under South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), solar PV accounted for 1,899MW while Concentrated Solar Power (CSP) accounted for 400 MW, among the projects approved under Window 4 of the REIPPPP in 2015. The average price per MWh of solar PV declined sharply between REIPPPP window 1 in 2011 and window 4 in 2015 – from ZAR 3,288 (US$274) to ZAR 786 (US$65).

Fig 4.1 **Average Price in Rand/kWh Bid Windows 1-4**



Source Centre for Scientific and Industrial Research (South Africa), 2014

Botswana, Malawi, Namibia and Tanzania are developing large-scale PV projects and Tanzania has successfully focused on small-scale off-grid (often linked to mini-grids using the innovative use of standardized PPAs. Mozambique's FUNAE aims at electrification of schools and clinics using PV and other renewables. Tanzania's unique Feed-in Tariff (FIT) programme assisted the first solar project with 208 KW of PV panels. The result is 208 kW of PV panels providing electricity to 45 secondary schools, 10 health centres, 120 dispensaries, municipal buildings and businesses across 25 village market centres in the Kigoma region.

Botswana has a single solar PV "pilot" project (1.3 MW), operational since 2012. Zimbabwe's Rural Energy Agency (REA) has been active in implementing renewable energy projects using

solar PV and targeting rural institutions such as clinics and hospitals, schools and chiefs' homesteads. The Zimbabwe Government has announced plans to gazette a Statutory Instrument outlawing the installation of electric geysers in all new structures so to promote the use of solar-powered geysers. In October 2015, the government ordered all mining companies and other big industries to reduce their electricity consumption levels by 25 percent with immediate effect due to the current power shortages affecting the country.

The larger solar PV projects being developed in South Africa include the 100MW Xina Concentrated Solar Power (CSP) project, approved in the REIPPPP window three in November 2013. In the country's four REIPPPP bidding windows up to April 2015, solar PV accounted for 632MW, 417MW, 435MW and 415MW respectively for a total of 1,899 MW. Energy from CSP accounted for 150 MW, 50MW and 200MW, for a total of 400MW, although not all of this capacity has been commissioned.

Namibia is moving forward with the largest rooftop solar PV project in Africa, a 1.1MW hybrid project. The project uses an integrated energy management system that integrates solar energy into a local diesel-powered grid. In May 2015, the Namibian utility, NamPower, commissioned a 4.5 MW grid-connected solar PV park near Omburu, which includes 30,000 ground-mounted panels and covers 15 hectares. In addition to the 1.3 MW single solar PV pilot project operational since 2012, Botswana is now moving forward with detailed feasibility studies for a 200 MW CSP/parabolic collector project and the possible sites being considered are Jwaneng, Letlhakeng, Maun, Selebi-Phikwe and Serowe.

The Tanzanian government's openness to mini-grids and its unique FIT programme led to a first solar PV project in 2013. All of Tanzania's solar programmes to date have been off-grid, and many are part of mini-grids, often with hybrid systems. Zimbabwe, where the FIT programme is awaiting final government approval, is moving forward on a project-by-project basis. Planned projects include a 100 MW solar farm in Gwanda, a 50 MW solar plant in Marondera in the east of the country, and two 10 MW grid-connected PV arrays in the Harare and Melfort areas. Zimbabwe has in the past benefited from the Global Environment Facility's Solar Photo Voltaic Pilot programme which resulted in some 10,000 units installed in rural areas.

Malawi, with one of the lowest rates of grid access in the region (9 percent), has been providing solar power for its many remote, underserviced areas, with donor assistance. In January 2015, a project was announced to provide 250 solar streetlights and 533 sets of mobile solar PV systems for rural areas, especially health clinics. In Mozambique, the government has promoted solar PV and mini-hydropower solutions in rural areas, reporting that 700 schools, 600 health centres and 800 other public buildings in rural areas now have electricity from solar PV.

With all these developments in place, it should be noted that the potential for expansion and widespread use of solar energy in southern Africa will depend on innovative measures to reduce the initial cost while improving performance of solar electric technologies. This is because, with all its advantages and declining production costs, solar systems delivered to the end user are not cheap to install, and a typical

home system costs between US$500 and US$1,000. The use of innovative financing schemes, such as Fee For Service (FFS) arrangements, is one way to overcome these high up-front costs. Installing solar panels to power multiple houses at once can help to cut down on costs. Botswana, Namibia and Zambia have developed solar markets, in many cases with special funds to support consumer credit.

4.3.2 Hydropower

SADC's installed hydro capacity represents about 21.5 percent of total electricity capacity, of which large-scale hydro is 97.6 percent. The existing projects and those planned for development in the six riverine countries of Angola, DRC, Malawi, Mozambique, Zambia and Zimbabwe have a total potential capacity of 21,580MW. Of this total, 61 percent is undeveloped at present. South Africa's operational capacity includes macro, mini, micro and pico projects.

Mauritius has 60MW from both large- and small-scale hydro facilities while Swaziland has 60.6MW of operational small-scale hydropower. Angola has 5,435MW of planned hydropower under development and Malawi has 280MW of large-scale hydro plus 6MW of small-, micro- and pico-scale hydro; another 6.25 MW is listed as "potential".

The importance of hydropower to the SADC integrated grid is clear. All four large-scale hydro projects are directly linked to the SAPP network. The region's governments and utilities have agreed that expanding the amount of hydropower is the easiest and quickest way to achieve significant increases in renewable energy.

Plans to expand the Inga Hydropower Project to incorporate a third stage (Inga III, at 4,800 MW) will make it by far the largest hydroelectric project on the African continent. The hydropower potential of the SADC region is some 150 GW, of which only 12 GW is installed (SADC, 2011). By 2027, the region aims that 75GW is installed to meet the SAPP targets and to export to other Regional Economic Communities (RECs). This target is feasible if both the Inga Hydropower Project in DRC and the Batoka Hydropower Station between Zambia and Zimbabwe are implemented by 2027.

4.3.3 Wind

The estimated potential for electricity generation from wind in the SADC region is 800TWh with total installed capacity amounting to less than one percent of expected potential. Unlike solar, however, this potential is not widely distributed but rather is concentrated in coastal regions (more on the west than the east coast) and in mountainous countries such as Lesotho. Nevertheless, several SADC countries such as Angola, Lesotho, Namibia and South Africa have enormous wind energy potential, and all are proceeding with development of this resource (REN21, 2015).

Over the four REIPPPP bidding windows to 2015 in South Africa, a total of 2,660MW capacity has been added since 2011. Large-scale operations were commissioned in 2014 at Jeffrey's Bay Wind Farm and Cookhouse Wind Farm. Both plants have a capacity of 138MW.

Mozambique, Namibia and Tanzania are pursuing large-scale wind farms with renewable energy atlases having been developed. Namibia has issued three licences for wind farms, but these are yet to be implemented.

Box 4.1

SOLTRAIN promotes use of solar thermal technologies

Southern Africa is turning to solar energy as it takes initiatives to address challenges caused by the shortages of electricity afflicting most countries in the region. One example is the Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN), a regional initiative on capacity building and demonstration of solar thermal systems in the SADC region.

The main objective of the project is to help to move the region away from the use of environmentally unfriendly fossil fuels and promote use of renewable energies, with focus on solar water heating. The focus on solar thermal or heating systems is deliberate because solar radiation levels in SADC are high, and these systems can readily be manufactured or assembled in the region.

Started in 2009, with support from the Austrian Development Agency and the OPEC Fund for International Development, the SOLTRAIN initiative has benefited five countries during the first two phases – Lesotho, Namibia, Mozambique, South Africa and Zimbabwe. The first phase ran from May 2009 to August 2012 while the current second phase began in November 2012 and is expected to be completed at the end of February 2016.

The first two phases of the project had four focus areas. These were to raise awareness about the potential of solar heating technology in the SADC region; build competence in production of solar heating technology; create discussion and lobby platforms in participating countries; and establish demonstration projects to show that the technology works.

About 2,150 people were trained in 80 training courses between 2009 and 2015. Some 187 small- to large-scale solar heating systems were installed during the first and second phase of SOLTRAIN. The applications of these systems range from small-scale thermo-siphon systems for single family houses to medium-sized systems for industrial and commercial applications.

Some of the demonstration projects were installed at food and beverage companies that require a lot of hot water for their operations. South Africa has the largest number of installed solar heating systems with 85 beneficiaries at breweries, abattoirs, orphanages, hospitals, retirement homes and tertiary institutions. It is followed by Namibia which has 71 solar water heater installations at a low-cost government housing project, restaurants and tertiary institutions. Zimbabwe has the third highest number of beneficiaries at 19 projects, followed by Lesotho with 10 and Mozambique with two projects.

The third phase of the programme will commence in March 2016 and will see the initiative being expanded to include Botswana as the sixth country. This phase will run until July 2019, with implementation of roadmaps developed by participating countries. These roadmaps that outline the strategies and targets to be met by 2030 have been developed already by three participating countries -- Mozambique, Namibia and South Africa.

Mozambique plans to install at least one million solar water-heaters in residential areas by 2030 as well as more than 30,000 in hotels and other tourism establishments and 15,000 in public institutions such as government offices, hospitals and schools by the same period. The South African roadmap shows that the country plans to install at least eight million high pressure and low pressure solar water-geysers in residential areas over the next 14 years to encourage and promote the widespread implementation of solar water-heating.

Namibia also has equally ambitious targets to install solar thermal systems in residential areas, tourist facilities, hospitals and office blocks by 2030. This will include more than 200,000 installations in houses and at least 343 at hospitals and clinics around the country.

Source Southern African News Features, SARDC 2016 February

As the need for clean energy sources gains momentum, some countries in the region are slowly turning to wind power to boost production and meet the ever-growing demand for electricity. Wind energy is regarded as one of the most reliable and clean forms of power that does not pollute the environment, although some environmental impacts are beginning to emerge from studies conducted on large-scale wind farms. The construction of wind farms is considered as faster as it only takes one year to build one with a capacity of 100MW. SADC Member States are expanding their efforts to exploit this alternative source of energy that has emerged as one of the most lucrative sources of "carbon financing" under the Clean Development Mechanism (SADC/SARDC 2009).

Box 4.2

Clean Development Mechanism

The Clean Development Mechanism (CDM) allows a country with an emission reduction or emission limitation commitment under the Kyoto Protocol to implement an emission-reduction project in developing countries, thus using some of the capacity in the recipient country to cover their own excess. The mechanism stimulates awareness of sustainable development and emission reductions, while giving industrialised countries extra time to meet their emission reduction or limitation targets.

Source SADC/SARDC 2014b

Similar to the solar power projects, South Africa is leading the way in wind development through its tender process in the region. In 2014 alone, the country commissioned more than 500 MW of wind projects, and the latest tender announcement in April 2015 includes an additional 676 MW. Regarding Mozambique, the country is planning to develop a wind farm in Matutuíne district, north of the capital, Maputo, with capacity to produce more than 20MW of power (ZAMCOM, SADC, SARDC 2015).

Table 4.6 shows the wind capacity credit for SADC Member States. Wind capacity credit refers to the amount of conventional generation capacity that can be replaced with wind generation capacity, while maintaining the existing levels of security of supply.

In Namibia, the government has issued three licences for wind farms, but so far only a small 3.2kW pilot facility has been implemented, built in 2002 at Luderitz. Namibia now intends to develop a 72MW wind farm at Luderitz, although disputes over risk-sharing have held up construction. An additional 60MW facility is planned but yet to be confirmed for Walvis Bay. Namibia's very high coastal wind profile and modern infrastructure is likely to attract more investments of this kind in the near future (REN21 2015).

In Tanzania, the National Development Corporation recently entered into an agreement to build the country's first large-scale, grid-connected wind energy project — a 50MW wind farm in Singida

Table 4.6 **Wind Capacity Credit by Country**

Country	Total Area sq km	Wind Capacity Credit %	Justification
Angola	1 246 700	10	Resource is all along one coast
Botswana	581 7302	5	Resource is concentrated and poor
DRC	345 000	5	Resource is concentrated in one area
Lesotho	30 352	0	Resource relatively poor
Madagascar	587 051	-	-
Malawi	118 484	5	Resource is concentrated and poor
Mauritius	2 000	-	-
Mozambique	802 000	10	Resource is all along one coast
Namibia	824 269	10	Resource is all along one coast
South Africa	1 221 040	20	Resource is spread around country along coastline and inland - study underway
Seychelles	455 000	-	-
Swaziland	17 164	0	Resource relatively poor
Tanzania	945 087	10	Resource is concentrated in two areas that are relatively close
Zambia	752 614	5	Resource is relatively poor
Zimbabwe	390 759	5	Resource is relatively poor

** No data available for Madagascar, Mauritius and Seychelles*

Source IRENA 2013

Region. Mauritius has a 1.28MW wind farm on Rodrigues Island and is adding two additional projects, a 29.4MW facility at Plaine Sophie and a 9 MW facility at Plaine des Roches, both of which are under construction and are grid-connected. In Seychelles, a six megawatt wind farm near Port Victoria on the main island of Mahé has been in full production since 2013 and supplies some 2.2 percent of the country's power needs.

Madagascar is home to a few small, village-level wind energy projects, most of which are 20 kW or less, but large-scale wind development is still a distant prospect. Other countries such as DRC, Zambia and Zimbabwe have completed preliminary assessments of wind energy and have determined that the potential for development of this resource is minimal, except possibly for pumping applications. However, a pilot project that was undertaken in Zimbabwe by ZERO Regional Environment Organisation showed that it is possible to generate electricity even at low speeds, using specifically designed turbines.

4.3.4 Biomass

SADC's estimated biomass-generated electricity is 2,500MW with traditional biomass accounting for 57 percent of final energy consumption. Biomass used for domestic cooking and heating accounts for 23 percent.

Biomass is fuel derived from any living organism, traditionally it comprises wood, charcoal, dung and agricultural residues. These are burned in simple fires throughout the region for food processing and for heating.

Lesotho, Malawi, South Africa and Tanzania have been designated as "partner countries" for the Global Alliance for clean cook stoves and are improving the sustainability of biomass energy use in the region. Clean cook stoves are designed to use less firewood and emit less carbon monoxide. They are intended to replace traditional open fire systems commonly used in rural areas across southern Africa and thus reduce exposure to smoke. These clean cook stoves can also improve livelihoods through savings from the reduction of fuel use, and benefit the environment through a decrease in emissions and deforestation.

