SACREEE
SADC CENTRE FOR RENEWABLE ENERGY & ENERGY EFFICIENCY

SADC RENEWABLE ENERGY AND ENERGY EFFICIENCY STATUS REPORT

UNIDO

Austrian Development Cooperation

REN21 Renewable Energy Policy Network for the 21st Century

SADC

RENEWABLE ENERGY AND ENERGY EFFICIENCY STATUS REPORT 2018

PARTNER ORGANISATIONS

The Southern African Development Community (SADC) Centre for Renewable Energy and Energy Efficiency (SACREEE) was established as a subsidiary organisation of SADC, by the SADC Ministers responsible for Energy in July 2015 in Johannesburg, South Africa and endorsed by the 35th SADC Council of Ministers Meeting in August 2015 in Gaborone, Botswana.

Based in Windhoek, Namibia, SACREEE was established to contribute towards increased access to modern energy services and improved energy security across the SADC Region through the promotion of market-based uptake of renewable energy and energy efficient technologies and energy services.

REN21 is the global renewable energy policy multi-stakeholder network that connects a wide range of key actors. REN21's goal is to facilitate knowledge exchange, policy development and joint actions towards a rapid global transition to renewable energy.

REN21 brings together governments, non-governmental organisations, research and academic institutions, international organisations and industry to learn from one another and build on successes that advance renewable energy. To assist policy decision making, REN21 provides high-quality information, catalyses discussion and debate and supports the development of thematic networks.

UNIDO is the specialized agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability.

The mandate of the United Nations Industrial Development Organization (UNIDO) is to promote and accelerate inclusive and sustainable industrial development in developing countries and economies in transition.

The Organization is recognized as a specialized and efficient provider of key services meeting the interlinked challenges of reducing poverty through productive activities, integrating developing countries in global trade through trade capacity-building, fostering environmental sustainability in industry and improving access to clean energy.

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Austrian Development Agency GmbH (ADA) is the operational unit of Austrian Development Cooperation. ADA is a public-benefit, non-profit, limited liability company headquartered in Vienna. On behalf of the Federal Government, it plans, finances and supports development programmes and projects in the countries of Africa, Asia, South-Eastern and Eastern Europe and the Caribbean. The goal of ADA is to improve conditions of life in developing countries and assist partner countries in their sustainable development. It also promotes projects in development communication and education in Austria to advance discussion on development cooperation.

FOREWORD

SACREEE

Fellow Citizens, Partners and Colleagues,

I am delighted to present the 2018 Southern African Development Community (SADC) Renewable Energy and Energy Efficiency Status Report by the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE). This report is in line with the mandate of SACREEE to represent and communicate the common position and needs of SADC Member States on issues of renewable energy and energy efficiency at the international level, thereby providing a basis for engagement. As a subsidiarity institution of SADC, SACREEE provides a platform for effective co-ordination of activities and the required support for the development of the region's abundant renewable energy resources and energy efficiency opportunities that are much needed to address the region's energy access and energy security challenges.

Despite the vast renewable energy resources of the SADC Member States, the renewable energy market remains largely underdeveloped. The challenges encountered in efforts to extend the electricity grid especially to remote sparsely populated rural areas have proven the cost effectiveness of using distributed renewable energy for increasing energy access. Expanding access to modern, reliable and affordable energy services has therefore become a key regional priority.

The objective of the report is to capture the current status of the renewable energy and energy efficiency markets and of investments in distributed and on-grid solutions, as well as to examine the policy trends and regulatory frameworks in the region. The report also explores the latest market developments and activities undertaken in the Member States to accelerate the diffusion of renewable energy and energy efficiency locally and regionally and to promote foreign investments.

The report was undertaken through a consultative approach at all stages of development to ensure that the data and analysis presented reflect the information provided by the Member States. I therefore encourage all stakeholders to make use of the study and to take advantage of opportunities, gaps and overlaps in the SADC renewable energy and energy efficiency space that are highlighted in the report to develop a conducive environment to increase the uptake of renewable energy and energy efficiency.

In conclusion we are grateful for the technical support from the United Nations Industrial Development Organisation (UNIDO) and REN21 and for the financial support from Austrian Development Cooperation in the development of the 2018 SADC Regional Renewable Energy and Energy Efficiency Status Report. It is our hope that the publication of this report is a biannual event, and we therefore welcome your feedback and support in making the next edition a great success.

Mr Kudakwashe Ndhlukula
Executive Director
SACREEE

UNIDO

The new edition of the *SADC Renewable Energy and Energy Efficiency Status Report* comes in a timely manner. It provides a comprehensive overview of the renewable energy and energy efficiency sector in the region as well as an outlook on opportunities and perspectives together with a pipeline of projects and investment needs identified in the region.

The understanding of the SADC region's emerging renewable energy industry, market development and growth is critical to realising the region's potential and to scaling up investment opportunities. The availability of profound data and information is key to enable informed decisions on actions to overcome the pertinent energy and climate change challenges. Addressing these challenges by fostering regional co-operation accelerates results and triggers growing sustainable energy markets.

The SADC Centre for Renewable Energy and Energy Efficiency has a very important role to play. SACREEE was mandated to contribute to increased access to modern energy services, and improved energy security across the SADC region through the promotion of market-based adoption of renewable energy and energy-efficient technologies and energy services in SADC Member States. I am particularly pleased that this report has a strong focus on energy efficiency.

As UNIDO, it is our mission to promote and accelerate inclusive and sustainable industrial development (ISID), and energy efficiency is a key factor to stimulate sustainable industrialisation.

UNIDO and SADC have a long-standing partnership in the commitment to attain the region's Sustainable Energy Agenda. The SADC 2018 Renewable Energy and Energy Efficiency Status Report is an excellent example of this continuous solidifying partnership.

Mr Tareq Emtairah
Director
Department of Energy - UNIDO

REN21

At the end of 2017 access to electricity in Africa dropped 1%, securing it the dubious honour of being the only continent to have both an increase in population and a decrease in electricity access. Yet renewable energy is already a reality in many developing countries worldwide, with over 266 gigawatts of grid-connected renewable power capacity and more than 360 million people being supplied by distributed renewable energy systems. However, more investment – between USD 45 billion and USD 56 billion annually – is needed globally to bring renewables to scale.

Encouraging developments in the SADC region demonstrate the contribution of renewables in meeting the region's energy needs. The use of renewables in the power sector is growing. Renewables are being used both on- and off-grid, with decentralised systems helping countries meet rural electrification requirements. Because electricity alone cannot cover all energy needs, thermal renewable energy offers additional opportunities to reduce pressure on transmission and distribution infrastructure.

The establishment of SACREEE demonstrates the region's commitment to increasing energy security and meeting the energy needs of its citizens with affordable and sustainable energy. This report is a baseline, documenting what is happening where. It uses both formal and informal data to ensure the most up-to-date information possible. A continuous data collection process informs energy planning, policy development and market design, helping in turn to direct policy and investment.

REN21 is pleased to support this first report from SACREEE and would like to thank SACREEE, UNIDO and ADA for their support and contribution to this collaborative process. We are glad that REN21's multi-stakeholder approach to data collection is being replicated in the SADC region to help advance the energy transition.

Ms Rana Adib
Executive Secretary
Renewable Energy Policy Network for the 21st Century (REN21)

The 2018 report was commissioned by the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), a SADC subsidiarity agency established in 2015 and based in Windhoek, Namibia. SACREEE is mandated to contribute to increased regional energy access and energy security by promoting market-based adoption of renewable energy and energy efficiency.

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TABLE OF CONTENTS

TABLES, FIGURES AND SIDEBARS

EXECUTIVE SUMMARY

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BACKGROUND

The 2018 *SADC Renewable Energy and Energy Efficiency Status Report* builds on the initial status report for the Southern African Development Community (SADC) issued by REN21 in 2015. It provides an updated review of renewable energy and energy efficiency developments in the SADC region[i], including market trends and related activities, achievements in renewable energy on- and off-grid, achievements in energy efficiency, evolving policy landscapes and investment flows.

The 2018 report was commissioned by the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), a SADC subsidiarity agency established in 2015 and based in Windhoek, Namibia. SACREEE is mandated to contribute to increased regional energy access and energy security by promoting market-based adoption of renewable energy and energy efficiency. The Centre plays a key role in the implementation of the recently adopted SADC Renewable Energy and Energy Efficiency Strategy and Action Plan (REEESAP). This report is developed in partnership with REN21 with the support of the United Nations Industrial Development Organization (UNIDO) and financing by the Austrian Development Agency.

With a population of about 341 million that is growing at around 2% a year, the SADC region accounted for approximately 33% of sub-Saharan Africa's total population of 1.02 billion in 2017. Three Member States – the Democratic Republic of the Congo (DRC), South Africa and Tanzania – together account for 57% of the region's population. The gross domestic products (GDPs) of Member States vary widely, from USD 1.4 billion (Seychelles) to USD 294 billion (South Africa), as does GDP per capita, ranging from USD 317 (Malawi) to USD 15,144 (Seychelles), with both overall and per capita GDP declining slightly since 2015. Differences also exist in levels of socio-economic development, as measured by the United Nations Human Development Index: from a low of 0.418 (Mozambique) to a high of 0.782 (Seychelles).

Since 2015 SADC Member States have greatly increased their commitment to renewable energy and energy efficiency, including important innovations in tariffs, increased use of independent power producers (IPPs) to meet growing electricity demand, and new legislation to stimulate mini-grids and distributed renewable energy. South Africa, which has introduced a successful auction system to stimulate development of renewables, has been a leader in this area, but Tanzania and Zambia are also developing feed-in tariffs (FITs) and capacity auctions under the guidance of the GET FiT initiative and the World Bank's Scaling Solar programme, respectively. Namibia is implementing FITs and net metering in the development of its substantial renewable energy efforts.

Since 2015 SADC Member States have greatly increased their commitment to renewable energy and energy efficiency, including important innovations to stimulate mini-grids and distributed renewable energy.

Several other Member States – Angola, Botswana, Lesotho, Malawi and Swaziland (Eswatini) – are increasing the role of renewable energy in their power supply systems. Despite significant progress, technical and financial barriers remain to the expansion of renewables, and some Member States such as Botswana, Malawi, Mozambique, South Africa, Zambia and Zimbabwe also continue to develop traditional, non-renewable energy sources such as coal to satisfy rapidly increasing demand for electricity, as all six countries have massive coal reserves.

Electricity access remains a key policy issue for SADC Member States, with average access in the region at 48%, and 32% in rural areas. Nevertheless, countries at the low end of the access scale have made significant improvements since 2010, for example Malawi (11% overall access), the DRC (17%), Madagascar (23%), Lesotho (34%) and Tanzania (33%).

Energy security is another area of policy concern and is being addressed in two ways: 1) expanded interconnections and transmission capacity and 2) accelerated generation capacity, allowing increased inter-country sales. The Southern African Power Pool, formed in 1992, has proven to be a key resource and facilitator in this work. As of 2017 all but three mainland SADC Member States – Angola, Malawi and Tanzania – were connected to and buying or selling electricity from other SADC Member States.

[i] In this report the SADC region refers to the 15 Member States of Angola, Botswana, the Democratic Republic of the Congo, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia and Zimbabwe. The island state of Comoros was admitted as the 16th member of SADC in 2017 but was not included in this report, as detailed energy data for the country are not yet available.

RENEWABLE ENERGY MARKET AND INDUSTRY OVERVIEW

Since 2015 the SADC region has experienced significant growth in the renewable energy market as Member States include renewables in their generation capacity planning and take steps to integrate these technologies into their overall energy supply systems. The private sector has emerged as a key part of this market, both in off-and on-grid and large- and small-scale applications.

Setbacks have occurred as well. Efforts to reduce reliance of the region's rural and peri-urban populations on biomass energy for cooking and heating – principally through the introduction of more-efficient cooking technologies – have had only limited success, and as a result deforestation caused by excessive harvesting of fuelwood continues to be a major problem in SADC Member States, with the exception of the Indian Ocean states.

Although government support for renewables has improved, delays over the signing of power purchase agreements (PPAs) have slowed project implementation. In South Africa – a leader in renewables development – the financial constraints of the off-taker (the national utility Eskom) delayed the signing of PPAs for nearly three years until April 2018.

Despite this, solar photovoltaic (PV) projects are being introduced at a rapid pace, thanks to the expanded development of utility-scale projects and the use of FITs and auctions. Examples include the 40 megawatt (MW) Mocuba project in Mozambique, a 37 MW project and fourteen 5 MW REFIT projects in Namibia, two 50 MW projects in Zambia based on competitive auctions, and more than 800 MW of solar PV projects approved in South Africa's most recent bid window.

Wind energy projects also are proliferating, primarily in South Africa where 3,366 MW was approved in the latest bid window, but also in Namibia and Tanzania where smaller projects are either operational or awaiting financial closure.

So far relatively few concentrated solar power (CSP) projects exist in the region, the exceptions being South Africa, which has approved two such projects and implemented a third, and Namibia, which is planning a 40 MW CSP project in Arandis, near Swakopmund. In addition, in 2018 ACWA Power, an IPP, signed a PPA for the 100 MW Redstone CSP project in South Africa, an independent project outside of the government auction system.

With the exception of Botswana, hydroelectric projects at all scales are the leading source of both current and planned renewable energy development in the region. In a few Member States, notably Angola, the DRC and Zambia, hydropower is virtually the only renewable energy source in play at present, although Angola has expressed interest in signing up to the World Bank's Scaling Solar Programme, which should greatly increase opportunities for solar development there.

According to Member State reporting, the SADC region had 21,760 MW of installed renewable energy capacity as of mid-2018, of which 15,996 MW was hydropower. Another 17,361 MW of renewables capacity had reached financial closure and was awaiting commissioning, of which 8,305 MW was large-scale hydropower. In the DRC political uncertainty has raised the country's risk profile and deterred potential investors from participating in development of the DRC's enormous hydroelectric potential, in particular the 4,800 MW Inga 3 project that remains on hold.

Renewable energy use in the transport sector continues to lag behind the electricity sector, and since 2015 only small changes have occurred to biofuels mandates in Eswatini, Malawi and Zimbabwe, and new incentives for biofuels were developed in South Africa, Tanzania and Zambia. Meanwhile, both Mozambique and Tanzania have launched new public transport initiatives, with the former experimenting with compressed natural gas for buses and also looking at a Bus Rapid Transit (BRT) system for the capital city, Maputo.

Since 2015 the SADC region has experienced significant growth in the renewable energy market as Member States include renewables in their generation capacity planning and take steps to integrate these technologies into their overall energy supply systems.

DISTRIBUTED RENEWABLE ENERGY

SADC Member States are increasingly turning to distributed renewables for energy access (DREA) to improve energy access for rural populations as well as communities in low-income and peri-urban areas. The most common examples are 1 to 100 kilowatt (kW) solar PV facilities located at or near electricity end-users, but distributed renewable energy (DRE) systems also may include cooking, heating and cooling systems that generate and distribute services independently of any centralised system, using other renewable energy sources such as wind, small-scale hydropower or even hybrid diesel-renewable generation systems.

Most SADC Member States have developed national energy access targets, typically linked to the rate of electrification – that is, the percentage of the population that is able to access electricity through either the main grid or mini-grids. Countries with specific rural electrification targets include Angola, Botswana, the DRC, Madagascar, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe.

Member States increasingly consider the option of distributed generation and mini-grids as part of their rural electrification programmes. Eswatini, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe have met this challenge by developing specialised agencies to implement these policies. Typically rural electrification agencies or authorities are based within, or closely associated with, the major national utility, as the main source of revenue. In Mauritius, the rural electrification programme was completed decades back and was implemented by the national utility itself; as such no specialised agency was set up for that purpose.

In Member States with low population density, the challenge is to provide electricity access to the high share of the rural and peri-urban population that does not currently have access by establishing off-grid solutions that are feasible to establish and maintain. To address this problem as well as the challenge of dealing with growing financial constraints, rural electrification efforts in the SADC region are moving strongly towards incentivising the use of mini-grids and/or household solar systems and other mini- and pico-scale technologies. To improve the rate of uptake, most countries offer subsidies of some kind for the installation of off-grid systems, recognising that rural households rarely will have the financial capacity to pay for the technologies themselves.

For example, in Zambia the Energy Regulatory Board has collaborated with the Bureau of Standards and the Revenue Authority to control the quality of renewable energy products at the point of entry. This is aimed at lowering the costs of these products and encourages consumers to purchase items only from licensed service providers.

Some Member States have received funding/support for their rural electrification programmes from the Sustainable Energy for All (SEforALL) initiative (supported by United Nations Development and the Global Environment Facility). In the case of Mozambique this has been extended to mini-grids through the national renewable energy organisation, FUNAE.

Despite improvements in access, some Member State programmes have not generated local jobs in the private sector. The perception that the government will provide energy access at below actual cost has further reduced the ability of the private sector to engage in these programmes. Some local communities also lack trust in off-grid solutions, seeing DRE as an indication that the government is resigning its responsibilities to provide promised grid connection, which may be perceived to be superior to off-grid supply.

Tanzania provides an example of a successful DRE-based rural electrification programme that has avoided subsidisation by shifting the burden to the private sector, developing a standardised PPA that encourages investment by IPPs using renewable energy. The country's renewable energy development has been assisted by private entrepreneurs operating outside of the government framework, developing innovative solar projects using a pay-as-you-go (PAYG) approach.

Biogas projects for local cooking and heating also are being developed; however, despite documented success no structured process is in place to use the learning from these projects to introduce biogas on a larger scale. Dairy farmers are expected to be a major target for biogas projects, as they can use biogas as a fuel for powering milk chillers, pasteurising milk and even generating electricity for lighting in animal enclosures. Biogas also can be used for cooking in households.

On the biomass side, the SEforALL Action Agenda has followed the earlier SADC Biomass Energy Strategy (BEST) initiative, seeking to better regulate and reduce biomass consumption. This has led to efforts and strategies aimed at rolling out improved cook stove programmes. Typically these programmes have promoted the use of locally made artisanal clay stoves, although some examples of manufactured clay and metal stoves also have been introduced into some markets, such as in Eswatini, Mozambique and South Africa.

ENERGY EFFICIENCY

Energy intensity has generally improved in the SADC region over the period from 2015 to mid-2018. The highest energy intensities persist in the same three countries as reported previously: the DRC, Mozambique and Zimbabwe. The SADC average of 7.9 megajoules (MJ) per USD of GDP in 2015 is well below the 9.4 MJ per USD of GDP noted in 2012, although it is still higher than the global average of 5.1 MJ per USD of GDP.

In the SADC region, utility performance and transmission and distribution losses remain a major constraint in achieving efficiency goals. Transmission losses in 2017 averaged 5.97%, a slight drop compared to the 6.0% reported in the 2015 *Status Report*. Eskom in South Africa realised the most significant improvement, reducing losses from 3% to 0.1% on the back of a performance improvement and capacity build-and-expansion programme and improved maintenance of its ageing infrastructure.

SADC Member States recognise the importance of energy efficiency as a cost-effective way to ensure energy security and reduce greenhouse gas emissions. As a key example, the recently launched Renewable Energy and Energy Efficiency Strategy and Action Plan (REEESAP) treats energy efficiency as the region's

"first fuel." A large untapped potential exists for enhancing conservation measures across key sectors, such as buildings and air conditioning, heavy industry and transport – all of which are major sources of energy demand growth.

Improved energy efficiency is a key sector performance indicator in the REEESAP, including energy intensity, transmission and distribution losses, demand-side management, technology and fuel substitution, and efficient buildings. The strategy acknowledges the potential of both renewable energy and energy efficiency to diversify the SADC region's energy mix and to reduce its energy intensity.

REEESAP is closely aligned with other SADC initiatives as well as global initiatives, and is expected to rapidly increase energy access and security at an affordable cost, setting ambitious regional and national targets for 2030. For example, with support from the European Union's (EU) Technical Assistance Facility, SACREEE is designing and developing a regional SADC Industrial Energy Efficiency Program (SIEEP), which is meant to support the implementation of the SADC Industrialization Strategy and Roadmap 2015-2063.

New approaches and business models for energy efficiency also are being implemented across the region, designed to attract and involve private sector players. This is expected to help contribute to the SADC Industrialisation Strategy and Roadmap 2015-2063. The Revised Regional Indicative and Strategic Plan (RISDP) (2015-2020) identifies energy efficiency as a "key enabler" for industrial development that can contribute towards increased competitiveness of the industrial sector.

Across the region lighting upgrades in the form of exchanges of compact fluorescent lamps (CFLs) for inefficient incandescent light bulbs continue to be the most common initiative, occurring in 9 of the 15 Member States. Energy-saving awareness and hot water load control programmes are the next most common. The

least common initiatives are standards and products labelling, the banning of incandescent bulbs and the installation of pre-paid meters for utility customers.

The SADC energy ministers have issued a directive to phase out inefficient lighting, with the deadline being moved from December 2017 to December 2019 to allow Member States to put in place necessary mechanisms and to allow for further consultations. With the assistance of the Swedish International Cooperation and Development Agency, SACREEE is implementing a project on energy efficiency lighting and appliances that will focus on developing regional minimum energy performance standards (MEPS) and testing capacities, among other activities.

The Southern African Power Pool has been working with utilities in the region through various working groups to help with strategies and activities that encourage efficiency through demand-side management and related initiatives. It reported a cumulative energy savings of 4,031 MW in 2017, which was expected to increase to 6,000 MW by 2018.

Although the benefits of MEPS and labelling programmes have been demonstrated globally and in the EU in particular, only three SADC Member States – Mauritius[i], Seychelles and South Africa – have implemented such programmes since 2015. In both Mauritius and South Africa, the focus is to reduce the electricity demand of household appliances, with a resultant reduction in greenhouse gas emissions.

Efficient cook stoves are being promoted annually at platforms such as trade fairs/shows, and there are also national campaigns to promote alternative energy sources (liquefied petroleum gas, biogas, briquettes, ethanol).

A number of SADC Member States are developing initiatives to improve transport efficiency. In South Africa, these have taken the form of a light rail system, electric bus programmes and the installation of solar power at some bus and maintenance depots, as well as at bus stations. In Madagascar, a project aims to remove vehicles with more than 25 years of service from traffic, and the customs code now prohibits selling vehicles more than 10 years old in the local market.

SADC Member States recognise the importance of energy efficiency as a cost-effective way to ensure energy security and reduce greenhouse gas emissions.

[i] MEPS is not being implemented in Mauritius per se. However, an additional levy of 25% is being applied at customs on household electrical appliances that are below a set level of energy efficiency index.

POLICY LANDSCAPE

Since 2015 the SADC region has undergone a significant change in the number and quality of its renewable energy and energy efficiency policies. This is due in large part to the changing economics of wind and solar energy, but also to the increasing policy knowledge base, allowing SADC governments to access global experience concerning which policies are most effective and appropriate to local conditions. Concepts such as FITs, specific technology mandates, net metering and auctioning of power supply from IPPs have all gained traction and are expanding rapidly.

Member State efforts to develop targets and policies promoting renewable energy and energy efficiency have been assisted by their involvement in various global initiatives, including the United Nations' SEforALL initiative. As of mid-2018, all 12 of the mainland SADC Member States (one more than in 2015) had joined the SEforALL initiative and had expressed an interest in developing policies and targets to ensure a rapid transition to sustainable energy.

In addition, as of mid-2018 eight Member States – Angola, the DRC, Eswatini, Lesotho, Namibia, South Africa, Tanzania and Zimbabwe – had carried out the SEforALL gap analysis, and gap analyses for another four Member States (Botswana, Malawi, Mozambique and Zambia) were classified as "under development". Two Member States (Angola and Tanzania) had both completed an Action Agenda and developed an Investment Prospectus.

As of mid-2018 four SADC Member States – Mozambique (2012), Zambia (2013), Eswatini (2014) and Tanzania (2017) – had undergone Renewable Energy Readiness Assessments supported by the International Renewable Energy Agency (IRENA), one more than in 2015. IRENA assessments have helped countries to identify areas where improvement is needed, and to set realistic targets for renewable energy and energy efficiency implementation.

The SADC Secretariat also has been active in the energy policy arena. The 2003 SADC Regional Indicative Strategic Development Plan was the first effort to set specific quantitative targets for infrastructure development including energy for a 15-year period (2004-2018). The RISDP was revised in April 2015, establishing a reduced five-year programme (2015-2020) that included the original target of "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".

In 2017 the SADC energy ministers approved the REEESAP, which in effect provides a framework for SACREEE's work. The Plan includes targets for energy access, renewable energy and energy efficiency for the region as a whole.

Efforts to reduce dependence on traditional biomass for cooking will be assisted by the fact that many Member States are now linked to international programmes supporting the promotion of efficient cook stoves and assisting countries to develop specific policies to achieve this. In addition, a number of regional efforts have been aimed at developing policies to encourage more-efficient use of biomass in general. For example, the BEST programme for biomass was initiated by joint German and EU funding during the period 2009-2014.

National policy and programming efforts have centred on the development of targets, whether in quantitative form (e.g., renewable energy capacity in MW) or qualitative form (e.g., policies to incentivise renewables and energy efficiency). All 15 SADC Member States have set, or are expected to soon set, quantitative targets based on a variety of baseline and target dates. Co-ordination to produce a comprehensive and consistent set of targets for the region is still to be realised. As an example, Namibia has set a target of increasing its renewable share of electricity generation to 70% by 2030, while Tanzania has a target of only 5% for the same year. Mauritius, facing a more constrained process due to its island status and heavy dependence on fossil fuels, has set an overall target for renewable energy generation of 35% by 2025 but lower targets for specific technologies.

Since 2015 the SADC region has undergone a significant change in the number and quality of its renewable energy and energy efficiency policies. This is due in large part to the changing economics of wind and solar energy, but also to the increasing policy knowledge base, allowing SADC governments to access global experience concerning which policies are most effective and appropriate to local conditions.

INVESTMENT FLOWS

Globally, the value of renewable energy investments has fallen significantly since 2015, and southern Africa is no exception. This downturn reflects in part the rapid decline in capital costs of many renewable energy technologies. In South Africa, tendered costs for solar PV and wind declined substantially from Bid Window 1 to Bid Window 4, and these technologies are now cheaper than Eskom's average cost of supply and well below the cost of its new coal-fired power stations. The trend towards lower prices is evident elsewhere in the region as well: recent renewable energy auctions in Zambia have resulted in some of the lowest prices for solar PV projects in the world.

Decreased investment flows in the region also were due in part to delays in policy implementation and financial closure in several Member States. This included notable delays in finalising PPAs for projects in South Africa, the regional leader in grid-connected renewables. South Africa had until 2015 attracted by far the greatest amount of renewable energy investment in Africa and stood fifth internationally in Bloomberg's *Global Trends* rankings. In 2017 South Africa fell from fifth to sixth place in these rankings and recorded an 88% drop in renewable energy investment.

Although South Africa still leads the continent in renewables investment by a substantial margin, the rapid decline In recent years has worried investors who previously had targeted the country as a lower-risk jurisdiction within Africa because of its mature financial markets, stronger governance, independent judiciary and strong energy infrastructure. Reflecting the need to close the supply-demand gap, the most recent draft of South Africa's new Integrated Resource Plan advocates a threefold increase in power generation from all sources by 2050.

Financing remains a major barrier for most SADC Member States despite the increased availability of funding from international sources. To deal with this challenge, some Member States – for example, Namibia, Tanzania, Zambia and Zimbabwe – have been able to use innovative funding mechanisms such as PAYG to incentivise small-scale, off-grid solar PV and hydropower projects.

The pipeline of renewable energy projects in the region seeking financing is large. Large-scale hydroelectric projects (15,341 MW) dominate the pipeline, led by projects in the DRC, Angola and Tanzania, but solar (3,367 MW) and wind (2,500 MW) also represent significant opportunities. Tanzania leads all Member States with 9,087 MW of projects in the pipeline, which includes 5,000 MW of geothermal energy.

More than 30 organisations and funds provide financing opportunities for projects in at least one SADC Member State. These cover a wide range, from private investment funds dedicated to renewable energy, to private funds that cover infrastructure generally, to funds sponsored by developed-country governments or international funding agencies. As much as an estimated USD 10 billion may be available from various private and government-sponsored investment funds for renewable energy projects in the region.

Most investors have used a blended approach to financing projects in the region, preferring to share the risk with other investors. Such blended investments may include direct equity investments, loans (debt), mezzanine financing (for example, through preferred shares or debt convertible to shares), catalytic funding (grants or loans intended to stimulate further investment) and concessional loans. The role of banks in such financing is to package a combination of loans and equity financing, plus concessional financing if necessary. Private investment firms have been especially active in South Africa's tendering programme the Renewable Energy Independent Power Producer Programme (REIPPPP), with the EU, the United Kingdom and the United States providing approximately ZAR 66 million (USD 4.3 million) as of mid-2018.

Other international financing sources also are involved in renewable energy projects in the SADC region. For example, the African Development Bank is a major funding source for renewables both directly through its lending facilities and in its capacity as the manager of various programmes dealing with renewable energy. One of these programmes, the Sustainable Energy Fund for Africa, has supported seven projects in five different SADC Member States, ranging from solar PV and wind power to energy-efficient cooling using deep-ocean water.

Building on its successful implementation in Uganda, a programme supported by the German development bank KfW – the Global Energy Transfer Feed-in Tariff (GET FiT) – is being implemented in Mozambique, Namibia and Zambia. The programme promotes the use of a standardised set of bankable legal, risk mitigation and financing support procedures, and offers technical assistance ranging from input on solar PV grid integration to procurement support. In Namibia, where private investors in solar PV and wind already are comparably active, GET FiT will focus on projects to generate electricity through the combustion of invasive bush.

01 REGIONAL OVERVIEW

01
REGIONAL OVERVIEW

The first Southern African Development Community (SADC) *Renewable Energy and Energy Efficiency Status Report* was published in 2015. The report demonstrated that the SADC region[i] had substantial renewable energy resources, which were expected to provide a strong basis for "improved energy access within the region and across Africa as a whole".[1]

Since publication of that report, many of the region's Member States have greatly increased their commitment to developing both renewable energy and energy efficiency, including important innovations in tariffs, increased use of independent power producers (IPPs) to meet growing electricity demand, and new legislation to incentivise mini-grids and distributed energy generally. But improvement has not been uniform: several Member States have encountered technical and financial barriers to the continued expansion of renewables, while the development of traditional, non-renewable energy sources such as coal continues as Member States such as Botswana, South Africa, Zambia and Zimbabwe struggle to meet rapidly increasing demand for electricity.

In 2013 the International Renewable Energy Agency (IRENA) estimated that the potential of electricity generation from centralised renewable energy sources (including large-scale hydropower) in the SADC region during the period 2010-2030 was 62,781 megawatts (MW), and that the potential from decentralised (off-grid) projects was 24,725 MW[ii].[2] In 2017 the total installed renewables capacity in the region reached 18,066 MW, only 28.7% of IRENA's 2030 estimates.[3] However, this represented an increase of 51.7% in the four years from 2013 to 2017[iii], suggesting steady growth in the readiness of governments to consider renewable energy as a viable alternative to non-renewable sources.[4] As the rate of growth of renewables, particularly in the electricity sector, continues to increase (see section 2), it looks likely to exceed 50% of IRENA's 2030 target by 2020.

South Africa was an early adopter in developing renewable energy capacity and also a leader in the development of auction systems through its internationally lauded Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). The country's initial target was to commission 17,800 MW of new capacity from renewable energy sources between 2010 and 2030,

In 2013 IRENA estimated that the potential of electricity generation from centralised renewable energy sources (including large-scale hydropower) in the SADC region during the period 2010-2030 was 62,781 MW, and that the potential from decentralised (off-grid) projects was 24,725 MW.

according to the 2011 version of the Integrated Resource Plan (IRP).[5] As of March 2018 the IPP Office had already procured some 6,422 MW from 112 renewable energy IPPs from seven bid rounds, of which 3,776 MW was connected to the grid.[6] An additional 92 MW had been procured from the small-scale REIPPPP, although financial closure of these projects was delayed until finalisation of the new IRP, scheduled for later in 2018.[7] South Africa was expected to open another "expedited" auction round in late 2018.[8] (For more on the REIPPPP, see sections 2 and 5 of this report.)

While South Africa's deployment of new renewable energy projects has slowed somewhat due to financial problems experienced by the national utility (Eskom), other SADC Member States have greatly increased both actual and planned commitments to renewables. Namibia, Tanzania and Zambia have been particularly progressive, developing national programmes to support utility-scale renewables and introducing feed-in tariffs (FITs), net metering and (in Zambia's case) national renewable energy capacity auctions (under the World Bank's Scaling Solar umbrella). Several countries are developing regulatory and financial instruments to stimulate the use of renewables as part of national grids as well as for off-grid applications, while also developing new legislation to incentivise energy efficiency.

[i] In this report the SADC region refers to the 15 Member States of Angola, Botswana, the Democratic Republic of the Congo, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia and Zimbabwe. The island state of Comoros was admitted as the 16th member of SADC in 2017 but was not included in this report, as detailed energy data on the country are not yet available.

[ii] IRENA's estimates include only 11 countries in the SADC region; they exclude Madagascar, Mauritius, Seychelles and South Africa.