South Africa has the lowest biomass use (13.7 percent) as this is replaced by coal use. In Mauritius and Seychelles, biomass is used for heat and power generation using bagasse and contributed to 16.3MW of electricity generated in Mauritius in 2013. Bagasse is fibrous residue left over when sugarcane is squeezed for its juice, which can be used as a primary source of energy (heat) or in generation of electricity.

The potential for biomass generated electricity is estimated at 9500 MW. South Africa and Mauritius also use methane from municipal waste for power generation and in South Africa operational biomass plants include: methane from cow dung decomposition, boiler and electricity generation. Waste biomass at pulp and paper industry is also used for electricity generation and bagasse in the sugar industry is used for heat and co-generation of electricity in the sugar industry.

Mauritius has announced the development of two municipal waste-to-energy projects, to be ready by 2017 and producing 36MW of electricity using ultra-high temperature gasification technology.

The recognition of the need to improve the sustainability of biomass energy use in SADC Member States is gradually increasing. A programme to establish national biomass policies and targets, widely known as the Biomass Energy Strategies (BEST) Programme, was initiated during the period 2009-2014. Four SADC countries developed BEST plans during this period. These are Botswana and Malawi, which developed policies in 2009, Mozambique (2012) and Tanzania (2014). However, there has been little follow-up to the BEST programme to date and it has not been integrated into the regional policy framework.

Biomass resources are less easily accessed than solar or wind because they tend to be either scattered over large areas (for example, forests or cultivated areas or cattle ranges) or concentrated in a few specific locations (for example, dung at abattoirs or cattle lots, bagasse at sugar factories, or wood waste at pulp and paper plants). Nevertheless, a number of projects in the SADC region utilise waste biomass for modern biomass-to-heat energy or biomass-to-electricity projects.

A recent and pioneering example is South Africa's 4.4 MW Bronkhorstspruit biogas project, which uses methane from cow dung decomposition at a large feedlot near Pretoria to fire a boiler and generator, selling the electricity directly to an industrial customer. Other operational examples include the use of waste biomass to generate electricity at pulp and paper companies in South Africa and the use of bagasse to generate heat and co-generate electricity in the sugar industry – the latter a longstanding practice that is now being expanded to provide surplus electricity to the grid. One 25MW biomass-to-energy project at Ngodwana in Mpumulanga Province was selected in bidding window four of South Africa's REIPPPP in April 2015, joining two other biomass projects.

Expanding electricity generation from bagasse in the private sector is an important element in renewable energy expansion plans in Mauritius, Mozambique, Swaziland and Zimbabwe. Mauritius in particular has a long history of buying surplus electricity from the sugar industry, and almost all of the country's sugar mills are involved. The total installed capacity within the sugar industry is 243 MW, and in 2013, 16.3 percent of generated electricity in the country came from bagasse.

Biomass used for cooking remains the dominant energy source in most SADC countries. Apart from domestic use, wood fuel energy is used by some rural industries that consume significant amounts of firewood and these include brick-making, lime production, fish-smoking, beer-brewing, and the drying of coffee, tea and tobacco (ZAMCOM, SADC, SARDC 2015). Table 4.7 shows the proportion of wood usage in cooking and access to modern fuels in the SADC region. As shown, in 2006, about 96.4 percent of Malawi's population used wood as fuel for cooking and only 1.2 percent had access to modern energy.

Table 4.7 **Wood Usage in Cooking and Access to Modern Fuels in SADC, % per Total Population**

Country	Wood %	Access to Modern Fuels %	Year
Angola	36.8	54.1	2011
Botswana	43.4	56.2	2006
DRC	66.2	4.7	2007
Lesotho	52.2	46.0	2011
Madagascar	81.7	0.6	2005
Malawi	91.4	1.2	2006
Mauritius	1.2	98.7	2011
Mozambique	84.0	2.7	2003
Namibia	62.3	35.1	2006-07
Seychelles	n.a	>95.0	2007
South Africa	15.2	83.2	2006-07
Swaziland	71.7	23.8	2006-07
Tanzania	77.6	2.8	2007-08
Zambia	15.8	15.8	2007
Zambia	16.8	16.8	2010
Zimbabwe	32.6	32.8	2005-06

Source SADC, 2013

Box 4.3

SADC Member States embark on Biomass Energy Conservation

An ambitious regional programme for biomass energy conservation has been launched in southern Africa with a vision to satisfy the energy requirements of the region.

The programme targets mainly the lower-income population groups who often depend on wood fuel, with plans to ensure the protection of millions of hectares of forest resources while ensuring social equity.

Through the Programme for Biomass Energy Conservation (ProBEC) established by SADC, German Technical Co-operation (GIZ) is supporting the training of metal fabricators and engineers in the region to construct efficient energy-saving stoves.

The ProBEC project is active in eight SADC countries -- Lesotho, Malawi, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe.

In Zambia, the ProBEC project trained 13 regional entrepreneurs in the production of the improved "Rocket Cook Stove" in the capital, Lusaka. The stove is environmentally friendly as it produces minimal carbon dioxide, making it safer for indoor cooking.

Experience in Malawi has shown that half a drum of cooking local maize meal *(nshima)* could use up to 170 kg of firewood on an open fire, while preparation of the same quantity of *nshima* used only 14 kg when prepared on a Rocket Stove, accounting for 60 percent energy efficiency.

Integrated approaches to Biomass Energy Conservation thus offer ways to tackle fuel shortages, reduce the burden of fuel collection and preparation, and reduce exposure to indoor air pollution. The ProBEC project benefited rural and urban households in the region, as well as small business and institutions that are now using biomass energy for thermal processes.

A Tea Estate in Malawi, for example, used 170 kg of firewood to prepare food for 120 employees on ordinary open fires, but after buying the Rocket Stove, they now use only 20 kg. Among the institutions that have benefited from the Rocket Stove in Malawi are hospitals and schools.

Analysts say that biomass will remain the primary source of basic energy consumption for families and small businesses in most parts of southern Africa in the foreseeable future, and therefore it is of paramount importance that the available energy is being used in an environmentally sound and socially responsible way.

Source Southern African News Features, SARDC 2005

Overall, the figures show that a greater population in most of the SADC Member States are still using wood fuel for cooking whilst a few of the countries, such as Mauritius, Seychelles and South Africa, have a greater percentage of their total population with access to modern fuels.

4.3.5 Biofuels

Southern Africa has great potential for biofuel feedstock production, processing and utilization hence has attracted substantial interest in largescale biofuel investments. The reasons for this interest stem from the potential of biofuels to reduce dependence on imported fossil fuels, their ability to assist farmers through the expansion of markets, and their contribution to lowering Greenhouse Gas (GHG) emissions. Biofuels are therefore considered as a readily available, highly promising, innovative energy solution – provided their social, environmental and financial benefits can be optimised.

SADC Member States are moving forward in using biofuels as a partial substitute for fossil fuels in the transport sector. For example, countries with a strong tradition of producing ethanol from sugar cane (Malawi, South Africa and Zimbabwe) are accelerating production of ethanol from waste molasses and are exploring dedicated cane-to-ethanol production systems. With the expansion of the SADC Free Trade Area (FTA), biofuels are expected to become a regionally traded commodity included in the FTA agreement.

Malawi and Zimbabwe are both mandating, or planning to mandate, increased ethanol blend ratios and are exploring the possibility of operating fleet vehicles on pure ethanol in the next two to three years (REN21 2015). In Malawi, ethanol processing facilities have been operating for more than 25 years, and Zimbabwe produced ethanol for blending in the 1980s for a period, and has now resumed.

Other countries with small sugar industries (Angola, Mozambique, Tanzania, and Zambia) are monitoring developments and considering a conversion to low blends of ethanol to offset imported fuel costs. In 2014, Angola launched the 32 million litre per year BioCom plant to produce ethanol exclusively for vehicle transport. Apart from sugar cane, the region possess great potential for ethanol production from crops such as cashew nuts, manioc, maize, citrus trees and other related crops.

The main challenges faced with programmes focusing on jatropha is that they were based on very limited information on soil quality, weather conditions and nutrient requirements, and again suffered from a lack of fuel distribution and refining capacity. As a result, several international investors in Mozambique and Zambia have since withdrawn from the market, leaving a massive gap in biodiesel production (REN21 2015). Problems with insect infestation, low yields and larger-than-expected water requirements have affected the jatropha industry, and efforts are now underway regionally and internationally to undertake selective breeding to produce jatropha varieties that are better suited to southern and central African conditions.

Another challenge related to large-scale production of biofuels is that they may threaten food security in the region, in cases where agricultural production may be diverted from food crops to energy crops.

In that situation, food prices could rise, an increase that would disproportionately fall on the low-income earners in urban and rural areas who are not engaged in farming. The food crops may directly compete with energy crops in multiple ways, including competition for land, investment and water. Similarly, energy crops could encourage deforestation as land is cleared to make way for their production.

However, it has since been realised that while biofuels may increase competition for land, some countries in the region still have potentially productive land in relative abundance, for example in Angola, Mozambique, Zambia and Zimbabwe. Thus, the increased production of bioenergy feedstock, if carefully planned, would not disturb food production and could, if integrated into national agricultural development strategies, contribute towards increasing food-crop production and agricultural productivity. In addition, countries in the region are conducting agricultural mapping exercises to identify suitable land for biofuel feedstock production. Using existing and current climatic and soil data, crop suitability maps are being developed to identify areas most suited to biofuel production.

Furthermore, the emerging biofuel sector in the region has the ability to improve farming practices and avoid environmental degradation associated with modern farming practices if guided by a set of sustainability criteria sensitive to production methods and operational scale. Biofuel feedstock production can provide an additional cash crop for farmers, thus supporting a diversified cropping system. Biofuel production can increase rural incomes and if well managed and can empower women through development of farming skills for biofuel feedstock. However, the ability of rural women to take advantage of these opportunities depends on an enabling legislative environment and investment in extension services and skills training.

Despite these challenges, there are signs of recent improvements in regional biodiesel production. For example, in 2014 the Copperbelt Energy Corporation announced that it had built a biodiesel facility in Kitwe, Zambia with a capacity of 1 million litres per day, which would be used entirely to supply the company's own equipment. A 2014 review of the status of the biofuels industry in southern Africa indicated that sustainable jatropha biodiesel projects can still be found in Madagascar, Malawi and Mozambique.

South Africa has been involved in biofuels development and published a Biofuels Industrial Strategy in 2006, which was revised following public consultation and finalised in 2007. The purpose of the strategy was to stimulate the development of a production, refining and distribution industry in the country, aimed at achieving a two percent displacement of fossil fuels within five years. After failing to meet this target through fiscal incentives such as rebates on the fuel levy, the government decided instead to make blending mandatory, commencing in late 2015. The target will be B5 for biodiesel and between E2 and E10 for ethanol in petrol.

4.3.6 Geothermal Power

Based on preliminary exploration, current estimates indicate a geothermal potential of 650 MW in Tanzania. In Malawi, 21 major hot springs are reported in the Chitipa-Karonga area down to Chipudze in the

southern region. All of the geothermal energy sources of the country are of convective type. For Mozambique, the most promising areas for geothermal energy development are in the northern and central provinces. South Africa is relatively well-endowed with 87 thermal springs to date of 25° to 67.5° Celsius.

In Madagascar, eight sites have been identified while several sites are planned for construction in Zambia. In Botswana, the government called for companies to tender for the provision of consultancy services to conduct feasibility study for the construction of a solar geothermal power plant in the country.

The main challenge with geothermal power is that plant construction is capital intensive resulting in costs rising along with increasing engineering, procurement and construction costs. The price tag for projects planned for the period 2015 to 2020 is expected to drop from current levels, but overall these high upfront costs, along with associated uncertainties, are the key barriers to the development of geothermal power plants. In many instances, geothermal projects require long-distance transmission lines. Suitable risk-mitigation and transmission-network development approaches are therefore vital for the development of these resources.

4.3.7 Rural Electrification

There is evidence of use of mini-grids, household solar systems, and mini and pico systems. All 15 SADC Member States have rural electrification targets using renewable energy to achieve targets. Subsidies for installations of off-grid systems are offered in most countries. Tanzania has developed standardized Power Purchase Agreements (PPAs) that encourage investment by Independent Power Producers (IPPs) using renewable energy, and Malawi and Namibia and Zimbabwe have Rural Electrification Funds (REFs) administered by independent boards and by the Energy Regulatory Authority in the case of Malawi and the REFs funded by a levy on the electricity tariff.

And so generally SADC Member States are looking at the option of distributed generation and mini-grids as part of their rural electrification programmes. These include Angola, Botswana, DRC, Madagascar, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe who have specific rural electrification targets for this purpose.

4.3.8 Distributed Renewable Energy

Most electricity worldwide is produced at large power plants and delivered to electricity users via the transmission and distribution system. This is called a "centralized" electricity system. There is, however, an alternative through the use of smaller (1kW-100kW) power plants located at or near electricity users, known as a "distributed" system. This distributed electricity model has both advantages and disadvantages relative to the traditional, centralized model.

Distributed Renewable Energy (DRE) systems generate clean, renewable electricity on site, where that energy will be used. The term "distributed generation" distinguishes these systems from the large, centralized power plants that provide the vast majority of the nation's power. Distrib-

uted renewable energy systems can take many forms, including geothermal systems, micro-hydroelectric systems, solar panels and wind turbines. There are many programmes and policies that can either help or hinder the adoption and integration of distributed energy systems.

SADC Member States are making efforts towards embracing DRE. Tanzania, for example, has been a leader in this area in developing and promoting policies motivating small-scale DRE. There is expanded electrification and increased energy access, using solar mini-grids to 16 villages ie 11,000 households, 2,600 businesses, 42 public offices, 32 schools, 12 health centres and 77 religious buildings. The Tanzania Rural Energy Agency has 90 off-grid projects in its pipeline of mini-grids, solar PV or mini-hydro. REIPPP South Africa has developed Small Projects Programme (SPP) with simplified rules and ceiling price for different technologies. Zimbabwe is active in solar PV and mini-hydro development, particularly in the eastern Manicaland province which, because of its geology and perennial rivers and dams, lends itself to the development of such systems.

4.4 Energy Efficiency and Conservation

The SADC Energy Protocol aims to reduce commercial energy intensity and involve the national utilities in energy efficiency schemes. There are significant variations in implementation and progress. Estimates indicate that it is often possible for the commercial sector to reduce energy use by 10 percent with little or no cost. This could be achieved by adjusting temperature set points and making sure lights are switched off when no one is at work.

Energy intensity is a measure of the energy efficiency of an economy. It is calculated as units of energy per unit of Gross Domestic Product (GDP), meaning that if the energy intensity is high then the cost of production in the country is also high. Although there is no standard measure of national energy efficiency, energy intensity often is used as a proxy indicator, measuring the amount of energy (in MJ) required to produce US$1 of GDP.

SADC Member States vary widely in the efficiency of energy use. The highest energy-intensive countries are DRC, Mozambique and Zimbabwe while the least energy-intensive countries are Madagascar, Namibia and Swaziland. South Africa has a low energy intensity, which means that it costs less for South African companies to manufacture products, partly due to the technology and the higher quantities produced.

SADC has included energy efficiency in its overall mandate, although support for projects in this area has been very limited. At least 13 SADC Member States have started initiatives to replace Compact Fluorescent Lamps (CFL). SAPP has developed specific programmes for CFL replacement involving 11 national utilities and initiated an expanded Energy Efficiency Framework covering four technologies -- CFLs, commercial lighting retrofits, solar water heating and distribution, and transformer retrofits. This has resulted in an expected demand reduction of 4500 MW by the end of 2015.

The most common initiatives in the SADC region have been phasing out incandescent bulbs for CFLs. Demand Market Participation has been the least common. South Africa and Namibia have implemented Demand Market Participation (DMP) and with Mauritius, South Africa has developed full national energy efficiency programmes with supporting policy initiatives. In Zimbabwe, the national utility ZESA has implemented a CFL roll-out, with project performance monitoring and verification. ZESA also has a scheme to reward exceptional effort in efficient energy use by individuals, students, companies or other institutions. The DRC's national utility, SNEL, is in the process of establishing a standing committee responsible for energy efficiency.

Mauritius has instituted a National Energy Efficiency Programme, including a voluntary labelling scheme, incremental duty on sub-standard appliances, pre-paid meters and distribution loss reduction. There are some emerging innovations where, for example, Mauritius has used a seawater air-conditioning system.

Demand management and energy conservation are an important part of the energy sector, and the Southern Africa Power Pool (SAPP) was instructed by its members to implement a Power Conservation Programme (PCP) for the SADC region (ZAMCOM, SADC, SARDC 2015). As a result, countries in the region have initiated energy efficiency initiatives that include Demand Side Management (DSM) measures such as the use of CFLs, Solar Water Heaters (SWHs), smart meters, grid codes, as well as energy efficiency campaigns and targets (SADC 2012). Switching from traditional light bulbs to CFLs has been an effective programme by SAPP to reduce energy use at home and prevent greenhouse gas emissions that contribute to climate change (SADC/SARDC 2013). CFLs have been shown to save 80 percent of electricity consumption, compared to the incandescent bulbs.

4.5 Key Findings and Scenarios

An assessment carried out by the International Renewable Energy Agency for southern Africa shows that the share of renewable technologies in electricity production in the region could increase from the current level of 10 percent to as high as 46 percent by 2030, provided that the cost of these technologies continues to fall and fossil fuel prices continue to rise. In this scenario, nearly 80 percent of new capacity additions between 2010 and 2030 would be with renewable technologies (IRENA 2013). The assessment indicates that the promotion of renewable energy and the associated transformation of the power sector could bring down average generation costs by nine percent compared to the case without such promotion.

Key findings based on Renewable Promotion scenario, along with alternative scenarios, are as follows:

- Renewable technologies can play an increasingly important role in providing reliable, affordable, low-cost power in Southern Africa.

- Renewable technologies bring a reduction in fossil fuel consumption; and decentralised renewable options, in particular, reducing investment needs in domestic transmission and distribution networks.
- Over the model period, investment costs for introducing more renewable technologies into the future power system are higher than for fossil or nuclear; however, the cost savings, such as fuel saving and the reduction of transmission and distribution investments, far exceed the additional investment costs.
- Deployment and export of hydropower from the Inga hydropower project in DRC to the region would significantly reduce average electricity generation costs.
- Financial requirements for interconnector investment are minimal compared to the resulting benefits of international power trade.

4.6 Conclusion and Recommendations

Although SADC has great potential to harness renewable energy and diversify its energy mix, a number of challenges remain. Renewable technologies in SADC are still nascent with the exception of hydro, and often costly. However, the will to embrace the technologies is present as evidenced by the increasing uptake of renewable energy sources. Targets set by the SADC region to increase uptake of renewable energy are within reach.

There is need to adopt measures to stimulate the uptake of renewable energy products and technologies. Such measures include making it compulsory for the electricity industry to purchase renewable energy or supply a certain proportion of their energy from renewable sources as well as the development of guaranteed markets.

The region should develop a harmonized sub-regional renewable energy framework that will result in a reduction of investment costs in renewable energy technologies and improved reliability of the quality of new and renewable energy sources (SADC, SARDC 2014). The region will require new investments in the form of generation plants and the evacuation of power to demand centres.

An emphasis on the importance of community participation in the development of renewable products and technologies remains critical to ensure ownership and acceptance of these new sources of energy.

Renewable energy provides an opportunity for the region to address climate change concerns by increasing its uptake and therefore, reducing greenhouse gas emissions.

Chapter 5

COAL, PETROLEUM AND GAS SECTOR

5.1 Introduction

The SADC region is endowed with significant deposits of coal (and associated coal bed methane gas), crude oil, shale gas and natural gas whose optimal exploitation could potentially prove to be the "missing ingredient" in terms of diversifying the region's energy mix, reducing the cost of energy and improving its accessibility to the citizens of the region, as well as reducing carbon dioxide emissions which are associated with advancing global warming and climate change. However, the resources are unevenly distributed amongst the Member States and in some cases underdeveloped. This, and the lack of infrastructure to extract, process, store and distribute throughout the region, makes the resources unavailable to the majority of the population in the region. Another factor is export commitments, especially to those countries from which the investment companies originate.

This situation calls for regional integration in developing the infrastructure required to distribute the resources to areas of need in order to facilitate production and boost economic activity across the region.

Natural gas is becoming more significant to the region's energy sector as Angola, DRC, Madagascar, Mozambique, Namibia, South Africa and the United Republic of Tanzania develop natural-gas fields in their respective countries. Parallel to these developments, countries endowed with coal resources, particularly Botswana, Mozambique, South Africa and Zimbabwe are redoubling efforts to extract coal-bed methane gas on commercial scale. Due to the region's relatively small urban population, access to commercial energy sources is limited. The majority of SADC's population still relies on the use of biomass as its primary source of energy.

Investments in the oil and gas sector are rising, particularly in Angola, Mozambique and Tanzania due to the vast resources found in those countries. However, the sector is plagued by volatile prices, which have been uncharacteristically low in the last two years, thus generally discouraging investment.

5.2 Contribution of Petroleum and Gas to the Energy Mix

Internationally there has been a shift from coal to gas-generated electricity, driven by climate change concerns arising from the relatively high carbon dioxide (CO_2) emissions from coal-fired power stations. According to statistics compiled by the International Energy Agency, all regions of the world shifted from coal to gas-fired power stations during the period 2000 to 2010, with Africa registering a three percent increase in the gas supply and energy mix share (Table 5.1). This shift has created the need to align gas infrastructure with that for electricity.

Table 5.1. **Continental Gas Supply in TWh and % Share from 2000 - 2010**

	2000	2008	2009	2010	%	% Change 2000-2009
North America	6 654	6 740	6 375	6 470	16	(1)
Asia, excl. China	5 013	7 485	7 370	7 806	19	19
China	7 318	16 437	18 449	19 928	47	86
EU	3 700	3 499	3 135	3 137	8	(4)
Africa	1 049	1 213	1 288	1 109	3	0
Russia	1 387	1 359	994	1 091	3	(2)
Others	1 485	1 763	1 727	1 812	4	2
Total	26 606	38 496	39 338	41 353	100	100

Source International Energy Agency, 2011

5.2.1 SADC Regional Energy Mix

In 2008, the SADC primary energy supply was estimated around 9,552 PetaJoules (PJ) (IEA, 2011). Coal dominated the primary energy mix with 44 percent, followed by renewable energy (39 percent), oil (14 percent), gas (2 percent), and nuclear (1 percent). The 39 percent share for renewable energy is distributed among various types of supply including traditional biomass (36.66 percent) which is used primarily for cooking and heating, hydro (1.95 percent), and modern biomass (0.39 percent). Other renewable energy sources such as solar, geothermal, wind and biofuels were negligible. The overall contribution of oil and gas to the total energy mix of the SADC region in 2008 is shown in Table 5.2.

Table 5.2 **Share of Oil and Gas in Total Energy Mix of SADC Region in 2008**

Fuel	Contribution to Energy Mix %	
Coal	44.0	
Renewable Energy		
. Biomass	36.66	
. Hydro	1.95	39.0
. Modern Biomass	0.39	
Oil	14.0	
Gas	2.0	
Nuclear	1.0	

Source International Energy Agency, 2011

In recent years, the coal-fired power stations and other coal-related uses have come under scrutiny in the context of climate change, resulting in the contribution of renewable energy sources such as solar and wind rising significantly, together with that of gas and oil which are relatively less polluting. There are many energy sources used for electricity production in the SADC region, such as hydropower, coal, nuclear, natural gas and the distillate/diesel-based power generation.

The SADC generation mix is dominated by coal, which in 2010 accounted for 74.3 percent of the energy mix, hydro 20.1 percent, nuclear 4 percent and diesel 1.6 percent. To date, medium- to large-scale renewable energy projects from wind and solar (concentrated solar power) are still being deployed for power generation. So far, the development of these technologies is rather slow and their contribution to the generation mix is very small. South Africa is the only country in SADC that produces electricity from nuclear technology.

Of the 58 387 MW of electricity generated in the region in 2014, Closed Circuit Gas Turbines contributed a mere 1.3 percent while diesel- and petrol-fired generators contributed 4.8 percent, giving a total contribution by oil and gas of 6.2 percent.

Of the 58 387 MW of electricity generated in the region in 2014, Closed Circuit Gas Turbines contributed a mere 1.3 percent while diesel and petrol fired generators contributed 4.8 percent, giving a total contribution between oil and gas of 6.2 percent.

5.3 Production of Oil and Gas in the SADC Region

The main producers of gas in the SADC region are Angola, Tanzania, DRC and Mozambique. Angola leads the region in deposits of gas and petroleum, while South Africa is rich in shale gas and coal-bed methane gas. The United Republic of Tanzania is emerging as a force in this sector as new discoveries of natural gas continue to be made along its Indian Ocean coast. Mozambique has also seen a rapid expansion of its gas industry since the commissioning of the 865km-long gas pipeline from Pande and Temane gas fields in south-central Mozambique to Sekunda in South Africa by the multinational company SASOL, headquartered in South Africa.

The Rovuma area, in the far north of Mozambique near the Tanzanian border, has seen positive results of natural gas exploration while the Tete Province, with its vast coal deposits, is also home to significant coal-bed methane gas. The Democratic Republic of Congo, and more recently Namibia, have discovered significant reserves of natural gas offshore. Other SADC Member States such as Botswana, Malawi, Zambia and Zimbabwe have large reserves of coal and hence coal-bed methane gas, which has not yet been extracted commercially although extensive pilot tests have been conducted, especially in Botswana and Zimbabwe.

Oil is mainly refined to form petroleum products such as diesel and petrol which are predominantly used in the transport sector and to fire generators in peaking power stations and emergency generators, both industrial and domestic.

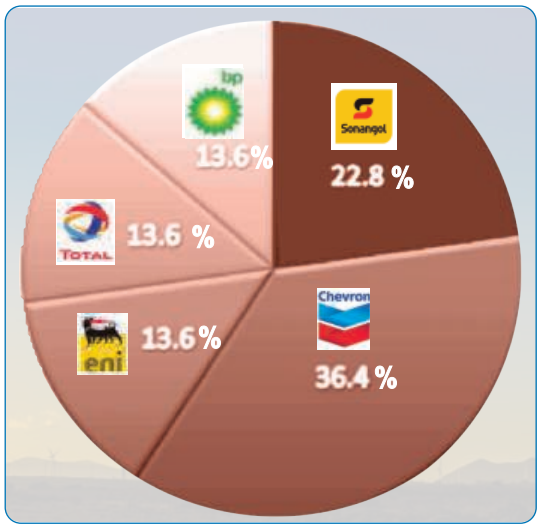
Angola is the only significant oil producer in southern Africa and because of Angola's oil production, the SADC region is a net petroleum exporter. Angola produced an average of 1.25 million barrels of oil per day (bbl/d) in 2005, rising to about 1.7 million barrels per day in 2014. According to the *Oil and Gas Journal,* Angola had proven crude reserves of 5.4 billion barrels in 2006, which constituted 96 percent of the region's total estimated proven crude reserves. Smaller proven reserves are found offshore DRC and South Africa.

Angola's national oil company, Sonangol, established in 1976, works in partnership with various international oil companies through joint ventures and Production Sharing Agreements (PSAs) to produce and supply oil. Although exploration and production of crude oil and natural gas are well developed, the refinery and distribution of the products derived from crude oil remain underdeveloped, resulting in the flaring of nearly 50 percent of the gas.

5.3.1 Unlocking Value

In the absence of a sufficiently large domestic market for gas, Angola is seeking a large-scale opportunity to commercialize associated gas from current and future developments and to commercialize non-associated gas from fields that have already been discovered in the country. The Government of Angola and its national oil company Sonangol consider the opportunity to expand production of Liquefied Natural Gas (LNG) to be of national importance and the cornerstone of its plans to commercialize and develop the country's natural resources and reduce gas flaring. To turn this opportunity into reality, Angola LNG Project was formed - a joint project involving major players in the oil industry as shown below:

Figure 5.1 **Angola LNG Project Structure**



Source Sonangol and US Energy Information Administration, 2015

The proven gas resources in Angola are sufficient to supply a nominal 5.2 million tonnes/year (6.8 billion cubic meters/year) to the LNG plant for over 20 years with natural gas resources of 10.5 trillion cubic feet (297 billion cubic metres) having been identified. Much of Angola's deep and ultra-deep water areas are considered to be highly prospective and remain to be explored. Angola LNG is the major LNG producer with operations in the country.