[iii] The year 2017 is the latest one for which IRENA data are available.

The use of renewable energy in heating and cooling, by comparison, has progressed slowly in the region since 2015. With the exception of gradual market penetration of more-efficient cook stoves, the main advances have been Mauritius' privately financed project to use sea water for cooling of buildings in the capital city of Port Louis, awaiting government approval for implementation; some use of biomass for steam-raising and electricity generation in Mauritius and South Africa; and energy efficiency improvements in sugar extraction plants and refineries in Eswatini, Mozambique, South Africa, Tanzania, Zambia and Zimbabwe.

The use of renewable fuels in transport continues to make slow progress, with minor increases in blend mandates for ethanol and biodiesel in Malawi, Mozambique and Zimbabwe. South Africa finally implemented a minimum blend of E2 (2%) for ethanol and B5 (5%) for biodiesel starting in October 2015, following a lengthy review process after publication of the country's original national Biofuels Industrial Strategy in 2007.[9]

Several Member States – including Mozambique and Tanzania – are working on developing efficient urban transit options, but these programmes are still in their early days. Increased use of renewable energy and improved energy efficiency in the transport sector are major challenges for SADC Member States moving forward.

The region's high renewable energy potential and the growing commitment of Member States to implement supportive policies and continued expansion of renewable energy in the electricity sector suggest that a large portion of the region's growing demand for electricity will soon be served by both hydropower and non-hydropower renewables. The introduction of variable power sources such as wind and solar will require changes to base- and peak-load management in the region's utilities – including innovative forms of electricity storage – as well as new contractual relationships between utilities and their customers.

Opportunities for using modern biomass in industry and transport are evident, including the use of pelletised wood for heating and some cooking applications. The use of waste biomass such as bagasse and sawmill waste in both power and heat production is increasing, although at a slower pace than other renewables. In the transport sector, production of biofuels to replace fossil fuel dependence has increased slightly; however, the rate of increase has slowed because of the need for Member States to develop appropriate blending ratios and supply chains, as well as to ensure engine compatibility.

The status of energy efficiency programming is somewhat mixed. The region has moved forward in implementing demand-side management programmes in several power utilities, in encouraging the adoption of solar water heating to replace traditional electric domestic water heaters in urban and peri-urban areas, and in adopting ripple control and time-of-use management systems (see section 4). However, the development of efficiency programmes in housing and commercial buildings has lagged, as have programmes to improve efficiency in energy-intensive industries.

Since the previous *Status Report*, SADC finalised and obtained ministerial approval for the Renewable Energy and Energy Efficiency Strategy and Action Plan (REEESAP). This document was expanded from its original form to include energy efficiency as well as renewable energy and was validated by a meeting of Member State officials and experts in October 2016. In July 2017 the SADC energy ministers gave the document their final approval, and it now serves as a guide for implementation through the year 2030.[10]

REEESAP augments and complements other SADC energy documents, including the SADC Protocol on Energy (1996), the Regional Infrastructure Development Master Plan (RIDMP), the SADC Regional Energy Access Strategy and Action Plan (REASAP) and the Revised Regional Indicative Strategic Development Plan (RISDP) (updated in April 2015).[11] Together these documents provide a strong background for progressive policy development in the region and can serve as a basis for implementation at the national level.

In 2015 SADC ministers responsible for energy approved the establishment of the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), located in Windhoek, Namibia as Host Country[i]. The Centre is mandated to promote increased access to modern energy services and improved energy security across the SADC region through the market-based adoption of renewable energy and energy-efficient technologies and energy services. The establishment of SACREEE is supported by Austrian Development Cooperation and the United Nations Industrial Development Organization (UNIDO). SACREEE is already implementing various programmes such as the Entrepreneurship Support Facility, the SADC Industrial Energy Efficiency Programme[ii] and the Energy Efficient Lighting and Appliances Project, as well as promoting the uptake of renewables in the region.

[i] A detailed explanation of SACREEE's development and current activities can be found at http://www.sacreee.org/content/history-sacreee.

[ii] Preparation of a consultant report on the proposed SADC Industrial Energy Efficiency Programme (SIEEP) was undertaken in 2017, and the final report was submitted in April 2018 and accepted at the annual meeting of SADC energy and water ministers in June 2018.

In 2015 SADC ministers responsible for energy approved the establishment of the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), located in Windhoek, Namibia as Host Country.

POPULATION AND ECONOMY

The 15 SADC Member States exhibit a wide diversity of demographic and socio-economic characteristics. With a population of about 341 million, SADC Member States accounted for approximately 33% of sub-Saharan Africa's total population of 1.02 billion in 2017, a slight increase in both numbers and proportion since the previous *Status Report* in 2015 (see figure 1).[12]

FIGURE 1

Overview of Population Statistics in the SADC Region, 2017

Angola

- 28.6 million
- 1,247,000 km²
- 22.9 ppl/km²
- 3.5%
- 45%

Botswana

- 2.3 million
- 582,000 km²
- 4 ppl/km²
- 1.6%
- 58%

Democratic Republic of the Congo

- 81.5 million
- 2,345,095 km²
- 34.8 ppl/km²
- 2.4%
- 43%

SADC Total

- 340.6 million
- 9,863,207 km²
- 34.5 ppl/km²
- 1.91%
- 46%

Seychelles

- 90,000
- 455 km²
- 197.8 ppl/km²
- 0.8%
- 54%

Eswatini

- 1.4 million
- 17,364 km²
- 80.6 ppl/km²
- 1.1%
- 21%

Lesotho

- 2.2 million
- 30,355 km²
- 72.5 ppl/km²
- 0.3%
- 28%

Madagascar

- 25.5 million
- 587,051 km²
- 43.4 ppl/km²
- 2.5%
- 36%

Total population | Physical area | Population density | Population growth | Urban population share

Source: see endnote 12 for this section.

Malawi

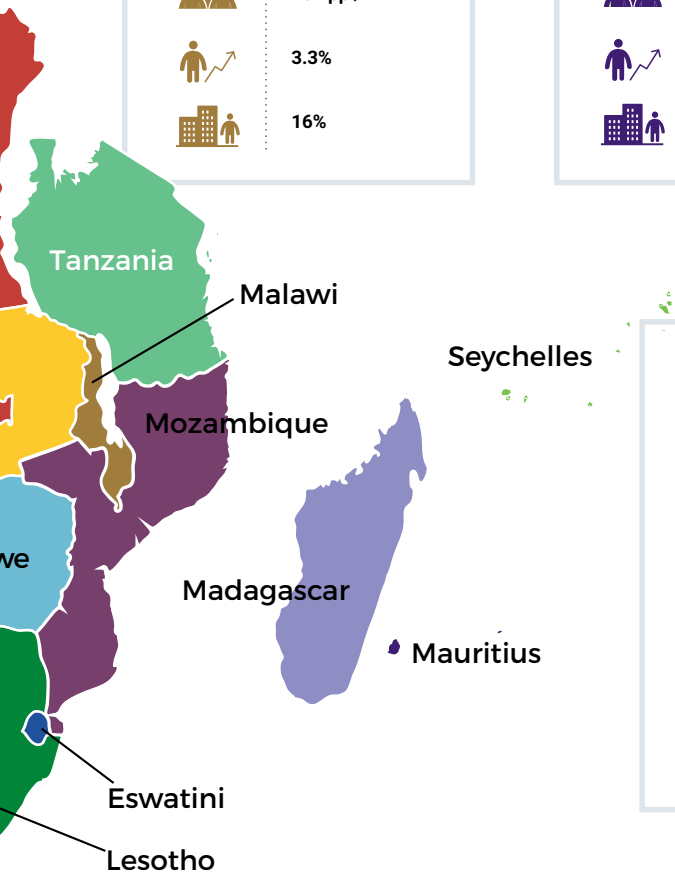
- 18.6 million
- 118,484 km²
- 157 ppl/km²
- 3.3%
- 16%

Mauritius

- 1.3 million
- 2,040 km²
- 637.3 ppl/km²
- 0.6%
- 41%

Mozambique

- 29.7 million
- 799,380 km²
- 37.2 ppl/km²
- 2.5%
- 33%



Namibia

- 2.5 million
- 825,615 km²
- 3 ppl/km²
- 2%
- 48%

South Africa

- 56.5 million
- 1,219,912 km²
- 46.3 ppl/km²
- 1%
- 65%

Tanzania

- 57.5 million
- 945,087 km²
- 60.8 ppl/km²
- 2.8%
- 32%

Zambia

- 16.4 million
- 752,612 km²
- 21.8 ppl/km²
- 2.9%
- 40%

Zimbabwe

- 16.5 million
- 390,757 km²
- 42.3 ppl/km²
- 1.6%
- 33%

Three countries – the Democratic Republic of the Congo (DRC), South Africa and Tanzania – together account for 57% of the region's population.[13] Average population growth in the region from 2016 to 2017 was 1.91%, a slight increase from 2015 but still low compared to other parts of Africa.[14] Average population density increased slightly to 34.5 persons per square kilometre (km^2).[15] The countries with the lowest population densities are Botswana (3.95 persons per km^2) and Namibia (3.03 persons per km^2).[16]

The share of the population living in urban areas in SADC Member States was 46% in 2017, up from 35% in 2013, a substantial change that reflects the general trend toward urbanisation worldwide.[17] Urban population as a share of the total population ranges from a low of 16% in Malawi to a high of 65% in South Africa, with both countries experiencing a slight decrease from 2013.[18] This compares with urban shares of 46.7% in West Africa and 26% in East Africa.[19]

The economies of SADC member states are extremely varied in both size and complexity. As shown in table 1, South Africa remains by far the largest economy in the region, with a gross domestic product (GDP) of USD 294.8 billion in 2016.[20] This is, however, a 21% decrease from 2013, as the economy has suffered frequent recessions and structural problems.[21] Angola follows with a GDP of USD 107.5 billion, representing a decline of over 21% since 2013.[22] Overall, the combined GDP of SADC member states decreased from USD 704 billion in 2013 to USD 599.9 billion in 2016 (an average of 14.8% decrease), with only 7 of the 15 member states showing increases.[23]

Most of the declines are due to the drop in commodity values worldwide, as southern African countries depend heavily on the production and export of minerals and other natural resources for continued economic growth. In countries dependent on hydropower, the deficit in generation due to drought during 2016-2017 led to reduced agricultural and industrial production, also contributing to reductions in GDP. Declines in exchange rates versus the US dollar were a factor as well.

Table 1 also illustrates the large variation in GDP per capita among SADC member states, from a low of USD 317 in Malawi to USD 9,633 in Mauritius and USD 15,144 in Seychelles.[24] Overall, average GDP per capita in the region decreased from USD 2,322 in 2013 to USD 1,834 in 2016, a 21% slide.[25]

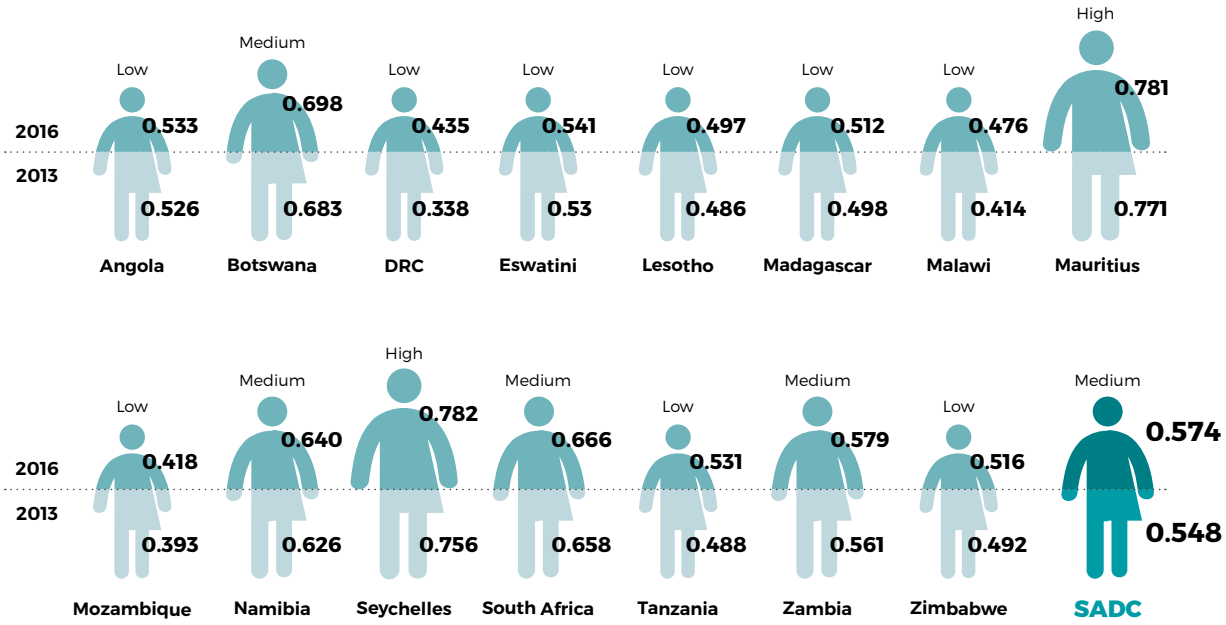
The region's social and economic development profile remains extremely varied, with little change since 2013 (the base year used in the previous *Status Report*). Comparing SADC Member States on the United Nations Human Development Index for 2016, Mauritius and Seychelles remained the only two countries to achieve a high ranking (over 0.7), while nine countries still ranked in the lowest category (less than 0.5) (see figure 2).[26]

TABLE 1.
Gross Domestic Product in the SADC Region, 2016

	2013 GDP at current market price (USD million)	2016 GDP at current market price (USD million)	Annual growth in GDP per capita (2013-2016)	GDP per capita (USD)
Angola	136,725	107,462	-21.4%	3,879
Botswana	14,902	15,568	4.5%	7,013
DRC	32,687	40,338	23.4%	464
Eswatini	4,467	3,725	-16.6%	3,290
Lesotho	2,534	2,241	-11.6%	1,154
Madagascar	10,602	9,796	-7.6%	414
Malawi	5,222	5,343	2.3%	317
Mauritius	12,122	12,167	0.4%	9,633
Mozambique	16,128	10,867	-32.6%	413
Namibia	12,767	10,823	-15.2%	4,656
Seychelles	1,316	1,434	9.0%	15,144
South Africa	366,818	294,833	-19.6%	5,274
Tanzania	44,401	47,642	7.3%	950
Zambia	28,076	21,031	-25.1%	1,282
Zimbabwe	15,224	16,619	9.2%	1,168
SADC	**703,991**	**599,889**	**-14.8%**	**1,834**

Source: see endnote 20 for this section.

FIGURE 2.
Ranking of SADC Member States on the UNDP Human Development Index, 2016



Note: The minimum and maximum values of HDI calculation are expressed between 0 and 1, with 1 being the aspirational target.

Source: see endnote 26 for this section.

RENEWABLE ENERGY IN THE ECONOMY

The region's final energy consumption profile for renewable sources (see table 2[i]) continues to reflect the massive impact of traditional biomass fuels, a pattern repeated in other regions of sub-Saharan Africa[ii].[27]

Biomass – including wood, charcoal and some animal waste – is used primarily for cooking and heating in the domestic sector. Overall, more than 44% of final energy consumption in the region was attributable to traditional biomass use in 2014 (the latest data available), a slight improvement from 45% in 2012; if the use of modern biomass[iii] is included, the share exceeds 59%.[28] The exceptions to this pattern of high biomass use are Mauritius and Seychelles, where biomass resources are either scarce or used for process heat, accounting for 0.7% and 0.6%, respectively,

[i] The most recent data from Tracking SDG 7: The Energy Progress Report, the main source of these data, are for 2014. The previous *Status Report* included data from 2012, which are repeated in this table to demonstrate the minimal change that has occurred.

[ii] Some experts argue that traditional biomass (wood and charcoal used for cooking and heating) is not truly "renewable" because such uses are typically unsustainable, and that it therefore should not be included in calculating the share of renewable energy in final energy consumption.

[iii] Modern biomass is defined in REN21's *Renewables 2017 Global Status Report* (GSR) as: "Energy derived from combustion of solid, liquid and gaseous biomass fuels in high-efficiency conversion systems, which range from small domestic appliances to large-scale industrial conversion plants. Modern applications include heat and electricity generation, combined heat and power (CHP) and transport."

TABLE 2.

Share of Renewable Energy in Total Final Energy Consumption (TFEC) in SADC Member States, 2014

	Share of renewable energy in TFEC, 1990-2014 (%)					Share of renewable energy in TFEC by source, 2014 (%)								Type of final use 2014 in PJ			Total FEC in 2014 in PJ
	1990	2000	2010	2012	2014	Traditional biomass	Modern biomass	Hydro	Liquid biofuels	Wind	Solar	Geothermal	Other	Electricity	Heat	Transport	
Angola	72.30	75.50	54.19	52.25	50.80	46.35	1.12	3.33	0.00	0.00	0.00	0.00	0.00	15.66	223.47	0.00	**470.74**
Botswana	47.58	35.70	30.19	30.28	29.17	29.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	22.72	0.00	**77.92**
DRC	92.05	97.20	96.83	95.53	92.87	75.96	13.75	3.15	0.00	0.00	0.00	0.00	0.00	28.41	807.99	0.00	**900.59**
Eswatini	82.25	46.80	62.68	63.03	63.55	21.06	37.34	5.15	0.00	0.00	0.00	0.00	0.00	1.95	22.14	0.00	**37.91**
Lesotho	52.03	53.00	53.45	52.32	51.82	47.37	0.00	4.44	0.00	0.00	0.00	0.00	0.00	2.47	26.30	0.00	**55.52**
Madagascar	85.91	78.50	81.93	76.70	73.56	32.19	39.36	2.01	0.00	0.00	0.00	0.00	0.00	2.43	86.28	0.00	**120.58**
Malawi	84.03	76.90	79.73	81.16	80.58	34.37	37.11	9.10	0.00	0.00	0.00	0.00	0.00	5.85	45.99	0.00	**64.34**
Mauritius	47.07	14.60	13.66	11.61	10.64	0.71	8.50	0.93	0.00	0.03	0.26	0.00	0.22	1.98	1.47	0.00	**32.49**
Mozambique	93.10	92.50	91.30	90.82	88.85	70.43	8.81	9.62	0.00	0.00	0.00	0.00	0.00	40.88	336.84	0.00	**425.12**
Namibia	n/a	38.20	26.37	28.56	27.62	6.21	1.72	19.58	0.00	0.00	0.11	0.00	0.00	13.37	5.49	0.00	**68.31**
Seychelles	4.25	n/a	0.63	0.63	1.03	0.56	0.00	0.00	0.00	0.43	0.04	0.00	0.00	0.02	0.03	0.00	**5.13**
South Africa	16.63	18.20	17.09	16.64	16.59	13.32	2.82	0.09	0.00	0.10	0.25	0.00	0.00	9.92	479.69	0.00	**2,951.72**
Tanzania	94.78	94.30	90.32	86.35	86.67	66.92	18.91	0.83	0.00	0.00	0.01	0.00	0.00	7.58	769.46	0.00	**896.51**
Zambia	82.98	89.90	92.10	88.63	88.09	56.91	19.95	11.23	0.00	0.00	0.00	0.00	0.00	37.50	256.65	0.00	**333.93**
Zimbabwe	63.98	70.20	82.88	78.02	81.13	71.32	5.44	4.07	0.29	0.00	0.00	0.00	0.00	16.50	302.65	1.15	**394.79**
SADC	**70.7**	**63.0**	**62.4**	**56.8**	**56.2**	**44.06**	**14.99**	**5.66**	**0.02**	**0.04**	**0.05**	**0.00**	**0.02**	**15.38**	**282.26**	**0.10**	**6,835.6**

Note: TFEC = total final energy consumption; PJ = petajoules; n/a = data not available. "Zero" entries in this table mean either that the figure is too small to be significant, or that there are no examples of this technology at present.

[1] This number varies from the data reported for Mauritius at the Validation Workshop for the SADC Renewable Energy and Energy Efficiency Status Report (Victoria Falls, Zimbabwe, 12 September 2018). The Validation Workshop reported that biomass used for process heat in Mauritius represented 3.3% of TFEC in 2016 and 3.9% of TFEC in 2014.

Source: see endnote 27 for this section.

of those countries' final energy consumption in 2014.[29] Of the remaining countries, traditional biomass use is lowest in South Africa, at 13%, because coal, paraffin and liquefied petroleum gas (LPG) tend to dominate heating and cooking requirements in the country's urban areas.[30] In the remaining 12 countries, traditional biomass used for domestic cooking and heating ranges from 21% to 76% of final energy consumption.[31]

SADC Member States vary widely in the type of fuel used for domestic energy. South Africa uses large amounts of bituminous coal and paraffin for heating and cooking in both rural and urban areas, as well as LPG and electricity for households with higher incomes. The DRC, Madagascar, Malawi, Mozambique, Tanzania and Zambia use mostly charcoal, often produced in small, low-efficiency earth kilns in rural areas and then sold through traders in urban and peri-urban areas. In a few countries – Botswana, Namibia and Zimbabwe – charcoal is used infrequently and wood tends to be the dominant domestic fuel. Namibia, for example, produces a substantial amount of charcoal from invader bush, but 99% of this is exported to Europe as barbeque fuel.[32] In Zimbabwe, fuelwood (not charcoal) accounted for 67.8% of final energy consumption in 2017, mainly for household cooking.[33]

The share of fossil fuels in final energy consumption relative to the use of traditional biomass is relatively small in most SADC Member States, but it is still significant in several. South Africa used fossil fuels for 87% of final energy use in 2014 (a high share of which is either coal for power generation or coal-based liquid fuels), while Botswana used fossil fuels for 75% and Angola for 48% of final energy consumption.[34] By comparison, fossil fuels accounted for only 12% of final energy consumption in Mozambique and only 5% in the DRC in 2014[i].[35]

REGIONAL ENERGY CHALLENGES

The main challenges facing the energy sector in the SADC region are electricity access, energy security, health and environment, and infrastructure financing.

Electricity Access

Access to grid-based electricity has improved greatly since 2015, as ambitious grid extension programmes continue in several Member States. Urban electricity access far outstrips rural access in most Member States, the exceptions being Mauritius and Seychelles, where rural and urban access percentages are at 100%.

Access to electricity services has been strengthened by the continued development of specialist rural electrification agencies and authorities in Tanzania, Zambia and Zimbabwe, as well as by the rapid growth of private companies selling micro-scale clean energy products such as pico-lanterns, street lighting, and power for irrigation pumps, with many using pay-as-you-go (PAYG) systems to generate revenue and provide supportive services.[36]

The SADC Regional Energy Access Strategy and Action Plan (REASAP), approved by the SADC energy ministers in 2010, is now fully operational, although its first operational stage will expire in 2020. REASAP proposes two broad goals for energy access in the region:

- a *strategic goal*, to harness regional energy resources to ensure, through national and regional action, that all the people of the SADC region have access to reliable, least-cost, environmentally sustainable energy services; and
- an *operational goal*, to endeavour to halve the proportion of people without such access within 10 years for each end-use and to reduce by half again in successive five-year periods until there is universal access for all end-users.[37]

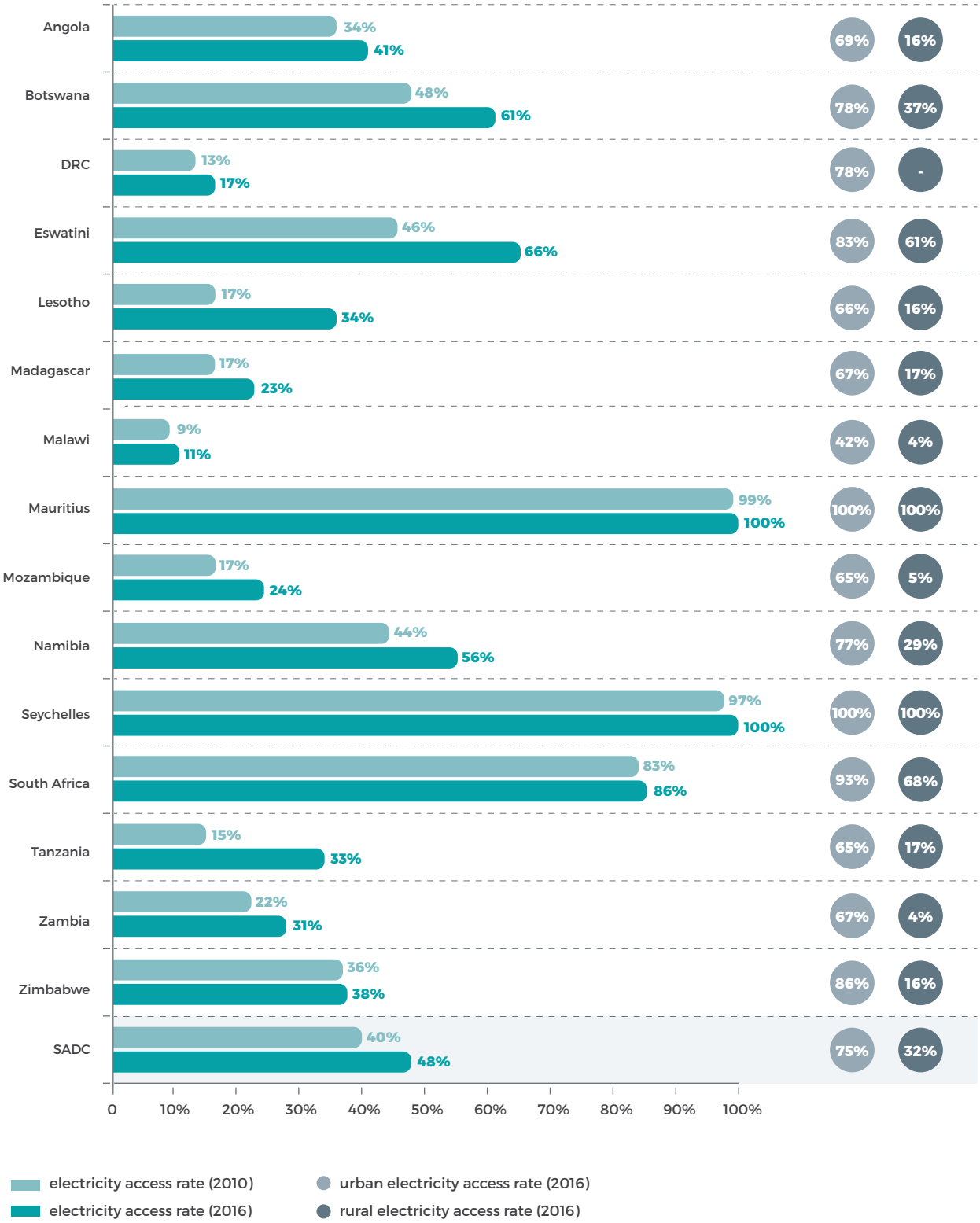
A summary of electricity access by Member State, in 2010 and 2016, is provided in figure 3.[38] Further details on the status of electricity access and efforts to improve access through grid extension and distributed energy are provided in section 3.

Access to grid-based electricity has improved greatly since 2015, as ambitious grid extension programmes continue in several Member States.

[i] The low figures for fossil fuel use include transport. This may seem counter-intuitive, but it is simply a reflection of the massive dependence of these countries on biomass for energy.

FIGURE 3.

Electricity Access in SADC Member States, 2010 and 2016



Note: Urban and rural electrification rates depict the share of the population that had access to electricity in urban and rural areas respectively. For Zambia, rural access is 4.4% on grid and 7.5% off grid, per the Rural Electrification Authority.

Source: see endnote 38 for this section.

Energy Security and Power Capacity

Improvements in electricity interconnections among SADC Member States are a major factor in strengthening energy security, and the Southern African Power Pool (SAPP) has continued to work towards improving regional interconnections. Founded in 1995, SAPP has been a strong force in identifying new transmission and generation projects and prioritising projects in accordance with the security and supply needs of the region as a whole.

Increasing energy security through transboundary electricity transmission links is not a new phenomenon in southern Africa. In the late 1950s an electricity transmission line was constructed from the DRC (then Zaire) to the Copperbelt Province in Zambia, which remains the country's mining hub. That same decade, construction began on the Kariba Dam, a joint project between Northern and Southern Rhodesia (now Zambia and Zimbabwe), with power stations located on both sides of the border. In the 1980s an expanded interconnection between Zimbabwe and Botswana (effectively carrying power from the DRC via Zambia) was planned to reduce Botswana's dependence on South Africa for its power needs, but it was never fully implemented due to technical problems. As of mid-2018 Angola, Malawi and Tanzania were the only mainland SADC Member States not connected to the SAPP grid.

Table 3 lists SAPP interconnection projects that were under way as of mid-2018, including the ZIZABONA project that will connect four SADC Member States.[39]

TABLE 3.
Key Electricity Interconnection Projects in the SADC Region, as of Mid-2018

Project	Countries connected	Voltage in kilovolts (kV)	Expected date of commissioning	Current status
ZIZABONA Interconnector	Zimbabwe/Zambia/ Botswana, Namibia	300 kV (phase 1); 600 kV (phase 2)	2018-2019 (phase 1); 2022 (phase 2)	Tender documents being prepared for engineering, procurement and construction (EPC) contract
Zambia-DRC Interconnector	Zambia, the DRC	330 kV	2019	Commissioned April 2016
Mozambique Backbone	Internal, but links Mphanda Nkuwa to the regional grid	400 kV AC + 800 kV DC	2019	Economic and SEIA studies completed
Zambia-Tanzania-Kenya Interconnector	Zambia, Tanzania, Kenya – providing first major East-Southern Africa link	400 kV	2019	Environmental impact assessment completed for final link Zambia-Tanzania; EPC contract awarded for Zambia section
Mozambique-Malawi Interconnector	Mozambique, Malawi	400 kV	2021	Awaiting financing
Botswana-South Africa Interconnector	Botswana, South Africa	400 kV	2022	Feasibility stage completed
Namibia-Angola Interconnector	Namibia, Angola	400 kV	2024	Pre-feasibility under way
MOZISA Transmission Project	Mozambique, South Africa, Zimbabwe	330 kV	2027	Under review; first phase will be Zimbabwe-South Africa only

Note: DC = direct current; AC = alternating current; SEIA = Social Environmental Impact Assessment. Commissioning dates post-2015 are based on current SAPP estimates only and are not firm. The list of projects in this table is not comprehensive but is intended only to show the range of interconnectors being considered by SAPP. Additional information and updates can be found in SAPP, *Annual Report 2017* (Harare, Zimbabwe: 2018), www.sapp.co.zw/docs/Annual%20report-2017.pdf.

Source: see endnote 39 for this section.