The region's refineries are concentrated in South Africa, with additional refining capacity located in Angola, Madagascar, Tanzania and Zambia. South Africa is the SADC region's largest oil consumer, accounting for over 68 percent of the region's total consumption, and is the second largest oil consumer in Africa after Egypt. The refineries in Zimbabwe and Tanzania were closed because they were uneconomic to run due to the small size which did not offer economies of scale.

South Africa does not have significant proven oil and gas reserves but produces oil and gas from coal and imported crude oil. The relative under-utilisation of gas is as a result of the abundant coal resources in the country that has allowed South Africa to produce petroleum and by-products as well as electricity cheaply from coal. However, declining coal resources and the relatively high cost of coal-generated electricity and petroleum, in financial and environmental terms, may see South Africa diversifying its energy mix, a process that is already underway (SAOGA, 2015).

While gas has largely been liquefied and exported to Europe, a significant application has been its fast-growing use in cooking and general heating. In recent years, gas-fired power stations have been constructed in Mozambique (2014) and South Africa (2012) by SASOL, thus changing the energy mix, particularly of South Africa, towards a more environmentally friendly combination. The natural gas extraction in Tanzania occurs mainly in the area of Songo Songo Island and the Mnazi Bay area, having started in 2004 and 2006 respectively.

The current barriers or obstacles to increased production and consumption of oil and gas in the SADC region include a lack of exploration to increase the size of proven reserves in producing countries and discover new deposits in the other countries, coupled with a lack of human skills and capacity to explore and extract the gas safely and efficiently, and lack of essential infrastructure such as pipelines, storage and refining facilities.

5.4 Regional Integration Initiatives

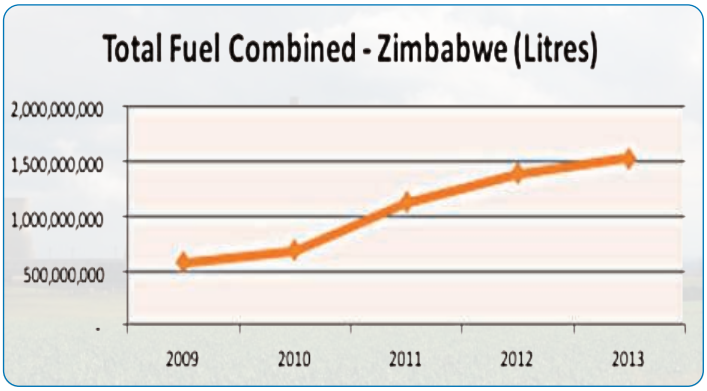
SADC has acknowledged that the limited access to energy is a major constraint to socio-economic development in the region and has set its sights on achieving an energy supply that is adequate, reliable, least cost and environmentally friendly. Regional integration is one way to ensure that the challenge is overcome in a sustainable way to support economic development.

Some efforts have been made in this direction and the 865km pipeline constructed by SASOL from the Pande and Temane gas fields in Mozambique to Secunda in South Africa a decade ago is one example of collaboration between countries in this regard. The project incorporated a Central Processing Facility (CPF) with a capacity of 183 Megajoules per annum (MJ/a), designed to clean and dry the natural gas before pumping it. This development was followed by the commissioning of a 140MW gas-fired power station at Sasolburg in South Africa in 2012 and a 175MW gas-fired power station at Ressano Garcia on the border between Mozambique and South Africa in 2014, which supplies electricity to both countries and is a joint venture between Mozambique (51 percent) and SASOL (49 percent).

Earlier on, the Tazama pipeline had been constructed and continues to operate satisfactorily from the port of Dar es Salaam in Tanzania, delivering crude oil imported offshore to the Indeni refinery in Lusaka, Zambia. Another example is the road and rail infrastructure linking South Africa and Botswana which is used to transport nearly all the petroleum needs of Botswana. Another example of regional integration in this regard is the pipeline from Beira in Mozambique to Msasa in Harare, Zimbabwe, which is managed jointly by the two governments and delivers nearly all the diesel and petrol requirements for Zimbabwe. See Figure 5.2.

In yet other examples of regional integration, the road and rail infrastructure linking South Africa and Botswana is used extensively to transport nearly all the petroleum needs of Botswana.

Figure 5.2 **Combined Petrol and Diesel Imports in Zimbabwe (litres)**



Source International Energy Agency, 2011

5.5 Policies and Regulations

The SADC Energy Protocol and the Regional Infrastructure Development Master Plan - Energy Sector Plan (RIDMP-ESP) (2012) provide the broad goals and guidelines for regional integration in this sector. SADC Member States have national policies that guide their development of this sector, and there is a need for regional policies and regulations to guide integration and coordinate developments and operations, along the lines of the Southern African Power Pool.

Plans are already underway for SADC to establish a Regional Petroleum and Gas Association (REPGA) to promote trade in the respective products. REPGA is also expected to harmonize standards and regulations in the sector, as well as create a common investment destination with harmonized environmental standards and policies. Other objectives of REPGA are to

co-ordinate hydrocarbon exploration activities in the SADC region and to assist in establishing and implementing harmonization of laws, rules, standards and regulations related to the petroleum and gas sector in the region (Mmegi, 2007).

5.6 Trends and Future Plans

The International Energy Agency (IEA) envisages that oil production in the region will see a continued rise led by Angola up to 2027, and start to gradually decline as the reserves become depleted. For gas, the focus for new gas projects is on the east coast, with the huge offshore discoveries in Mozambique and Tanzania which potentially provide a 75 billion cubic metre (bcm) boost to annual regional output (IEA, 2014). It is evident that as exploration progresses, new discoveries are being made especially in the two countries mentioned above, with prospects of a new facility to produce Liquefied Petroleum Gas (LPG) constructed by SASOL and its investment partners, which would substitute much of the 15,000 to 20,000 tonnes/annum that is currently imported at significant cost to Mozambique (SASOL, 2013).

East coast export of Liquefied Natural Gas (LNG) is favoured by relative proximity to the importing markets of Asia, with an estimated $150 billion in fiscal revenue for the period up to 2040 (IEA, 2014). However, both countries are determined to promote domestic and regional markets for gas, which are currently at low base levels. Nearly 50 percent of the gas produced from Angola, however, is flared due to lack of distribution infrastructure such as pipelines and storage facilities, as well as refineries to transform the resource into the form required and deliver it to the SADC market.

5.7 Conclusions and Recommendations

The region has been experiencing energy shortfalls for more than a decade due to growth in demand, forcing most countries to implement Demand Side Management (DSM) programmes such as load shedding. However, these DSM programmes have had a negative impact on production in some cases, and thus a negative impact on economic development. The region's thrust towards industrialization, which was emphatically endorsed during the Extraordinary Summit of SADC Heads of State held in Harare, Zimbabwe in April 2015, may not be realized if the current state of energy deficit is allowed to continue. It is therefore imperative that SADC develops its energy sector to a level where it is not just adequate for its needs, but also that there is excess energy to allow for growth and exports outside the region.

Given the abundance of oil and gas in the region, the relatively low cost of production and distribution compared to other sources of energy, and the attendant carbon emissions in the case of coal-fired power stations, SADC realizes the opportunity to expand this sector through regionally integrated infrastructural development, to give a low-cost energy mix and boost socio-economic development in Member States. In pursuing this goal, it is recommended that efforts be directed towards the following.

- Developing and implementing a regional regulatory framework to manage the development of this sector in terms of pricing, prioritization of projects, and regional integration. An organization that coordinates the development of the gas and oil sector is desirable, similar to the way in which the Southern African Power Pool (SAPP) coordinates the planning, generation, transmission and marketing of electricity.
- Development of infrastructure such as pipelines, storage facilities and refineries, with regional integration as the guiding philosophy. The starting point would be to ensure that the gas which is currently being flared and therefore wasted, in Angola, is put to good use in the region. This would provide some income to Angola while also providing an efficient source of energy to communities around the region that are currently dependent on biomass.
- Capacity building, that is, education and training, and financial support for the Small to Medium Enterprises (SMEs) in the marketing and distribution of gas in safe, environmentally friendly and cost-effective ways.
- Expansion of curricula and educational opportunities at tertiary institutions to include courses in gas and oil extraction, as well as processing to recover by products such as chemicals and pharmaceuticals. It is noted that there are few universities and colleges offering courses in gas and petroleum extraction and applications within the region, and yet there is a requirement for a much expanded skilled and semi-skilled workforce throughout the energy sector, including technical skills as well as skills related to policy, regulation and project management.
- Adopting efficient technologies for energy conversion and/or consumption, such as power generation and direct heating facilities. In general, gas-fired power plants require less time to construct and install, taking between 20 to 30 months, as compared to the 40 to 60 months required for a coal-fired power plant and more than 60 months (five years) for a nuclear power plant (SASOL, 2014).
- Increasing the oil and gas component of the energy mix in the region as a way of reducing carbon emissions and addressing climate change concerns. Approximately 70 percent of the electricity generated in SADC is from coal-fired thermal power stations.
- Attracting the necessary funding from development banks, bilateral or regional assistance. A number of SADC M ember States face difficulty in financing the needed infrastructure, with low domestic savings rates and tax revenues limiting the available pool of domestic finance, and the credit ratings of some countries deterring international investors. In Member States where international oil and gas companies already operate, the new investments can often be financed from retained earnings. However, in many of countries in the region, power generation and transmission projects should typically be sourced more reliably from third party finance such as loans, grants or guarantees.

INVESTMENT AND FUNDING OF ENERGY

6.1 Background

The Energy Sector Plan (ESP) is a component of the SADC Regional Infrastructure Development Master Plan (RIDMP) whose aim is to define regional infrastructure requirements and conditions for the realisation of key infrastructure in the energy, water, transport, tourism, meteorology and telecommunications sectors by 2027. Such infrastructure would enable the SADC region to attain regional integration, economic growth, a nd poverty eradication. This chapter looks at the investment and financing mechanisms for energy in SADC, including available sources of funding for future projects, and focuses on related institutional and policy frameworks that are in place to promote investment in energy.

6.2 Policy and Institutional Framework

Article 3 of the SADC Protocol on Energy sets as one of its objectives the cooperation in the development and utilisation of energy. The cooperation specified in the Protocol covers the following energy subsectors: wood fuel, petroleum and natural gas, electricity, coal, new and renewable energy sources, energy efficiency and conservation, and other crosscutting themes of interest to Member States. The Protocol envisages the establishment of a Commission comprised of the Committees of Ministers and Senior Officials, the Technical Committee, and Sub-Committees set up by the Committee of Ministers.

The Commission was initially established in Angola but was later made part of the Energy Division at the SADC Secretariat in Botswana during restructuring and centralisation. Two pertinent functions of the Commission which are relevant to this chapter, relate to:

- the facilitation of regional energy projects from conceptualisation, initiation, preparation and implementation, monitoring and evaluation; and,
- the mobilisation of finance for implementing SADC energy programmes and projects.

Article 8 of the Protocol also provides for cooperation between the commission and non-state actors including non-governmental organisations, and business and industrial communities, if their objectives are not at variance with the objectives of the Protocol.

The SADC Energy Thematic Group (ETG) was formed on the basis of the Windhoek Declaration but meets the objectives of the Protocol on Energy to facilitate the mobilising of resources to develop sustainable energy sector projects in the region. The ETG is comprised of SADC, International Cooperating Partners (ICPs), the Southern African Power Pool (SAPP), the Regional Energy Regulatory Authority for Southern Africa (RERA), and the Southern African Research and Documentation Centre (SARDC) as the knowledge partner.

Over the years, a number of regional development plans have been put in place by SADC to spur development in the energy sector. These include the SADC Energy Cooperation Policy and Strategy (1996), the SADC Energy Action Plan (1997), the SADC Energy Activity Plan (2000) and the Energy Sector Plan (2012).

These plans show the intent of the region to develop the energy sector. By their nature, most of the energy sector projects have long lead times in terms of their planning and execution. The lack of resources has at times caused delays in the implementation of projects, and this has resulted in costs escalations, leading to further stalling of project implementation. The bulk of the projects in the energy sector are within the electricity sub-sector, as indicated previously.

6.3 Sources of Finance

The ESP expects the exploitation of the various investment and financing options that exist. The conventional source of funding for infrastructure in the Member States is public funding in the form of national budgets and this is considered important in delivering the needed energy infrastructure, including both "hard" and "soft" types.

Private sector participation in various forms is a feasible method of financing large infrastructure projects. This participation may take different forms such as – Build-Operate-Transfer (BOT), Build-Own-Operate (BOO), Build-Own-Operate-and-Transfer (BOOT), or Public Private Partnerships (PPP). These sources qualify for all the energy sub-sectors.

Infrastructure bonds and pension funds have been mobilised recently to finance infrastructure projects or leverage more financing from other sources, including but not only, commercial banks or multilateral banks such as the European Investment Bank, World Bank and African Development Bank (AfDB). Utilities should also use their balance sheets to borrow from the banks for their equity share.

Close cooperation with the emerging economies of China, India and Brazil will also yield new financial resources. Following the SADC China Infrastructure Investment Seminar held in Beijing in July 2015, Chinese investors and financiers expressed interest in various SADC infrastructure projects in the areas of power generation, power transmission and interconnectors; and water infrastructure development relating to water supply and hydro-generation as well irrigation and related projects. The China Exim Bank is already supporting a number of energy projects in SADC Member States, and has expressed willingness to focus on a number of areas going into the future, among them, financing solutions for power, including green energy development.

ICPs have been a major source of financing for "soft" projects such as studies, formulation of policy/regulatory frameworks, planning and capacity-building. Their resources can also be used to leverage financing from banks. The soft projects need to be implemented in the short term to facilitate implementation of the physical projects. The costs of implementing these strategic options will be determined on a case-by-case basis.

The Programme for Infrastructure Development in Africa (PIDA) estimates its project preparation costs at about 7 percent of the investment

costs, which collectively would cost about US$18 billion when all the estimated projects are to be prepared for funding. PIDA is a blueprint for African infrastructure transformation for the period 2012-2040. The programme was adopted by African leaders in January 2012 and provides a strategic framework for priority infrastructure projects expected to transform the continent into an interconnected and integrated region.

Project preparation can be coordinated through a project development fund such as the New Partnership for Africa's Development (NEPAD) Infrastructure Project Preparation Fund, or with support from the Development Bank of Southern Africa (DBSA). Tapping into climate funds should be considered and therefore capacity developed to access innovative financing mechanisms.

Other sources of financing for development in SADC are: Public finance, Official Development Assistance (ODA), debt relief, domestic savings, Foreign Direct Investment (FDI) and portfolio investment, Development Finance Investment (DFI) and the DFI network.

In the 1990s, most infrastructure projects in Africa were financed from public funds with some concessionary loans coming from development finance institutions. However, due to lack of funding and poor performance by some state enterprises, governments started looking at alternative financing models, including PPPs.

The World Bank estimates that between 1990 and 2004, Sub-Saharan Africa attracted an average of just US$2.6 billion annually in total investment for infrastructure projects with private participation. The data indicates that Africa ranks last among developing regions in investment flows to such projects, with US$39.4 billion invested in the period 1990-2004, lagging behind investment in other developing regions such as Latin America (US$391 billion) and East Asia (US$199 billion). South Africa accounted for about half of the flows to Africa in 1990-2004 with an amount of US$19 billion. Mobile telephony accounted for more than half of the investment flows into infrastructure projects. It is notable, however, that public and private sector investment from China has grown exponentially in the period since 2004, with particular focus on infrastructure development, which was identified as a priority by the African Union and the Regional Economic Communities (RECs).

Private investment is emerging as a significant source of funding within the energy sector particularly for renewable energy projects. The World Bank tracks private participation in infrastructure projects through its Private Participation in Infrastructure (PPI) Project Database. The database tracks and captures the publicly available information on private participation in infrastructure projects.

Appendix A (at the end of this report) maps the trend in private participation in energy sector projects within the individual SADC Member States from 1990 to 2015. The investment has been mainly in the electricity subsector. There was not much activity in the decade 1990 to 2000, but the activity picked up from the year 2000, with South Africa dominating private sector participation in energy projects and most projects being in the renewable energy sector, with solar and wind power projects dominating.

The figures in Appendix A are a mirror of the low levels of investment in the energy sector within the SADC region. Some reasons for this lack

of investment relate to poor public sector management and lack of fiscal reforms. There was also lack of skills to execute some of the basic tenets of project design, including the identification and allocation of risk, and ensuring sound procurement practices. There was also lack of financial resources at both the regional and national levels to support such projects.

The rise in investment in the energy sector from the year 2000 reflects on public sector management reforms undertaken by most governments in the region. These have in most cases been accompanied by improvements in the business environment to attract both domestic and foreign investment. At regional level, SADC has shown a keen interest in establishing the project preparation unit to ensure that there is sufficient time and money put into the planning of projects within the infrastructure sector.

SADC is also working closely with the Development Bank of Southern Africa (DBSA) with which it has signed a Memorandum of Understanding (MoU). The MoU operationalises the SADC Project Preparation and Development Facility (PPDF) and clarifies the principles, roles and functional areas of cooperation between the SADC Secretariat and the DBSA.

The SADC PPDF was established within the context of the Regional Development Fund and as an instrument to finance regional cooperation and integration projects. The PPDF is expected to increase throughput for viable regional infrastructure projects and unleash abundant project capital available in the region by developing capacity for project identification, preparation and development. This will ensure that projects are bankable and attractive to investors, and thereby contribute to the enhancement of the state of infrastructure in the region.

6.4 Sectors Status

6.4.1 Electricity

The SADC region has faced an electricity deficit since the turn of the 21st century, as noted in Chapter 3, and this was initially expected to be resolved by 2014 if the planned projects had been implemented on time. Investments and financing were hampered by a number of barriers, including non-profitable tariffs, poor project preparation, no off-takers who can sign Power Purchasing Agreements (PPAs) under single buyer models, and other required policy/regulatory frameworks.

The largest investments within the energy sector tend to be in the electricity sub-sector where significant amounts are required for investment in generation plant and associated transmission equipment. Multilateral development banks tend to be the main providers of funding for such projects, working in partnership with local development banks or other bilateral sources of finance.

An example is the financing of infrastructure development in Africa which has the AfDB as the executing agency for the Programme for Infrastructure Development in Africa (PIDA), which is an initiative of African Union Commission (AUC) and also supported by NEPAD. The Priority Action Plan for PIDA has 51 priority infrastructure backbone projects and programmes in energy, water, transport and ICT that will need to be funded in the amount of US$68 billion by 2020.

Table 6.1 Investments and Grants in the Energy Sector at Regional Level

Funder	Project Description
Transmission Projects	
Government of Norway, AfDB, DBSA, AFD	**Zimbabwe-Zambia-Botswana-Namibia (ZIZABONA) Transmission Line –** A project to decongest the central transmission corridor that passes through Zimbabwe. The line has capacity to carry an additional 200MW in Phase 1 and 400MW in Phase 2. Estimated to cost is US$225 million
DBSA	**Mozambique-Zimbabwe-South Africa (MOZISA) Interconnector –** Part A: A 320km transmission line from Triangle in Zimbabwe to Nzehelele in South Africa Part B: A 230km transmission line from Orange Grove in Zimbabwe to Inchope in Mozambique
World Bank	**Mozambique-Malawi Interconnector –** A project to increase access to diversified, reliable, affordable supply of energy and to expand the opportunities of Malawi and Mozambique to benefit from bilateral and regional power trading through the SAPP. Estimated cost is US$109.7 million
TBA	**Zimbabwe Central Transmission Corridor –** Transmission lines for the project are the Bindura- Mutorashanga line, Alaska-Sherwood line and Orange Grove-Triangle line. Estimated cost is US$100 million
Government of Norway leading other ICPs	**Mozambique Transmission Backbone Project –** A project to connect north and south Mozambique with sufficient transmission capacity and to reach other members of SADC, in particular South Africa. Estimated cost is US$1700 million
World Bank, AfDB, JICA	**Zambia-Tanzania-Kenya Interconnector –** A project to connect the Zambian grid to Kenya, via Tanzania, covering a distance of 2206km depending on final routing. Estimated cost is US$1116 million
Energy Conservation	
GTZ	**Programme on Basic Energy Conservation (ProBEC) –** The project, which ended in 2010, focused on energy security and supply for low-income households and improved energy solutions through market development and policy support. Various energy conservation projects were undertaken in Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Namibia and Zambia.
Climate Change	
ICPs led by Embassy of Norway in Maputo	**Clean Development Mechanism (CDM) Programme of Action –** A number of projects have benefited from this initiative in South Africa, Tanzania, DRC, Madagascar, Mauritius and Mozambique.
Renewable Energy	
Government of Finland	**Energy and Environment Partnership (EEP) Programme with East and Southern Africa –** This project covered studies for all renewable energy sources such as solar, mini-hydro (15MW or below), wind, geothermal and bio-diesel as well as energy efficiency.
UNIDO, ADA	**SADC Centre for Renewable Energy and Energy Efficiency (SACREEE) –** The Centre aims to promote market-based adoption of renewable energy and energy efficiency technologies and services in SADC Member States, and is based in Namibia.
World Bank	**Funding of Studies for the Development of Large Scale Sustainable Energy Projects in Southern Africa –** US$20 million is availed through an International Development Association (IDA) grant.
SAPP Projects	
Governments of Norway and Sweden	**Day Ahead Market (DAM)** allows SAPP member utilities to sell surplus electricity to others and is administered by the SAPP Coordination Centre in Harare, Zimbabwe.
World Bank	**Project Advisory Unit for SAPP** is to be set up in Johannesburg, South Africa to provide advice on project implementation.

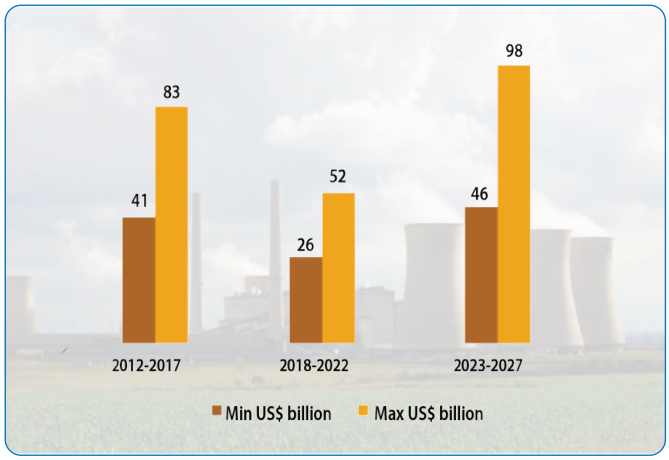
Source Compiled from SADC Energy Thematic Group reports and SAPP reports 2012-2015

The energy sector accounts for 60 percent or US$40.3 billion of this amount. Most of the projects are within the electricity sub-sector and relate to investment in generation plant and transmission infrastructure. The size of the investments required a call for syndication by a number of financiers to enable them to share the associated risks.

A number of projects have been undertaken at regional level to address the challenges faced by the energy sector within SADC Member States. Table 6.1 summarises some of these investments.

The SADC Energy Sector Plan estimates the total cost of additional electricity generation capacity to be in the range of US$114 billion to US$233 billion. The related transmission investment costs to support new generation capacity are about US$540 million. This transmission investment does not include planned transmission interconnectors and national backbone lines. Figure 6.1 shows the minimum and maximum investment needed from 2012-2027, based on the SADC/SAPP generation and transmission projects, using a SAPP agreed criteria.

Figure 6.1 **Estimated Investment Costs for Generation Projects in SAPP and RSA Integrated Resource Plan**



Source SADC Energy Sector Plan, 2012

Table 6.2 provides a list of electricity generation projects that have been prioritised under the SADC Regional Infrastructure Development Master Plan, using the SAPP prioritisation criteria. Other projects which are at the level of Member States are not included on this list as the focus is on projects of a regional nature.

SADC's plan is to increase the share of renewable energy in the grid to 21 percent by 2017, 33 percent by 2022, and 37 percent by

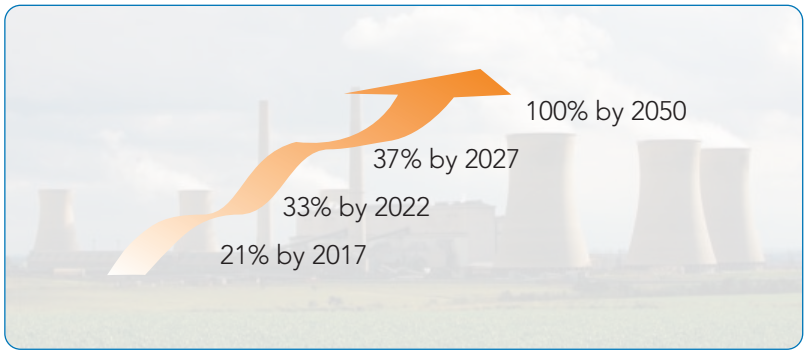
Table 6.2 **SAPP Priority Generation Projects**

Priority Ranking	Country	Project Name	Capacity [MW]	Technology	Expected Commissioning Date
1	Mozambique	HCB North Bank	1 245	Hydro	2015
2	Mozambique	Mphanda Nkuwa	1 500	Hydro	2017
3	Zambia/Zimbabwe	Batoka	1 600	Hydro	2022
4	DRC	Inga 3	4 320	Hydro	2018
5	Zimbabwe	Gokwe North	1 400	Coal	2017
6	South Africa	New PF + FBC	6 250	Coal	2026
7	South Africa	Nuclear	9 600	Nuclear	2023
Total			**25 915**		

Source SADC Energy Sector Plan

2027, in pursuit of the goal of 100 percent renewable energy by 2050, as illustrated in Figure 6.2.

Figure 6.2 **Increase in Share of Renewable Energy in the Grid**



Source SADC

6.4.2 Coal

The coal industry is the backbone of power generation in the region and a significant share of the resource is earmarked for export. Coal exports are an opportunity that can yield economic benefits to the region if carefully planned so not to prejudice the local demand. Both mining and transport infrastructure are needed for coal redistribution and export.

However, as the world is fast running out of traditional energy sources and slowly embracing the use of renewable energy services and sources, the overall share of coal in the SADC energy generation mix is being diluted. For example, the total installed hydro capacity has increased from about 52,000MW to 58,000MW between 2004 and 2013, while coal's contribution has remained somewhat constant at around 40,000MW.

6.4.3 Nuclear

Nuclear technology is included in the electricity sub-sector but what is required is to demonstrate that nuclear can be a safe electricity generation option and winning the confidence of civil society and governments to endorse nuclear energy deployment in the SADC region. It was proposed at a stakeholder meeting on in May 2012 that sections on nuclear energy, energy efficiency and climate change should be included in the ESP. Because of its experience in this area, South Africa is the only SADC Member State that can easily negotiate the development and financing of nuclear power plants.

6.4.4 Renewable Energy

The region has a large potential renewable energy estimate including hydropower, which is currently being exploited on a commercial scale. However, the necessary infrastructure for grid connection, manufacturing and quality testing for other renewable energy is lacking. The prices for most renewable energy technologies are coming down but more needs to be done in the form of innovative financing.

6.4.5 Petroleum and Gas

The petroleum and gas sub-sector is plagued by volatile prices and although the region is endowed with some petroleum and gas resources, these are not directly available to the region, either due to external commitments or the lack of necessary infrastructure to exploit, process, store and distribute throughout the region.

6.5 Investment Requirements

6.5.1 Electricity

Some investment costs have been estimated for all the planned generation p rojects by considering the known minimum and maximum estimated investment costs per kW.

SADC/SAPP has prioritised some generation and transmission projects using a SAPP agreed criteria. For example, generation projects that scored above 50 percent with capacity greater than 1000MW were estimated in this study to cost a minimum of US$65 billion and a maximum of US$104 billion. Those projects that scored above 50 percent with a capacity of less than 1000MW were estimated to cost a minimum of US$7 billion and a maximum of US$18 billion. The total cost of the prioritised projects (>50 percent score) would range from US$42 billion to US$122 billion. The planned projects that were below a 50 percent score of various sizes would cost a minimum of US$50 billion and a maximum of US$90 billion. The grand total of all these projects to be implemented from 2015 to 2027 would cost in the magnitude of US$93 billion to US$212 billion, which is close to the budget for all the planned projects (Table 6.3).