In its 2017 annual report SAPP indicated that a total generation capacity equivalent to 4,180 MW was commissioned in 2016.[40] The projects were commissioned by both public utilities and IPPs, with IPPs contributing 54% (2,236 MW) of the new generation capacity that year.[41] Renewable energy (including large-scale hydropower) contributed 21% (886 MW) of the total generation capacity.[42] In 2017 another 3,008 MW of renewables was added, of which 38.5% was hydropower, 8.9% was solar power, and 6.7% was wind power.[43] A total of 30,646 MW of additional renewable energy capacity is planned to be commissioned between 2017 and 2022.[44]

These figures suggest that the goals outlined in the RIDMP energy infrastructure plan for the period 2012-2027 are achievable, including shares of 31% coal, 24% hydropower, 15% wind, 11% solar, 11% nuclear, 3% natural gas and 5% petroleum distillates.[45] To meet these goals, renewable energy capacity would need to have increased by 13,719 MW in 2017; however, the actual increase was far less than this figure, as discussed in section 2[i].[46]

The share of hydropower in the region's future power mix could be much larger than indicated by the RIDMP figures, as the potential expansion of the DRC's Inga hydropower facility (the so-called Grand Inga) alone could result in an additional 40 gigawatts (GW) of capacity.[47] However, the prospects for early development of the Congo River's resources have diminished greatly since 2015. A planned western transmission corridor through Angola and Namibia to South Africa was cancelled because of the DRC's decision to use any surplus power for in-country industrial development (principally aluminium smelting), a project that was subsequently scrapped.[48] More recently, technical assistance funding from the World Bank for the next stage of the project (Inga 3) was put on hold in September 2016 owing to differing views on the project's strategic direction.[49] Final determinations on the project remain on hold pending further support from the World Bank and the African Development Bank (AfDB), but the DRC has agreed that the date for completion of Inga 3, initially planned for 2020-2021, would be postponed to 2024-2025.[50]

Even with a greatly expanded role for hydropower, coal is expected to remain the dominant electricity source in the SADC region, due largely to the expected addition of coal-fired power stations already planned or under construction in Botswana, Mozambique, Namibia, South Africa and Tanzania.[51]

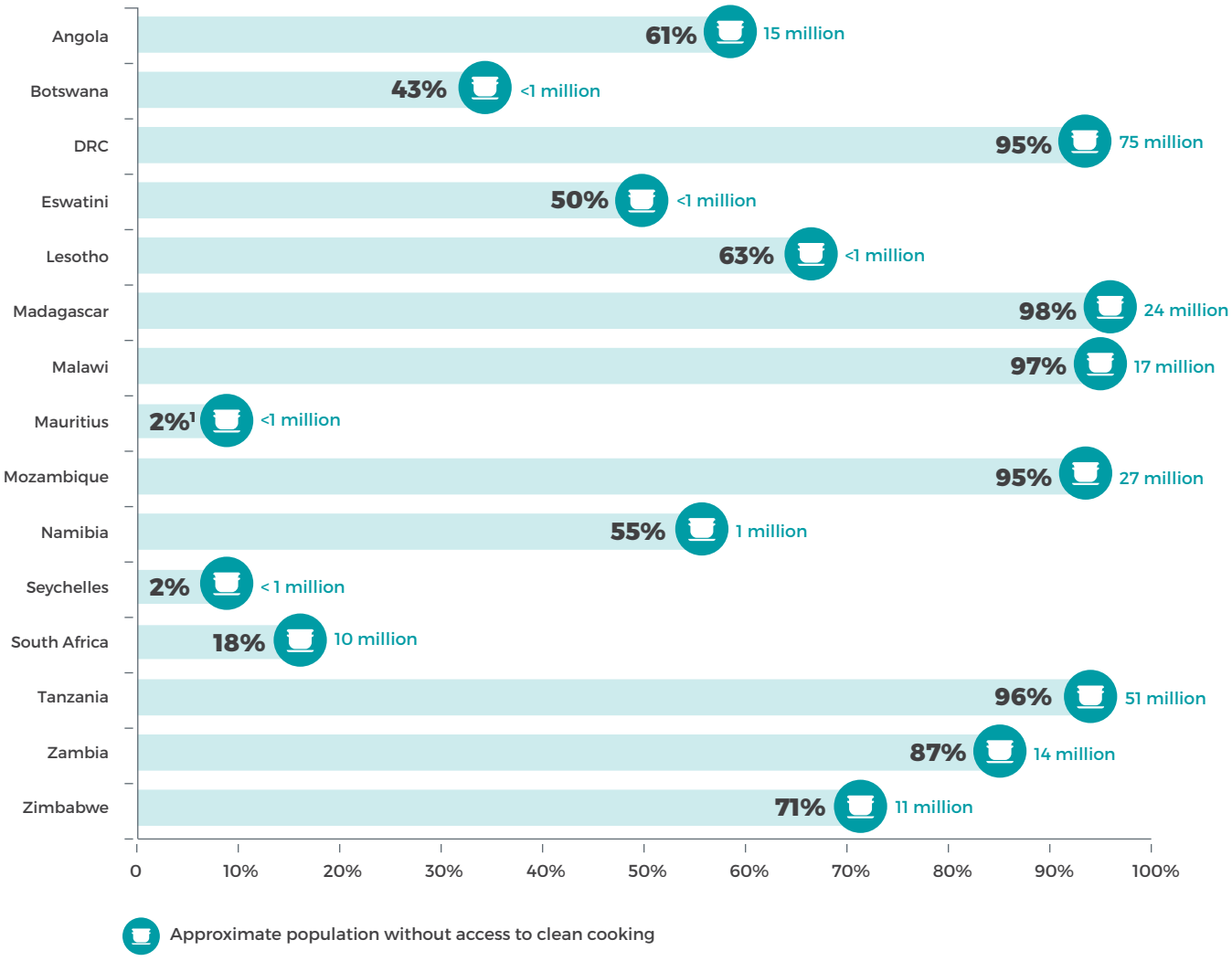
Health and Environment

SADC Member States – with the exception of Mauritius and Seychelles – remain heavily dependent on traditional biomass and other solid fuels such as coal for cooking, with attendant negative effects on health for both women and children, who tend to spend more time near open fires and traditional cook stoves.

The World Health Organization (WHO) estimates that in 2016, some 174,561 deaths in the SADC region were attributable to household air pollution, primarily as a result of cooking and heating with solid fuels[ii].[52] Globally, the WHO estimates the number of premature deaths from household air pollution at 3.8 million annually.[53]

[i] These figures differ slightly from the IRENA figures given at the beginning of the section, as the latter are based on a re-assessment of the SAPP in 2013.
[ii] Data cover all SADC Member States except for Malawi.

FIGURE 4.
Share of Population Without Access to Clean Cooking in SADC Member States, 2017



Note: For Mauritius, LPG is widely used for cooking (LPG cost is subsidised), followed by electricity. Use of fuelwood for cooking is negligible.

[1] This number varies from the data reported for Mauritius at the Validation Workshop for the SADC Renewable Energy and Energy Efficiency Status Report (Victoria Falls, Zimbabwe, 12 September 2018). According to the Validation Workshop the total population of Mauritius has access to clean cooking facilities.

Source: see endnote 54 for this section

REN21's *Renewables 2018 Global Status Report* provides information on access to clean cooking[i] facilities in SADC Member States as of the end of 2015. According to these data, the DRC, Madagascar, Malawi, Mozambique and Tanzania all show clean cooking penetration of less than 10% (see figure 4).[54] (For further discussion of the distribution of cooking fuels and modern cooking technologies within individual SADC Member States, see sections 2 and 3.)

Several SADC Member States remain heavily dependent on coal for power generation, adding further health burdens. In South Africa the share of coal in generation in 2016 was 85.7%, marginally less than in 2013 (at 88.3%) despite efforts to introduce renewables and natural gas as alternatives.[55] Botswana's share is even higher, at 95.8% in 2014, as the country generates most of its local electricity from coal at the Morupule plant[ii].[56] Both countries are increasing their use of coal for power generation as well as for industrial heat, creating an enormous potential for adverse health impacts while also increasing national greenhouse gas emissions[iii].[57]

[i] The term "clean cooking" encompasses the use of modern biomass fuels (such as wood pellets) in existing stoves, the introduction of more-efficient cook stoves, as well as the introduction of alternative "clean" fuels such as ethanol and LPG.

[ii] The new South African coal-fired power stations (Medupi and Kusile) are employing super-critical technology that is expected to greatly reduce carbon and other emissions, although these still do not qualify as "clean coal" generation.

[iii] Botswana is planning major expansion of its existing coal-fired power plant at Morupule, while South Africa commissioned two 4,800 MW coal-fired plants in 2016 and has issued tenders for additional coal-fired stations. A 600 MW coal-fired station at Mmamabula in Botswana has been in the planning stages for several years but has encountered financing problems and was described as being at the "pre-permit" stage in late 2017; see https://www.sourcewatch.org/index.php/Mmamabula_West_power_station.

Greenhouse Gas Emissions

With the exception of South Africa, the SADC region is a small contributor to global greenhouse gas emissions, at roughly 2.2% in 2011.[58] South Africa by itself remains the world's 13th largest emitter of carbon dioxide (CO_2) and was responsible for about 48% of CO_2 emissions from the SADC region in 2016.[59] In 2016 the country released 500 million metric tonnes of CO_2-equivalent, a slight decrease over the previous decade but still 42% above 1990 levels.[60] CO_2 accounted for approximately 80% of those emissions.[61] South Africa's energy sector alone – including electricity generation, petroleum refining, coal synthesis and transport – was responsible for more than 67% of the country's total emissions in 2013.[62] Electricity generation accounted for 60%, due to the heavy reliance on coal.[63]

The SADC region's relatively small contribution to global emissions is compromised by extremely rapid deforestation, due largely to burning of biomass for cooking and heating. The SADC Secretariat reports that since 1990, Southern Africa has experienced the continent's highest rate of deforestation, contributing 31% to Africa's deforested area.[64] It notes that carbon emissions from deforestation and degradation combined are over five times larger than emissions from all other sources.[65]

Financing

Financing of energy infrastructure in general and of renewable energy in particular remains a major challenge for the SADC region. Several SADC Member States have moved forward with innovative financing schemes for renewables, for example by developing FITs or competitive tendering systems. In both cases, financing has been driven by the private sector, including several large financial institutions and utilities that are willing to underwrite utility-scale renewable energy.

FIT programmes have been proposed in South Africa (now discontinued and replaced with an auction system[i]), Namibia (for wind, solar and biomass projects less than 5 MW), Tanzania (for small-scale hydropower less than 10 MW and for off-grid applications) and Zambia (up to 20 MW per site). New FIT programmes are expected to be introduced soon in Mozambique and Zimbabwe, while in Botswana a decision was made to postpone a FIT. Auctions for wind and solar are expected to be introduced in Mozambique by 2019. (For more on the relative advantages and disadvantages of FIT programmes and auctions, see section 6; for more on specific national FIT programmes, see sections 2 and 5.)

Funding from so-called green investment funds and global and regional support programmes is having a significant effect on the adoption of energy efficiency and renewable energy technologies. Several SADC Member States have completed rapid assessment/gap analysis under the United Nations' Sustainable Energy for All (SEforALL) initiative, and several have developed their associated Action Agendas and Investment Prospectuses.[66] (For more on international and domestic programmes and financing for renewable energy and energy efficiency projects, see section 6; for details on projects that are under way and planned, see section 2.)

Several SADC Member States have moved forward with innovative financing schemes for renewables, for example by developing FITs or competitive tendering systems. In both cases, financing has been driven by the private sector, including several large financial institutions and utilities that are willing to underwrite utility-scale renewable energy.

[i] The proposed South African FIT programme was found to be unconstitutional as it permitted the government to pre-determine prices rather than allow the market to provide a competitive price from which the government can choose the most cost-effective projects. (Noma Qase, IPP Office, Department of Energy of South Africa, personal communication with REN21, August 2018)

PLATFORMS FOR REGIONAL ENERGY CO-OPERATION

SADC (in its original form as the Southern African Development Coordinating Conference) was created in 1980 to provide Member States with a means to co-ordinate infrastructure developments without involving apartheid South Africa. From its beginning as a community of nine Member States, co-ordination of the energy sector was a key component of the SADC programme, at first hosted by Angola (as the only Member State with petroleum resources at the time), and later (with the streamlining of management structures in 1995) hosted by the Secretariat itself, located in Gaborone, Botswana.

During its early years SADC was active in developing a series of energy initiatives, the most significant of which were the interconnectors between Zimbabwe and Zambia and Zimbabwe and Botswana (noted earlier), as well as the implementation of regional fora for key sub-sectors including electricity, coal, biomass, renewable energy and energy conservation. The SADC energy sector unit also was host to a number of donor-funded projects on renewable energy, energy efficiency in industry, energy planning and biomass energy.

The Declaration and Treaty establishing the current form of SADC, which replaced the Coordination Conference, was signed at the Summit of Heads of State or Government on 17 August 1992 in Windhoek, Namibia.

Southern African Power Pool

The Southern African Power Pool was implemented in 1995 in response to concerns by Member States about the lack of strong electricity interconnections, which for practical purposes had divided the region into a northern sector (Angola, the DRC, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe), where base load was supplied primarily from hydropower, and a southern sector (Namibia, Botswana, South Africa, Eswatini and Lesotho), where base load was supplied primarily by coal thermal generation.[67]

Since its inception SAPP has made efforts to link the northern and southern sectors into a coherent regional grid and has been a major force in rationalising the region's electricity generation and transmission operations, including co-ordinating financial support for transmission projects. SAPP also has been instrumental in assisting national utilities to improve integration of renewable power supplies, encouraging the involvement of IPPs and developing strategies for demand-side management as part of its mandate to ensure that the region is able to meet its power needs in an environmentally sustainable manner.

In addition, SAPP has operated an electricity trading market, which aims in the long run to provide a fully integrated and competitive electricity market in the region (see sidebar 1).[68] SAPP's involvement in efforts to meet the region's electricity needs is likely to expand in the coming years as more interconnections are commissioned (making cross-border power trading increasingly attractive) and as the role of renewable energy supplies in the regional grid increases in size and importance.

SIDEBAR 1. SAPP as a Trading Platform

Apart from its role in promoting new interconnections and capacity building in SADC, SAPP functions as an electricity trading platform for its member utilities. From its beginnings as a series of bilateral agreements between member utilities, SAPP implemented a Short-term Energy Market in 2001, then a Day-ahead Market in 2009 and in 2010 the use of periodic Energy Imbalance Settlements.

Development of the SAPP-Market Trading Platform (MTP) was completed during 2016/17, with all four trading platforms successfully developed and commissioned. In addition, energy imbalance, bilateral wheeling and losses calculations were incorporated in the MTP. Over and above the day-ahead market platform that was used for live trading from 1 April 2015, the following trading platforms were added in the SAPP-MTP system:

- Forward Physical Month and Week Ahead Markets (FPM-Monthly and FPM-Weekly), commissioned in August 2015 and used for live trading from 1 April 2016;
- Intra-Day Market (IDM) or hour-ahead market, commissioned in October 2015 and used for live trading from 1 March 2016;
- Energy Imbalance, bilateral wheeling and losses calculations, commissioned in February 2016.

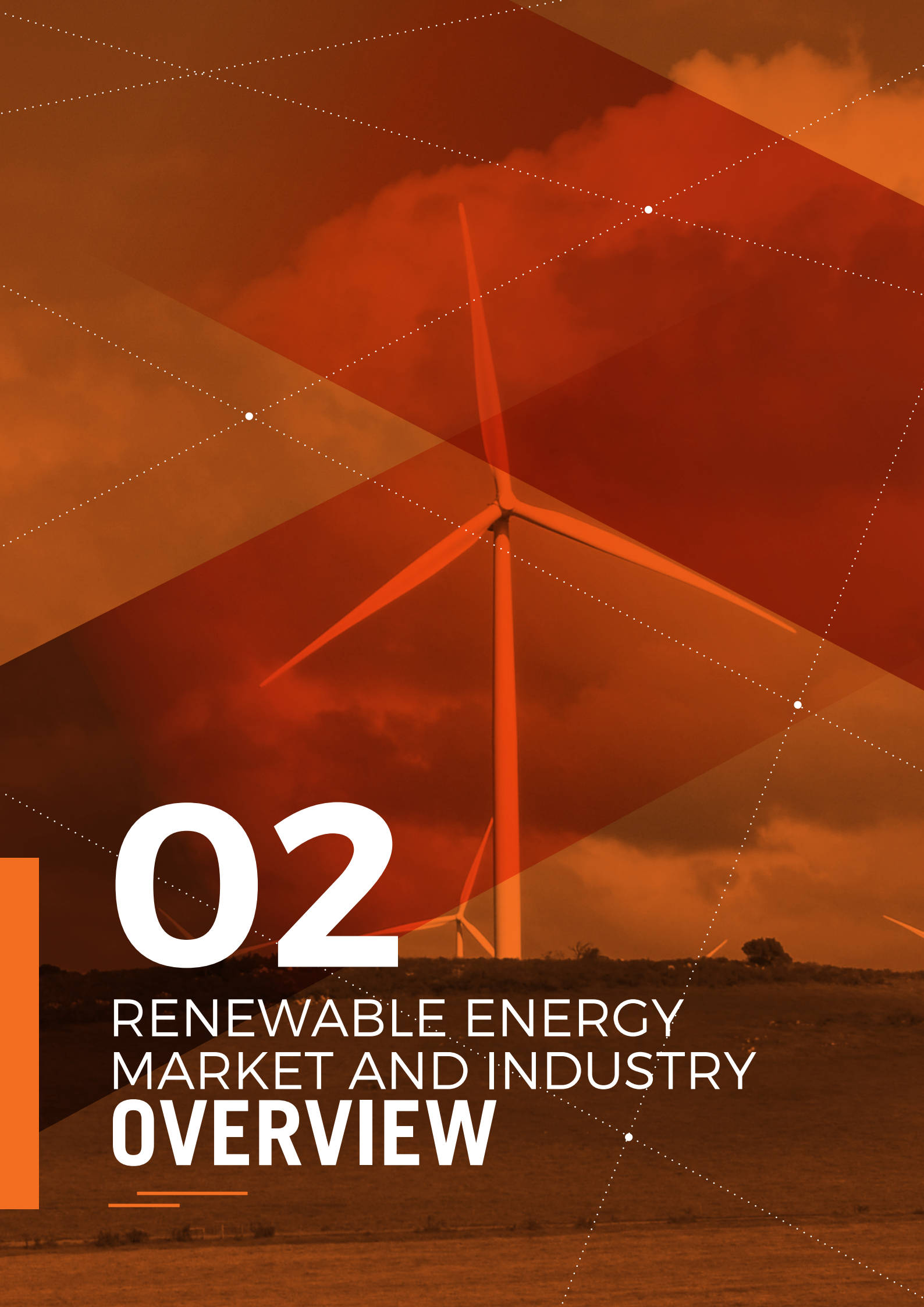
Activity on the competitive market decreased marginally in 2016/17: a total of 1,023,056 megawatt-hours (MWh) was traded, down from 1,059,540 MWh in 2015/16. In 2016/17, 19% of power offered and 27% of power requested from the market was matched on the competitive market.

Source: see endnote 68 for this section.

Regional Energy Regulators Association of Southern Africa

The Regional Energy Regulators Association (RERA) was instituted in 2002 in response to the growing role of electricity/energy regulators in the region. In 1990 only three southern African Member States had regulatory bodies, and these had little power to enforce action in key areas such as tariffs and capacity development. As of mid-2018, 13 of the 15 SADC Member States had either electricity or overall energy regulators in place, the most recent being Botswana, which created its energy regulatory body in October 2017.[69] RERA's formal membership was limited to regulators in only 10 of the 13 countries.

RERA has focused primarily on information sharing and policy dialogue on new areas of endeavour, for example a 2014 study of opportunities for developing mini-grids in the region.[70] It also has facilitated discussions around new interconnections. Efforts to harmonise electricity supply industry policies were under way in mid-2018 but were expected to take longer to implement.



02

RENEWABLE ENERGY MARKET AND INDUSTRY OVERVIEW

02
RENEWABLE ENERGY MARKET AND INDUSTRY OVERVIEW

Since the previous *Status Report* in 2015, significant changes have occurred in both the amount and type of renewable energy technologies in use and under development in the SADC region. The region has experienced a notable maturation of the renewable energy market as Member States increasingly view renewable energy as a normal part of generation planning. Many have taken steps to integrate these technologies into their overall energy supply systems, including through the development of FITs and auction systems to attract independent renewable energy producers. As a result, private sector players have emerged as a key part of the market, in both on- and off-grid and large- and small-scale applications.

Some setbacks and new obstacles to renewables development are apparent. Efforts to reduce reliance of the region's rural and peri-urban populations on biomass energy for cooking and heating – principally through the introduction of more-efficient cooking technologies – have had only limited success. As a direct result, the rate of deforestation has accelerated in some Member States, while health problems resulting from excessive use of solid fuels for cooking have not been sufficiently addressed. Efforts to permit only sustainable use of biomass fuels in cookstove projects may affect the rate of deforestation in the future, but there is no evidence of short-term benefits[i].

Solar photovoltaic (PV) projects are being introduced at a rapid pace, thanks to the development of utility-scale projects and to the use of FITs and auctions. These include the 40 MW Mocuba project in Mozambique, a 37 MW project and fourteen 5 MW REFIT projects in Namibia, as well as two 50 MW projects in Zambia, and more than 800 MW of solar PV projects approved in South Africa's most recent bid window. Further details of these are provided in the country summaries below.

So far relatively few concentrated solar thermal (CSP) projects exist in the region. The exceptions are South Africa, which has approved two such projects and implemented a third, and Namibia, which is planning a 40 MW CSP project in Arandis, near Swakopmund[ii]. In addition, in 2018 ACWA Power, an IPP, signed a power purchase agreement (PPA) for the 100 MW Redstone CSP project in South Africa, which is not part of the country's REIPPPP.[1]

The region has experienced a notable maturation of the renewable energy market as Member States increasingly view renewable energy as a normal part of generation planning. Many have taken steps to integrate these technologies into their overall energy supply systems, including through the development of FITs and auction systems to attract independent renewable energy producers.

Financing (discussed further in section 6) remains a major barrier despite the increased availability of funding from international sources. Some Member States – for example, Namibia, Tanzania, Zambia, and Zimbabwe – have been able to use innovative funding mechanisms such as PAYG to incentivise small-scale, off-grid solar PV and hydropower projects.

Government support for renewables has generally improved, but conflicts over the awarding of PPAs have slowed implementation, particularly in South Africa, where the financial situation of the off-taker (the utility Eskom) has been a major factor. In the DRC, political uncertainty has raised the country's risk profile and has deterred potential investors from participating in the development of the country's enormous hydroelectric potential.

Hydropower and solar and wind energy projects are now planned or under way in most Member States, and significant development of both modern biomass energy for industrial heating and biofuels for transport is occurring in several Member States.

[i] The Clean Development Mechanism requires that cookstove projects take account of the percentage of wood fuel harvested that is non-sustainable, based on nationally determined data. This has the effect of reducing the amount of emissions reductions eligible for carbon credits. Other carbon crediting mechanisms (e.g., The Gold Standard) have adopted similar rules, limiting the credits achieved from cookstove projects where their implementation endangers forest sustainability.

[ii] The Arandis project is estimated at 150 MW and has been the subject of a feasibility study funded by United Nations Development and the Global Environment Facility. The project went to tender in December 2017, but no decision had been made as of mid-2018.

Hydroelectric projects dominate the renewable energy landscape. With the exception of Botswana, hydropower at all scales – pico, micro, mini, small and large scale[i] – is the leading source of both current and planned renewable energy development in SADC Member States. In a few Member States, notably Angola, the DRC and Zambia, hydropower is virtually the only renewable energy source in play at present.

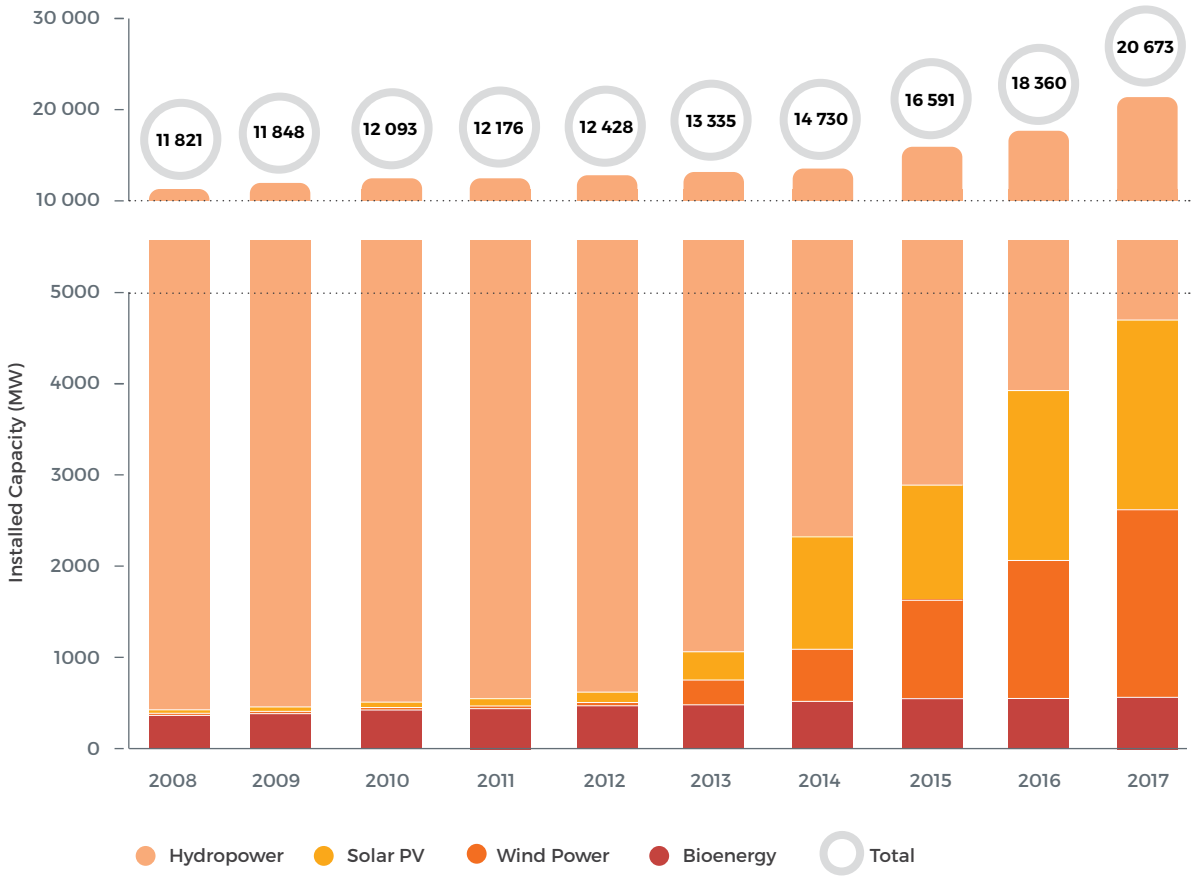
This section documents the use of renewable energy in the 15 SADC Member States as of mid-2018, including the role of renewables in electricity generation, the use of biomass energy in cooking, as well as the use of biofuels in transport and the introduction of biomass energy in industrial and utility applications. Although off-grid applications are also included, the broader role of so-called distributed renewables for energy access (DREA), including the development of mini-grids, is addressed in section 3.

RENEWABLE ENERGY CAPACITY

The contribution of renewables to electricity supply in the SADC region has increased steadily over the past decade. According to IRENA, the region's installed renewable energy capacity grew from 11,821 MW in 2008 (dominated by large-scale hydropower) to 20,673 MW in 2017 – an increase of more than 72% (see figure 5).[2] Although large-scale hydropower remained the major source of renewable energy during this period, the greatest rise in capacity was in wind energy, followed by solar. The large majority of these gains took place in South Africa.

[i] These terms have been variously defined by different sources. The most commonly used definition is: pico 0-5 kW, micro 5-100 kW, mini 100 kW – 1 MW, small 1-10 MW, medium 10-100 MW, large 100 MW+. However, because of variation in usage by the SADC Member States, our tabular summaries differentiate only between small-scale (<100 MW) and large-scale (≥100 MW) hydropower. (See http://www.renewablesfirst.co.uk/hydropower/hydropower-learning-centre/what-is-the-difference-between-micro-mini-and-small-hydro.)

FIGURE 5.
Installed Renewable Energy Capacity by Type in the SADC Region, 2008-2017



Source: see endnote 2 for this section.

Hydroelectric projects dominate the renewable energy landscape. With the exception of Botswana, hydropower at all scales – pico, micro, mini, small and large scale – is the leading source of both current and planned renewable energy development in SADC Member States.

Data collected for this report from Member State focal points as of mid-2018 indicate that the region's renewable energy capacity has increased further since the 2017 figures provided by IRENA. Table 4 shows a total installed capacity of 21,760 MW in mid-2018, an increase of 6,902 MW since the previous *Status Report* in 2015.[3] This includes additions of more than 4,656 MW in South Africa (mostly projects that were under construction in mid-2015), 1,550 MW in Angola, 390 MW in Zimbabwe (due largely to a single hydropower project, the Kariba South extension) and 296 MW in Zambia.[4]

TABLE 4.
Installed Renewable Energy Capacity by Technology in the SADC Region, as of Mid-2018

	Biomass/ waste (MW)	Other bioenergy[5] (MW)	Hydropower (MW)	Onshore wind (MW)	Solar PV (MW)	Solar CSP (MW)	Total 2018 (MW)	Total 2015 (MW)	Change 2015/18 (MW)
Angola[1]	–	–	2,415.0	–	13.0	–	**2,428.0**	878.0	1,550.0
Botswana[2]	–	–	–	–	1.3[2]	–	**1.3**	1.0	0.3
DRC	5.0	–	2,593.0	–	3.0	–	**2,601.0**	2,416.0	185.0
Eswatini	106.0	–	61.1	–	0.5	–	**167.6**	138.0	29.6
Lesotho	–	–	77.0	–	0.3	–	**77.3**	77.0	0.3
Madagascar	0.1	–	174.6	–	2.3	–	**177.0**	173.0	4.0
Malawi	17.0	–	360.5	–	0.9	–	**378.4**	369.0	9.4
Mauritius	143.5	5.4	60.7	10.7	27.0	–	**247.3**	171.0	76.3
Mozambique	10.0	–	2,187.3	0.3	1.3	–	**2,198.9**	2,187.0	11.9
Namibia	–	–	347.0	5.0	52.5	–	**404.5**	337.0	67.5
Seychelles	–	–	–	6.0	2.7	–	**8.7**	6.0	2.7
South Africa	84.0	18.0	3,485.0	2,100	2,392.0	600.0	**8,679**	4,023.0	4,656.0
Tanzania	19.7	–	593.2	–	–	–	**612.9**	600.0	12.9
Zambia	43.0	–	2,552.8	–	2.0	–	**2,597.8**	2,302.0	295.8
Zimbabwe	87.0	–	1,089.0	–	4.0	–	**1,180.0**	790.0	390.0
SADC	**515.3**	**23.4**	**15,996.2**	**2,122**	**2,502.8**	**600.0**	**21,759.7**	**14,468**	**6,901.7**

Note: In the REEESAP document as well as this report all hydropower (large or small) is considered as renewable energy. In this report small-scale hydropower is less than 100 MW.

[1] International Hydropower Association statistics for Angola do not differentiate between large and small scale, so all hydro capacity is included under large-scale.

[2] Solar data include 1.3 MW grid-connected.

[3] Figure assumes that all five turbines are operating at Cahora Bassa hydro station.

[4] "Other hydro" for South Africa is generally pumped storage.

[5] "Other bioenergy" may refer to landfill gas or other technologies, depending on the country.

Source: see endnote 3 for this section.

Table 4 also confirms the significant gap between hydropower development and the deployment of other renewable energy resources (solar, wind and biomass). For some Member States – notably Angola, the DRC, Lesotho, Malawi, Madagascar, Mozambique and Zambia – hydropower dominates the renewable energy profile. However, other Member States – such as Namibia, South Africa and Tanzania – show a more diversified picture, with gains in solar, wind and biomass energy. High biomass capacity in Mauritius, South Africa, Eswatini, Zambia and Zimbabwe is due mostly to power generation using bagasse in the sugar industries of those countries, as well as to a few examples of biogas-to-power. Only Mauritius and South Africa experienced increases in all four renewable energy sources.

The overall share of renewables in the region's power capacity by mid-2018 was approximately 38.7%, up from the 23.5% in 2015 reported in the previous *Status Report*, suggesting that renewables are more than keeping pace with the additions to fossil fuel generation.[5] Hydropower dominates this, accounting for 69.5% of renewable energy capacity.[6]

Additional capacity is expected to come online over the coming years. Table 5 summarises the estimated capacity from renewable energy facilities that were financed but not yet commissioned as of mid-2018, contributing at least another 17,361 MW, dominated by large-scale hydropower (8,305 MW) but with substantial solar PV (5,333 MW) and onshore wind power (2,238 MW).[7] Added to existing capacity, this suggests that as much as 35,000 MW of renewable energy capacity could be fully operational by 2020-2021. In addition, another 29,045 MW of renewable energy capacity have been approved but are still awaiting financing (see table 23, page 93).

The overall share of renewables in the region's power capacity by mid-2018 was approximately 38.7%, up from the 23.5% in 2015 reported in the previous *Status Report*, suggesting that renewables are more than keeping pace with the additions to fossil fuel generation.

TABLE 5.
Renewable Energy Projects Financed But Not Yet Commissioned, by Technology and Capacity, in SADC Member States, as of Mid-2018

	Large-scale hydro (MW)	Small-scale hydro (MW)	Other hydro[1] (MW)	Solar PV (MW)	Solar CSP (MW)	Onshore wind	Biomass energy (MW)	Total (MW)
Angola	4,941.0	10.0	–	3,436.0	–	100.0	0.0	**8,487.0**
Botswana	–	–	–	–	–	–	–	**0.0**
DRC	390.0	114.5	–	–	–	–	–	**504.5**
Eswatini	–	14.5	–	–	–	0.01	–	**0.9**
Lesotho	–	95.0	–	–	–	–	–	**95.0**
Madagascar	454.0	162.0	–	50.0	–	–	–	**666.0**
Malawi	–	–	–	70.0	–	–	–	**70.0**
Mauritius	–	–	–	–	–	–	27.0	**20.0**
Mozambique[2]	–	379.0	6.1	80.0	–	–	110.0	**575.1**
Namibia	–	–	–	134.5	–	44.0	–	**178.5**
Seychelles	–	–	–	9.0	–	–	–	**9.0**
South Africa[3]	–	–	87.0	1,400.0	400.0	2,094.0	50.0	**4,031.0**
Tanzania	–	7.2	–	150	–	–	2.5	**159.7**
Zambia[4]	1,320.0	–	–	–	–	–	–	**1,320.0**
Zimbabwe[4]	1,200.0	6.7	–	4.0	–	–	–	**1,210.7**
SADC	**8,305.0**	**288.9**	**93.1**	**5,333.5**	**400.0**	**2,238.0**	**189.5**	**17,360.9**

[1] Includes pumped storage of any scale.

[2] Does not include planned expansion of Cahora Bassa or new large-scale hydropower such as Mpanda Nkuwa, as these are yet to attract financing.

[3] South Africa data include both REIPPPP projects plus Eskom projects plus projects under the Wholesale Electricity Pricing System.