Table 6.3 SAPP Prioritised Projects 2015 - 2027

Generation Projects	Minimum US$ Million	Maximum US$ Million	Period
>50% and capacity>1000MW	4 845	12 155	2017
	5 920	17 760	2022
	24 735	74 140	2027
Subtotal	35 500	104 055	2015-2027
>50% and capacity<1000MW	5 134	12 251	2017
	1 305	3 915	2022
	543	1 629	2027
Subtotal	6 982	17 795	2015-2027
Total>50%	42 482	121 850	2015-2027
<50% score	50 392	89 964	2015-2027
Grand Total	**92 873**	**211 814**	2015-2027

Source RIDMP, 2012

SAPP has identified 11 priority transmission projects but only five have been costed, totalling about US$3 billion. The projects are ZIZABONA (Zimbabwe-Zambia-Botswana-Namibia) at US$225 million; Zimbabwe Central Transmission Corridor at US$100 million; Zambia-Tanzania-Kenya Interconnector at US$860 million; and Mozambique Transmission Backbone Project at US$1.7 billion.

6.5.2 Renewable Energy

Outside the big hydroelectric projects, a study by the International Renewable Energy Agency (IRENA) indicates that renewable energy projects in most developing countries are mainly funded by governments, banks, equity firms, insurance companies, pension funds, industry bodies, clean energy companies, and start-up project developers.

The study notes that different types of investors will provide funding depending on the type of business, the stage of technology development, and the degree of associated risk. The banks will generally provide debt financing while equity funding is provided by infrastructure and pension funds. National development banks provide the bulk of the renewable energy funding and MDBs also come in to either fund projects directly or partner with local banks. The SAPP priority projects include renewable energy projects that are to be connected to the grid.

6.5.3 Petroleum and Gas

In the petroleum and gas sector, new refineries are anticipated to be set up in South Africa, Mozambique and Angola with estimated investment costs in the range of US$1 billion to US$5 billion based on global investment costs per bbl/day. More detailed studies will need to be undertaken to refine the costs estimates.

6.5.4 Energy Efficiency

At a regional level, energy efficiency is being promoted through the implementation of the concept of the Demand Side Power Station (DSPS) promoted by SAPP. The virtual power station is comprised of Compact Fluorescent Lamps (CFLs), Solar Water Heaters (SWH), Commercial Lighting (CL) and Hot Water Load Control (HWLC).

According to the *SAPP Sustainability Bulletin (Vol 4 No 4, January 2011),* the DSPS initiative looks at realising 4,500 MW by 2016 in terms of power savings. The attainment of this target is hinged on SAPP members promoting policies that facilitate a reduction of electricity usage in the home, switching to energy efficient lighting, improving the efficiency of home appliances, buying energy efficient appliances, reducing energy needed for heating, reducing energy needed for cooling, turning to renewable energy technologies, and recycling air-conditioner coolant.

Projects in the energy efficiency sub-sector relate to legal/regulatory frameworks to ensure sustainable development of projects, creating incentives and energy management schemes and capacity building. Climate change projects relate to development of low carbon emission development projects and the development of a climate change impact-monitoring framework and related adaptation measures on the energy resources and infrastructure.

6.5.5 Climate Change

Projects proposed under climate change relate to developing a Low Carbon development path, for example, by ensuring that clean energy projects benefit from carbon revenue. Another project is developing a climate change impact-monitoring framework and related adaptation measures on the energy resources and infrastructure. The low-carbon development path, and impact assessment and adaptation frameworks, ought to be in national development plans in order to be implemented.

6.6 Conclusions

The energy sector in the SADC region still faces a number of problems with respect to investment and funding of energy, and the major challenges encountered are as follows

- Member States' commitment to support regional initiatives and to allocate resources for that purpose;
- Capacity for project preparation and implementation at the level of national utilities and Member States;
- Demand for energy services to sustain growth in the energy sector;
- Financial sustainability for continued sectoral development;

- Strength of SADC institutions to co-ordinate the energy sector activities in the region; and
- Updating of the plans to ensure that the ESP remains relevant to the circumstances of the time.

Investment and financing are hampered by a number of barriers, which include low tariffs, poor project preparation, no off-takers that can sign PPAs under single buyer models, and other required policy/regulatory frameworks.

6.7 Recommendations

SADC Member States need to address the following issues and challenges.

- The "regional project" concept needs to be clarified, and there is a need for the development of a framework for the coordination, implementation, championing and financing of such projects.
- Creation of an enabling environment for investment is essential at both the regional and national levels as potential investors look for stability, sustainability and returns.
- There is need for new strategic approaches to regional cooperation with a clear regional financing framework to raise funds for project implementation. This should result in coordinated approaches to fundraising at regional, national and utility levels.
- Promotion of private sector participation in renewable energy projects is needed, considering the drop in cost of renewable energy technologies.
- There are limited alternatives to achieve financial closure, as most utilities and IPPs are expecting Eskom to sign PPAs for their regional projects.
- The inability of national utilities to raise equity for projects is a challenge, as the regional projects are owned by utilities.
- Access to long-term funds and development of a diversity of funds can be achieved through innovative credit structures and co-financing arrangements.
- The investment base must be widened by increasing the level of local currency liquidity.
- The credit rating of all utilities must be enhanced to enable borrowing for their project equity share.

TRENDS AND SCENARIOS

This chapter discusses the key trends in the various sub-sectors and possible scenarios in the event that the region takes action to address the issues raised or it adopts a business-as-usual approach. This is crucial in flagging the key issues that the region should focus on as it moves to ensure that energy plays its role as a "key enabler" for socio-economic development.

For energy demand projections to 2027, three scenarios are presented:

1. ***SADC economy develops at three percent, which is considered to be the current expected rate of growth.***
2. ***SADC economy grows at 5-6 percent, if its potential is not constrained.***
3. ***The economy should grow at 7-8 percent if the region is to eradicate poverty and achieve the RISDP targets and the new Sustainable Development Goals (SDGs).***

Projections for energy demand for electricity, petroleum and gas, coal and RE were therefore calculated at three, five and eight percent, and the expected infrastructure requirements estimated. All scenarios were taken forward to guide the necessary preparedness that is required should the region grow at these growth rates, without selecting one scenario, as to do so is to presume a particular growth rate.

Indications are that SADC has sufficiently planned to meet energy demand for the three percent growth rate but additional preparedness is required if the regional economy is to grow at five or eight percent. For electricity, where there is an existing regional plan, the deficit was measured with respect to the planned projects as stipulated in the SAPP Plan and country Integrated Resource Plans (IRPs).

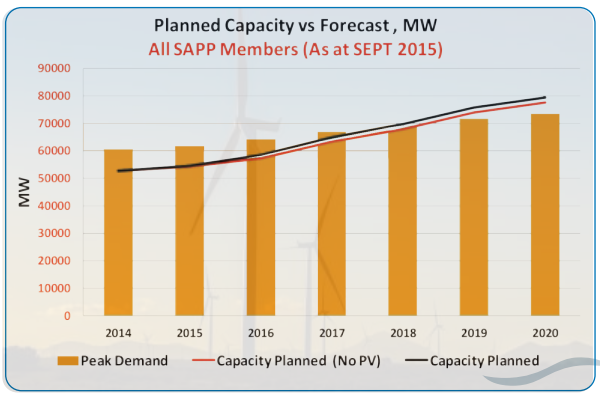
7.1 Electricity

The SADC Regional Infrastructure Development Master Plan highlights some key issues that impact on the energy sector in the region. Below we discuss these key issues/trends for the electricity sub-sector.

7.1.1 Electricity Deficit

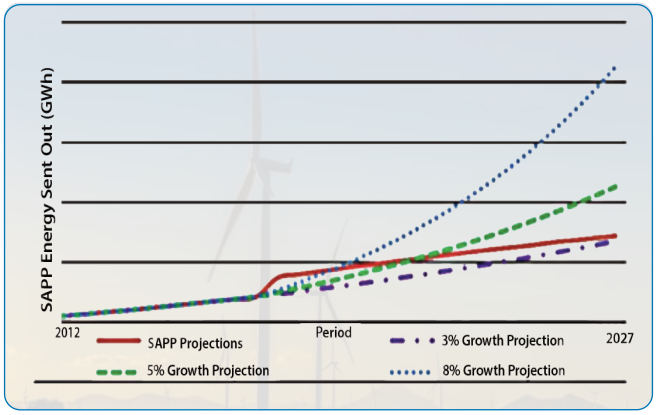
One of the topical issues is that the SADC region faces an electricity deficit which was, at the time of drafting of the infrastructure master plan, expected to be met by 2014 if all planned projects were implemented on time. However, experience has shown that there is often a lag in the implementation of planned projects. As a result, the target of achieving equilibrium between electricity supply and demand by 2014 was missed and has since been moved to 2019 (Figure 7.1).

Figure 7.1 **Planned Capacity versus Forecast, MW**



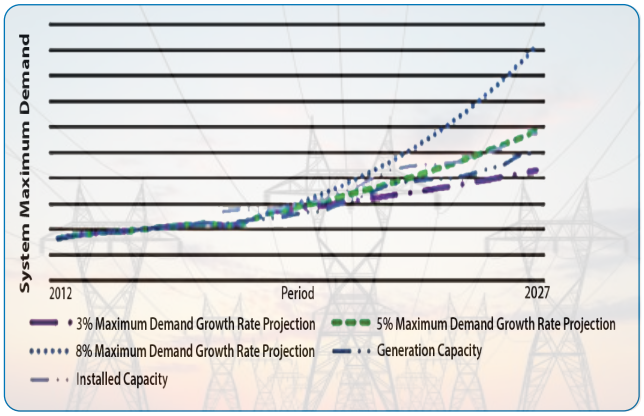
Source SAPP, September 2015

Figure 7.2 **SAPP Electricity Energy Sent Out Projection**



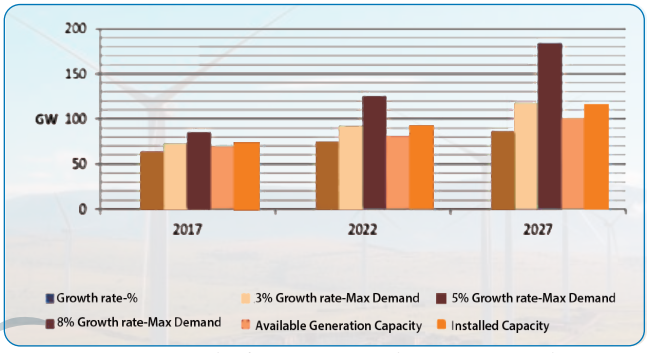
Source SADC Regional Infrastructure Development Master Plan, 2012

Figure 7.3 **SAPP Grid Electricity Demand versus Electricity Capacity Generation Projection**



Source SADC Regional Infrastructure Development Master Plan, 2012

Figure 7.4 **Supply-Demand Situation for the Electricity Sub-Sector**



Source SADC Regional Infrastructure Development Master Plan, 2012

Figure 7.2 shows that at the current growth rate of about three percent, the electricity sent out (a proxy for demand) would grow to as much as 500,000 Gigawatt hours (GWh) by 2027. However, projected electricity sent out at the higher growth rates of five and eight percent show a potential increase of as much as 650,000 GWh and above one million GWh, respectively. By considering the current regional supply situation, characterised by supply deficits and the drive to increase the region's electricity access, it is likely that the electricity sent out will grow at a rate of five to eight percent if all the regional plans are implemented successfully.

The Master Plan notes that planned generation capacity in SADC will be adequate if the maximum demand grows at a rate of three percent up to 2027, in line with the SAPP scenario. However, this requires planning for suppressed demand if the region is to meet its energy access and economic development objectives.

Projections indicate that if the SADC economy and electricity demand grow at five or eight percent, the planned generation capacity will never meet the maximum demand, inclusive of the 10 percent reserve margin, in 2017, 2022 and 2027. The installed capacity will be slightly higher for the five percent growth rate in 2017 and 2022 (Figure 7.4). In 2027, the installed capacity will also be lower than the maximum demand for the five percent growth rate.

In terms of the generation mix, projections are that beyond 2022, the supply scenario will be such that fossil fuels will be reaching a plateau and renewable energy such as hydro, wind, solar and co-generation, and to some extent nuclear, will be increasing (Figure 7.5). Any shortfall at that stage should be looking at additional renewable generation to meet the deficit that is in line with the global trend, without over-depending on one type of energy source.

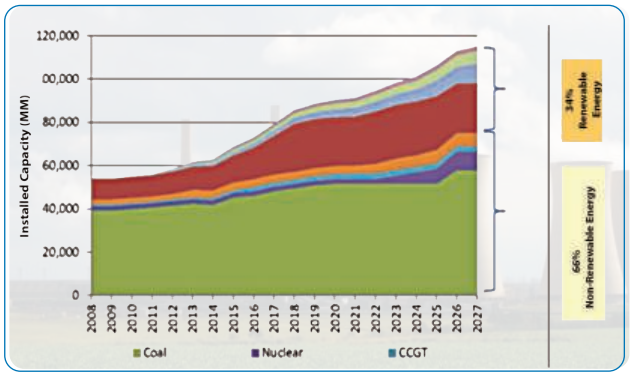
According to the RIDMP, assuming average economic growth rate of eight percent per annum, the forecast peak load is expected to rise to more than 77,000MW by 2020 and to over 115,000MW in 2030. With total peak demand plus reserves of more than

55,000MW as of September 2015 (the figure drops to about 52,000MW when only SAPP operating members are considered), the region will have to invest in new generation capacity to add up to 25,000MW to meet rising demand.

As shown in Table 7.1, SAPP members have planned to add an additional 24,000MW between 2015 and 2019 in order to meet the deficit and become self-sufficient. A number of generation and transmission projects are planned over the period but the big question is whether this new target of equilibrium by 2019 is feasible, considering that most of the planned projects are either at pre-feasibility or feasibility stages.

Based on the peak load estimate mentioned above, the SADC region will need to invest in 40,000MW additional capacity in the decade from 2020 and 2030 if it is to ensure supply matches demand. This calls for concerted efforts by Member States to ensure that the 35 generation projects and 12 transmission projects identified in the RIDMP as priority between 2015 and 2027 are implemented. Top priority generation projects are those with capacity of more than 1,000MW (Table 7.2).