[4] Included for both Zambia and Zimbabwe is 1,200 MW each from the planned Batoka Gorge hydropower plant, still in the feasibility stage but highly likely to proceed.

Source: see endnote 7 for this section.

RENEWABLE ENERGY TECHNOLOGIES

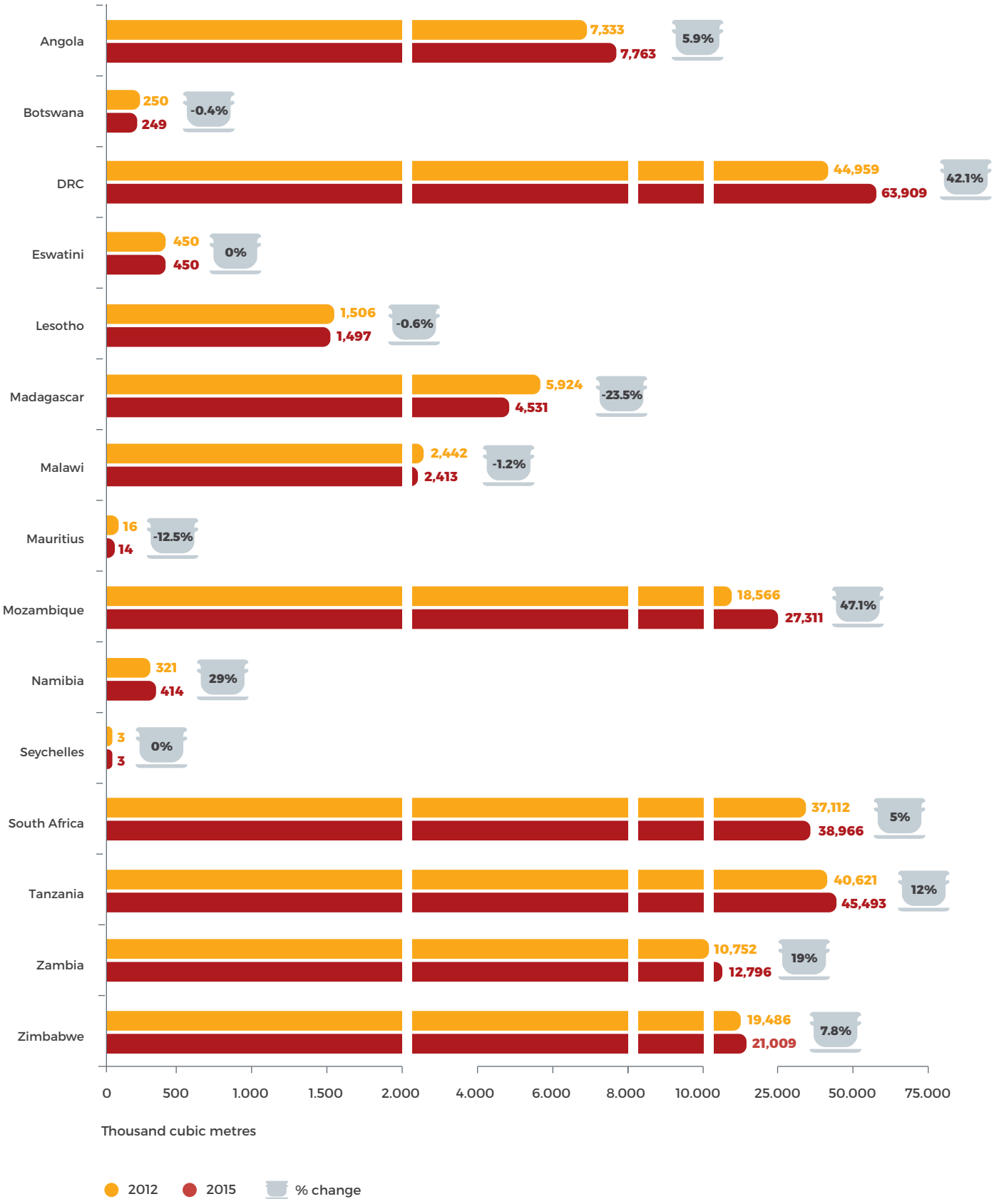
Biomass Energy

Biomass is by far the major source of primary energy in most SADC Member States. Overall, traditional biomass accounted for 44% of the region's final energy consumption as of mid-2018; if bagasse for boilers in the sugar industry is included, this figure rises to 57%.[8] By far the greatest amount of biomass energy is used for cooking, in both homes and some institutions (for example, schools, offices and retail premises, particularly in rural areas).

Between 2011 and 2015 (the most recent data available), household consumption of fuelwood for cooking and other uses declined in some SADC Member States, while approximately half showed an increase (see figure 6).[9] Regional fuelwood consumption overall increased 7%, much higher than could be accounted for by population increase alone.[10]

FIGURE 6.

Household Fuelwood Consumption in SADC Member States, 2012 and 2015



Source: see endnote 9 for this section.

This suggests that programmes to introduce more-efficient cooking devices have had little real impact on biomass use. This conclusion is supported by anecdotal information on the failure of several major improved cook stove projects in the region, including Botswana's BPC Lesedi programme (terminated in late 2015 for lack of support) and Mozambique's Clean Star ethanol stove programme (terminated in 2014 due to poor market response).[11] While work on improved cook stoves continues with support from the Global Alliance for Clean Cookstoves and other initiatives, the number of improved cook stove projects in the region has not increased markedly since 2015.[12] However, interest in these stoves is rising in some countries, such as South Africa and Lesotho, due to higher purchasing power as well as to increased recognition of the benefits.[13]

The status and overall impact of improved cook stoves is discussed further in section 3. In the present section, the discussion is restricted to fuel switching and in particular to efforts to replace fuelwood with alternative renewable energy sources.

Switches to fossil fuels such as LPG and paraffin/kerosene for cooking are increasingly common in the region, although most SADC governments view paraffin as potentially more dangerous than LPG or ethanol, particularly if used in densely populated peri-urban areas. While safer, LPG has the major disadvantage that it is an imported fuel in all SADC Member States except South Africa and Zambia.

Where possible, SADC Member States have promoted switching to fuels using renewable resources, for example ethanol produced from sugar cane or cassava, and biogas from animal or other organic waste. The most significant effort at switching to ethanol was the Clean Star Mozambique agricultural project, which began in 2010 and promoted the dedicated production of ethanol from cassava, tied to a plan to market cook stoves that were able to use the ethanol fuel. The recommended Clean Cook stove was manufactured by the Swedish firm Dometic and was eventually to be manufactured in South Africa. Although the project failed in 2014 due to poor consumer response, the stove distribution programme was taken over by Zoe Enterprises, which claims to have sold more than 35,000 ethanol stoves under the NDZiLO brand name (meaning "fire" in the local language).[14]

Other countries have taken up the cause and are sponsoring both liquid and gel forms of ethanol as an alternative cooking fuel. In Malawi, the current biomass consumption rate of 7.5 million tonnes annually is unsustainable at more than twice the recommended sustainable supply of 3.7 million tonnes per year.[15] The SuperBlu ethanol stove was developed to address this challenge by taking advantage of the country's established ethanol production facilities, which previously had supplied ethanol only for transport uses.[16] Also in Malawi, gel fuel was produced prior to 2012 using ethanol from the sugar refineries, but this was discontinued due to the rising cost of liquid ethanol.[17]

Other projects have promoted ethanol as a potential cooking fuel. For example, the multi-country Project Gaia distributes liquid ethanol stoves in three SADC Member States – Malawi, South Africa and Tanzania – and also manufactures these stoves in South Africa.[18] In South Africa, an ethanol gel called Greengel was produced and distributed as part of a campaign to promote safer cooking options for low-income communities.[19] In Malawi, Madagascar, Tanzania, Zambia and Zimbabwe, the Clean Cook stove from Sweden has been rolled out in a series of pilot projects, mostly via the Project Gaia initiative.[20]

In 2017 the World Bank completed a study of alternative biomass cooking options for sub-Saharan Africa that shows that southern Africa has the highest number of distributors of ethanol and ethanol gel, while the region also has the lowest number of manufacturers producing other biomass fuel types, such as carbonised briquettes and wood pellets.[21]

Large-scale Hydropower

Two major hydropower expansion projects have been completed in the region since the 2015 *Status Report*: the Kariba South extension (adding 300 MW of capacity to the Zimbabwe side of this hydropower station, now rated at 1,050 MW) and Namibia's Ruacana extension, adding 15 MW to the existing 332 MW hydropower station at that location. Several other large-scale hydropower projects[i] in SADC Member States have made progress in finalising design and attracting financing during the past three years, as summarised below.

Angola is pursuing rapid expansion of its hydropower potential, estimated to be as high as 18,200 MW.[22] Much of the country's development activity is centred on the Kwanza River, which already has two existing large-scale plants: Capanda (520 MW) and Cambambe (260 MW). Expansion of the Cambambe plant to 610 MW was completed in 2016, and in the next stage it is scheduled to expand to 960 MW.[23] Two other stations on the Kwanza River – Laúca (2,070 MW) and Caculo Cabaça (2,172 MW) – are under construction. Laúca commenced operation of its first turbine (668 MW) in August 2017, and the remaining turbines were due to be fully operational by mid-2018.[24] Construction of Caculo Cabaça began in August 2017 and is expected to be completed by 2024.[25] Another project in the pipeline is Jamba ia Mina (180 MW).

Further hydropower projects along the Keve River in central Angola have been identified by the government and include Capunda (330 MW), Dala (440 MW) and Cafula (520 MW).[26] Another long-delayed project, the Baynes Hydro station (600 MW) on the Cunene River, was scheduled to start construction in 2017 but encountered financial problems and was on hold as of mid-2018.[27] A joint Namibia-Angola initiative, the project would be supported by a proposed new power transmission line being co-ordinated by SAPP, which would further improve the region's connectivity.

In the **DRC**, the massive 4,800 MW Inga 3 project, intended to be the first of several major additions to the existing Inga stations on the Congo River, had secured World Bank and AfDB financing, but this was put on hold in 2016, and no clear decision on a way forward had been made as of mid-2018.[28] The DRC also commissioned a 150 MW hydropower facility at Zongo in mid-2018, and the Busanga (240 MW) and Nzilo (120 MW) plants are scheduled to be commissioned in 2020.[29]

[i] In this report, large-scale hydropower is defined as having a capacity of 100 MW or more. In the REEESAP document as well as this report all hydropower (large or small) is considered as renewable energy.

In **Eswatini**, the Ngwempisi (120 MW) hydropower project was in the pre-feasibility study stage as of mid-2018.[30]

Madagascar has focused increasingly on small-scale hydropower, as detailed in the next section, but had a total of 140.6 MW of large-scale installed hydro capacity as of mid-2018.

Malawi had 351 MW of total installed hydropower capacity as of mid-2018 and was planning at least six new large-scale projects: Mpatamanga (300 MW) and Songwe (180 MW), both of which were approved and awaiting financing; and Fufu (260 MW), Kholombidzo (200 MW), Hamilton (100 MW) and Kapichira III (100 MW), all of which were planned but not yet approved.[31] Notably, all of these planned facilities are located on the Shire River, Malawi's only source of hydropower, and there are concerns that the recent droughts and consequent shortfalls in power supplies cannot be met simply by adding generation facilities to an existing hydrological system[i].[32]

Mozambique, with 12,500 MW of hydropower potential, is progressing on two major large-scale projects.[33] The 1,500 MW Mphanda Nkuwa plant has been promoted for several decades as the next-best project for Mozambique but has been on standby pending finalisation of the funding package from China's Export-Import Bank and other sources.[34] The second project is the north bank expansion of the existing Cahora Bassa plant (1,245 MW), and in 2018 the World Bank completed a thorough sustainability assessment for this next phase of work.[35] Issues around the requirement to use generated power to reduce poverty and improve electricity access have been a major barrier for both projects, as have the economics of the projects, as both would be feasible only if there were sufficient demand for the electricity from South Africa and other regional partners[ii].[36] Meanwhile, a 500 MW hydropower project at Chemba (the first phase of a 1,000 MW project) is progressing based on Chinese finance.[37]

Namibia's only new large-scale hydropower development is the 600 MW Baynes Hydro station being developed collaboratively with Angola, which is still awaiting Namibian government approval. Generation at the existing Ruacana hydro station was increased by 15 MW to 347 MW in October 2016, following efficiency improvements.[38]

South Africa has been a regional leader in hydropower development. As of 2015 Eskom operated two large-scale hydropower stations: Gariep (360 MW) and Vanderkloof (240 MW).[39] In 2018 the utility commissioned an additional 1,332 MW pumped storage hydropower station (comprising four generating units at 333 MW each) known as the Ingula Pumped Storage Scheme, located on the border of the Free State and KwaZulu-Natal provinces.[40] This pumped storage scheme was recorded as the fourteenth largest in the world, according to Eskom, and it added to the existing 1,400 MW of pumped storage (Drakensberg and Palmiet Pumped Storage Schemes) used by Eskom for peaking purposes.[41]

[i] Efforts to improve interconnections with Mozambique could alleviate this risk, and are actively under development by SAPP.

[ii] These two projects are listed as scheduled for commissioning in 2015 (Cahora Bassa North Bank) and 2017 (Mphanda Nkuwa), according to the 2017 SADC Energy Monitor, but neither project had yet broken ground as of end-2018. (https://www.sadc.int/files/1514/7496/8401/SADC_Energy_Monitor_2016.pdf)

Tanzania, not historically associated with the development of large-scale hydropower, is moving forward with the 2,100 MW Rufiji Hydro Power Project (Stiegler's Gorge), which has attracted widespread criticism from environmental organisations as it will flood areas of the Selous Game Reserve, a UNESCO World Heritage Site[i].[42] The government opened bids for the project in September 2017 and had targeted start-up for May 2018; however, as of July 2018 a proposal made to the AfDB for funding of the project had not been acted on.[43] At the same time, WWF announced that it would be conducting a Strategic Environmental Assessment of the project, as required by major donors and lenders.[44] The government is now targeting a 2021 completion date.[45]

In **Zambia**, the Kafue Gorge Lower power station (750 MW) commenced construction in late 2015, financed by the Export-Import Bank of China with the EPC contract awarded to Sinohydro Corporation.[46] After several delays, the plant is now scheduled to become operational in 2020.[47] Two additional large-scale projects – Kalungwishi (247 MW) and Lunsemfwa (255 MW) – are planned to be commissioned by 2021.[48] In addition, Luapula (totalling more than 1000 MW) is undergoing feasibility studies and would be a joint project with the DRC.[49] An IPP, Lufubu Hydro Power Company, is raising financing through the AfDB to develop 326 MW of cascade hydropower plants on the Lufubu River.

Zimbabwe draws more than half of its power from large-scale hydropower (the Kariba South Power Station).[50] The Kariba South extension project has been completed, and the total capacity is now 1,050 MW, an increase of 300 MW.[51] Zimbabwe and Zambia also are jointly planning the Batoka Gorge Hydroelectric scheme on the Zambezi River below Victoria Falls, with a planned capacity of 2,400 MW.[52] Detailed technical feasibility studies were expected to be completed by the end of 2018.

Small-scale Hydropower

Despite the continued dominance of large-scale hydropower in the region's power development, there has been a significant upturn in small-scale hydroelectric development since 2015. As of mid-2018 the SADC region had approximately 789 MW of small-scale capacity had approved financing but awaiting commissioning[ii] (see table 5). This represented 4.5% of the 17,347 MW total of projects awaiting commissioning, a relatively small proportion compared to 8,305 MW of large-scale hydropower capacity and 93 MW of large-scale pumped storage at the same stage of development.[53] However, it is indicative of a gradual shift towards the small-scale option as financing large-scale schemes becomes increasingly difficult because of potentially negative environmental impacts, for example from flooding. Small-scale hydropower is also a better fit with national programmes to extend electricity supply to remote areas[iii].

Some key examples of small-scale hydropower projects are summarised below.

In **Angola**, the Matala hydro facility (40 MW) on the Cunene River is now operational after undergoing rehabilitation in 2016 to ensure its structural safety and to increase its production capacity.[54] In addition, the 65 MW Lomaum hydropower plant in Cubal, Benguela Province, reopened in 2016 after lying idle since 1984 due to damage incurred during the country's civil war.[55] Existing small-scale plants include Gove (62 MW), Mabubas MW (27 MW), Calueque (20 MW) and Biopio (14 MW).[56] Also in the pipeline are Jamba ia Oma (65 MW), Luapasso (26 MW) and Chicapa (16 MW).[57]

Botswana had no hydropower opportunities, small or large, as of mid-2018[iv].

In **Eswatini**, the Lower Maguduza hydropower station (13.6 MW) and the Lubovane Dam (0.859 MW) were approved and awaiting financing as of mid-2018.[58] The Lower Maguga (15-20 MW) hydropower project was in the feasibility study stage.[59]

In **Lesotho**, no new hydroelectric facilities have been commissioned since 2015. Several studies have been conducted on small-scale hydropower, and 53 initial potential sites around the country were narrowed down to 4 sites for pre-feasibility under the Lesotho Highlands Water Project Phase II: Tsoelike (46 MW potential), Oxbow dam (40 MW), Ntoa-hae (15 MW) and along the Quthing River (30 MW).[60] Potential for small-scale hydropower also exists at Katse, Mohale and Polihali dams, with ranges from 10 MW to 12 MW.[61]

Lesotho Electricity Company (LEC) operates two isolated hydroelectric mini-grids at Mants'onyane and Semonkong with capacities of 2 MW and 180 kW, respectively.[62] The Semonkong system consists of a hydropower plant of 180 kW, combined with a 190 kW diesel back-up generator, serving a small isolated community of some 200 customers centred in the town of Semonkong, in central Lesotho.[63] The size of the electricity demand does not justify connection to the LEC grid, and the diesel generator provides back-up during the dry season for 14 hours a day.[64]

In **Madagascar**, significant increases in small-scale hydropower have occurred since 2015. For example, Andekaleka 4 (34 MW) is operational and Ranomafana (86 MW) and Ambodiroka (42 MW) were to be commissioned in late 2018, while Tsinjoarivo (43 MW), Andranoma-mofona (15 MW) Namorona (15 MW) and Nosy-be (5 MW) had been approved and were awaiting financing as of mid-2018.[65]

In **Malawi**, several small-scale hydropower projects are fully operational, including Wovwe (4.5 MW), Lujeri Estate (840 kW), Ruo (464 kW), Bondo (60 kW) and Livingstonia (20 kW).[66] The Chimgonda (60 MW) project is planned but not yet approved. Additional planned hydropower is all large-scale.[67]

[i] The amount of the reserve land area that would be flooded is between 3% and 5%, but the greater risk is from uncertainties around flood control. For a detailed treatment of the issue, see https://mobil.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/WWF-Report-Selous-True-Cost-Of-Power.pdf.

[ii] The 2015 *Status Report* included data from SAPP indicating that by the end of 2017, an estimated 1,593 MW of small-scale hydropower capacity should be added to the SADC total. However, most of the projects included in the SAPP estimate were actually large-scale (100 MW or more), including the Kariba South extension.

[iii] SACREEE's own mandate includes hydroelectricity up to 40 MW of capacity.

[iv] This is due to the absence of major rivers with sufficient flow and on public land that could be flooded without negative environmental impacts. As well, "Botswana is not suitable for a significant hydropower development due to low and uneven rainfall that has caused severe water restrictions and supply interruptions." See: https://www.africa-eu-renewables.org/market-information/botswana/renewable-energy-potential/.

Mauritius had 60.74 MW of installed small-scale hydropower capacity as of mid-2018, of which 56.3 MW is effective capacity[i].[62] There were no plans to build additional hydropower at any scale, as the country is focusing on wind, solar and biomass power to meet its renewable energy targets.

In **Mozambique**, numerous existing small-scale hydropower plants, built prior to 2015, were still operational as of mid-2018, including Mavuzi (52 MW), Chicamba (38.4 MW), Corumana (16.6 MW)[ii], Cuamba (1.9 MW) and Lichinga (0.73 MW).[69] Several additional small-scale plants were under development, including Rotanda (620 kW), Majaua (530 kW), Muoha (100 kW), Senbezeia (62 kW) and Chiurairue (23.1 kW)[iii].

South Africa has been a regional leader in small-scale hydropower, including several pumped storage units. As of 2015 Eskom operated four small hydro stations: Colley Wobbles (42 MW), Second Falls (11 MW), First Falls (6 MW) and Ncora (1.6 MW).[70] A substantial number of plants were in operation in the KwaZulu-Natal and Eastern Cape provinces, mainly serving individual farmers.[71] The City of Cape Town operates hydropower turbines at four of its water treatment plants: Faure (1.5 MW), Blackheath (700 kW), Steenbras (340 kW) and Wemmershoek (260 kW).[72] A research project at the University of Pretoria installed a 15 kW system at the Pierre van Ryneveld Reservoir in Pretoria, while at BloemWater, the water distribution company of the city of Bloemfontein, a 96 kW system was developed at the inlet of a reservoir and is now providing power to the company's headquarters.[73]

Several additional sites are planned or under development. The municipality of eThekwini is developing six small-scale hydropower sites, and Rand Water utility is developing four sites.[74] The City of Johannesburg plans to install 3 MW of hydropower capacity in its bulk water reticulation system, and has recently gone to tender for this project.[75]

As of mid-2018 the SADC region had approximately 789 MW of small-scale capacity had approved financing but awaiting commissioning. This represented 4.5% of the 17,347 MW total of projects awaiting commissioning.

The future of grid-tied small-scale hydropower systems is closely linked to South Africa's policy on renewable energy development. The 2030 target set for small-scale hydropower by the IRP and the REIPPPP is significantly less than the estimated potential and could limit small hydro development in the country. In the second round of the REIPPPP, two hydropower developers, Kakamas Hydro Electric Power and NuPlanet, were jointly granted preferred bidder status to construct the Neusberg (12.57 MW) and Stortemelk (4.47 MW) plants. However, for the Neusberg site, only 10 MW is planned to be developed in accordance with the REIPPPP requirements. In the fourth round, the 4.7 MW Kruisvallei system was selected for implementation.

Aside from operational systems, South Africa has a number of existing, inactive small-scale installations that could be refurbished, such as Belvedere (2.1 MW), Ceres (1 MW), Hartbeespoort (potential up to 8 MW), Teebus (up to 7 MW) and others.[76]

In **Tanzania**, the development of small-scale hydropower has been a priority for the national government's rural electrification effort, and many small hydro stations have been developed as part of mini-grids (see section 3 for further discussion). As of mid-2018 small-scale hydropower either commissioned or approved and awaiting financing since 2015 totalled more than 302 MW, covering 29 separate projects ranging in size from 0.32 MW to 87 MW.[77]

Zambia has moved forward with approval (pending financing) of several small-scale hydropower projects, including Lusiwasi Lower Hydro Scheme (86 MW), Ngonye Falls (45 MW), Lusiwasi Upper Hydro Scheme (15 MW), Kasanjiku Hydro (0.64 MW) and

[i] Actual installed capacity is 60.74 MW (Government of Mauritius, personal communication with REN21, July 2018).

[ii] This project had achieved no generation as of mid-2018 due to unusually dry weather.

[iii] A comprehensive list of small-scale hydropower projects in Mozambique is available at: http://renewables4africa.net/klunne/publications/JonkerKlunne_JESA24_3_current_status_hydro_southern_africa.pdf.

Chipota Falls (0.20 MW).[78] Lunzua was upgraded from 0.75 MW to 14.8 MW in 2015, and Musonda Falls was upgraded from 5 MW to 10 MW in 2017. The upgrading of Chishimba Falls from 6 MW to 15 MW was under way as of mid-2018.[79]

In **Zimbabwe**, developers worked with commercial farmers in the 1990s to capture energy from existing agricultural dams, and as of mid-2018 these and other facilities accounted for some 9 MW of small-scale hydropower capacity.[80] Since 2015 Zimbabwe has commissioned additional capacity at Pungwe B (15 MW), Pungwe (7 MW), Pungwe C (3.75 MW), Hauna (2.3 MW) and Kupinga (1.6 MW).[81] It also has approved and was awaiting financial closure as of mid-2018 for a 30 MW project at Gairezi, a 3.3 MW project at Tsanga and a 5 MW project at Great Zimbabwe, which was granted a generation licence but had not yet broken ground.[82]

Solar PV

In its 2014 study of infrastructure requirements for the African Clean Energy Corridor, IRENA estimated the potential to generate electricity from solar in the SADC region at approximately 20,000 terawatt-hours (TWh) per year.[83] SAPP estimated in 2017 that the installed solar capacity on the regional grid (not including South Africa) would reach 2,265 MW by 2022.[84]

As shown in table 4 on page 37, the total installed solar capacity in the SADC region (including South Africa) in mid-2018 was 3,102 MW, of which 2,503 MW was solar PV.[85] South Africa accounted for 97% of this total, a figure that will likely continue to rise as the country re-starts its REIPPPP. By late 2016 the REIPPPP had procured more than 2,292 MW of solar PV (out of a total of 6,422 MW of procured renewable energy generation), an amount that exceeds SAPP's estimates for 2022 for the region even when construction lag times are factored in.[86] (Construction lead times for solar PV and wind energy projects procured under the first three bidding windows averaged between 15 months and two years.[87]) Before the signing of new PPAs in April 2018 this process had been seriously delayed but was on track again by mid-year.

Angola had installed 13 MW of solar PV as of 2017, mostly in small home systems and some commercial systems.[88] The Angolan government has expressed interest in signing on to the World Bank's Scaling Solar Programme, which should greatly increase opportunities for solar development there.[89]

Botswana had a single 1.3 MW solar PV pilot project as of mid-2018, funded by the Japanese government and operational since 2012.[90] In 2016 the country approved a 100 MW utility-scale solar PV facility, and in June 2017 Botswana Power Corporation invited expressions of interest for this project, receiving 166 responses from both local and external companies and consortia.[91] The government is considering offers to include storage as part of the facility, enabling it to assist in meeting the country's morning and early evening peaks.[92] Another option being considered for the country is CSP, which was identified in Botswana's Renewable Energy Strategy as the least-cost renewable technology for the country owing to its potential for efficient use of storage.[93]

The government has approved an off-grid solar programme intended to cover 50,000 households.[94] BPC Lesedi (mentioned in the biomass sub-section for its innovative franchise-based approach) had begun moving forward with a programme to introduce PV-based solar home systems in the country's off-grid communities, but the organisation was forced to close in 2015 due to financial difficulties. The government is now considering whether to resurrect the programme on its own.[95]

The **DRC** has not seen any significant growth in solar PV installations despite its massive solar resource. The country acquired a large number of stand-alone PV systems in remote areas, which continue to operate. As of 2015 an estimated 836 solar home systems, with a total installed power capacity of 83 kW, were located in Bas-Congo (170 systems), Nord-Kivu (170), the two Kasaï provinces (170), Equateur (167) and Katanga (159).[96] In addition the 148 Caritas network system had a total installed capacity of 6.31 kW.[97] The government has identified an investment opportunity in the town of Mbandaka for a hybrid solar/pumped storage system, rated at 20 MW, but there is no indication of when or how this will proceed.[98]

Eswatini had an estimated 454 kW of solar capacity as of mid-2018, mostly in small-scale PV arrays.[99] Of this, only 100 kW was connected to the grid, with the remainder being stand-alone with battery storage.[100] Plans for a 100 MW solar ground array near the main commercial centre of Manzini did not materialise[i].[101] In June 2018 the Swaziland (Eswatini) Electricity Company (SEC) requested qualifications for companies to build a 10 MW solar PV farm in the Lavamusa area; the project would be connected to the grid via a 66 kV substation in Maloma, approximately 11 kilometres away.[102]

The Eswatini government is embarking on an ambitious programme of small-scale solar PV projects, seven of which had been commissioned as of mid-2018, with a total capacity of 323 kW.[103] These projects – some owned by the government and some owned by the private sector – aim to reduce the use of grid electricity in energy-intensive public institutions. In addition, the private developer Wundersight, which already operates a 100 kW peak project at Buckwood that feeds into the grid, was developing a smaller 850 kW-peak plant.[104] A PPA for this project had been signed by the utility, and the IPP was concluding project finance as of mid-2018.

Lesotho is moving forward on its first utility-scale solar PV project (20 MW), funded by the AfDB's Sustainable Energy Fund for Africa (SEFA). In 2017 SEFA approved a USD 695,500 grant to a subsidiary of OnePower Lesotho Pty Ltd., which won the 2016 government tender for the project, to support the preparation of a bankable business case for the project's development.[105] The power from this facility, which would feed into the national grid in Mafeteng district, is expected to improve energy security by reducing Lesotho's reliance on imported coal-generated power.[106] An environmental and social impact assessment of the project was expected to commence in late 2018.[107]

[i] For this project, the SEC had signed a PPA for only 5 MW, and the remainder was to be exported by the IPP. The PPA for the 5 MW expired within the stipulated validity period, which was 12 months after signing of the PPA.

Lesotho also has identified a 70 MW solar PV project under the Forum on China-Africa Cooperation (FOCAC); the project is being implemented in collaboration with relevant line ministries and the Lesotho Electricity Company.[108] Engagement of a consultant for the development of an environmental and social impact assessment was scheduled for August 2018.

Madagascar has joined the World Bank's Scaling Solar programme and aims to deploy between 30 MW and 40 MW of solar PV capacity across the country by 2020.[109] In February 2017 an expression of interest was issued for a 3 MW solar PV power plant in Nosy Be, in the region of Diana.[110] The government also issued a Request for Pre-Qualification for the construction of a 25 MW solar PV power plant near the capital city of Antananarivo.[111] In February 2018 a list of six pre-qualified contractors was issued, and detailed terms of reference for the project were expected in late 2018.[112] Final selection was to be based on the lowest proposed tariff, and the project is intended to include battery storage to facilitate meeting peak power requirements in Antananarivo.[113]

In December 2016 the government issued an expression of interest for 30 MW of hybrid solar-biomass projects.[114] Through the tender, the government hopes to build three hybrid solar-biomass projects with capacities of 5 MW, 15 MW and 10 MW, respectively, to be located in the regions of Menabe, Diana and Atsimo Andrefana.[115] The French developer Green Yellow began work on a 20 MW solar PV facility in Ambohipihaonana, in the region of Ambatolampy; the now-commissioned EUR 25 million (USD 29 million) project will sell power to the local utility Jirama under a long-term PPA.[116]

Malawi is moving forward with utility-scale solar as well. To address the country's prevailing power crisis, the national utility ESCOM plans to add 70 MW of solar capacity to the grid over the short term through the use of IPPs.[117] Between December 2016 and May 2017 the government held a public tender that resulted in the selection of four firms. In 2018 one of the firms, the IPP JCM Matswani Solar Corp.[i], issued a request for expression of interest to select EPC contractors to develop a 40 MW utility-scale solar PV project in the Salima District of central Malawi, which would sell power to ESCOM under a 20-year PPA.[118] Solar PV plants established by IPPs at three other sites – Nkhotakota, Lilongwe and Golomoti – were expected to be fully operational by October 2018.[119]

Mauritius had just over 27 MW of installed solar capacity as of mid-2018, including the Bambous solar PV power plant that, with output of 15.2 MW peak, was the first utility-scale solar facility to be built in the country.[120] The country also contracted with Akuo Energy for a 17.5 MW solar PV project at Henrietta, which had confirmed financing and was about to begin construction as of June 2018.[121]

Mauritius has commissioned three 2 MW solar farms at Mont Choisy, L'Esperance and Petite Retraite and approved two distributed generation net metering schemes for solar, of 1.6 MW and 3.8 MW respectively.[122] A solar-diesel hybrid system with an overall capacity of 1.2 MW at a large shopping centre in Flacq was planned in 2015 but later cancelled due to high cost implications; a 1.2 MW solar PV grid-connected system was installed instead.[123] The country aims to increase renewable energy in the generation mix from 18% in 2015 to 35% by 2025.[124]

Mozambique's O Fundo de Energia (FUNAE), charged with promoting renewable energy in rural areas, has been responsible for a range of solar installations. FUNAE oversaw the construction of three solar PV plants funded by the Republic of Korea that enabled electrification of the Mavago (0.55 MW), Muembe (0.40 MW) and Mecula (0.35 MW) districts in Niassa province, as well as the construction of a solar panel factory in Maputo province with a production capacity of 5 MW per year, which was expected to help reduce the implementation costs of solar energy projects in Mozambique.[125] In 2014 the total installed capacity of solar home PV systems in the country was said to be 2.25 MW, but these were installed as part of an earlier programme and there is no information as to whether they are still operational.[126]

[i] JCM Matswani is a special purpose vehicle owned by UK provider of project development and funding services for infrastructure projects in sub-Saharan Africa, InfraCo Africa Limited; by Canadian-based private equity firm, JCM Power; and by South Africa's Matswani Capital.

As of mid-2018 two grid-connected 40 MW solar projects were planned to start construction in Mocuba (Zambezia Province) and Metoro (Cabo Delgado Province).[127] Mocuba had reached financial closure and construction commenced, while Metoro had not yet reached financial closure.[128] In addition, a 100 MW grid-connected solar facility was planned for Maputo Province, with the final location still to be selected.[129]

Namibia had 52.5 MW of installed solar capacity as of mid-2018.[130] This included rooftop installations of 1.1 MW at Namibia Breweries (for own-use), 4.5 MW at Ombura, 3 MW at Erongo RED Arandis, as well as 5 MW installations each at Erongo HopSol Otjiwarongo, Hopsol Grootfontein, Osona Sun Energy, Aloe Investment, Ejuva Solar One Energy, Ejuva Solar Two Energy, Alcon Consulting Services, Momentous Energy and Metdecci Energy Investment.[131] An additional five rooftop projects rated at 5 MW were expected to be commissioned before the end of 2018.[132] Three larger projects – AlternHardap Solar (37 MW), GreeNamMariental (10 MW) and GreeNamKeetmanshoop (10 MW) – were under construction and expected for commissioning by end-2018.[133] In addition, NamPower, the national utility, had pre-qualified nine companies for the final bidding process to build a planned 40 MW CSP plant at Arandis, but decided to terminate negotiations in April 2018 for unexplained reasons.[134] A recent study has also proposed a 100 MW CSP plant linked to a desalination plant, but this is still in early planning stages.[135]

Seychelles had 2.7 MW of installed solar capacity as of mid-2018, compared to 0.92 MW at the end of 2014.[136] In a scheme that has now ended, the government provided incentives for private companies and homeowners to build small solar PV arrays, including a 15% rebate for commercial installations and a 25% rebate for residential installations.[137] One new facility – Democratisation Phase 1 (2.1 MW) – had been commissioned as of mid-2018, and two others – Floating PV Lagoon (4 MW, still to go to tender) and Ile de Romainville (5 MW), supported by IRENA – were approved but awaiting financing.[138]

South Africa leads the region in developing solar capacity because of its REIPPPP auctioning system. Despite the contracting delays mentioned earlier, the country was able to commission just under 1,800 MW of solar PV by mid-2017, based on contracts awarded under Bid Windows 1, 2 and 3.[139] Another 405 MW procured for solar PV in Bid Windows 4 was approved in April 2018, with 50 MW of small-scale PV projects still on hold.

As of mid-2018 four CSP projects were commissioned and operational: two 100 MW projects near Pofadder, a 50 MW project near Bokpoort and a 50 MW project near Upington – all in the Northern Cape province.[140] Another two 100 MW CSP projects in the same province were expected to come online by the end of 2018: a 100 MW project at Upington and a 100 MW project at Kathu.[141]

Table 6 shows the first five REIPPPP windows (to the end of August 2015), including two small-scale procurement windows now treated as one (Window 4.5).[142] In this period, 1,949 MW of solar PV was procured, 600 MW of CSP, 2,656 MW of wind energy, 49 MW of biomass/biogas, 18 MW of landfill gas and 19 MW of small hydro.[143] As mentioned earlier, the successful bids from Windows 3.5 and 4, totalling 2,300 MW in capacity (of which solar was 615 MW), were initially put on hold by Eskom but were allowed to proceed following a Ministerial decision in March 2018 and the signing of PPAs at the end of April. An "expedited bid window" of 1,800 MW (referred to as BW 4.5), launched in 2015, was still on hold as of mid-2018 pending assessment of the "affordability" and "value for money" of the proposals.[144] Procurement from the small-scale window, involving 10 approved solar PV projects of 5 MW each, was also on hold pending release of the new IRP later in 2018.[145] A further allocation of up to 1,800 MW was expected in the final quarter of 2018.

TABLE 6.
Summary of South African REIPPPP Procurement, as of April 2018

Technology	Window 1 2011	Window 2 2012	Window 3 2013	Window 3.5 2014	Window 4 2015	Small IP Window (4.5)	Total procured	PPA issued	Remaining allocation
	MW	MW	MW	MW	MW	MW	MW	MW	MW
Solar PV	632	417	435	0	415	50	1,949	1,899	626
Solar CSP	150	50	200	200	0	0	600	400	0
Wind	634	559	787	0	676	0	2,656	2,656	660
Biomass/ Biogas	0	0	24	0	25	0	49	86	202
Landfill gas	0	0	18	0	0	0	18		
Small hydro	0	14	0	0	5	0	19		
Total	1,416	1,040	1,464	200	1,121	50	5,291	5,041	1,488

Source: see endnote 142 for this section.

Tanzania has invested heavily in off-grid renewable energy technologies and particularly in small-scale hydropower and solar PV for mini-grids, some of which are connected to the national grid.

The country's Rural Energy Agency is active in the renewables field but is focused primarily on off-grid, distributed renewable energy, which is discussed further in section 3.

Utility-scale solar power previously has received minimal support in Tanzania, in part because the country has many small, off-grid diesel-powered facilities that can easily be converted to (or supplemented by) solar PV. As of July 2018 the only recent addition was the 5 MW NextGen solar PV facility at Kigoma, which had been constructed but was awaiting the signing of a final PPA with the national utility Tanzania Electric Supply Company Limited (TANESCO).[146] The private company NextGen is planning a series of similar 1 MW to 5 MW facilities, all connected to isolated mini-grids, to reach up to 40 MW of total capacity; as of February 2017 it had received a provisional licence.[147] Overall, Tanzania's Power System Master Plan anticipates 120 MW peak of solar by 2018.[148] However, the French development agency AFD and the government of India have committed to financing an additional 150 MW of solar PV in Kishapu Shinyanga, and a feasibility study for the project was in progress as of mid-2018.[149]

Zambia, with only 2 MW of installed solar capacity as of mid-2018, has opted for a rapid expansion by joining the World Bank's Scaling Solar programme and developing a FIT strategy.[150] Under Scaling Solar the World Bank's International Finance Corporation (IFC) agreed to support up to 500 MW of solar development in the country.[151] The first Scaling Solar round for 100 MW in Zambia, held in 2016, yielded two projects of 50 MW each and saw a new benchmark for low-cost solar power in sub-Saharan Africa.[152] The winner of the auction was a consortium of Neoen and First Solar, which jointly bid at just USD 0.0602 per kilowatt-hour (kWh).[153] In June 2017, 12 bidders were pre-qualified following the request for qualifications for Zambia's second round of Scaling Solar tenders for up to 300 MW of grid-connected solar PV projects.[154] A third tender was expected in late 2018 or early 2019, based on Zambia's GET FiT programme[i] and aimed at contracting 100 MW of solar PV in allotments of 20 MW each.[155]

Zimbabwe, with 4 MW of installed solar capacity as of mid-2018, is moving forward rapidly although still awaiting finalisation of its FIT programme, which will facilitate additional independent power production.[156] Two solar PV projects had been commissioned: Riverside (2.5 MW) and Notingham (1.5 MW).[157] Three larger projects promoted by the government-owned Zimbabwe Power Company were approved but awaiting financing: Gwanda, Insukamini and Munyati (100 MW each).[158]

Wind Power

Despite an estimated wind energy potential in the SADC region of approximately 800 TWh per year, only eight countries were identified as having current or planned wind energy capacity:

Lesotho, Madagascar, Mauritius, Mozambique, Namibia, Seychelles, South Africa and Tanzania.[159]

Lesotho had no installed wind power capacity as of mid-2018, but two projects had been approved by the government and were awaiting financing: Lets'eng (35 MW) and Semonkong (15 MW).[160] The Lets'eng project was reportedly on hold pending land issues. The Abu Dhabi Development Fund expressed interest in financing Semonkong, but no agreements had been signed and no firm dates established.[161] A feasibility study was under way and expected to be completed by end-2018.

Madagascar had no grid-connected renewable energy of any kind as of mid-2018. A study by the Renewable Energy Cooperation Programme of the European Union (EU) identified 2,000 MW of potential wind power capacity.[162] Plans to install 50 MW of wind energy capacity, identified in the 2015 *Status Report*, had not been implemented as of mis-2018.[163]

[i] GET FiT is the acronym for Global Energy Transfer Feed-in Tariff, a programme developed by the German development bank KfW. A more detailed discussion of GET FiT can be found in section 5, including GET FiT programmes in Mozambique, Namibia and Tanzania, as well as Zambia.

Mauritius' largest existing wind power plant as of mid-2018 was the 9.4 MW Plaine des Roche facility, which is fully operational.[164] In addition, a 1.28 MW facility on Rodrigues Island is operational, and a 29.4 MW facility at Plaine Sophie was scheduled for completion in 2019.[165] In 2017 the government of Mauritius published a request for expressions of interest for the development of offshore wind farms.[166]

In **Mozambique**, a small wind turbine (300 kW) was installed by a private sector developer at Praia da Rocha in Inhambane Province, used as a pilot to assess the potential for onshore wind.[167] The Renewable Energy Atlas developed by FUNAE has helped to identify the best areas for wind generation.[168] As a result, five new projects had been approved and were seeking financing as of mid-2018: Magure (100 MW), Tete (100 MW), Namaacha (60 MW), Manhica (50 MW), Xai-Xai (50 MW) and Praia da Rocha (30 MW).[169]

Namibia had 5 MW of existing wind energy capacity as of mid-2018, at an onshore facility at Ombepo in the coastal town of Luderitz.[170] In December 2017 NamPower signed a PPA for NAD 1.5 billion (USD 101 million) over a 25-year period with the private Namibian company Diaz Wind Power to develop a second 44 MW wind farm nearby, which was expected to be operational in 2019.[171] Earlier plans for a 72 MW wind farm at Luderitz and a 60 MW facility at Walvis Bay were reportedly shelved.[172] Namibia's National Integrated Resource Plan, in its Base Case, calls for 149 MW of wind energy to be developed between 2017 and 2035.[173]

Seychelles has not added any additional wind energy projects since 2015. As of mid-2018 the 6 MW wind farm near Port Victoria on the main island of Mahé remained the only such facility in the country. The farm was funded by the United Arab Emirates and Masdar but is owned and operated by the national utility, PUC.[174]

South Africa has continued to develop utility-scale wind energy, notwithstanding the delays in finalisation of contracts for Bid Windows 3.5 and 4 of its REIPPPP, which included 1,363 MW of wind energy projects procured during Bid Window 4 (Bid Window 3.5 was exclusively meant for CSP projects; see table 6). In total about 2,656 MW of wind energy was procured[i] during the first five bidding rounds of the REIPPPP.[175] The Centre on Scientific and Industrial Research estimated that by the end of 2016, 1,360 MW of wind energy was operational in South Africa from Bid Windows 1, 2 and 3, with another 624 MW from Bid Window 3 expected to be operational in 2017, bringing the total installed wind power capacity to 2.1 GW.[176] South Africa continues to lead the region in wind energy development, thanks to optimal conditions on its extensive coastlines.

Tanzania had plans to develop four onshore wind energy projects as of mid-2018: Singida I, II and III (50 MW, 200 MW and 100 MW, respectively) and Njombe (200 MW: Windlab 100 MW and Sino-Tan 100 MW).[177] Requests for expressions of interest for construction, management and maintenance of the Singida III project were issued in 2017 by Wind East Africa, the private developer, and construction was expected to commence in 2018.[178] Singida I, originally scheduled for development by the Export-Import Bank of China, had been put on hold as of mid-2018.

In **Zambia** and **Zimbabwe**, which are both landlocked, the potential for wind power generation is reportedly low. Wind energy has, however, been used for water pumping in the agricultural sector, mostly for water supply for livestock. Research is reportedly under way to explore the wind potential at high altitudes above 100 metres.

Bio-power and Biogas

The potential for bio-power (biomass-generated electricity) in the SADC region is estimated at 9,500 MW based on agricultural waste alone.[179] The potential for identified projects is 358 MW, of which "committed" projects comprise 228 MW.[180] A number of projects in the SADC region use waste biomass for the implementation of modern biomass-to-electricity projects, and several use waste-derived biogas for heating.

Bagasse (residue from sugarcane stalk) is already used for own-generation by sugar companies in seven Member States: Eswatini, Malawi, Mauritius, Mozambique, South Africa, Zambia and Zimbabwe. Although no other Member States have noted plans for expanding generation from bagasse, efforts to increase use of this energy source in both Malawi and Zimbabwe are expected soon. For example, in Zimbabwe plans are under way to increase generation from bagasse from 5 MW to 15 MW in Chisumbanje, pending the availability of land and water resources to expand the sugarcane estates.[181]

Eswatini plans to increase the co-generation capacity in its sugar belt by installing new capacity and improving boiler efficiencies in existing plants. As of mid-2018 there were also plans to develop a new 37 MW biomass plant using forestry waste, and the project developers were looking for financing.[182]

In **Lesotho**, biogas technology has been exploited previously, but poor workmanship and maintenance have reduced its success. The Technology for Economic Development programme, supported by the Energy and Environment Partnership (EEP), the Department of Energy and the University of Science and Technology Beijing, has installed more than 100 biogas plants for rural households across five locations.[183] Communal grazing lands used for cattle may provide an opportunity for biogas production.[184]

In **Mauritius**, the sugar industry practises co-generation for raising process steam combined with electricity generation. As of 2018 it generated over 140 MW of surplus electricity for direct sale to the national utility, in addition to 103 MW for own-use.[185] The country obtained another 3 MW of power from landfill gas.[186] In 2015 Mauritius announced the development of two municipal waste-to-energy projects, potentially producing 36 MW of electricity using ultra-high temperature gasification technology.[187] Mauritius listed three biomass projects as in an early planning phase as of mid-2018: a 75 MW coal/bagasse co-generation plant being developed by Alteo Energy Ltd, an upgrade of an existing 3 MW landfill gas plant to 4 MW, and a 15-20 MW waste-to-energy plant that was expected to be commissioned in 2021, for which a request for proposals had been launched.[188]

[i] The term "procured" refers to capacity that has been awarded in auctions; the term "operational" in this context means installed or commissioned.

Mozambique was developing three projects to use biomass waste for electricity as of mid-2018, totalling 120 MW in all. The only one to be commissioned so far is a 10 MW generator using bagasse from the Illovo Sugar Estate at Maragra. Similar facilities at Manica (50 MW) and Titimane (60 MW) were also being considered, but the latter has not been implemented as the national grid is being extended to that area.

In **South Africa**, biomass including landfill gas provided 69.5 MW of capacity to the electricity generation system in 2016.[189] In October 2015 the 4.6 MW Bronkhorstspruit biogas generation project, financed independently of the REIPPPP, became the first operational project of its kind, using methane from cow dung decomposition at a large feedlot near Pretoria as the main feedstock to fire a boiler and generator, and selling the electricity directly to an industrial customer (BMW South Africa).[190] A second project, the Cape Dairy Biogas Plant, is being developed in the Cape region by the same company (Bio2Watt), again using cow dung as the main biomass input.[191] The project was submitted to the REIPPPP under the Expedited RFP provision and was expected to be operational in late 2018.

In 2015 the South African company SAPPI received approval under Bid Window 4 of the REIPPPP for a 25 MW biomass-to-energy project at Ngodwana in the Mpumulanga province, using waste pulp from its paper mill.[192] This project was only confirmed in April 2018, when the Minister signed the delayed PPAs with the successful bidders.[193]

Only one of the two previously selected REIPPPP projects was a biomass project *per se*: Mkuze in KwaZulu-Natal, a 16 MW project generating electricity from sugarcane waste. The other was a landfill gas-to-electricity project: the 16 MW City of Johannesburg project, now partially operational.[194] About 7.5 MW of this project was approved under Bid Window 3 and was operational as of mid-2018.[195]

Tanzania obtained 19.7 MW of energy from biomass sources as of mid-2018 and was planning only one additional biomass project: the 2.5 MW Ngombeni wood-waste-to-energy project on Mafia Island, which will provide electricity to replace the power currently supplied by a local diesel-based mini-grid. The project was approved in 2016 as a Clean Development Mechanism (CDM) project and was expected to save 12,000 tonnes of CO_2-equivalent annually[i].[196]

Zambia obtained 43 MW of electricity from generation at sugar plants as of mid-2018, and the government was not planning for any expansion of bagasse-fuelled generation or of any other biomass sources.[197] However, the private sector company Consolidated Farms Limited, which already has a 6 MW bagasse plant that supplies internal requirements, announced plans to develop a second 40 MW plant for sales to the grid and was negotiating a PPA with the off-taker for 35 MW.[198]

Zimbabwe obtained 87 MW from generation at sugar plants as of mid-2018 and was planning additional biomass capacity at Chisumbanje, as noted above. The government had several pilot initiatives reviewing the use of biogas for home cooking and heating and was exploring the use of waste biomass for tobacco curing. An estimated 60 institutional biogas digesters had been completed in the country as of mid-2018, with 40 more under construction.[199] More than 300 domestic biogas digesters have been constructed in Zimbabwe since 2012.[200]

Biofuels: Trends in Transport

The use of renewable fuels in the transport sector is the main driver behind the SADC region's quest for local production of biofuels, although production of ethanol for non-transport uses such as cooking is also significant. As noted in the 2015 *Status Report*, Member States with a strong tradition of producing ethanol from sugar cane – Malawi, South Africa and Zimbabwe – are increasing production, although not without some setbacks. Angola, Mozambique, Tanzania and Zambia are also pursuing biofuels production.

Much of the innovation in this sector is based on changes to biofuel blending mandates and target-setting, which is discussed further in section 5. But significant changes also are occurring in the use of biofuels. In 2015 the main news was the development of projects for biodiesel using the Indian-originated crop, *jatropha curcas* – and their subsequent collapse. At the same time numerous efforts were made to expand ethanol production using alternative crops such as cassava and sorghum. With the exception of South Africa, there were no innovations in fuel efficiency or fuel switching that might hasten a reduction in fossil fuel use for transport.

Since publication of the 2015 *Status Report*, SADC Member States have made a variety of changes in public transport and the use of alternative fuels.

Eswatini has declared mandatory blending of up to 10% ethanol-blended fuel by 2022.[201] The ethanol is to be sourced from local ethanol distilleries (the Royal Swaziland Sugar Association and USA Distillers) where it is manufactured from molasses, the by-product of sugarcane processing. This policy has been submitted to the United Nations Framework Convention on Climate Change (UNFCCC) as part of the country's Nationally Determined Contribution (NDC). On biodiesel, a suitable feedstock that will not compete with food security was still under review as of mid-2018, and no decision had been made.[202]

Mozambique has introduced compressed natural gas (CNG) as an alternative bus fuel in Maputo and Mazola, and the country as a whole is looking at developing bus rapid transit (BRT) systems to reduce urban and peri-urban dependence on private taxi services, which add greatly to the country's fossil fuel dependency.[203]

In **South Africa**, the government had already committed to a short-term goal for biofuels production amounting to 2% of the total road transport pool.[204] According to the Biofuels Industrial Strategy, mandatory blending was expected to commence in October 2015, but this did not materialise, and as of mid-2018 the government was in the process of developing mechanisms to reduce the impact of large-scale biofuels production on food security and was also looking into a biofuels financial support or subsidy mechanism. An interdepartmental Biofuels Task Team was developing the Biofuels Regulatory Framework, and a new Biofuels Feedstock Protocol

[i] Ngombeni is part of a CDM Programme of Activities called the Tanzania Renewable Energy Programme.

The use of renewable fuels in the transport sector is the main driver behind the SADC region's quest for local production of biofuels, although production of ethanol for non-transport uses such as cooking is also significant.

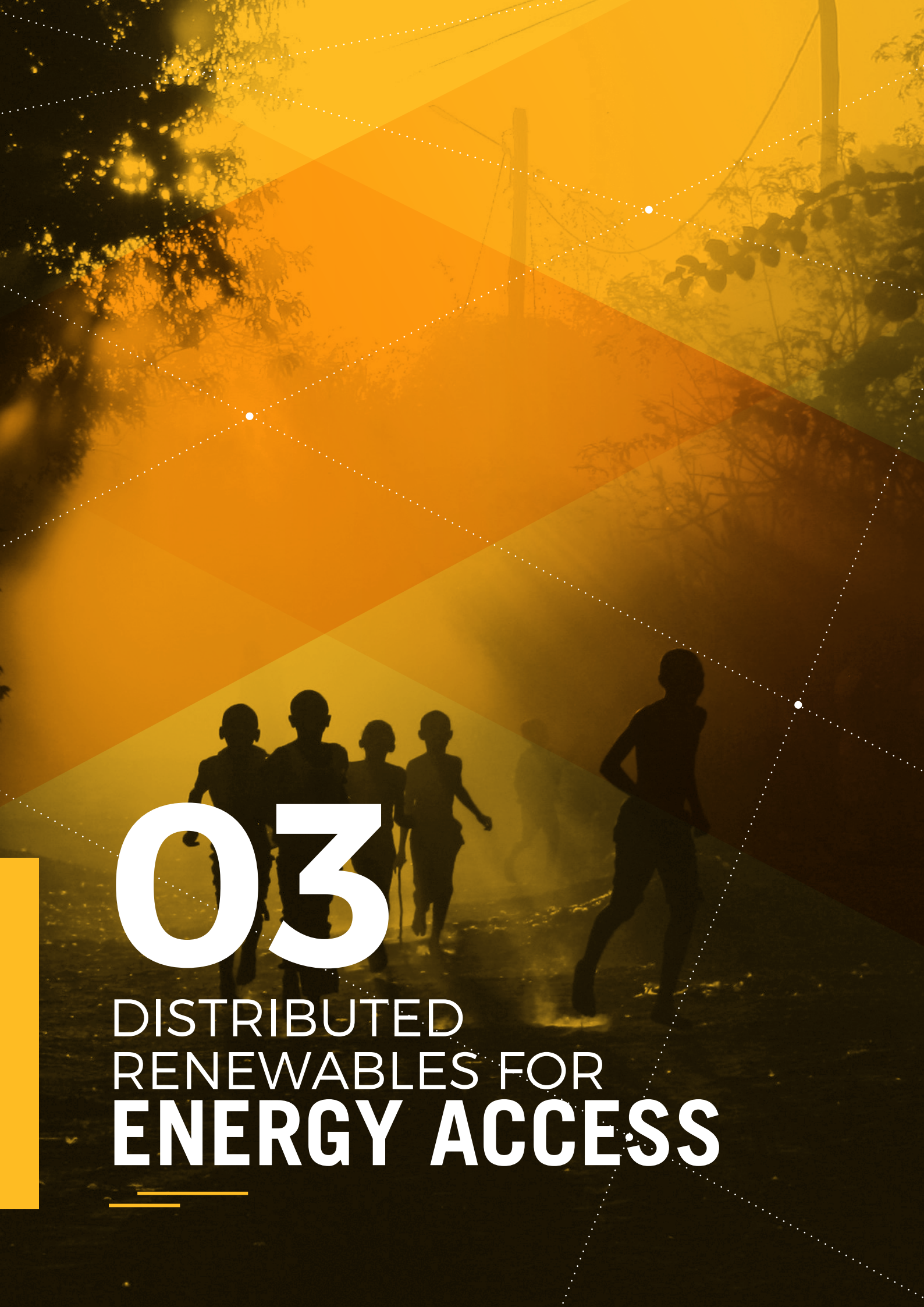
has been developed to safeguard concerns around the possible conflict between food security and the use of food crops to produce biofuels.[205] Among the conditions in the Protocol is the use of idle land for commercial and small-scale feedstock production under rain-fed conditions. Furthermore, the use of maize and potatoes for biofuel production is prohibited.[206]

Tanzania established in 2010 a set of Liquid Biofuel Guidelines, which remained in force as of mid-2018.[207] A 2017 study listed 18 biofuels production facilities, covering a wide range of crops from sugar cane (1 facility) to palm oil (2 facilities) to jatropha (12 facilities), and called for a moratorium on biofuels production until the government can ensure that these facilities are compliant with environmental law in the country.[208]

Zambia was an early leader in biofuels development, particularly the development of biodiesel from jatropha. Most of these early efforts failed due to the continuation of government subsidies for fossil fuel imports, which rendered biofuels uncompetitive. After the subsidies were removed in 2013 (in an effort to move towards cost-reflective pricing of energy products), interest in biofuels picked up, and in 2014 investments were announced for a USD 150 million cassava-based ethanol plant in Luapula province, based on a similar plant developed by China New Energy in Thailand.[209]

In 2016 the Copperbelt Energy Corporation, a privately owned electricity distributor, tendered for a market study to determine if there was a basis for expanding its existing biodiesel plant at its premises in Kitwe, which produces 1 million litres of biodiesel annually from soybeans and jatropha purchased from local farmers.[210] No results of the study had been made public as of mid-2018.

Zimbabwe announced an increase in the blending ratios for ethanol to 20% (E20) in June 2018.[211] A recommendation to institute biodiesel blending at 5% (B5) failed to take off owing to challenges in the availability of feedstock.[212]



03

DISTRIBUTED RENEWABLES FOR ENERGY ACCESS

03
DISTRIBUTED RENEWABLES FOR ENERGY ACCESS

Distributed renewables for energy access (DREA) refers to any renewable energy supply system or technology that operates independent of the national grid. The term may include both rural off-grid systems and systems providing energy to urban populations in grid-connected areas where supply is unreliable or where consumers cannot afford high upfront costs to access grid electricity. Distributed renewable energy (DRE) systems are increasingly used to improve energy access to populations and communities in low-income and peri-urban as well as rural areas.

While DRE systems also can be connected to the grid, they are typically small-scale. The most common units are 1-100 kW power plants located at or near electricity end-users, but DRE systems may also include systems for cooking, heating and cooling that generate and distribute services independently of any centralised system. They are sometimes found in urban areas but are most commonly found in rural areas. The technologies used in DRE systems include solar PV, small-scale hydropower, small wind turbines, methane digesters and direct biomass combustion devices (including clean cook stoves).[1]

ACCESS TO ELECTRICITY AND NATIONAL ENERGY TARGETS

Most SADC Member States have developed national energy access and renewable energy policies, which include targets for implementation. Improved access is typically linked to electrification – that is, the percent of the population that is able to access electricity through either the main grid or mini-grids. Table 7 shows Member State targets for the share of renewables in the energy mix and table 8 describes electrification/energy access targets.[2]

TABLE 7.
Renewable Energy Share Targets in Selected SADC Member States, 2020/30

	Renewable energy share targets (%)
Eswatini	50% of electricity by 2030
Madagascar	54% of final energy by 2020
Malawi	7% of final energy by 2020; 10% by 2050
Mauritius	35% of electricity by 2025
Mozambique	24.4% new renewable installed capacity by 2030
Namibia	70% of grid electricity by 2030
Seychelles	15% of electricity by 2030
South Africa	50% of electricity by 2030
Tanzania	50% of electricity (including off-grid) by 2030; >2.6% energy efficiency (per year)

Source: see endnote 2 for this section.

TABLE 8.

Electricity Access in SADC Member States, 2016, and Targets for Energy Access for 2020/2030

	Energy/electricity access (%) 2016			People without access to electricity in 2016 (millions)	Energy access targets (%)
	Total	Urban	Rural		
Angola	41	69	16	17	100% electricity access by 2030
Botswana	61	78	37	1	100% electricity access by 2030
DRC	17	78	–	68	60% electricity access by 2025
Eswatini	66	83	61	<1	100% electricity access by 2030; 75% by 2018; 85% by 2020
Lesotho	34	66	16	1	40% electricity access by 2020
Madagascar	23	67	17	19	–
Malawi	11	42	4	16	30% electricity access by 2030
Mauritius	100	100	100	–	–
Mozambique	24	65	5	21	100% electricity access by 2030; 30% modern cooking fuels by 2030
Namibia	56	77	29	1	50% modern energy services by 2020; 100% electricity access by 2030
Seychelles	100	100	100	–	–
South Africa	86	93	68	8	100% electricity access by 2025[1]
Tanzania	33	65	17	36	75% electricity access by 2030
Zambia	31.4	67.3	4.4	11	66% electricity access by 2030
Zimbabwe	38	86	16	11	100% electricity access by 2030; 90% by 2030 (urban); 51% by 2030 (rural)
SADC	48	75	32	49	–

[1] South Africa's target is to reach 100% electricity access by 2025, which requires connecting 90% of the 3.4 million outstanding households to the grid (formal metered supply) and the remaining 10% using non-grid technology solutions. The National Development Plan, however, sets the target for universal access at 97% grid connections by 2030 with the remaining 3% using non-grid technologies. See Department of Energy of the Republic of South Africa, "New Household Electrification Strategy" (Pretoria: 2013), p. 8.

Source: see endnote 2 for this section.

As shown in table 8, the national targets are not uniform across Member States and are set for different time frames, with some Member States not having specific targets. Overall, average electricity access in the region in 2016 was 48%.[3] To increase energy access, Member States are employing a wide range of strategies, including setting up or continuing their support for dedicated institutions with the mandate to improve electrification and energy access, with a particular focus on rural areas far from the electricity grid.

RURAL ELECTRIFICATION AND THE ROLE OF RENEWABLE ENERGY

Rural electrification is a major focus of programme development in the region, and Member States increasingly consider the option of distributed generation and mini-grids as part of their rural electrification programmes. Several SADC Member States have met this challenge by developing specialised agencies to implement these policies. Typically, rural electrification agencies or authorities are based within, or closely associated with, the major national utility. Examples of such agencies are described briefly below.

Eswatini has a Rural Electrification Unit within the Department of Energy that aims to electrify a minimum of 10,000 households annually to achieve universal electricity access by 2030.[4] This is subject to the availability of funds on an annual basis.

Malawi has developed a slightly different approach, creating a Rural Electrification Fund that is administered by the Malawi Energy Regulatory Authority and funded by a levy on the tariff.

Mauritius' new Renewable Energy Agency (MARENA) is responsible for "creating an enabling environment" for renewable energy in the country.[5] As the population is nearly 100% grid-connected, there is no requirement for an agency promoting grid extension.

Mozambique's Fundo de Energia (FUNAE)[i] was set up as a financially and administratively autonomous agency to develop renewable energy projects, mostly off-grid.

Namibia has a Rural Electrification Programme that is administered by the Electricity Division of the Ministry of Mines and Energy and funded by NamPower and regional electricity distributors[ii]. In 2017, as part of the Implementation of the Renewable Energy Policy, a proposal was made for the formation of a Rural Energy Agency, but it was rejected by the Cabinet, suggesting that the stakeholders should instead use existing institutions to implement rural electrification, for example the national utility through a special fund maintained by a tariff levy.[6]

Tanzania's Rural Energy Agency, which administers the Rural Energy Fund, is independent of the national utility TANESCO and is supported by a 5% levy on commercial energy sales.

Zambia's Rural Electrification Authority is tasked with carrying out the country's Rural Electrification Master Plan.

Zimbabwe's Rural Electrification Agency operates through a fund derived from an electricity tariff levy of 6% and is administered by a board that reports to the Minister of Energy and Power Development.

The use of special tariff levies for funding rural electrification is widespread, and all of the specialised agencies or authorities mentioned above are dependent on a levy of some kind.

Table 9 summarises trends in rural electrification in the SADC region and indicates which countries have appointed specialised agencies to address it, and what targets have been established to expand it.[7] Countries with specific rural electrification targets include Angola, Botswana, the DRC, Madagascar, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe. The target date for South Africa's rural electrification plans has shifted to 2025 considering the universal access date stated in the National Development Plan of 2013.

[i] FUNAE was established in 1997 as a public institution. Its objectives are to develop, produce and use different forms of low-cost power and promote the conservation and rational, sustainable management of power resources. The bulk of its financing has been provided by international funding/donor agencies. Although FUNAE is designed to catalyse and enable rural electrification, it is also operating and maintaining off-grid electricity supply, in a role as a utility.

[ii] NamPower and the regional electricity distributors only fund and implement part of the electrification programmes. The main implementer of rural electrification is the Ministry of Mines and Energy.

TABLE 9.
Rural Electrification Targets and Programmes in SADC Member States

	Rural electrification target	Target date	Programme name/ Data source
Angola	8 million people, 1.2 million households	2016	Rural Electrification Programme 2012
Botswana	400,000 people	2021	National Decentralised Rural Electrification Programme (BPC and BPC Lesedi)
DRC	50% rural electrification	2025	IFC / Lighting Africa
Eswatini	100% access	2019	Rural Electrification Unit within SEC, supported by government of Taiwan
Lesotho	100% access to modern energy services	2030	GEF and government of Japan funding off-grid renewable energy programmes
Madagascar	70% electricity access	2030	National Development Plan (PND) and New Energy Policy (NPE)
Malawi	30% access (from current 11%)	2030	Rural Electrification Plan administered by the Malawi Energy Authority
Mauritius	100% access	Achieved	–
Mozambique	10.3 million people (up from 1.3 million), of which 3.7 million are to be supplied with off-grid solar PV	2014	FUNAE and Electricidade de Mozambique
Namibia	2,157 localities; about 52,000 new connections; 810 schools; 360 clinics	2031	Namibian Rural Electrification Master Plan administered by NamPower
Seychelles	100% access	Achieved	–
South Africa	97% grid access for all households (rural and urban), with the remaining 3% being met with off-grid solutions	2030	National Development Plan
Tanzania	30% access (from current 18%)	2030	2012 Power System Master Plan, Rural Energy Agency
Zambia	30% access (from 3% in 2012); 1,217 households	2030	Rural Electrification Authority
Zimbabwe	100% access, with initial focus on rural schools and health centres	2040	Rural Electrification Agency

Source: see endnote 7 for this section.