Figure 7.5 **SAPP Grid Electricity Generation Energy Mix**



Source SADC Regional Infrastructure Development Master Plan, 2012

Table 7.1 **Planned Generation Projects 2015-2019**

	Committed Generation Capacity, MW					
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
Angola	50	780	2 571	200	-	3 601
Botswana	-	30	90	364	-	484
DRC	430	-	150	-	-	580
Lesotho	-	-	-	-	-	-
Malawi	-	20	36	94	300	450
Mozambique	-	140	-	400	300	840
Namibia	-	15	-	-	800	815
South Africa	1 479	2 486	2 596	1 445	2 169	10 175
Swaziland	-	-	-	-	12	12
Tanzania	150	-	900	1 440	250	2,340
Zambia	145	300	15	113	1 090	1 663
Zimbabwe	15	-	120	1 230	1 200	2 625
TOTAL	**2 269**	**3 771**	**6 478**	**4 886**	**6 181**	**23 585**

Source SAPP, September 2015

Table 7.2 **SAPP Priority Generation Projects (Capacity >1,000MW)**

Priority Ranking	Country	Project Name	Capacity [MW]	Technology	Expected Commissioning Date
1	Mozambique	HCB North Bank	1 245	Hydro	2015
2	Mozambique	Mphanda Nkuwa	1 500	Hydro	2017
3	Zambia/Zimbabwe	Batoka	1 600	Hydro	2022
4	DRC	Inga 3	4 320	Hydro	2018
5	Zimbabwe	Gokwe North	1 400	Coal	2017
6	South Africa	Pulverised Fuel (PF) & Fluidised Bed Combustion (FBC) plant	6 250	Coal	2026
7	South Africa	Nuclear	9 600	Nuclear	2023
Total			**25 915**		

Source SADC Regional Infrastructure Development Master Plan, 2012

If all goes according to plan, these top priority projects are expected to add close to 26,000MW to the regional power grid between 2015 and 2026. Successful implementation of these eight projects could be a game changer for SADC, given the sheer size of the envisaged plants and their contribution to total generation capacity. Failure to see closure to these projects could perpetuate the region's electricity problems.

The region is also supposed to implement a second tier of priority projects over the planning horizon, as identified in the RIDMP. With a capacity below 1,000MW, the 18 projects should add 6,481MW to the regional grid between 2015 and 2019 (Table 7.3). The region is already doing well in this regard, given that its target of projects for commissioning between 2015 and 2019 is about 23,600MW, as mentioned previously. Implementation of these short-term projects is crucial in ensuring that the rest of the SAPP Plan remains on course.

Table 7.4 gives a list of 10 priority integrated resource generation projects that are planned between 2015 and 2027 by SAPP utilities. Should these projects come to fruition, the regional grid would have additional generation capacity of 23,220MW.

Table 7.3 **SAPP Priority Generation Projects (Capacity <1,000MW)**

Priority Ranking	Country	Project Name	Capacity (MW)	Technology	Expected Commissioning Date
1	Zimbabwe	Kariba South Extension	300	Hydro	2016
2	Namibia	Kudu	800	Gas	2016
3	Botswana	Morupule 5 and 6	300	Coal	2015
4	Namibia	Baynes	360	Hydro	2018
5	Mozambique	Benga	600	Coal	2015
6	Zimbabwe	Hwange 7 and 8	600	Coal	2015
7	Zambia	Lunsemfwa Lower	255	Hydro	2016
8	DRC	Busanga	240	Hydro	2016
9	Zambia	Kalungwishi	220	Hydro	2016
10	DRC	Zongo 2	120	Hydro	2016
11	Tanzania	Kiwira	200	Coal	2015
12	Tanzania	Kinyerezi	240	Gas	2015
13	Tanzania	Rumakali	520	Hydro	2018
14	Mozambique	Moatize	300	Coal	2015
15	Zambia	Mambilima Falls Site 1 & 2	425	Hydro	2019
16	Zambia	Mpata Gorge	543	Hydro	2023
17	Malawi	Lower Fufu	100	Hydro	2015
18	Tanzania	Ruhudji	358	Hydro	2017
Total			**6 481**		

Source SADC Regional Infrastructure Development Master Plan, 2012

Table 7.4 **SAPP Utility Integrated Resource Plan Generation Projects**

Priority Ranking	Country	Project Name	Capacity (MW)	Technology
1	Lesotho	Kobong Pumped Storage	1 200	Hydro
2	Zambia	Devils Gorge	500	Hydro
3	Malawi	Mpatamanga	260	Hydro
4	Malawi/Tanzania	Songwe	340	Hydro
5	Malawi	Kholombizo	240	Hydro
6	South Africa	OCGT	2 370	Gas
7	South Africa	CCGT Gas	3 910	Gas
8	South Africa	Wind	7 200	Wind
9	South Africa	Solar PV	6 900	Solar
10	Zimbabwe	Lupane	300	Gas
Total			**23 220**	

Source SADC Regional Infrastructure Development Master Plan, 2012

7.1.2 Low Access Levels

The SADC region has a low access to electricity of less than 30 percent, much lower than other Regional Economic Communities (RECs) in Africa, as mentioned in Chapter 3. To ensure electricity self-sufficiency and improve access, a total of 12 transmission and interconnector projects are included in the planning horizon, according to the RIDMP. As shown in Table 7.5, four of these projects are expected to decongest the power grid in the region and allow for greater trade in power among interconnected member states.

Implementation of all these projects has however been delayed or missed the target dates due to a combination of administrative and technical issues. It is imperative that they are implemented as a matter of urgency to complement efforts to strengthen the generation capacity. Simply put, failure to decongest the existing transmission infrastructure would negate efforts to boost generation capacity in the region.

Table 7.5 **Transmission Projects to Relieve Congestion**

No.	Project Name	Countries	Capacity (MW)	Expected Date
1	ZIZABONA	Zimbabwe, Zambia, Botswana, Namibia	600	2014
2	Central Transmission Corridor	Zimbabwe	300	2013
3	Kafue–Livingstone Upgrade	Zambia	600	2014
4	North West Upgrade	Botswana	600	2014

Source SADC Regional Infrastructure Development Master Plan, 2012

The Central Transmission Corridor (CTC) that passes through Zimbabwe and Zambia is particularly important for the region, given that Zimbabwe's electricity network is interconnected to all its neighbours and, therefore, acts as a conduit for the rest of the region. Most SAPP utilities have power supply contracts that use or need to use the Zimbabwe transmission network for power wheeling purposes.

The ZIZABONA interconnector project is equally important as it will allow the four countries involved (Zimbabwe, Zambia, Botswana and Namibia) to export or import more power and to trade energy with each other and with the wider SAPP area (South Africa in particular), in addition to easing congestion on North-South transmission corridor through Zimbabwe to South Africa.

The same urgency is needed for implementation of transmission projects that have been identified to bring on board non-operating SAPP Member States such as Angola, Malawi and Tanzania (Table 7.6). Unless these are brought on board, interconnected SAPP Member States will continue not benefitting from power generated in the three countries, and vice versa.

Another important area of focus in the planning horizon should be implementation of interconnector projects to bring in new generation capacity to the SAPP grid. These include the Mozambique Backbone Project initially set for completion in 2017 and now expected to be commissioned in 2021. There is also the second interconnector between Mozambique and Zimbabwe, the 2nd interconnector linking the South African and Zimbabwean electricity systems, and a second transmission line between the DRC and Zambia.

Table 7.6 **Transmission Projects to Interconnect Non-Operating SAPP Members**

No.	Project Name	Countries	Capacity (MW)	Expected Date
1	Zambia-Tanzania	Zambia, Tanzania	400	2016
2	Mozambique-Malawi	Malawi, Mozambique	300	2015
3	Namibia-Angola	Angola, Namibia	400	2016
4	DRC-Angola	Angola, DRC	600	2016

Source SADC Regional Infrastructure Development Master Plan, 2012

Table 7.7 **Transmission Projects Associated with New Generation**

No.	Project Name	Countries	Capacity [MW]	Expected Date
1	Mozambique Backbone	Mozambique	3 100	2017
2	2nd Mozambique-Zimbabwe	Mozambique, Zimbabwe	500	2017
3	2nd Zimbabwe-South Africa	South Africa, Zimbabwe	650	2017
4	2nd DRC-Zambia	DRC, Zambia	500	2017

Source SADC Regional Infrastructure Development Master Plan, 2012

7.1.3 Cost-reflective Tariffs

Tariff viability is a hotly contested area. Naturally, investors want user tariffs that can justify a reasonable return on their investment. On the other hand, most governments want user tariffs that are affordable and can ensure access for as many citizens as possible. The challenge, therefore, is how to strike a balance between these competing interests. Recent studies commissioned by SAPP and RERA have concurred that power tariffs throughout the region are below the combined real cost of generation, transmission and distribution and, therefore cannot sustain the power supply industry, provide the right signals for investment, and encourage efficiency.

SADC Council of Ministers, meeting in Zambia in February 2008, resolved that Member States should endeavour to reach cost-reflective tariffs within a period of five years, i.e. by 2013. However, only two countries have so far reached cost-reflective tariffs – Namibia and Tanzania.

The slow pace of migration towards cost-reflective tariffs will continue to be one of the impediments to development of new power projects in the SADC region. Combined with the absence of a defined feed-in-tariff mechanism to promote renewable energy technologies, low tariffs are expected to remain a stumbling block for the entry of independent power producers into the sector as well as regular maintenance of existing power infrastructure. This calls for political will to ensure that the region attains cost-reflective tariffs and ultimately energy self-sufficiency.

7.1.4 Financing of Power Projects

Financing of power projects is one of the main factors cited for the current electricity deficit in the SADC region. One of the reasons often cited as contributing to the lack of investment in the SADC energy sector is that the region lacks the capacity to carry out proper planning and project preparation due to staff shortages. As a result, most of the proposed regional energy projects are poorly structured and packaged and therefore fail to attract investment. A number of long-planned projects have failed to take off as the private sector has been reluctant to engage in partnerships with governments mainly due to inappropriate financing formulas. Most SADC Member States have been slow in putting in place mechanisms that promote private sector participation in the energy sector and therefore improve the attractiveness of the industry for investors.

The policy environment in most SADC countries does not encourage private sector participation in the energy sector. Except for a few countries such as Zambia and South Africa, the majority of SADC Member States are yet to fully embrace the concept of Public Private Partnerships (PPPs) despite being party to the SAPP Inter-Utility Memorandum of Understanding that formally allowed private players into the region's energy sector. Zambia has established a public institution that facilitates and promotes the implementation of PPPs. The Zambian government has classified power as a strategic resource and has put in place mechanisms to implement various power projects.

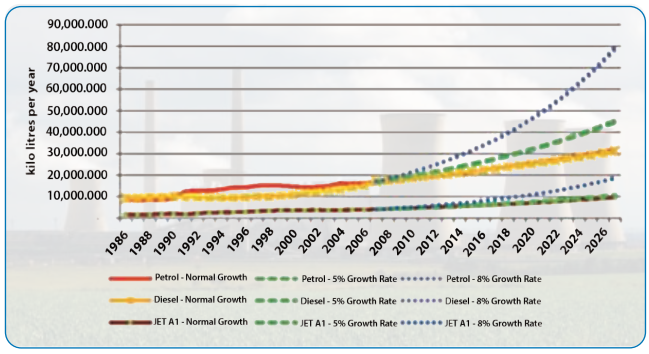
Given the foregoing, there is need for the region and its member states to build individual and collective capacity to package energy projects and develop incentives that can attract investors to the sector. Generally, there is need for a review of the operating environment in the power sector to encourage investment, including PPPs. This would involve a review of the legal and regulatory framework governing the sector.

Proposed incentives include introduction of tax exemptions for investors involved in the construction and rehabilitation of power stations. For example, Member States could allow tax exemptions for defined periods for those companies and investors who import power equipment and machinery.

In addition, other incentives should include the introduction of rebates for power producers in the form of subsidies as well as government grants for power utilities. While subsidies to lower tariffs have an important role to play in extending access, subsidy programmes need to be carefully designed and targeted at the power producers to encourage more investment. The rationale is that subsidies to consumer energy prices simply reduce the cost of energy for those who already have access to electricity. For this reason, government or donor resources available for subsidies would contribute more to equity and efficiency objectives if they are spent on once-off capital subsidies than on subsidies to recurrent costs.

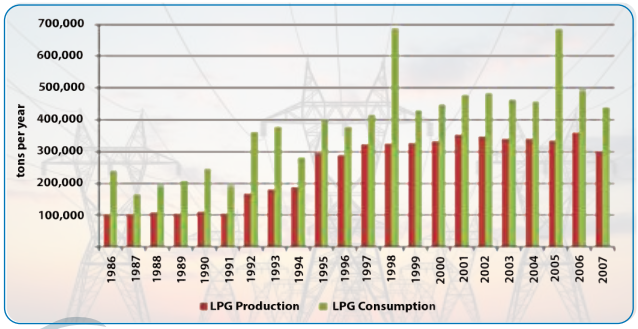
There is also scope for the creation of a Demand Side Management (DSM) fund to support DSM initiatives. The rationale behind the fund is to compensate utilities for revenue losses emanating from the reduced energy usage as a result of the DSM initiatives. This will be important in ensuring the viability of utilities so they are adequately resourced to maintain plants and invest in new infrastructure.

Figure 7.6 **Projected Demand for Petroleum Products**



Source RIDMP, 2012

Figure 7.7 **LPG Demand and Production**



Source RIDMP, 2012

7.2 Petroleum and Gas

Projected demand for petroleum products in the SADC region up to 2027 is shown in Figure 7.6. The graph shows that the demand for petrol and diesel was almost equal in 2007 and projections show an equal growth for these products going forward. The annual demand for either petrol or diesel is projected to be more than double the 2008 demand – at 30 million kilolitres, 45 million kilolitres and almost 80 million kilolitres, at three percent, five percent and eight percent growth rates, respectively by 2027. Demand for Jet A1 fuel is projected to be below 10 million litres at three percent and five percent growth rates and below 20 million litres per year at an eight percent growth rate by 2027.

7.2.1 Liquid Petroleum Gas

Data summarised in Figure 7.7 shows the historical consumption and production of Liquid Petroleum Gas (LPG) in the SADC region between 1986 and 2007. The graph shows that the region traditionally has a production shortfall of about 100,000 tonnes per annum. Though demand and production have grown in tandem between 1986 and 2002, the graph shows evidence of a demand/production plateau between 2002 and 2007.

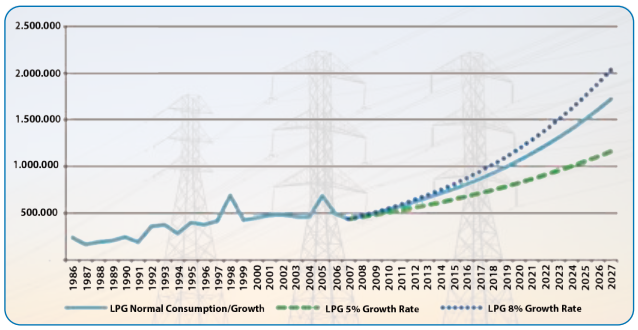
According to the regional infrastructure master plan, demand is projected to grow by much as two million tonnes by 2027. However, given the slow average growth of about three percent in the latter years

of the historical data, the most likely growth is between three and five percent in the absence of the more aggressive promotion of LPG in the region.