Many Member States have specifically included renewable energy as part of efforts to meet their targets. For example, Zimbabwe includes solar PV, small-scale hydropower, and bagasse-based and biogas generation, while Zambia includes mini-hydropower, solar PV systems and solar mini-grids. Lesotho has received support from UNDP/GEF for a Renewable Energy-Based Rural Electrification Project and also from Japan for using renewable energy in income-generating activities in off-grid areas.

The trend in rural electrification in the SADC region is moving strongly towards the use of mini-grids and/or household solar systems and other mini- and pico-scale technologies, as national utilities face significant financial constraints that have hampered their capacity to meet government targets for energy access and grid extension.

OFF-GRID POWER GENERATION

As noted earlier, the trend in rural electrification in the SADC region is moving strongly towards the use of mini-grids and/or household solar systems and other mini- and pico-scale technologies, as national utilities face significant financial constraints that have hampered their capacity to meet government targets for energy access and grid extension. To improve the rate of uptake, most Member States offer subsidies of some kind for the installation of off-grid systems, recognising that rural households will rarely have the financial capacity to pay for the technologies themselves.

In **Eswatini**, the recently reviewed National Energy Policy and update of the implementation strategy that commenced in January 2018 prioritises the use of solar home systems and micro grids, particularly for rural areas deemed too expensive for grid extension.

In **Lesotho**, under the UNDP/GEF-funded Lesotho Renewable Energy-Based Rural Electrification Project, the Lesotho Solar Energy Society was reactivated from dormancy; of the 5,000 households expected to benefit, just over 1,500 had benefited as of mid-2018.[8] The National University of Lesotho certified 19 solar PV practitioners, and 50% of solar dealers received training.[9] A credit guarantee scheme was provided for off-grid rural areas to enable residents to access loans.

Lesotho is implementing an SEforALL project with UNDP/GEF that is aimed at developing cornerstone policies and establishing a financial support scheme to assist in de-risking private sector renewable energy investment and helping the private sector develop bankable projects. Under the project Lesotho plans to increase energy access by developing mini-grids and energy centres.

In **Malawi**, biomass dominates energy consumption, providing 99.4% of energy use in rural areas and 35% in urban centres.[10] (This is followed by liquid fuels at about 6%, electricity at 2.3% and the rest from coal and solar power.[11]) Households are the main energy market, using up to 83% of the total energy, followed by manufacturing industries at 11.9% and the service industry at less than 2%.[12]

Due to the dominance of household uses, there is considerable potential for mini-grids in rural areas of Malawi, where the cost of connecting to the national grid may be prohibitive. With only 30% of the rural population planned to be grid-connected by 2030, the rest will be served through mini-grids and solar PV.[13] By 2016 an estimated 5,000 solar home systems, 2,000 solar water heaters and more than 7 off-grid mini-grids were supplying electricity to about 900 people nationwide.[14]

Based on current sales volumes provided by Sunny Money, pico solar products are rapidly becoming an alternative source for lighting in Malawi's rural areas, replacing the dominant wick paraffin lamps.[15] Pico solar, if used as a substitute for a paraffin or kerosene lamp, can repay itself in three to four months.[16] The market for electricity appliances and other services lies in lighting, communication technology (phone charging, TV, radio), ventilation, refrigeration, etc.

Malawi's targets for renewable energy technologies by 2030 are: 75,000 solar home systems, 13,500 mini-grids and 4,500,000 pico solar products.[17] This presents an opportunity for a growing market of pico solar products and other solar systems as communities become aware of the advantages of the technology, and also as distribution channels and consumer financing services become better developed.

In **Mozambique**, solar PV home systems are used for off-grid electrification and for mini-grids and stand-alone solutions. FUNAE has supported two such mini-grids, each just under 500 kW. After assessing more than 10,000 villages for their potential for small-scale renewable or hybrid systems (5 kW to 100 kW), FUNAE found that solar hybrid and wind hybrid systems would be the most economical.[18] Several successful biogas projects have been supported, but no structured process is in place to use the learning from these projects to introduce biogas on a larger scale.

The vast majority of households in Mozambique use charcoal and fuelwood for cooking at home; less than 5% of households use a modern form of energy.[19] In rural areas, where most of the population lives, 97% of households rely on wood for their energy needs.[20] In urban areas, charcoal has become the fuel of choice, accounting for over 50% of all energy expenditure.[21]

The traditional biomass energy sector in Mozambique is vibrant, stimulated in part by FUNAE's impetus to expand rural electrification in its role as an alternative, off-grid utility. FUNAE has implemented close to 1,000 off-grid projects, including mini-grids. The principal management model has been to oversee the implementation of projects directly and to undertake quality control of installations and equipment. Although this has resulted in speedy installations, it has failed to generate local jobs in the private sector because FUNAE uses internal resources to operate and maintain systems. This model has created the perception that the government will provide energy access at low cost, limiting private sector engagement.[22] In a bid to improve the local market, FUNAE has established a factory to produce solar panels. But because FUNAE's services are subsidised, and tariffs are required to conform to national tariffs, FUNAE's multiple roles are seen as dampening the market for the private sector.[23]

SEforALL's assessment of mini-grid markets in Mozambique, summarised in table 10, provides an overview of the market potential based on the average annual energy expenditure and the potential population.[24] The potential is most significant for stand-alone systems in terms of area covered and ease of deployment.

TABLE 10.
Estimated Market Sizes in Mozambique for Grid Extension, Mini-grids and Stand-alone Systems

Province	Grid extension (population)	Mini-grids (population)	Stand-alone systems (population)	Mini-grid share (%)	Mini-grid market size (USD)
Cabo Delgado	497,884	326,164	1,103,480	16.9	3,668,954
Gaza	844,965	35,039	289,038	3.0	394,147
Inhambe	761,645	288,211	475,893	18.9	3,242,028
Manica	1,713,050	12,788	150,977	0.7	143,850
Maputo	1,012,150	1,889,140	277,503	59.4	21,250,558
Nampala	3,020,700	717,449	1,084,450	14.9	8,070,440
Niassa	738,654	25,853	840,300	1.6	290,815
Sofala	857,987	451,958	431,554	26.0	5,083,985
Tete	788,869	510,900	1,228,760	20.2	5,747,012
Zambezia	1,426,630	1,361,990	1,988,490	28.5	15,320,753
Total	**11,662,534**	**5,619,492**	**7,870,445**	**22.3**	**62,921,727**

Source: see endnote 24 for this section.

In **Namibia**, a country with low population density, the challenge is to provide electricity access to the 79% of the rural and sparse population that does not have access by establishing feasible and maintainable off-grid solutions. The Rural Electricity Distribution Masterplan 2010 prioritises 2,879 rural localities to be electrified in the next 20 years and identifies 27 localities for off-grid electrification (including via renewables); however, implementation has been limited.[25] So far the country has developed several pilot mini-grids, including three off-grid systems: Gobabeb, Tsumkwe Mini Grid and Gam Solar PV Mini Grid.

In rural and remote areas where neither the main grid nor mini-grids are available, consumers depend on stand-alone electricity sources, mainly diesel generators. The use of solar technologies has been increasing, and hybrid solar/diesel systems have proved to be technically sound off-grid solutions.[26] The Solar Revolving Fund under the Ministry of Mines and Energy continues to subsidise stand-alone solar systems for individual household use: between 2015 and 2017, it financed some 1,600 solar systems (water heaters, pumps and solar home systems).[27]

EEP Africa supported a very successful biomass energy project that is harvesting invader bush – which covers substantial areas of northern Namibia – for use in a steam boiler. The project, Combating Bush Encroachment for Namibia's Development, has installed a 250 kW bush-to electricity gasification pilot power plant on a commercial farm in the heavily bush-infested Otavi area. The plant, which was not yet operational as of mid-2018, is considered as a proof-of-concept project to determine the financial feasibility of this approach, assess the robustness of the technology and establish Namibia's first IPP.[28]

Non-electricity off-grid renewable energy projects include the small/micro wind energy installations used for water pumping, which are very common in Namibia, especially on farms. This technology has been used successfully for decades, with about 30,000 wind-driven water pumps installed in the country as of 2005; however, the current trend is to replace these with solar energy sources.[29]

Seychelles' solar PV systems are mostly off-grid, especially for outlying islands that are not connected to the national grid. As of mid-2018 an estimated 68 kW of power was being generated from 13 known grid-independent systems, including 25 kW at the Aldabra Atoll Research Station, 7.5 kW in the Aride Nature Reserve, 2 kW in the Curieuse National Marine Park and 5 kW on Cerf Island.[30]

In **South Africa**, the availability of renewable energy products and technical expertise for off-grid applications is relatively high. Under the New Household Electrification Strategy the government aims to electrify some 300,000 households with non-grid solutions by 2025.[31] Since the early 2000s the country has introduced solar home systems to rural households that were too remote to be connected to the grid. Identification of these villages was done in close collaboration with Eskom and municipal distribution development planning to ensure that only households that would not be grid-connected for at least five years on average would receive solar home systems.

These systems were seen at the outset to be a temporary solution, and involved mainly stand-alone systems ranging from 50 watts peak (Wp) to 100 Wp. The 100 Wp systems were introduced starting in 2012 and were provided to both existing and new

customers. The non-grid service is offered on a fee-for-service basis: customers pay a one-off connection fee towards the installation, followed by a small monthly service fee that covers lifetime running costs including operation and maintenance, replacement of batteries, fee collection and customer support. The government subsidises about 80% of the capital costs of the systems, and 100% for households classified as indigent, using the government free basic services grant.[32]

However, local communities have lacked trust in off-grid solutions, particularly those provided for free, and some residents view this approach as an indication that the government is resigning its responsibilities to provide promised grid connection (which often is perceived to be superior to off-grid supply). Projects such as iShack[i] have encountered difficulties in obtaining buy-in from peri-urban or rural residents who fear that the government may change its priorities for investment if it sees that communities have found their own solutions.[33] One way to address the social perception of the inferiority of off-grid supply would be to provide a comparable level of service to grid connection and to establish demonstration projects – for example, in urban areas and in public sector institutions – to increase their credibility.

Some non-governmental off-grid schemes exist in South Africa, but scale has not been achieved in biogas, solar home systems, mini- or micro grids, solar kiosks or appliances. A segment of private sector suppliers – for example, Kestrel Renewable Energy Installations – is servicing the energy needs of the household and agricultural sectors, primarily providing small-scale solar PV and solar water pumping services.[34]

Tanzania provides an example of a successful rural electrification programme that has avoided subsidisation by shifting the burden to the private sector, developing a standardised PPA that encourages investment by IPPs using renewable energy.[35] Private entrepreneurs have boosted the country's renewable energy development by developing innovative solar projects using a pay-as-you-go approach for off-grid projects.[36] The main market growth is in solar home systems, with Off-Grid Electric taking off in the north and Mobisol and BBOXX penetrating the PAYG market.[37] The PAYG leased model increases accessibility by removing the one-off capital cost, and, in some cases, maintenance of the system is taken care of during the contract lifetime.

Tanzania's Rural Energy Agency and the Ministry of Energy and Minerals have placed specific focus on stand-alone and mini-grid systems. Under the Sustainable Solar Market Packages programme, which sought to stimulate the private market to deploy solar equipment, small power producers were encouraged to build local energy networks using results-based financing through local financing institutions.[38] The programme also facilitated the distribution of solar products by providing a one-stop shop for public institutions to obtain solar PV. However, market confidence in solar products has been shaken due to equipment spoilage related to the entry of inferior goods into the market. Lighting Africa has been working with government officials to address this.[39]

Since 2008 the World Bank has implemented the Tanzania Energy Development and Access Expansion Project to address urban electricity access and rural energy access.[40] The EU, through the ACP-EU Energy Facility, has supported several off-grid IPPs, including the 4 MW Mwenga run-of-river hydropower plant and JUMEME's solar hybrid mini-grid models.[41] EEP Africa has supported companies in developing 12 stand-alone mini-grids.[42] Devergy, in partnership with Energy4Impact, is piloting the use of solar micro-grid systems to power larger appliances, such as refrigerators, as well as agricultural equipment.[43] E.ON is working with non-governmental organisations to build productive uses, aiming to install 100 new mini-grids in the country in the next few years.[44]

In total Tanzania had at least 109 mini-grids as of 2016, with an estimated installed capacity of 157.7 MW and serving about 184,000 customers.[45] Sixteen of these plants were connected to the national grid (with the power sold to the national utility, TANESCO), and the remaining 93 operated as isolated mini-grids.[46] Hydropower was the most common technology (49 mini-grids); however, the 19 fossil fuel-based systems accounted for 93% of customer connections and for almost half of total installed capacity.[47] Tanzania also had 25 biomass mini-grids and 13 solar mini-grids (10 of them small donor-funded, community-owned demonstration projects).[48] There were no wind power mini-grids in the country as of mid-2018.

Zambia has a growing market for solar home systems and mini-grids, and hydropower mini-grids also are being implemented. The product range includes solar home systems for households (6 Wp to 250 kW) and schools and health centres (100 Wp to 600 Wp), solar lanterns as well as solar pumps for irrigation. Irregular household cash flow, however, has limited people's ability to pay for these products, even though solar importers and distributors have developed innovative financing models such as fee-for-service and PAYG. The ability of consumers to make informed purchasing decisions is also limited by a lack of awareness about solar power and its possibilities, a lack of information regarding available financing options, and a lack of understanding of the differences between good and poor-quality products (which has resulted in the entry of sub-standard products). All of these factors pose a major constraint to expansion of the Zambian market.

Since early 2017 the Energy Regulatory Board (ERB) has collaborated with the Zambian Bureau of Standards (ZABS) and the Zambia Revenue Authority to control the quality of renewable energy products at the point of entry. Only companies licensed by ERB are entitled to import products free of duties and value-added tax (VAT), and licence holders are required to meet quality standards set by ZABS. The tax exemption lowers the costs of these products and encourages consumers to purchase items only from licensed service providers. Some 28 solar companies hold licences from ERB to import household solar products.[49]

[i] The iShack Project is using solar electricity to demonstrate how green technologies can be used appropriately to incrementally upgrade informal settlements and slums and at the same time build local enterprising capacity and resilience within the community.

The Zambian renewables programme offers a 100% subsidy, but because its tariffs are the lowest in the region, the levy has generated insufficient funds to meet the electrification target, and implementation has been limited to 80 small grid-extension projects and 300 small solar PV systems for chiefs' palaces, schools and clinics.[50] Among the pilot solar power mini-grids is one with battery storage employing PAYG.[51]

Many examples of hydropower mini-grids exist in Zambia. Zengamina, a mini-grid located in the Ikelenge district, is powered by a 750 kW run-of-river hydropower plant. The grid consists mainly of 11 kV distribution lines, but a 15-kilometre-long 33 kV line had to be built to feed a large commercial farm and other households, as well as commercial customers along the way.[52] Additionally, a 1 MW small-scale hydropower plant at Shiwang'andu in the Chinsali District links reliable energy services with productive use activities to enhance employment opportunities in the rural areas of Zambia.[53]

SNV has instigated a revival of the biogas industry in Zambia.[54] For example, the Energy for Agriculture project, implemented during 2015-2018, has supported the construction of 3,375 bio-digesters in the Southern, Lusaka, Western, Central, Northern, Eastern and Copperbelt provinces. Its purpose is to provide farming households with access to clean energy, increased employment and income, and improved living conditions through the productive use of waste products (biogas and bio-slurry). Dairy farmers are expected to be able to use biogas as a fuel for powering milk chillers, and households will be able to use biogas for cooking. The size of the digesters ranges from 4 cubic metres (m^3) to 100 m^3, producing 1 m^3 to 25 m^3 of biogas per day at a cost of between USD 600 and USD 7,000, depending on the size and location of the installation.[55]

Zimbabwe offers a 100% subsidy for rural electrification at schools, health centres and chief's homesteads, although in practice a lack of funding has slowed implementation. The Rural Electrification Agency provides for the extension of the national grid to rural communities and also supports off-grid renewable energy solutions, such as solar mini-grids and biomass activities, through the Rural Electrification Fund. The Fund aimed to erect 50 mini-grids during 2018 in areas located at least 20 kilometres from the national grid.

Numerous potential micro-hydropower sites exist in Zimbabwe, particularly in the Eastern Highlands and at agricultural dams throughout the country. Practical Action has helped to install at least five schemes that are now operational: Himalaya (75 kW); NyaMWanga (30 kW, with 3,800 beneficiaries); Hlabiso (30 kW, with 3,800 beneficiaries); Ngarura (20 kW, with 5,500 beneficiaries); and Chipendeke (25 kW, with 4,000 beneficiaries and connecting 35 households, 5 businesses, a clinic, a school and a health centre).[56] However, these community-based schemes often struggle to deliver effective service due to challenges of governance and lack of professionalisation of the service. The role of the private sector is important in such schemes, but the absence of economies of scale makes them unattractive for private companies.

ACCESS TO CLEAN COOKING

To reduce rapid deforestation from the use of fuelwood for cooking, governments, the donor community and non-governmental organisations have heightened efforts to increase the manufacture, use and uptake of more-efficient cook stoves in the SADC region. Several Member States also have explored the use of domestic biogas systems for cooking.

Eswatini continues to promote the use of wood-efficient cook stoves in households and public institutions, such as schools.

In **Lesotho**, through collaboration with the EU under the 11th European Development Fund, the government signed a EUR 7 million (USD 8.1 million) financing agreement; a call for proposals for the distribution of energy-efficient appliances was advertised, and companies were identified to undertake the task of distributing improved cook stoves and other energy-efficient appliances.[57]

Manufacturers and distributors of improved cook stoves in Lesotho include Fairtrade International (FLO) and atmosfair (the Save80 model).[58] In 2013 the United Nations Food and Agriculture Organization assessed a project that trained farmers on stove construction using cow dung. Appropriate Technology Services has promoted the Mabotle, Thaba-Tseka and Nkokonono stove models, but uptake has been limited due to the multi-functionality of the traditional three-stone fire, which provides cooking, heating and light.[59] African Clean Energy has developed a stove manufactured in Lesotho that combines efficient cooking with a battery pack for a light and solar phone charging, but it is much more expensive than the simple stoves, at roughly EUR 40 (USD 46).[60]

In **Malawi**, more than 500,000 improved cook stoves were estimated to be in use in the country as of early 2017.[61]

In **Mozambique** efficient cook stoves have been distributed in Tete province in the vicinity of the bio-coal briquette factory. In **Namibia**, efficient cook stoves are being promoted annually at platforms such as trade fairs/shows.

In **South Africa**, a Biomass Action Plan is being developed with technical support from the Dutch government, and a newly launched Bioenergy Atlas is available online[i].[62] The technical support facility will support potential project developers in identifying potentials and exploiting them. Businesses are also using various distribution channels and models to market improved cook stoves and other renewable energy systems. For example, Restio Energy has distributed more than 32,000 stoves in addition to 1,700 household energy kits that include a solar light and phone charging capability.[63]

A new wood pellet technology was tried in South Africa but failed to take off, indicating the need to potentially subsidise the early stages of wood pellet market development and distribution until the market is large enough to maintain viability. The International Institute for Environment and Development suggests focusing on smaller-scale community-based biomass models, using local communities to establish distribution channels in combination with stove producers.[64]

[i] http://bea.dirisa.org/

In **Tanzania**, a campaign is being carried out to promote alternative energy sources for cooking, including LPG, biogas, briquettes and ethanol. The use of biomass is a major concern in Tanzania, representing 90% of total primary energy consumption in 2010 – primarily for cooking – and contributing to severe environmental (deforestation) impacts.[65] The country's SEforALL Action Agenda emphasises operationalising the Biomass Energy Strategy (BEST) to better regulate and reduce biomass use.[66]

The Tanzania Improved Cook Stove programme, implemented by SNV in collaboration with EnDev, has exceeded its target of reaching more than 60,000 households.[67] In addition to artisanal clay stoves, various manufactured stove brands are available on the market. To enhance impact, the entire value chain is being addressed, encouraging large-scale production of stoves and improved fuels.[68] Some businesses are experimenting with the "Nespresso model", offering the appliance at a low price and then recouping the cost through sales of the fuel required to run it.

Another cooking alternative in Tanzania is domestic biogas, which has an estimated potential of 165,000 installations nationwide over a 10-year time frame.[69] From 2009 to 2014 the Centre for Agricultural Mechanization and Rural Technologies and SNV constructed 11,013 biogas plants under the Tanzania Domestic Biogas Programme, greatly reducing biomass use for cooking.[70]

Potential also exists to use biogas to support dairy farmers in pasteurising milk and meeting their energy needs, and also to generate electricity.

Efforts to reduce dependence on traditional biomass for cooking will be assisted by the fact that many Member States are now linked to international programmes supporting the promotion of efficient cook stoves and are assisting countries to develop specific policies to achieve this, such as the Global Alliance for Clean Cookstoves (see sidebar 2).[71]

As of mid-2018 GACC was supporting one project each in Lesotho, Malawi, Mozambique and Zambia, relying on various financing facilities such as the Pilot Innovation Fund (up to USD 150,000), the Women's Empowerment Fund, the Catalytic Small Grants programme (up to USD 100,000), the Spark Fund (up to USD 500,000) and the Working Capital Fund in partnership with Deutsche Bank and the Capacity Building Facility.[72]

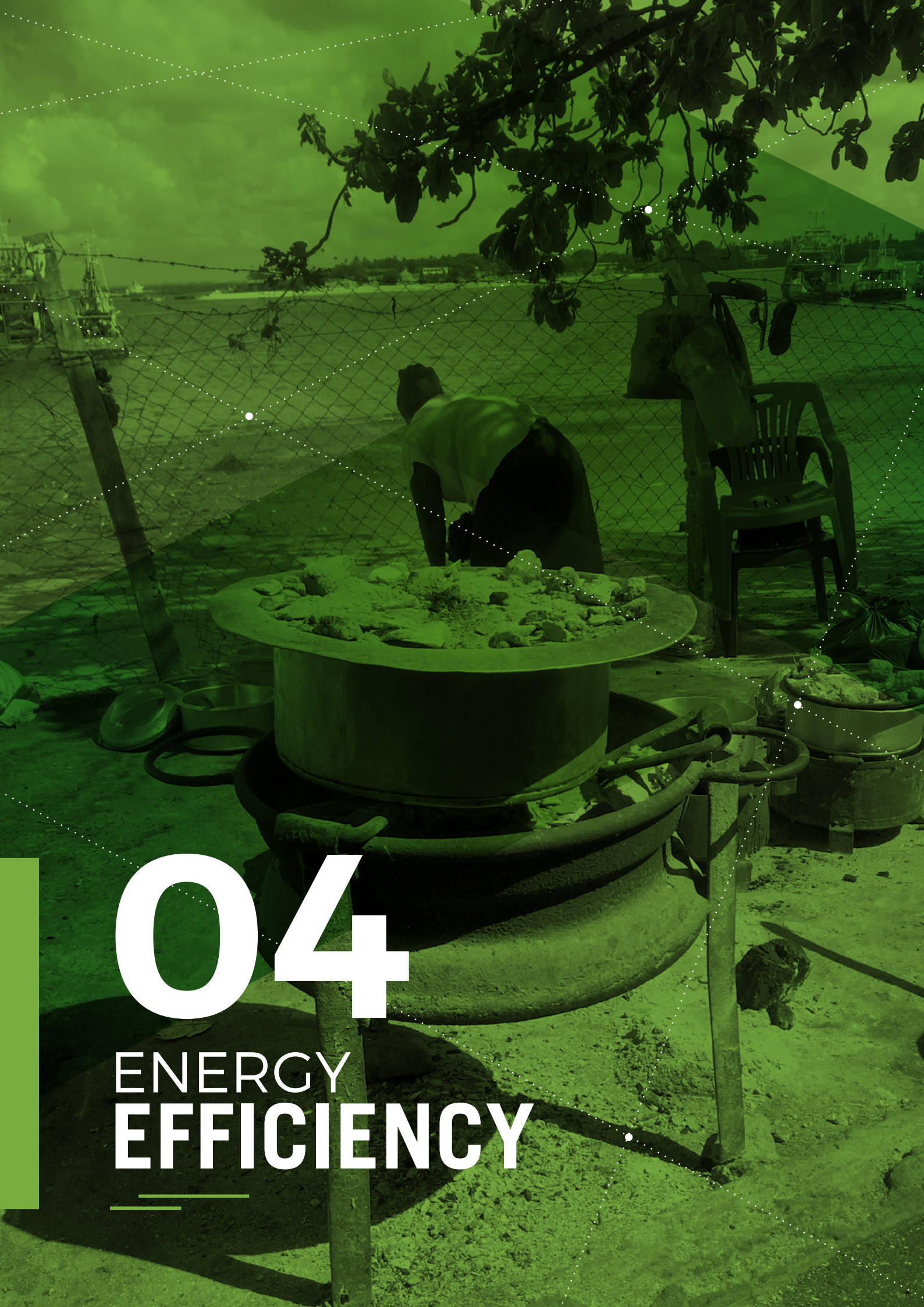
SIDEBAR 2.
Global Alliance for Clean Cookstoves

Six SADC Member States are now designated as "partner countries" in the Global Alliance for Clean Cookstoves (GACC) – the DRC, Lesotho, Malawi, South Africa, Tanzania and Zimbabwe – as compared to four in 2015. Partnership requires a commitment to support the adoption of clean cook stoves and fuels within national borders, taking a leadership role in employing clean cooking best practices and disseminating clean cook stoves and fuels.

Two Member States working with GACC also have established Lead Organisations that will guide their efforts to introduce improved cook stoves: the DRC (Alliance Congolaise pour les Foyers et Combustibles Améliorés[i]) and Malawi (the National Cook Stove Steering Committee).

GACC also distributes a Partner Country Toolkit that aims to assist partner countries by promoting a "10 Step Plan for Catalysing a Clean Cook Stoves and Fuels Market", including a number of specific policy initiatives, such as periodic status assessments and adopting technology standards and product testing.

Source: see endnote 71 for this section.



04

ENERGY EFFICIENCY

04
ENERGY EFFICIENCY

SADC Member States recognise the importance of energy efficiency as a cost-effective way to ensure energy security and reduce greenhouse gas emissions. As a key example, the recently launched Renewable Energy and Energy Efficiency Strategy and Action Plan (REEESAP) treats energy efficiency as the region's "first fuel". The SADC region has vast opportunities for energy savings through more-efficient technologies, fuel switching, change of habits and improved processes. A large untapped potential exists to enhance conservation measures across key sectors, such as buildings and air conditioning, heavy industry and transport – all of which have seen major growth in energy demand.

Energy efficiency needs to be supported at every stage, from primary energy extraction, through transmission, to the end-use of energy. Challenges are high, due to the diversity of energy uses and to problems with the availability of energy efficiency equipment and services. Key support for energy efficiency includes policy and regulatory measures, technologies and standards, capacity building, research and development, awareness raising and mobilisation of appropriate investments in related projects.

The SADC region's energy supply crisis, which began in 2007/2008, appears to have abated. According to SAPP, the region began registering an energy surplus in March 2017 (at 919 MW), and this is growing as new projects are completed and added to the SAPP system.[1]

The SADC region has vast opportunities for energy savings through more-efficient technologies, fuel switching, change of habits and improved processes.

A key sector performance indicator in the REEESAP, covering the 2016-2030 time horizon, is improved energy efficiency, which includes specific targets related to energy efficiency savings in grid use, the share of efficient charcoal production and improved energy Intensity, among others (see table 11 on page 64).[2] The strategy acknowledges the potential of both renewable energy and energy efficiency to diversify the SADC region's energy mix and reduce its energy intensity.

TABLE 11.
Select Sustainable Energy Targets for 2020 and 2030 Set in the REESAP

Targets	2020 (%)	2030 (%)
Cooking/heating efficiency	10	15
Ethanol blending ratio with gasoline	10	20
Biodiesel blending ratio with diesel	5	10
Energy efficiency % savings from grid consumption	10	15
Efficient charcoal production share in the charcoal market	5	5

Source: see endnote 2 for this section.

SACREEE INITIATIVES

As SACREEE enters its operational phase, among its activities are energy access (including clean cooking) and two specific programmes that address energy efficiency: the SADC Industrial Energy Efficiency Program (discussed below) and the SADC regional energy-efficient lighting initiative, which includes the development of a SADC Energy-Efficient Lighting Roadmap.

As part of implementation of the REEESAP, SACREEE is focusing strongly on the development and implementation of holistic regional energy efficiency programmes. The following demand-side management measures and energy efficiency options have been identified and highlighted as critical:

- awareness raising, including implementation of energy efficiency labels and minimum energy performance standards (MEPS);
- more-efficient technologies, including lighting, industrial equipment, efficient cooking, etc.;
- fuel switching, for example the use of LPG;
- load management, including ripple control and time-of-use-tariffs;
- electricity grid loss mitigation, for example with pre-paid and smart metering; and
- energy efficiency building codes and lighting upgrades.

SADC Industrial Energy Efficiency Program

With support from the EU Technical Assistance Facility, SACREEE is designing and developing a regional SADC Industrial Energy Efficiency Program (SIEEP), which is meant to support the implementation of the SADC Industrialization Strategy and Roadmap 2015-2063[i].[3] SIEEP will contribute to the competitiveness of the industrial sectors of SADC Member States by building their capacity to adopt, invest in and utilise energy-efficient technologies and practices. The target groups are medium- and large-scale industries.

A scoping study was concluded in October 2017, and the development of SIEEP commenced shortly thereafter. The draft workplan for SIEEP was submitted to SACREEE in May 2018. The objectives of the programme are contributing to the region's goals of 1) energising SADC towards adequate, reliable, least cost and environmentally sustainable energy service, and 2) long-term transformation of the SADC economy and creating the knowledge economy of the future.

Some of the expected impacts of SIEEP include:

- economically competitive industrial sectors through the adoption of energy efficiency and renewable energy;
- creation of a favourable climate for large-scale investment in renewable energy and energy efficiency; and
- employment growth in energy efficiency and renewable energy industries and increased energy security.

Most SADC Member States are completing the development of, and formally approving implementation of, their renewable energy and efficiency policies, strategies and action plans with clear and specific targets. Several Member States are exploring the introduction of MEPS, building efficiency standards and appliance labelling.[4]

REEESAP interventions are based on the development priorities of SADC, and Member States are free to choose and implement those actions that are most important to their development priorities. REEESAP is closely aligned with other SADC initiatives as well as global initiatives, and is expected to rapidly increase energy access and security at an affordable cost, setting ambitious regional and national targets for 2030. The overall scope of energy efficiency as envisioned by REEESAP includes energy intensity, transmission and distribution losses, demand-side management, technology and fuel substitution, and efficient buildings.

[i] The SADC Industrialization Strategy and Roadmap 2015-2063 has a long-term perspective and is aligned to national, regional, continental and international dimensions. The Action Plan covers Phase I and II of the Strategy, with specific focus on the first 15 years (2015-2030). The action plan was Approved by Summit in Lozitha, Eswatini on 18 March 2017.

ENERGY INTENSITY

Because of the lack of precise indicators of energy efficiency, primary energy intensity[i] is used as the international standard to monitor and identify trends in energy efficiency. Between 2011 and 2016 primary energy intensity worldwide decreased about 10%, or an average annual contraction of 2.1%, which was appreciably greater than the average decline during the preceding three decades.[5]

Energy intensity has generally improved in the SADC region, as shown in table 12.[6] The highest energy intensities persist in the same three Member States as reported in the previous *Status Report*: the DRC, Mozambique and Zimbabwe. The region's average energy intensity in 2015 (latest data available) was 7.9 megajoules (MJ) per USD of GDP, which is well below the 9.4 MJ per USD of GDP noted in 2012 but still above the global average of 5.13 MJ per USD of GDP.[7]

[i] Energy intensity is defined as the ratio of gross inland consumption of energy per unit of GDP. Due to limits on data availability, primary energy intensities are used for overall energy intensity comparisons, while final energy intensities are used for sectoral comparisons.

TABLE 12.
Energy Intensity in SADC Member States, 2012 and 2015

	Energy intensity, 2012 (MJ per USD 2011 of GDP)	Energy intensity, 2015 (MJ per USD 2011 of PPP GDP)	Change, 2012-2015 (%)
Angola	4	4	0
Botswana	3.1	3	-3.2
DRC	19.1	21	9.9
Eswatini	7.8	5	-35.9
Lesotho	11	10	-9.1
Madagascar	6.4	5	-21.9
Malawi	10.2	4	-60.8
Mauritius	6.2	3	-51.6
Mozambique	17.9	17	-5
Namibia	3.3	3	-9.1
Seychelles	4.5	3	-33.3
South Africa	9.3	9	-3.2
Tanzania	12.1	8	-33.9
Zambia	9	7	-22.2
Zimbabwe	17.5	16	-8.6
SADC	9.4	8	-14.9
World	5.1	5	-2

Source: see endnote 6 for this section.

ELECTRICITY TRANSMISSION AND DISTRIBUTION

The structure of national utilities in all SADC Member States remains the same as in 2015: all are vertically integrated and are responsible for generation, transmission and (with the exception of South Africa in most cases) local distribution.

Globally, notable improvements in the efficiency of electricity generation, together with the adoption of non-thermal renewable energy sources, have helped to reduce energy intensity. Between 2011 and 2016 the efficiency of electricity generation improved in all regions except Africa and Latin America, where it fell by 2.7% and 3.7%, respectively.[8] In the SADC region, utility performance and transmission and distribution losses remain major constraints in achieving efficiency goals.

Table 13 provides a comparison of transmission losses in SADC Member States in recent years, using data for 2014-2016 from SAPP and for 2016-2017 from the World Bank.[9] Transmission losses in 2017 averaged 5.97%, a slight drop from the 6.0% reported in the 2015 *Status Report*. South Africa's utility Eskom realised the most significant improvement, reducing losses from 3% to 0.1% on the back of a performance improvement and capacity build-and-expansion programme and improved maintenance of its ageing infrastructure.[10]

TABLE 13.
Transmission and Distribution Losses in SADC Member States, 2014-2017

	SAPP transmission losses			World Bank transmission and distribution losses	
	2014	2015	2016	2016	2017
Angola	11	10	10	11	10
Botswana	4	3.7	3.7	11	3.7
DRC	10	10	10	21	9
Eswatini	6	6	6	6	6
Lesotho	11	11	11	–	11
Madagascar	–	–	–	–	–
Malawi	8	9	9	–	6
Mauritius	–	–	–	6	6
Mozambique	6	6.4	6.4	15	6.4
Namibia	3	3.2	3.2	36	3.2
Seychelles	–	–	–	–	–
South Africa	3	3.3	3.3	8	0.1
Tanzania	6	6.1	6.1	18	6.0
Zambia	5	4.6	4.8	15	6.2
Zimbabwe	4	4	4	16	4
SADC	–	–	–	**10**	**5.97**
World	–	–	–	**8**	–

Note: Data are not available for Madagascar and Seychelles.
Source: see endnote 9 for this section.

New approaches and business models for energy efficiency are being implemented across the region, including many that are designed to attract and involve private sector players.

Non-technical electricity losses are a huge problem in the region, with the main challenge being the theft of underground and overhead copper cable. Losses gobble up funds that could otherwise be allocated to additional development or to energy efficiency initiatives. SAPP reported that non-technical losses in monetary terms increased 21% during the second half of 2016 as compared to the first half of the year.[11] The problem is so serious that SAPP has set up a Crime Prevention Working Group (CPWG)[i] that has developed a strategy to address the problem, including curbing vandalism and theft of utility infrastructure, which greatly affects reliability of supply. The CPWG actions and interventions are expected to reduce non-technical losses incurred through these incidences.

OTHER REGIONAL AND NATIONAL INITIATIVES

New approaches and business models for energy efficiency are being implemented across the region, including many that are designed to attract and involve private sector players. This is expected to contribute to the SADC Industrialisation Strategy and Roadmap 2015-2063.[12] The Revised Regional Indicative and Strategic Plan (RISDP) (2015-2020)[ii] identifies energy as a "key enabler" for industrial development that can contribute towards competitiveness of the region's industrial sector.

Table 14 summarises the major energy efficiency and demand-side management activities in SADC Member States as of mid-2018[iii].[13] The exchange of inefficient lighting for compact fluorescent lamps (CFLs) continues to be the most common initiative, occurring in 9 of the 15 Member States. This is followed by efforts to raise awareness about energy savings, as well as hot water load control programmes. The least common initiatives are efficiency standards and product labelling, the banning of incandescent lamps and the installation of pre-paid meters for utility customers. Additional regional activities were planned for late 2018 and beyond (see sidebar 3 on page 69).[14]

[i] The Crime Prevention Working Group held a meeting in Kitwe, Zambia from 5 to 6 February 2017 where these developments were discussed.
[ii] The RISDP is a comprehensive development and implementation framework guiding the Regional Integration agenda of SADC over a period of 15 years (2005-2020).
[iii] This table includes efficiency programmes and activities, not policy changes. The latter are provided in table 22 in the Policy Landscape section.

TABLE 14.

Energy Efficiency and Demand-Side Management Activities in SADC Member States and Utilities, as of Mid-2018

	Programme type														
	CFL exchange	Energy-saving awareness	Demand market participation	Time-of -use tariffs	Hot water load control	Solar water heating	Energy efficiency in buildings	Energy efficiency audits	Prepaid meters	General rehabilitation	Transmission line upgrade	Power factor correction	Distribution loss reduction	Standard and products labelling	Ban on inefficient lighting
Angola							■								
Botswana	■				■				■						
DRC															
Eswatini	■[1]	■		■			■	■	■		■	■	■		
Lesotho						■									
Madagascar	■								■						
Malawi	■											■			
Mauritius	■	■				■	■	■			■	■	■[3]	■	■
Mozambique	■								■	■					
Namibia	■	■		■	■		■								
Seychelles	■	■				■	■	■						■	■
South Africa[2]	■	■		■		■	■	■	■				■	■	
Tanzania	■														
Zambia	■	■		■		■			■			■			■
Zimbabwe		■			■	■		■	■						■

[1] The focus has been on free distribution of CFLs. The exchange programme has not begun, and regulations for banning of inefficient lighting are still under development.

[2] While inefficient lighting has not been banned, there has been a concerted effort to phase it out, starting with incandescent light bulbs and then shifting to increased promotion of LED lights instead of CFLs. A standards and labelling programme was also launched.

[3] Mauritius is not implementing MEPS but applies a 25% levy at customs on household electrical appliances that have an energy efficiency index below set thresholds.

Source: see endnote 13 for this section.

SIDEBAR 3.
Driving Energy Efficiency in the Region

An Energy Efficiency Lighting and Appliances project in Africa, funded by the Swedish International Development Agency, will cover the development of MEPS, appliance labelling, mapping and building up capacity in regional test laboratories. Implementation of Phase I began August 2018 across Member States of both SADC and the East African Community. The project consists of a market study (Phase I) followed by project implementation (Phase II) and is anticipated to run for five years with funding of EUR 7 million (USD 8.1 million).

An efficiency lighting project, co-ordinated by the Climate Technology Centre & Network and SAPP, will begin in 2019 for 10 SADC Member States (Botswana, Eswatini, Lesotho, Malawi, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe).

Source: see endnote 14 for this section.

Member States continue to enjoy support through their national utilities. SAPP has been collaborating with utilities through various working groups to help with strategies and activities that encourage efficiency through demand-side management and other initiatives.

ENERGY EFFICIENCY ACTIVITIES OF THE SOUTHERN AFRICA POWER POOL

Member States continue to enjoy support through their national utilities. SAPP has been collaborating with utilities through various working groups to help with strategies and activities that encourage efficiency through demand-side management and other initiatives. In 2017 SAPP reported a cumulative energy savings of 4,031 MW, compared to an installed operating capacity of 54,397 MW.[15] This was the result of interventions including programmes to promote CFLs, light-emitting diodes (LEDs), hot water load control, solar water heating and commercial lighting. Other savings were realised from industrial and mining activities.

Table 15 provides a summary of SAPP-instituted energy efficiency activities and related energy savings since 2015, and table 16 provides a summary of utility performance on energy savings through integrated demand management initiatives.[16] SAPP envisaged that regional energy savings would increase to 6,000 MW by the end of 2018, by which time the use of incandescent bulbs would be completely banned in all SADC Member States and a SAPP Energy Efficiency Framework Document would be in place.[17]

A task force has been formed to finalise this framework; it is expected to spell out how SAPP will roll out its energy efficiency programme, as well as participation of the private sector and energy service companies.[18] It also will address the need for consistent and scientifically derived data that facilitate proper reporting and policy formulation, end-use energy efficiency policies and harmonisation of equipment standards. Promoting partnership support structures with UN Environment on the Global Leapfrogging Program on Regional Efficient Appliance/Equipment strategy has been emphasised as well.[19]

TABLE 15.

Summary of Renewable Energy and Energy Efficiency Projects and Activities Supported Since 2015 by the Southern African Power Pool

	Name of activity or project	Scope	Expected start date	Expected end date	Energy impact (capacity or energy saved)
Eswatini	SEC IDM initiatives	LED street lighting, micro on-site generation, solar water heating and energy management	–	–	0.659 MW
Lesotho	LEC	Residential load control, promotion and installation of solar water heaters, solar PV installation and power factor correction	2017	2019	Savings of 1.816 MW; target 5 MW by end-2019
Mozambique	EDM IDM initiatives	Roll-out of split meters and CFLs, LED streetlights and solar water heaters, power factor correction and time-of-use tariff	2017	2020	Savings exceeds 37 MW
Namibia	NamPower 1mLED Campaign	Replacement of up to 1 million incandescent bulbs in the residential sector with LED bulbs	August 2016	June 2017	Savings of 3,314.98 MWh
South Africa	Eskom IDM initiatives	Hot water load control, CFL roll-out, solar water heating and commercial lighting	–	–	4,506 MW
Zambia	ZESCO IDM initiatives	Procurement of 4 million LED bulbs, roll-out of 700 units of low-pressure solar water heaters, commercial lighting and the distribution of 3.2 million CFLs	–	–	Cumulative savings of 145 MW as of mid-2018; total projected savings of 288.6 MW once all bulbs are distributed
Zimbabwe	ZESA IDM initiatives	Hot water load control, CFL and LED roll-out, and solar water heating	–	–	178 MW

Note: IDM = integrated demand management

Source: see endnote 16 for this section.

TABLE 16.
Summary of Utility Integrated Demand Management Programmes and Savings, as of Mid-2018

	Utility	CFL roll-out	LED roll-out	High-pressure solar water heater	Low-pressure solar water heater	Hot water load control	Commercial lighting
Eswatini	SEC	–	0.277 MW	–	0.382 MW	–	–
Lesotho	LEC	–	–	–	32 units installed, with targeted savings of 1 MW	0.816 MW	–
Mozambique	EDM	20 MW	17 MW	– [3]	– [4]	–	–
Namibia	NamPower	–	2.46 MW	–	–	–	–
South Africa	Eskom	2,100 MW	–	53 MW	41 MW	108 MW	219 MW
Zambia	ZESCO	3.2 million, units distributed with cumulative savings of 135 MW	4 million units procured, with targeted savings of 150 MW	–	3.5 MW	–	0.123 MW
Zimbabwe	ZESA	99 MW	2 MW	42 MW	10 MW	25 MW	–
	Total	**2,354 MW**	**21.737[1] MW**	**95 MW**	**54.882[2] MW**	**133.816 MW**	**219 MW**
	Total Savings	**2,878 MW**					

[1] Total does not include the savings from Zimbabwe. As of mid-2018 the project has been procured but actual savings are yet to be confirmed.
[2] Total excludes installations for Mozambique and Lesotho.
[3] Mozambique has 2 x 500 litre systems installed.
[4] Mozambique has 2 x 80 litre systems installed.

Source: see endnote 16 for this section.

STANDARDS AND LABELLING

Although the benefits of mandatory minimum energy performance standards and labelling programmes have been demonstrated globally, particularly in the EU, only two SADC Member States – Seychelles and South Africa – were implementing such programmes as of mid-2018. Mauritius is not implementing MEPS but applies a 25% levy at customs on household electrical appliances that have an energy efficiency index below set thresholds.

Seychelles has in place a regulation for MEPS, and a Solar Water Heater Endorsement Initiative – currently in place where standards have been established – is slated to be added as a regulation. A proposal for the country's first energy audit training is ongoing under the Energy Efficiency Program for the Public Sector.

South Africa is moving forward with both a mandatory MEPS and an efficiency labelling programme. These two initiatives are incorporated in a single programme, Market Transformation through Energy Efficiency Standards & Labelling of Appliances in South Africa. The initiative is part of a USD 13 million project to promote energy efficiency in the country, supported by UNDP/GEF and implemented in collaboration with the Department of Trade and Industry.

The objective of the project is to promote energy efficiency in the household sector by reducing the electricity demand of South African household appliances, with a resultant reduction in greenhouse gas emissions. This is to be achieved via the introduction of MEPS as well as standards and labelling into the appliances market in order to influence consumption patterns by raising awareness among policy makers, manufacturers, distributors and consumers.

The project also seeks to overcome the barriers impeding the widespread uptake of energy-efficient appliances and has focused on five key areas of activity. By mid-2018 it had achieved the following:

- established a policy and regulatory framework needed for a sustainable standard and labelling programme;
- defined energy classes and MEPS thresholds for 12 targeted appliances;
- strengthened the capacity of local institutions involved in the standards and labelling programme;

- implemented an appropriate education, awareness and communication campaign; and

- developed and implemented market surveillance and compliance procedures.

The objectives of the project are informed by South Africa's National Energy Efficiency Strategy of 2005, which calls for a 10% reduction in residential energy demand by 2015.[20] A 2014 Mitigation Potential Analysis has endorsed this approach by identifying energy-efficient appliances as the lowest marginal abatement cost option for reducing emissions in the country.[21]

LIGHTING

The exchange of incandescent light bulbs for CFLs remains the most common initiative by far in the SADC Member States and has increased significantly compared to the 2015 *Status Report*.

In **Eswatini**, Energy Management for Industry and Buildings, ISO50001, has been adopted as a National Voluntary Standard. One result is increased demand-side management activities that include distribution of CFLs.[22]

Malawi's national utility ESCOM achieved substantial demand savings in the first phase of its demand-side management project, which ended in April 2017. Launched in December 2016, the project is one of several ESCOM measures to reduce the impact of load shedding on customers and involves distributing 1.2 million LED bulbs in two phases: free distribution of the first 500,000 bulbs, followed by sale of the rest at a subsidised price of MWK 500 (USD 0.69).[23] The installation of all bulbs is expected to result in some 40 MW of saved power capacity, enough to supply around 45,000 domestic and commercial customers.[24]

In **Mauritius**, Incandescent lamps of 75 watts and above have reportedly been banned from importation since 2017.[25]

Namibia's national utility NamPower conducted a campaign from 2016 to 2017 to replace 1 million incandescent light bulbs with LEDs in residences nationwide. The demand-side programme, which targeted total energy savings of 30 MW, contracted with two companies known as LED Champions to facilitate the installation process.[26]

In **Seychelles**, the Government of Seychelles-UNDP-GEF Resource Efficiency Project, in collaboration with the Ministry of Environment, Energy and Climate Change, the Seychelles Energy Commission and the PUC, called for consumers to bring in their old incandescent bulbs for exchange during the launch of the National LED campaign in April 2017. This exercise, called Switch to LED, forms part of the government's national programme for energy efficiency in residences and targets the exchange of 200,000 LEDs for incandescent bulbs.[27] As of mid-2018 the campaign was ongoing at the PUC counters where customers pay their utility bills, until stocks were empty.

In **South Africa**, more than 65 million CFLs had been distributed to homes nationwide as of January 2017, making it one of the biggest energy-saving initiatives of its kind and earning Eskom both national and international recognition as an environmentally responsible utility.[28] The first phase of the programme targeted installing 5 million CFLs between November 2015 and March 2016 in five provinces.[29]

Tanzania, through the national utility TANESCO, launched a campaign to raise public awareness about the efficient use of electricity in households. In a USD 14.6 million project funded by the Swedish International Development Agency (SIDA), TANESCO planned to replace 3.2 million incandescent bulbs with energy-saving CFLs and LEDs, with expected savings of 37.9 MW.[30] The pilot phase started in the capital city of Dar es Salaam, which uses over half the electricity generated in the country.[31] However, SIDA was unable to sponsor the project due to sustainability considerations: disposal of the CFLs was a challenge because they contained mercury, and domestic customers often went back to using inefficient incandescent bulbs once the CFLs or LEDs expired. TANESCO also plans to work with industries to shift their power demand from peak hours and to reduce the use of emergency power during peak hours, which would lower demand by an estimated 100 MW and save the utility TZS 67 billion (USD 29.4 million) per year.[32]

In **Zambia**, the government introduced statute SI 74 of 2016 to ban the importation and local manufacturing of Incandescent light bulbs, effective January 2017.[33] As of February 2018 the national utility ZESCO had reportedly distributed more than 3.2 million energy-saving bulbs nationwide, for a total power savings of 145 MW.[34]

Zimbabwe banned all trade, manufacture and use of inefficient incandescent bulbs by a statutory instrument, SI 21 of 2017.[35] This was expected to save the country up to 40 MW of electricity, after the utility Zimbabwe Electricity Transmission and Distribution Company (ZETDC) carried out an exercise to replace inefficient lighting with CFLs.[36]

No major changes or activities in energy efficiency have been reported since 2015 for Angola, the DRC, Lesotho and Madagascar.

TRANSPORT

The energy intensity of the transport sector is affected by efficiency improvements within transport modes (rail, road, aviation and shipping) and by shifts between transport modes (for example, from private car use to public transport, or from road freight to rail).[37] Several SADC Member States are engaged in initiatives to improve transport efficiency, including through public transit projects and efforts to promote more efficient vehicles.

Madagascar plans to retire vehicles with more than 25 years of service from the country's roads, and the customs code now prohibits selling vehicles more than 10 years old in the local market.[38]

In **Mauritius**, the government launched construction of the Metro Express project, a light rail system that stretches for over 26 kilometres and is expected to be commissioned in 2021.[39] In a bid to promote the use of energy-efficient transport, the government reduced the excise duty on electric vehicles up to 180 kW and on hybrid cars below 1600 cubic centimetres (cc) from 55% to 25%,

and reduced the excise duty on hybrid cars of 1601 cc capacity and above from 55% to 30%.[40] The exemptions are reportedly not an effective measure as such, as the cost of hybrid vehicles remains relatively high. The number of hybrid cars in the country has increased but remains limited, and the availability of spare parts and proper maintenance support is an issue.

South Africa launched an electric bus programme in Cape Town with a fleet of 11 buses, which were expected to arrive by the end of 2017.[41] The City of Cape Town and the bus manufacturing company planned to open a local production plant for electric buses – possibly at the end of 2018 – with a view towards supplying the entire SADC region with the vehicles.[42] To offset the electricity consumed by the electric buses, which is largely coal-generated, the City of Cape Town aimed to install solar power at some of its bus and maintenance depots, as well as at bus stations.[43]

Elsewhere in the region, **Mozambique** introduced a metro bus service for Maputo and surrounding areas, **Namibia** introduced 26 new buses in 2016, and **Tanzania** developed an operational public bus rapid transit (BRT) system in Dar es Salaam.[44]

BUILDINGS

Several SADC Member States have taken steps to improve the efficiency of buildings, including through the development of standards and certification systems.

In **Botswana**, energy efficiency building guidelines have been developed, and an energy chapter was incorporated in the national building code.[45] Standards have been developed and are to be inserted in the technical booklet for building efficiency, all expected to be mandatory.

In **Eswatini**, the Eswatini Standards Authority is in the process of developing a National Standard for Energy Efficiency in Buildings: SZNS SANS 204. This is similar to the South Africa SANS 204 building standard that other countries are adopting/referencing. The standard specifies the design requirements for energy efficiency in buildings and of services in buildings with natural environmental control and artificial ventilation or air conditioning systems.[46]

In **Lesotho**, the National Energy Policy 2015-2025 and draft Sustainable Energy Strategy both advocate for renewable energy deployment and energy-efficient buildings.

In **Malawi**, penalties for low power factor have been implemented for the commercial/industrial and building sectors. The distribution of CFL and LED bulbs has been implemented together with the introduction of LED subsidies as a way of promoting energy efficiency in buildings.

In **Namibia**, the Namibia Energy Efficiency Programme in Buildings (NEEP), which began in 2011, provided energy audits of commercial buildings and training for building professionals until 2014. The NEEP also created a set of energy-efficient design guidelines for buildings and stimulated the founding of the Green Building Council (GBC) of Namibia, which is working closely with the national standards authority to create the Green Building Standard for Namibia.[47] A Voluntary Green Star Rating, put in place through the GBC, has led to the certification of several buildings nationwide, including First National Bank Namibia's @Parkside building in Windhoek (see sidebar 4).[48]

A demonstration and research house, where 60-70% of energy is saved through thermal envelope, air tightness and sub-soil heat exchangers, was constructed at Namibia University of Science and Technology for research purposes and to support the NEEP. This concept can ultimately lead to 100% energy savings, by using a combination of technologies including passive solar architecture for heat gain in the cold season and a ventilated, shadowed roof in the hot season.

South Africa continues to lead in buildings efficiency in the region. The EDGE (Excellence in Design for Greater Efficiencies) green building certification system for emerging markets, created by the IFC, is expected to boost residential green building investment in the country.[49] The Green Building Council of South Africa is the exclusive certification services provider for the IFC within the country.[50]

The C40 South Africa Buildings Programme, launched in April 2018, will support cities to move energy-efficient new building to scale and to become the new standard practice. C40, in partnership with Sustainable Energy Africa, will initially support four cities (Johannesburg, Cape Town, Durban and Tshwane) through locally employed technical professionals.[51] By sharing knowledge and collaborating with cities outside of South Africa, facilitated through C40's global city networks, city officials in the country will be able to adopt best practices in energy-efficient building policy and practices. The C40 South Africa Buildings Programme is funded by the Children's Investment Fund Foundation and is part of the Building Energy 2020 Programme.[52]

SIDEBAR 4.
First National Bank Namibia Obtains Green Star Africa Rating

In 2017 First National Bank Namibia Holdings set a benchmark in sustainable building in the country after its @Parkside building was awarded the Green Building Council's 5-Star Green Star Africa "as Built" rating. Previously, in 2014/15, the building had achieved the first 4-Star Green Star design rating in Namibia.

With the 2017 award, @Parkside became the first 5-Star rated building in Namibia and on the continent, outside of South Africa. The building, in the capital, Windhoek, achieved 64 points for its final "as Built" rating. According to Grant Rice, Sustainability Consultant for WSP Building Services Africa, "The as Built rating verifies that the building has been constructed and has been optimised to perform in the most efficient way possible, ensuring that the efforts put into design are in fact carried through to completion."

Source: see endnote 48 for this section.

05

POLICY LANDSCAPE

05
POLICY LANDSCAPE

Since 2015 the SADC region has undergone a significant change in the number and quality of its renewable energy and energy efficiency policies. This is due in large part to the changing economics of wind and solar energy, but also to the increasing policy knowledge base, allowing SADC governments to access global experience concerning which policies are most effective and appropriate to the region's conditions. Concepts such as feed-in tariffs, specific technology mandates, net metering and auctioning of power supply from IPPs have all gained traction and are expanding rapidly. Some Member States have developed targets for the implementation of renewable energy and energy efficiency, while others are focusing on programme development, leaving targets for future policy initiatives.

REGIONAL INITIATIVES TO SUPPORT POLICY DEVELOPMENT

Member state efforts to develop targets and policies promoting renewable energy and energy efficiency have been assisted by their involvement in various global initiatives, including the United Nations Sustainability for All initiative. As of May 2018 the 12 mainland SADC Member States (one more than in 2015) had joined the SEforALL initiative and had expressed an interest in developing policies and targets to ensure a rapid transition to sustainable energy[i].[1]

In addition, eight Member States – Angola, the DRC, Eswatini, Lesotho, Namibia, South Africa, Tanzania and Zimbabwe – had carried out the SEforALL gap analysis, and gap analyses for another four Member States (Botswana, Malawi, Mozambique and Zambia) were classified as "under development".[2] Only two Member States (Angola and Tanzania) had both completed SEforALL Action Agendas and developed an Investment Prospectus.[3]

Table 17 on page 76 summarises the SEforALL status of participating SADC Member States as of March 2018.[4] The SEforALL initiative is expected to assist these countries in refining their energy policy frameworks and developing appropriate incentives for renewable energy and energy efficiency. SADC energy ministers have endorsed the SEforALL initiative and instructed Member States to "…adopt the African Guidelines for SEforALL Action Plans".[5] The SEforALL targets for 2020 are increasingly reflected in local policy frameworks.

As of May 2018 the 12 mainland SADC Member States (one more than in 2015) had joined the SEforALL initiative and had expressed an interest in developing policies and targets to ensure a rapid transition to sustainable energy.

[i] Madagascar, Mauritius and Seychelles are not listed as SEforALL "partner countries".

TABLE 17.
Status of Sustainable Energy for All Initiatives in SADC Member States, as of March 2018

	Rapid Assessment and Gap Analysis	Action Agenda	Investment Prospectus
Angola	■	■	■
Botswana	□	□	□
DRC	■	□	□
Eswatini	■	□	□
Lesotho	■	n/a	n/a
Madagascar	–	–	–
Malawi	□	□	□
Mauritius	–	–	–
Mozambique	□	n/a	□
Namibia	■	n/a	n/a
Seychelles	–	–	–
South Africa	■	n/a	n/a
Tanzania	■	■	■
Zambia	□	□	□
Zimbabwe	■	□	□

■ Finalised □ Under development

n/a Not active **–** Not a partner

Source: see endnote 4 for this section.

As of mid-2018 four SADC Member States – Mozambique (2012), Zambia (2013), Eswatini (2014) and Tanzania (2017) – had undergone Renewable Energy Readiness Assessments supported by IRENA, one more than in 2015.[6] Like the SEforALL process, the IRENA assessments have helped countries to identify areas where improvement is needed, and to set realistic targets for renewable energy and energy efficiency implementation.

Policy development in the SADC Member States is also influenced by a number of key SADC documents that have been developed over the years as part of the region's efforts to set targets and establish policy initiatives.

The SADC Energy Protocol, finalised in 1996, treats "new and renewable energy", "energy efficiency and conservation" and "wood fuels" (fuelwood) as separate subsectors, for each of which *target activities* were established. Measures include developing appropriate financing mechanisms and introducing favourable tax regimes for both renewable energy and energy efficiency, targeting reductions in commercial energy intensity and involving utilities in energy efficiency schemes.[7]

The 2003 SADC Regional Indicative Strategic Development Plan (RISDP) was the first effort to set specific quantitative targets for infrastructure development, including energy, for a 15-year period (2004-2018). When the RISDP was revised in April 2015, it established a reduced five-year programme (2015-2020) that included the original target of "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".[8] 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".[9]

REEESAP

In 2011 SADC embarked on an ambitious exercise to develop a Renewable Energy Strategy and Action Plan. The plan was approved by the SADC energy ministers in 2017 after several revisions and the addition of energy efficiency to the plan, now referred to as the Renewable Energy and Energy Efficiency Strategy Action Plan (REEESAP). The Plan includes targets for electricity access, renewable energy and energy efficiency for the region as a whole, as summarised in table 18.[10]

TABLE 18.
Targets for Electricity Access, Renewable Energy and Energy Efficiency in SADC Member States, 2020-2030

Targets	2020 (%)	2025 (%)	2030 (%)
Access to electricity	–	71	85.5
Renewable energy mix in the grid	33	–	39
Off-grid share of renewable energy as per total grid electricity capacity	5	–	7.5
Cooking/heating efficient devices penetration	10	–	15
Ethanol blending ratio with gasoline	10	–	20
Biodiesel blending ratio with diesel	5	–	10
Energy efficiency % savings achieved from grid consumption	10	–	15
Efficient charcoal production share in the charcoal market	5	–	5

Source: see endnote 10 for this section.

The overall electricity access target of 71% by 2025 is taken directly from the 2011 SADC Regional Energy Access Strategy and Action Plan (REASAP). This should be compared to the latest data on access levels (see figure 3 in Regional Overview section), which show that overall electricity access in 2016 reached 48%, with urban access at 75% and rural access at 32%.[11] Only two Member States – the DRC and Malawi – had less than 20% overall access, with Malawi being the lowest at 11% overall (4% in rural areas).[12] Although accelerated implementation of distributed renewable energy will make it easier to improve rural access, an overall target of 71% by 2025 will require massive grid extension and/or expansion of mini-grids.

The proposed target for the renewable energy mix in the grid – 33% by 2020 – is achievable.[13] This target is generally consistent with the estimates developed for SAPP by IRENA, which suggest a renewable energy contribution to electricity of 46% by 2030, compared to only 12% in 2010.[14] These substantial increases assume that large-scale hydropower projects such as Inga 3 and Batoka Gorge are operational by 2020, or that South Africa moves forward rapidly with the next phases of its utility-scale programmes and other Member States implement expanded programmes of their own.

The figures for penetration of clean cooking devices across the SADC region (10% by 2020 and 15% by 2030) are likely achievable, as there is an added "push" from rapidly depleting fuelwood supplies in several Member States, and a strong "pull" from the increased availability of alternative fuels, particularly ethanol, as discussed in section 2.[15] Some of the increased penetration also may come from fossil fuel-based cooking devices, for example stoves running on LPG.

The proposed target for the renewable energy mix in the grid – 33% by 2020 – is achievable.

A number of regional efforts are aimed at developing policies to encourage more-efficient use of biomass. One such programme, the Biomass Energy Strategy (BEST) programme, was initiated by joint German and EU funding during 2009-2014.[16] Five SADC countries developed BEST plans during this period: Botswana (2009), Lesotho (2009), Malawi (2009), Mozambique (2012) and Tanzania (2014)[i]. No further additions to the BEST programme have been made since 2014, and as of mid-2018 BEST had not been integrated into the regional policy framework.

NATIONAL RENEWABLE ENERGY TARGETS

Member States have made substantial strides in developing renewable energy targets since the 2015 *Status Report*. These national targets are summarised in table 19 on page 78.[17] The term "target" is used here in both a quantitative sense (for example, the amount of gigawatt-hours (GWh) to be generated from renewable sources) and a qualitative sense (for example, government's intention to further develop renewable energy to offset fossil fuel sources), as evidenced in energy planning documents.

[i] A description of the results of these studies and references to individual country reports can be found at http://www.euei-pdf.org/sites/default/files/field_publication_file/EUEI_PDF_BEST_Guide_Mar_2011_EN.pdf.

TABLE 19.

National Renewable Energy Targets in SADC Member States, as of Mid-2018

	Renewable energy target
Angola	Increase in renewable energy capacity of the following amounts by 2025: • Small hydro: 100 MW, with 60 MW for municipalities • Solar: 100 MW, with 10 MW off-grid • Wind: 100 MW • Biomass: 500 MW
Botswana	• 82% access to modern energy services by 2016; 100% access by 2030 • Capacity increases expected from REFIT programme (delayed) • 15% renewable share in final energy consumption by 2036, but may increase to 20% in 2017 Renewable Energy Strategy once approved.
DRC	60% overall energy access (not renewable-specific) by 2025 (up from 9%)
Eswatini	• 60 MW of intermittent resources such as solar PV by 2030 • 50% renewable share in energy consumption by 2030
Lesotho	Targets pending completion of Sustainable Energy Strategy 2018
Madagascar	85% renewable share in electricity generation by 2030
Malawi	By 2025/2030: • 30% access to electricity (up from 9%) • 100% use of efficient cook stoves in off-grid households • 6% renewable share in energy mix (up from 1%) • Biofuels mandate of 20% ethanol and 30% biodiesel
Mauritius	35% renewable share in electricity generation by 2025, including: • Bagasse: 17% • Wind: 8% • Waste-to-energy: 4% • Hydro: 2% • Solar: 2% • Geothermal: 2%
Mozambique	400 MW increase in installed renewable energy capacity by 2024, including: • Wind: 150 MW • Hydro: 100 MW large-scale, 100 MW small-scale • Solar: 30 MW • Biomass: 30 MW
Namibia	70% renewable share in electricity generation by 2030
Seychelles	5% renewable share in electricity generation by 2020; 20% by 2030
South Africa	• 21% renewable share in electricity generation by 2030 • 17.6 GW solar capacity, 37.4 GW wind capacity by 2050 (IRP 2016)
Tanzania	5% renewable share in electricity generation by 2030 (up from less than 1%)
Zambia	200 MW increase in renewable energy capacity by 2020
Zimbabwe	• 1,100 MW increase in renewable energy capacity by 2025; 2,100 MW increase by 2030 (16.5% increase overall) • 2,400 GWh increase in renewable energy generation by 2025; 4,600 GWh increase by 2030 (26.5% increase overall) • Note: targets are conditional on final approval by government.

Source: see endnote 17 for this section.

All 15 SADC Member States have developed their own national targets for renewable energy, although Lesotho's and Zimbabwe's targets are still conditional on approval of their national strategies, and the DRC has focused on energy access targets that are not specifically linked to renewable energy sources. Several Member States have developed specific policies or programmes that embody renewable energy targeting as a key element. Generally, these focus exclusively on the use of renewable energy in the electricity sector and in a few cases on renewable liquid fuels.

Botswana and the DRC have included energy access as a part of their renewable energy targeting, through both targets for increased access to grid electricity and targets for increased off-grid access (for example, the development of local mini-grids).