The projected growth in demand for petroleum and gas products discussed above will have to be matched by the expansion of the necessary infrastructure for production, refinery, storage and pipeline/transport that goes with ensuring uninterrupted supply to the region.

With regard to petroleum and gas, the region will require the largest capacity additions for petrol and diesel, estimated at about 10 billion, 18 billion and 41 billion litres every five years should the regional economy grow by three, five or eight percent, respectively.

Figure 7.8 **Projected LPG Demand**



Source RIDMP, 2012

7.3 Renewable Energy

In terms of actual energy projects, based on the SAPP Energy Plan and national plans, SADC is planning to increase the renewable energy capacity by 13,719 MW, 10,345 MW and 8,243 MW in 2017, 2022 and 2027, respectively.

Most of the additional capacity will be from hydropower and these projects are already captured in the electricity sector (RIDMP, 2012).

Apart from hydropower, the major capacity addition will be from wind energy, followed by solar PV, Concentrated Solar Power (CSP) and biomass. Geothermal energy is not expected to make any significant contribution to the RE capacity up to 2027.

The largest growth is expected from tapping the existing hydropower projects, particularly along the Zambezi and Congo River Basins.

7.4 Energy Efficiency

Energy efficiency has shown great energy savings potential, particularly in the electricity sector. A manufacturing plant for compact fluorescent lamps was established through a SAPP initiative in the region. In 2010, the SAPP region saved 750MW through the deployment of CFLs. The region has set a target of progressively increasing energy efficiency savings of grid electricity from five percent in 2015 to 10 percent by 2020 and 15 percent by 2030 (RIDMP, 2012).

While Member States have reached milestones to promote energy efficiency, the legal or regulatory frameworks are too weak to ensure the continuity and sustainability of efforts. Adequate regulatory and legal frameworks for the sustainable use of energy efficient products, as well as mandatory energy audits are required.

Governments lack comprehensive energy management schemes and targets for savings from energy efficiency initiatives. There are also no clear incentives to consumers to adopt energy efficiency and energy conservation, apart from costs saving. This calls for systematic schemes that can enable countries to undertake energy efficiency programmes and meet targets.

Chapter 8

CONCLUSIONS AND RECOMMENDATIONS

SADC's objective for energy is ensuring "the availability of sufficient, reliable and least cost energy supplies", and the energy sector has several achievements in this regard despite the challenges in delivering sufficient energy supplies to meet demand.

The majority of people in SADC (about 75 percent) still rely on biomass fuel in one form or another as their main source of energy, with serious health and climate impacts. Given the region's relatively small urban population, a relatively small number of people have access to commercial energy sources.

The analysis in this report has looked at both "hard" and "soft" energy issues. The "hard" aspects relate to the physical infrastructure that will be required, while "soft" gaps relate to the necessary policies/strategies, institutional capacity and financial issues that need to be addressed to ensure the development of physical infrastructure. This chapter discusses some of the policy recommendations for SADC energy sector players.

8.1 Policy Recommendations for SADC Energy Sector

8.1.1 Electricity

The sub-region has been experiencing a power deficit situation in recent years due to growing demand against limited expansion in generation capacity. The prevailing instability in the sector is compounded by many factors that include the reality where access to energy takes an essentially national rather than a regional approach; tariff levels are caught between the viability and access conundrum; capacity issues at both national and the regional levels; and energy sector reforms that are generally perceived to be moving at a sluggish pace.

Southern Africa must work collectively towards creating a conducive environment that would make the region an attractive investment destination for energy projects. One interesting observation is the paradox of the region having abundant primary energy resources, yet most Member States continue to experience serious power shortages, thus providing opportunities for new investment.

Power projects, especially those with a regional dimension, have a long lead time, making it imperative for SADC Member States to accelerate implementation and the need to secure Purchase Power Agreements (PPAs) upfront. The magnitude of the financial outlay required for power projects means most governments in SADC cannot singlehandedly raise the necessary investment finance without the help of international financiers and perhaps even more sustainable, working with the private sector through Independent Power Producers (IPPs) and Public Private Partnerships (PPPs).

Equally important is the political will to move on agreed projects. Thus the current situation where projects wait for several decades for implementation is not attractive to private investors. In the case of electricity, the "hard" infrastructure gaps relate to additional generation capacity required to ensure energy self-sufficiency. Considering the planned and available capacity required under the various growth projections, the planned capacity will only be adequate for a maximum demand (inclusive of the 10 percent reserve margin).

A key sub-sector is that of nuclear energy, which is currently dominated by South Africa but could expand in coming years should the vast uranium deposits across the region be exploited. The "hard" infrastructure gap for nuclear energy relates to a lack of many planned projects for electricity generation and the uncertain future of the technology. The deficits reflected in the electricity sub-sector also include the nuclear plants that will be introduced by 2023. If there is justification that nuclear power can be deployed safely using the newly developed Pebble Bed Modular Technology, it could be considered for deployment earlier than 2023. A demonstration Pebble Bed Modular plant is thus required to test this new technology before deployment, which may require the resumption of finance for the PBMR project in South Africa.

There is need for awareness building to ensure that proponents and opponents of nuclear development agree on the safety of the new technology. This should be accompanied by a presentation of safe nuclear waste disposal mechanisms and the assurance that a nuclear disaster management plan is in place. None of these measures exist at present.

With regard to "soft" issues for the electricity sub-sector, this report noted that while the region has quite a comprehensive legal and regulatory framework, most Member States generally fall short in timely implementation of the policies or regulatory instruments. According to the SADC Regional Infrastructure Development Master Plan, the majority of Member States are unable to:

- Sign off regional projects that should gain priority for implementation;
- Establish binding policies on setting cost-reflective tariffs. Although it was agreed that such a policy would be put in place in the next five years, the pace is slow. This policy needs to be supported by a standardised tariff-setting formula at regional level. This requires Member States to underwrite the tariff gap between future tariffs and long-run marginal cost;
- Develop a centralised project preparation fund, as there are many scattered sources of such financing. The recently established SADC Project Preparation Development Fund (PPDF) is expected to serve this purpose;
- Establish policies to create a risk guarantee fund to allow utilities to borrow funds for capital expenditure. This is currently a problem for national power projects;
- Harmonise regulatory frameworks for cross-border electricity trade, e.g. currency setting, wheeling charges, grid code etc;

- Standardise regulatory frameworks and licensing, which are causing delays in the conclusion of PPAs due to a lack of standard PPA agreements;
- Facilitate a legal framework that would allow large electricity users to sign PPAs directly, if required, to spread the off-takers.

There is need for cross-sectoral planning for electricity, water and information communication technologies to take advantage of synergies in developing infrastructure that can serve all the sectors more cost effectively than if sectors were to plan separately. There is therefore need to ensure that there is proper planning for implementation of projects to harness the opportunities presented by these sectors.

Another reality of the regional electricity sub-sector is that SADC institutions are hampered by the limited authority and capacity to implement electricity projects. For example, RERA does not have powers that would enable it to spearhead the pace of regulation in the region. The same applies to the SAPP, which would need authority to raise funds and implement projects together with the involved Member States. There is need to give these SADC energy subsidiary organisations more authority to advance development in the energy sector.

The SADC Energy Division and the two subsidiary bodies, RERA and SAPP, have serious staff shortages and cannot adequately co-ordinate the implementation of projects, while SACREE is still at a formation stage. Due to the key role of these institutions in advancing regional priorities, there is a critical need to act on these challenges and ensure adequate staffing is in place.

Together with Member State institutions, the SADC Secretariat and the subsidiary organisations lack project preparation capacity as projects are not sufficiently prepared and packaged before being presented to funders. This capacity should be supplemented and strengthened through the SADC Project Preparation Development Fund (PPDF) and other initiatives.

8.1.2 Petroleum and Gas

For Liquefied Petroleum Gas (LPG), the current growth rate would require minimal additional capacity of 400,000 tonnes every five years up to 2027. The highest projected capacity expansion could rise to 500,000 tonnes every five years if the economy achieves an eight-percent growth rate. In anticipation of the increases in demand for LPG, there is, therefore, urgent need to invest in more projects and the relevant infrastructure.

There is no harmonised regional regulatory framework or utilities for distribution of petroleum and oil. This often causes challenges with price variability and uncertainty in the sub-sector. Going forward, Member States are advised to work towards crafting a coherent regional regulatory and policy framework to buttress the growth in the sub-sector.

There is potential for the region to strengthen self-sufficiency in petroleum and gas resources by undertaking joint regional exploration and development projects. Cooperation in this area must include the harmonisation of policies, regulations and legislation to facilitate cross-border trade and improve capacity utilisation and liaison in the joint procurement of petroleum products in the world market.

Southern Africa is also affected by the volatile and often ever-rising cost in world prices of petroleum fuels, and yet little comparative, cross-border pricing data is available in the public domain and shortages have been felt in a number of countries. High prices of hydrocarbon oils relative to prices of biofuels have created a strong incentive to expand production of biofuels in the SADC region.

SADC is limited in its support of this sub-sector's development, as it is largely driven by foreign-owned companies and Member States no longer have the authority on where the crude oil is sold. The region needs an oil pricing policy for cross-border trading, which can determine the currency of trade in the SADC region.

In addition, the region requires a comprehensive demand forecast for petroleum and oil, similar to that developed under the SAPP Plan, as this will provide better guidance for the development of the sub-sector. Currently this is hindered by a lack of co-ordinated data, as data are largely in the hands of the private and public oil companies and national associations. This limits long-term planning for regional infrastructure development.

Coupled with recent oil discoveries, it is crucial to have plan for a gas pipeline network to serve the electricity sector and industries. The development of both oil and oil pipelines should, however, be preceded by a study of a regional gas and petroleum pipeline network. A cost study is also needed on the implications of using refined products versus refining regional oil.

The projected growth in demand for petroleum and gas products will have to be matched by the expansion of the necessary infrastructure for production, refinery, storage and pipeline/transport that goes with ensuring uninterrupted supply to the region.

8.1.3 Renewable Energy

In terms of Renewable Energy (RE), the "hard" infrastructure needs have been stipulated in the Renewable Energy Strategy and Action Plan (RESAP) and various potential projects requiring infrastructure have been identified, including hydropower (large and small), wind, solar, biomass (bagasse and gasification), geothermal and biofuels. However, there is need for standardised rules, regulations and guidelines concerning RE as well as the development of standard specifications for biofuel products, and setting timeframes for the achievement of similar specifications by all Member States.

Member States are also encouraged to adopt feed-in tariffs to encourage use of renewable energy technologies. South Africa and Namibia have already embarked on the development of feed-in tariffs for renewable energy through the Renewable Energy Feed-in Tariff (REFIT). Feed-in tariffs are often used to encourage the use of new energy technologies such as wind power, biomass, hydropower, geothermal power and solar photovoltaics. This type of tariff is also used if there is a shortage of energy to get renewable energy sources on board within short periods of time. South Africa has recently approved REFIT tariffs and Namibia has also initiated a study on the possible use of tariffs for renewable energy sources.

The establishment of the Southern African Centre for Renewable Energy and Energy Efficiency (SACREEE) is a step in the right direction for the promotion of the deployment of renewable energy resources in the region. SACREEE is expected to address the challenges and barriers related to the development and integration of renewable energy and energy efficiency resources and technologies at regional level. This will contribute towards increasing access to modern energy services and improve energy security in SADC. The centre requires the full support of all SADC Member States and international cooperating partners involved in the energy sector, and establishment of this institution should be accelerated.

8.1.4 Investment and Funding of Energy

With regard to financing of the SADC energy sector, there is no clear regional financial framework through which to raise funds in order to implement projects, leading to the uncoordinated fundraising at regional and national levels. Financiers also need coordination on what they can support and that needs to be redirected. The "regional project" concept needs to be clarified, and there is a need for the development of a framework for the coordination, implementation, championing and financing of such projects. The inability of national utilities to raise equity for projects should be addressed, as the regional projects are owned by the utilities.

Control of electricity tariffs by governments has been a major cause of the problem regarding supply of energy in most countries. SADC policymakers must address the challenge of developing elaborate national energy-pricing policies and strategies that include cost-reflectivity as one of the major objectives, and how to combine these into a common regional policy and strategy. The Tariff Publication being developed by RERA is an important first step towards achieving this objective and should serve as a tracking device for the region.

Differences in energy-use patterns across Member States also pose a challenge for policymakers and regulators. A closer look at the category of energy sales per customer reveals the different electricity consumption patterns in SADC Member States. In most of the countries, large power users (customers who are on maximum demand metering) consume more than half of the total energy. In some countries this pattern seems quite extreme, with very little residential and commercial consumption in relation to large power users while the situation is quite different in other Member States where almost half the energy is consumed by residential users. These differences in consumption patterns pose a challenge in the development of a common strategy on cost-reflective energy tariffs. The considerations of Member States where energy consumption is heavily skewed towards residential users would, therefore, be different from those for countries where the bulk of the electricity is consumed by large power users such as mines and industrial companies.

Most SADC Member States determine tariff levels only for retail (that is, end-consumer price levels). Very few countries have tariff levels across the value chain from generation transmission and transmission

to distribution and/or retail. This failure to break down costs is another challenge that policy makers would need to overcome in determining the real cost-reflective tariffs.

8.1.5 Climate Change

Climate change is widely talked about as a potential threat to development in the region, but no concrete actions are in place to deal with it. It is, therefore, proposed that, among other measures, clean energy projects can benefit from carbon revenue, and often projects that qualify for carbon registration have higher chances of getting investment financing as well.

A number of renewable energy resources such as hydropower, wind and solar power can be affected by climate change and planning should take such impacts into consideration. Climate change through extreme events such as floods, strong winds and storms have damaged energy infrastructure. Planning is therefore required to monitor such impacts and develop adaptation measures.

Low carbon development paths with targeted carbon revenue incorporated into clean energy projects, and climate change impact analysis and adaptation measures, are not part of current energy planning in the region. These two issues need to be incorporated into the national development plans of Member States and promoted at SADC level to receive adequate financial support.

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