Increasing the renewable energy share in electricity generation is the most common form of targeting. Botswana, Eswatini, Madagascar, Malawi, Mauritius, Namibia, Seychelles, South Africa and Tanzania all have identified specific targets for the renewable share of electricity generation or consumption. Others, such as Angola, Mozambique, Zambia and Zimbabwe, have identified capacity targets (MW) only. In the case of Angola, these targets are broken down by technology, for example 100 MW of small-scale hydropower, 100 MW of solar (of which 10 MW is for off-grid solar), 100 MW of wind power (distributed among two or three installations) and 500 MW of biomass energy (forest and industrial) projects, all by 2025.[18]

Several changes in targeting are evident compared to 2015. For example, Mozambique has raised its target for capacity increases by 2024 as follows: solar by 30 MW, wind by 150 MW, large-scale hydropower by 100 MW, small-scale hydropower by 100 MW and biomass by 50 MW[i].[19] Tanzania, which has introduced significant policy initiatives in the past to support independent off-grid generation from solar and small-scale hydropower, has simplified its target: increasing the renewable share of electricity generation from less than 1% to 5% by 2030.[20]

Botswana has put on hold its REFIT programme and associated targets, and now assumes a future share of renewable energy of 16% by 2030, which may be increased to 20% when its Renewable Energy Strategy is fully implemented.[21] This strategy has been undertaken at a crucial time, when efforts to sell the 600 MW Morupula B coal-fired power station are under way after years of operational problems, and suggest that Botswana is looking at solar as a less costly and more reliable alternative than continued reliance on coal or on power purchases from South Africa and other SAPP market countries.[22] Replies to Botswana's tender for 100 MW of solar PV, expected to be located in one or more mining areas, were still under review as of mid-2018.

Identifying renewable energy targets does not in itself guarantee the dominance of renewables as a power source. For example, South Africa has a very aggressive capacity target, but at the same time it forecasts growth of both fossil fuels and renewables. In the IRP base case this means that by 2030, South Africa will have 21% of electricity generation from renewable energy and 48% from coal.[23] South Africa has very significant coal reserves and is planning to build additional coal-fired power stations; however, a number of experts have criticised these targets by showing that so-called new build (i.e., super-critical) plants, such as those recently commissioned at Medupi and the under-construction Kusile power plant, are more costly in the long and short term than wind or solar at current prices.[24]

Much the same problem plagues renewable energy targeting and policy development in Member States such as Botswana, Mozambique and Zimbabwe, all of which have substantial coal reserves, and Angola, which is Africa's second largest producer of petroleum.[25] In 2017 Zambia commissioned the 300 MW Maamba coal power station.[26] This suggests that fossil fuels will remain by far the easiest option for increasing energy security and access for the foreseeable future, although renewables will present a formidable challenge to this thinking as costs for solar and wind continue to decline.

Despite some recent setbacks, South Africa's REIPPPP remains the best example of using IPPs to assist governments in meeting their renewable energy targets efficiently and cost-effectively. The original target, set by South Africa's Renewable Energy White Paper, was to obtain 10,000 GWh of electricity from renewable energy sources by 2013 (equivalent to 1,667 MW of capacity).[27] This target was exceeded by the end of Bid Window 2 in late 2012, at which point 2,466 MW had been approved (although not yet commissioned).[28] Bid Windows 3 and 4 (in 2013 and 2014) added another 2,577 MW, and the government sought an additional 1,800 MW from previously unsuccessful bidders in the first four windows.[29] The cumulative capacity additions from projects identified under the REIPPPP by the end of April 2018 stood at 6,422 MW.[30]

In 2016 South Africa tabled a revised Integrated Resource Plan that sets a target of 17.6 GW of solar and 37.4 GW of wind energy generation by 2050.[31] This was open for comments until April 2017 and attracted a robust response from proponents of renewable energy, who felt that both the targets and target dates were unambitious, given the demonstrated cost-effectiveness of renewables already procured by the REIPPPP, and the global evidence of declining prices.[32] The revised IRP was gazetted for comments in August 2018 and was expected to be released in its final form in late 2018.[33]

The potential availability of very large hydropower resources in the DRC continues to influence renewable energy targets and policies in all of the SAPP-connected countries. As an example, South Africa's 2016 draft IRP has assumed that 2,500 MW of electricity from the Inga 3 project alone will be available for import by 2030-33.[34]

Solar energy is named as a major target for renewable energy expansion in five countries: Angola, Eswatini, Mauritius, Mozambique and South Africa. Wind energy is targeted as a source in only four countries – Angola, Mauritius, Mozambique and South Africa – although in practice wind is seen as a major opportunity in both Lesotho and Namibia, countries that have identified specific wind projects for early development.

[i] According to the Mozambique government, this target will be updated with approval of Master Plan currently under review, which will be approved in the near future. (Mozambique submission, SADC questionnaire, July 2018)

South Africa, which has by far the largest commitment to wind, has fallen short during auctions in meeting its specific technology targets as per the Ministerial Determinations. For example, in Bid Window 1, 1,850 MW of wind energy was targeted, but only 634 MW was awarded; in Bid Window 2, 650 MW was targeted and 562.5 MW was awarded; and in Bid Window 3, 654 MW was targeted but 787 MW was awarded.[35] In Bid Window 4, 590 MW was targeted and 676 MW was awarded.[36] As of April 2018, 3,357 MW of wind energy had been contracted by the REIPPPP, against a target (allocation) of 4,017 MW.[37]

Only two Member States – Mauritius and Tanzania – list geothermal energy among their targets for increased electricity share, although Tanzania does not actually include it in its targeting profile, listing it only as an upcoming investment opportunity, rated at 5,000 MW of potential generation.[38] Tanzania also participates in the East African Geothermal Risk Mitigation Facility (GRMF), an EU/ African Union project that provides financing for preliminary geophysical studies and project preparation. In the initial awards, Tanzania qualified for only one of the 26 project grants awarded, for a project at Ngozi. This project has, however, received an additional grant for implementation of a 100 MW project from the Scaling Up Renewable Energy (SREP) programme through the AfDB.[39] In addition, GRMF money has now been made available for a second project at Kisaki.[40]

Mauritius, by contrast, earlier targeted up to 2% of energy from geothermal, a fairly small target but all the more surprising given that Mauritius is not usually considered a source of geothermal energy.[41] Although the centre of Mauritius' main island does have some geothermal activity, a pre-feasibility study confirmed that there is no potential for commercial geothermal.[42] Therefore, this source of energy is no longer considered to contribute to the country's energy mix in the future.[43]

In Zambia, studies are being conducted at a potential geothermal site in Southern Province by a private company, Kalahari Energy. Indications from the government are that this option is no longer being pursued[i].[44]

Only three Member States – Mauritius, Mozambique and South Africa – have developed targets for biomass energy use. Despite this, targeting of biomass energy for power generation is increasing in the region, as Member States become more familiar with the technologies and resources available. Bagasse remains the major source of biomass for power generation, and this is specifically targeted by Mauritius (17% share of power generation by 2025) as well as Angola (500 MW targeted, of which the majority will be bagasse save a small amount from harvesting of forest residue)[ii].[45] In South Africa, there is a determination for 1,800 MW to be produced from co-generation that includes biomass or bagasse.[46]

Compared to 2015, future targets for biofuels in the transport sector are now found in only one country, Malawi, which has increased its blending target from 5% to 30% for biodiesel and from 15% to 20% for ethanol.[47] These are very high ratios by international standards, and the ethanol target in particular will require substantial modifications to the vehicle fleet if it is to be implemented successfully.

As before, the low availability of inputs (waste molasses, in the case of ethanol) is a major constraint: no SADC country has sufficient production capacity at present to increase ethanol blends beyond 20%, unless they switch to using sugarcane waste as feedstock rather than molasses[iii]. The use of alternative feedstocks for ethanol such as sweet sorghum has only been investigated by Botswana and South Africa[iv], and efforts to introduce ethanol production from cassava in Mozambique have failed, as noted in section 2.

The lack of interest in biofuels in both national targeting and policy and programme development is significant, especially when compared to the level of interest noted in the 2015 *Status Report*. Interest in biodiesel in particular shows a substantial downturn, as failed efforts to utilise specialised oil crops such as jatropha for biodiesel appear to have frightened off potential investors. Policies that encourage low fossil fuel prices are also a deterrent, as is the mounting concern over competition for land and water with food crops.

POLICIES AND PROGRAMMES

Table 20 shows the different renewable energy policies and programmes evident in each of the SADC Member States as of mid-2018.[48] The table is drawn from two sources: 1) questionnaires returned to SACREEE by the Member States, and 2) information provided by REN21 as part of the *Renewables 2018 Global Status Report* (GSR). Differences in information between these sources are indicated by colour coding, explained at the bottom of the table. Policies and programmes marked with a star have been introduced since 2015.

[i] Earlier assessments (2005) had identified the potential for geothermal in Zambia, but no follow-up exploration was initiated until much later. For background, see: http://www.grmf-eastafrica.org/database/musonda_sikazwe2005_zambia-country-update-wgc-2005.pdf.

[ii] Availability of land for sugarcane cultivation is a major constraint in all Member States. Any increase in use of bagasse for power generation would depend on the expansion of cane cultivation, or alternatively on improvements in the efficiency or use of other biomass sources.

[iii] Malawi's targets for increased ethanol have been constrained by their dependence on waste molasses, primarily from the Illovo plant; new efforts to use syrup from crushed cane are moving forward and will enable the country to achieve its targets for increased ethanol blends. See: http://www.biofuelsdigest.com/bdigest/2018/01/18/malawi-ethanol-producers-to-invest-100-million-to-crush-cane-for-feedstock/.

[iv] See for example: http://www.nda.agric.za/doaDev/sideMenu/forestry/docs/Booklet%2016%20Biofuels%20Feedstocks.pdf and http://www.crses.sun.ac.za/files/services/conferences/annual-student-symposium/daphney-mutepe-paper.pdf.

TABLE 20.
Renewable Energy Support Policies in SADC Member States, as of Mid-2018

			Regulatory policies								Fiscal incentives and public financing			
	Renewable energy targets	Renewable energy in NDC or INDC	Feed-in tariff / premium payment	Electric utility quota obligation / RPS	Net metering	Biofuels obligation / mandate	Grid code revisions	Tradable renewable energy credits	Tendering	Capital subsidy, grant, or rebate	Investment or production tax credits	Reductions in sales, energy, CO_2, VAT or other taxes	Energy production payment	Public investment, loans or grants
Angola		■	■		■	■	■		■			■	■[1]	
Botswana	■		★						■					★
DRC	■													
Eswatini	★[2]	■				■	★		★[2]					
Lesotho	■	■	★		★				★					★[1]
Madagascar	■	■	★				★[2]		★[1]					
Malawi	■	■	★			■	★		★			★		★
Mauritius	■	■	★		★		■		■	■		★		★
Mozambique	■	■							★					
Namibia	■	■	★		■				■					
Seychelles	■	■			★		★[2]		★[2]			★[2]		★
South Africa	■	■		★	■	■	■		■	■	■	■		★
Tanzania		■	■		★	★	★[2]		★[2]	■[1]		★[2]		★
Zambia	■	■	■			■	■		★	■[1]		■[1]		★
Zimbabwe	■	■	★		★	■			■	■				★

■ policy introduced before 2015

★ policy introduced since 2015

[1] Mentioned in REN21 2018 Global Status Report but not Member State questionnaire

[2] Mentioned in Member State questionnaire but not REN21 2018 Global Status Report

Source: see endnote 48 for this section.

Information on the incorporation of renewable energy in the Intended Nationally Determined Contributions (INDCs) and Nationally Determined Contributions (NDCs) that Member States submitted to the UNFCCC following the Copenhagen and Paris summits is reflected in the table[i]. All Member States except Botswana and the DRC have included specific renewable energy actions in either their NDCs or INDCs[ii]. (For further discussion of NDCs and INDCs as financing mechanisms, see section 6.)

[i] NDCs were previously referred to as INDCs, and before that, as Nationally Appropriate Mitigation Actions (NAMAs). They are essentially efforts by each country to set out their mitigation targets and to identify areas of the economy that will be focal points for achieving the required reductions in carbon dioxide-equivalents. In the SADC region, 12 of the 15 Member States have submitted NDCs, the exceptions being Angola, Mozambique and Tanzania, which submitted INDCs only. For more details see http://www4.unfccc.int/ndcregistry/Pages/All.aspx.

[ii] Botswana has submitted only an INDC, which currently appears on the NDC registry.

Although several policies – electric utility quota obligations (South Africa), investment or production tax credits (South Africa) and energy production payments (Angola) – were being implemented in only one Member State as of mid-2018, no Member States had these policies in 2015. Meanwhile, several policies in preparatory stages were included in the table because of the high probability that they will be adopted soon (for example, the Botswana, Namibia and Zimbabwe FIT programmes).

TENDERING AND/OR AUCTIONING

The most notable change is the introduction of tendering and/or auctioning for renewable energy projects, which was being practiced to some degree in all Member States as of mid-2018. In a few, however (for example, Botswana and Lesotho), implementation of the tendering policy is still in the early days.

In Mozambique, a tendering policy was introduced in late 2017 following support from the EU. The Project for Promotion of Auctions for Renewable Energies (PROLER) initiative will be implemented by the French Development Agency (AFD) in partnership with Mozambique's public electricity utility company, EDM.[49] The first project initiated under PROLER is the 40 MW Mocuba solar PV facility, which was expected to be commissioned in late 2018.[50]

The region-wide increase in tendering is undoubtedly due to South Africa's success in implementing a formal tendering programme for its utility-scale projects, which demonstrated the effectiveness of such programmes in attracting least-cost renewable energy alternatives. Although three Member States – Lesotho, Madagascar and Malawi – also have introduced (or will soon introduce) FITs for smaller renewable energy projects, they have done so at the same time as introducing tendering programmes for large-scale projects.

The concept of tendering is not simply about lowering the cost of renewable energy by introducing competition; it is also about attracting IPPs to these countries, many of which have previously restricted power development to government and parastatal entities (i.e., national utilities). Thus, several Member States – for example, Botswana, Eswatini and South Africa – are also inviting IPPs to tender on non-renewable power projects, mainly coal and natural gas. In this regard, only Namibia among all the Member States had until very recently relied exclusively on a FIT, and it has now joined the general trend towards tendering in reference to FITs.

NET METERING

Another policy that has increased in popularity is net metering, which favours smaller-scale renewable energy investments, for example household-scale solar PV. Mauritius, Namibia and South Africa were pioneers in this policy area, and as of mid-2018 net metering had been implemented in seven Member States. Net metering is an attractive alternative to FITs for smaller facilities such as household-level or small-scale commercial solar PV, as it does not require detailed contracts or financial analysis.

The most notable change is the introduction of tendering and/or auctioning for renewable energy projects, which was being practiced to some degree in all Member States as of mid-2018.

In the Namibia programme, net metering is limited to facilities with a "generation capacity" of 500 kV-ampere or lower – effectively, small businesses and households – and over 15 MW of solar PV is already installed through this scheme.[51]

In Mauritius, the second phase of the programme is limited to 2 MW (up to 5 kW per household) and is designed primarily for household-scale renewable energy.[52]

In South Africa, net metering is in place in several towns in the Western Cape, where electricity distribution is handled through the municipality. As part of its efforts to encourage localised, small-scale generation, South Africa's national regulator is looking at developing regulations for "small-scale embedded generation" (SSEG) – that is, household- and small business-size generation.[53] These regulations were due to be published in late 2018 or early 2019, following finalisation of the Department of Energy regulations and forecasts, including the IRP. This is to ensure that power plants of below 1 MW have an opportunity to grow in a sustainable manner while municipalities can adopt net metering with clearer boundaries.[54]

Municipal governments are confronted with both positive and potentially negative impacts of SSEG. On the one hand they see it as a way to ramp up renewable energy supply without the long delays and complex bureaucracy typical of auction systems. Such small-scale generation helps to achieve climate change mitigation targets and provides a source for potentially procuring competitively priced electricity. On the other hand the increasing spread of self-consumption systems leads to reduced sales of electricity, which requires municipalities to rethink their rate design for SSEG customers.

In addition the South African PV Industry Association has developed the PV Green Card programme to promote safe and high-quality solar PV installations.[55]

FEED-IN TARIFFS

Six countries – Lesotho, Madagascar, Malawi, Mozambique, Namibia and Zambia – initiated feed-in tariff programmes during the period from 2015 to mid-2018, although only one of these, in Zambia, is completely operational. FIT programmes in three of the countries – Mozambique, Namibia and Zambia – are modelled on the GETFiT programme that was used successfully in Uganda (see sidebar 5).[56]

SIDEBAR 5.
The GET FiT Programme

GET FiT (Global Energy Transfer Feed-in Tariff) is a programme supported by Germany's KfW development bank that promotes the use of a standardised set of bankable legal, risk mitigation and financing support procedures, and offers technical assistance ranging from input on solar PV grid integration to procurement support.

GET FiT's mission is to:

- support renewable energy scale-up and energy access in developing and emerging economies through the creation of new international public-private partnerships;
- help leverage private sector financing of renewable energy projects; and
- serve as a bridge to grid parity for renewable energy both by allowing developing and emerging economies to gain experience with renewable resources prior to break-even scenarios, and by adjusting incentive rates to reflect lower prices over time.

The programme was initially developed and designed in and for Uganda by the Government of Uganda, the Electricity Regulatory Agency and KfW to leverage commercial investment in renewable generation projects. GET FiT Uganda, launched in 2012, provides a so-called toolbox of direct incentives, risk mitigation strategies and technical assistance in order to create a conducive enabling environment for letting the private sector flourish; hence, the supportive regulatory environment is more important than the project-related support.

Based on the specific country/sector situation, the most appropriate and suitable tools from the GET FiT toolbox can be selected and combined and applied for the context, thereby ensuring the removal of legal and regulatory hurdles for private investment, mitigation of political and commercial risks, and the provision of an attractive risk-adjusted return for early-mover investors providing commercial finance for renewable energy deals.

Source: see endnote 56 for this section.

In **Mozambique**, in order to operationalise the REFIT, the government has requested KfW to undertake a detailed design and implementation readiness study to develop a concept for a GET FiT programme. The focus of the study will be solar PV with storage, small-scale hydropower, biomass and mini-grids; results were expected at the end of 2018. As in Zambia, the programme is anticipated to be implemented via auctions and not via FITs *per se*.

In **Namibia**, where private investors in solar PV and wind power are comparably active already, GET FiT will focus on the mobilisation of bush-to-electricity projects, or electricity generation through the combustion of biomass from de-bushing. GET FiT Namibia will not only incentivise energy generation from invader bush but will also provide multiple economic and ecological benefits. The Pre-feasibility Study was scheduled to commence in the third quarter of 2018, and EUR 20 million (USD 23 million) was set aside as grant funding for this promising fuel supply-side mobilisation.[57]

Namibia's original FIT programme (pre-GET FiT), drafted in 2013, is now operational and applies to projects less than 5 MW and greater than 500 kW in size, while larger developments such as the 150 MW CSP project mentioned earlier will be subject to competitive tender.[58]

In **Zambia,** the GET FiT programme is designed to help the government implement its REFiT Strategy, in force since October 2017.[59] The strategy is designed for projects up to 20 MW and is targeting 200 MW of renewables by 2020.[60] The initial phase targeted up to 100 MW of solar PV capacity to be launched in 2018.[61] The tender for hydropower, planned for late 2018, will help to develop additional hydro capacity of 100 MW until 2022/24.[62] The focus is on promotion of small on-grid projects of 1-20 MW. The programme is expected to help reduce CO_2 emissions by 10 million tonnes annually.[63] The German Federal Ministry of Economic Cooperation and Development (BMZ), through KfW, allocated EUR 31 million (USD 36 million) to the GET FiT initiative in 2016.[64]

Botswana and **Mauritius** have both planned FIT programmes, and while Mauritius' has been oversubscribed and is now completed, Botswana's was on hold as of mid-2018 pending development of the country's tendering programme, and Tanzania's FIT programme was still under review by the Regulator, with no clear date for inception.

Eswatini has rejected the FIT concept for utility-scale projects and is instead developing a Power Procurement Toolkit to manage the process of tendering for new capacity, including renewable energy.[65] In replacing the FIT, the Swaziland (Eswatini) Independent Power Producer has recommended the following:

- *Public competitive bidding* should be undertaken as set out in the legislation, for "larger projects" that represent a significant portion of the total capacity required for Eswatini and that would commit the country to a substantial long-term contract or funding liability.
- *Feed-in tariffs and/or net metering* should be applied for small capacity and embedded generation projects.

Tanzania's Small Power Producer programme, developed by the Energy and Water Utilities Regulatory Authority (EWURA), initiated its Second Generation Framework in late 2015, revising its model PPAs, standardised tariffs, and streamlined interconnection and licensing requirements. The new framework introduces a variety of improvements in both the tendering process and payment arrangements (see sidebar 6 on page 84).[66]

SIDEBAR 6.
Tanzania Second Generation Small Power Producer Framework

The Second Generation Small Power Producer (SPP) Framework is designed to respond to challenges identified during implementation of the First Generation SPP Framework and thus to improve the conditions for SPP investments in Tanzania. The main features of the Second Generation SPP Framework are as follows:

- SPPs will now receive a fixed tariff for the life of the SPP Agreement, instead of a tariff that fluctuates annually based on the distribution network operator's avoided cost.
- FITs for selling energy to a distribution network operator will be based on technology-specific costs for hydropower and biomass SPPs. For solar and wind SPPs, FITs will be based on bidding prices obtained through a competitive process to provide electricity buyers with the benefits of rapidly decreasing renewable technology costs. For both calculated FITs and competitively bid FITs, the cost-reflective tariffs will ensure investor security by providing a fixed price for the duration of the SPP Agreement, up to 25 years.
- Under the First Generation SPP Framework, payments were in local currency. However, payments for the Second Generation SPP Framework will be made in US dollars, which can be adjusted to another hard currency by the mutual agreement of the parties so that the seller does not take any currency exposure.
- Under the Second Generation SPP Framework, FITs do not distinguish between SPPs located on the main grid or on mini-grids. Instead, the Second Generation SPP Framework provides fixed tariffs by size for hydropower and for biomass SPPs wherever they are located. A key benefit of this feature is that for mini-grid connected SPP Agreement, tariffs will remain constant over the life of the SPP Agreement regardless of whether the main grid reaches the mini-grid or not.
- Development of solar and wind in a competitive bidding process. The initial capacity to be tendered is equal to the main grid reserve margin requirement (15% of the system installed capacity), but may be revised by EWURA from time to time as appropriate.

Source: see endnote 66 for this section.

In Tanzania, EWURA's regulatory work is co-ordinated with the development work of the Rural Energy Agency, which is primarily responsible for grid extension and off-grid developments. Other countries – Angola, Zambia and Zimbabwe – have instituted similar rural energy/electrification agencies or authorities that are playing key roles in both grid-based electrification development and off-grid, including mini-grids. In January 2016 Mauritius joined this trend by creating the Mauritius Renewable Energy Agency, responsible for promoting the use of renewables for electricity generation.[67]

CAPITAL SUBSIDIES, GRANTS OR REBATES

In 2015 no Member States were using capital subsidies, grants or rebates to support renewable energy. By mid-2018, however, 9 of the 15 Member States had introduced some form of subsidy or other financial support. This support typically comes through funds based on electricity or fuel levies.

Mauritius has continued its subsidy programme for solar hot water, introduced in 2008 but updated in 2016. The new programme will focus on vulnerable and low-income households, defined as those having a monthly income of less than USD 735, who will receive a subsidy of USD 303; those having a monthly income of more than USD 735 will receive a subsidy of USD 150.[68] The programme was expected to benefit 10,000 additional households.[69]

Namibia has created a Solar Revolving Fund that continues to provide subsidised loans to individuals for solar water heater installations, as well as through the SOLTRAIN project. SOLTRAIN also funded and facilitated the installation of water heating systems at five Vocational Training Centres (Okakarara, Valombola, Zambezi, Eenhana, and Rundu) for use in the training of their students.[70] All public buildings in Namibia are now expected to meet their hot water needs from solar, based on a cabinet directive.[71]

SOLTRAIN is also involved in solar thermal programmes in Botswana, Lesotho, Mozambique, South Africa and Zimbabwe, and recently initiated a third phase of training and promotion of solar thermal systems after the successful completion of the second phase in 2016.[72] In 2018 the Botswana Institute for Technology Research and Innovation set up a world-class Solar Thermal Testing Facility at its premises in Gaborone.[73] The facility will perform all outdoor technical tests, research and innovations in all solar thermal systems and components for the solar thermal industry, governmental bodies and members of the public strictly following international standards testing procedures and protocols for quality assurance and consistence purposes. The services of the facility will be available to other SADC Member States.

South Africa implemented a solar water heater programme in 2009 aimed at installing 1 million units, but as of February 2015 the programme had installed only 102,498 units.[74] The target of this programme was residences without existing electricity connections (which would receive low-pressure solar units) and residences with failed conventional electric water heaters, which are typically responsible for up to 40% of household energy use.[75] This programme was substantially revised in 2016, and now sets a cumulative target of 1.75 million solar water heater installations by 2019 and a long-term target through the National Development Plan of 5 million units by 2030.[76]

The new programme will include a "social" component that will install units free of charge for low-income households, and a regular programme that includes a variable subsidy. This programme will be jointly administered by the national government and municipalities, after it was taken back from Eskom by the Department of Energy.[77] Effectively the solar water heater programme includes a social component (low-pressure geysers to provide hot water services to households that currently do not have hot water on tap) and a load reduction component (targeting middle-income households where electric

geysers are responsible for high electricity consumption, which is to be substituted with high-pressure solar water geysers). In addition, the re-designed programme has been loaded with other government objectives such as job creation and local content requirements on manufacturing of components, for example 70% on storage tanks and 70% on collectors.[78]

Zambia instituted a Rural Electrification Fund (REF) in 2004, drawn from a 3% levy on every unit (kWh) of electricity consumed.[79] This fund was supplemented by grants and loans from development partners and was used primarily to fund project preparation studies and smart-capital subsidies. The REF can in principle provide capital subsidy of up to 100% for public-led rural electrification projects and can support privately driven rural electrification projects with up to 50% of their capital costs, with the remaining funds to be secured by the developer.[80] By late 2017 this fund had accumulated ZMK 251 million (USD 24 million) and was being targeted specifically to incentivise private sector involvement, including off-grid solar PV.[81]

Zimbabwe also has a Rural Electrification Fund that has focused primarily on grid extension but that is being linked to a forthcoming Renewable Energy Strategy with the intention of promoting renewable energy options for off-grid development.[82] The fund is supported by a 6% levy on the electricity tariff. Implementation of a Rural Energy Agency to operate an independent rural electrification programme was announced in 2016 and is likely to bolster the use of renewable energy in this sector. Zimbabwe also offers a rebate on import duty for solar equipment as well as for efficient lighting (but not for batteries).[83] The National Solar Water Heating Programme does not have provision for a subsidy yet.

OTHER POLICIES/PROGRAMMES

Quota obligations, also referred to as **renewable portfolio standards (RPS)**, are a popular policy globally for enforcing renewable energy contributions to power generation. South Africa's REIPPPP functions essentially as a quota obligation (in this case referred to as "allocations") and was the only such policy in the SADC region as of mid-2018. However, several Member States have imposed targets on renewable energy contribution to electricity generation, manifestly the same thing as a "quota obligation".

Grid code revisions[i] to accommodate the shift towards renewable energy had been implemented (or were being implemented) as of mid-2018 in Eswatini, Madagascar, Malawi, Seychelles and Tanzania, in addition to the three Member States noted in the 2015 *Status Report* (Mauritius, South Africa and Zambia).

Renewable energy certificates (RECs) had been developed by only one SADC country, South Africa, as of mid-2018. RECSA, the association of voluntary REC market participants in South Africa,

[i] For a detailed examination of the role of grid codes in scaling up variable renewable energy, see IRENA, *Scaling Up Variable Renewable Power: The Role of Grid Codes* (Abu Dhabi: 2016), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_Grid_Codes_2016.pdf.

Targets and policies on energy efficiency in the SADC region are so far found primarily at the national level and range from broad national targets included in national energy masterplans to specific programme goals.

was established in 2011, and all active producers, traders and consumers of RECs in the country are automatically members. A commercial company, zaRECs (Pty) Ltd., administers the South African voluntary REC market along the lines of the EU market specifications on behalf of members of RECSA. RECs are essentially a form of voluntary market instrument, useable primarily for "greening" projects or activities, meaning that other SADC countries (or organisations within these countries) could also participate in the South African REC market. Importantly, RECs in the South African market are not generated solely by large-scale renewable energy projects but also have been used as a source of financing for energy-efficient low-income housing.[84]

Since 2015 the REC market has undergone significant growth with more than 200 GWh of RECs traded through the RECSA market association platform and still counting. RECSA also has been active internationally and in other SADC Member States and approached SAPP for consideration of possible differentiation of green power in the power pool market.[85]

REGIONAL ENERGY EFFICIENCY TARGETS

The REEESAP proposes three efficiency targets for 2020 and 2030:

- percent savings from grid consumption (i.e., final electricity use): 10% and 15%
- cooking/heating efficient device penetration: 10% and 15%
- efficient charcoal production market share: 5% and 5%.[86]

Savings from grid consumption can be achieved through a number of methods: 1) reducing transmission and distribution losses, 2) employing more efficient end-use technologies, 3) improving power factor in industrial facilities and 4) instituting better load management. The proposed improvements of 10% and 15% are modest and can be achieved with little or no capital investment, suggesting that the targets could be met simply through training and communication initiatives. In the case of transmission and distribution losses, SAPP has already developed a programme to address this issue.

SAPP also has developed a demand-side management (now called "integrated demand management") programme, essentially providing support to member utilities to develop their own initiatives[i]. This programme has been operational since 2011 and claims a reduction in demand of over 4,013 MW by February 2017 against an initial target of 6,000 MW by 2018.[87]

NATIONAL ENERGY EFFICIENCY TARGETS

Targets and policies on energy efficiency in the SADC region are so far found primarily at the national level and range from broad national targets included in national energy masterplans to specific programme goals. The most widely used are targets for encouraging the replacement of inefficient lighting, while targets for introducing standards and labelling for household appliances are relatively uncommon. Table 21 provides a summary of energy efficiency targets in the SADC Member States as of mid-2018.[88]

South Africa, previously a leader in developing national energy efficiency strategies and programmes – for example, the National Energy Efficiency Strategy of the Republic of South Africa (NEES 2005, revised 2009) and the Policy to Support the Energy Efficiency and Demand Side Management Program for the Electricity Sector through the Standard Offer Incentive Scheme (2010) – tabled a new energy efficiency strategy in 2016, but this had not been finalised as of mid-2018.[89]

The original Efficiency Strategy targeted 12% overall savings by 2015, against a 2005 baseline.[90] This was not altered in the 2009 revision but was simply re-stated as a "Final Energy Demand Reduction of 12% by 2015".[91] In addition, the government stated that the targets were voluntary but reserved the option to make them mandatory in some sub-sectors.

The draft post-2015 strategy sets different energy reduction targets for key sectors by 2030, for example a 50% reduction in gigajoules per square metre in public buildings, a 33% reduction in consumption for new household appliances, a 37% reduction in consumption for the commercial sector, a 20% reduction in average vehicle energy intensity and a 16% reduction in specific energy consumption in the industrial sector.[92] Also included were targets for agriculture and co-generation.

The original South African national energy efficiency programme was further supported by the Energy Efficiency Accord, a voluntary agreement among 40 of South Africa's largest companies to achieve the Strategy target of a 15% reduction in final energy demand for the industrial and mining sectors.[93] A successor organisation, the National Energy Efficiency Leadership Network (EELN), was established at COP17 in Durban in December 2011 and replaced the Energy Efficiency Accord. EELN engaged the private sector into the NEES, and its signatories voluntarily pledged to:

- develop a road map for improved energy efficiency, supported by the implementation of an energy management system;
- develop appropriate internal energy efficiency targets appropriate to company operations and also respond to government policy and strategy; and
- report on progress towards energy efficiency targets and energy intensity of operations.[94]

[i] This is sometimes referred to in the SAPP and SADC literature as a "virtual power station" or "Demand Side Power Station" (DSPS).

TABLE 21.
Energy Efficiency Targets in SADC Member States, as of Mid-2018

	Energy efficiency targets
Angola[1]	No targets established
Botswana	Potential savings by 2032 in the following sectors: • residential sector: 15,590 terajoules (TJ) • transport: 8,500 TJ • mining: 2,400 TJ • public/commercial buildings: 2,020 TJ • manufacturing: 540 TJ • public services: 380 TJ • agriculture: 100 TJ
DRC[1]	No targets established
Eswatini	Energy Efficiency Strategy in draft stage
Lesotho	Targets pending, but priorities include: • promotion of thermally efficient buildings • promotion of energy efficiency • increased knowledge on energy efficiency and conservation • adequate investments for energy efficiency and demand side management • ensuring that appropriate technologies and practices are in place
Madagascar	Plan being developed
Malawi	No targets established, but priorities include: • distribution of CFL and LED lights • subsidies on LEDs • improved use of efficient cook stoves
Mauritius	Efficiency improvements in the electricity sector of 6% by 2020 and 10% by 2025 (over 2008 baseline)
Mozambique	No targets established
Namibia	By 2030: • 100% energy-efficient lighting in the household sector • 50% energy efficiency in productive sectors
Seychelles	10% reduction in energy intensity by 2020 (from 2010 baseline)
South Africa	By 2030 improve efficiency as follows: • economy as a whole: 29% • transport sector: 39% • commercial and public sector: 37% • residential sector: 33% • agriculture sector: 30% • industry and mining sector: 15%
Tanzania	National Energy Efficiency Strategy under preparation
Zambia	Reduce overall energy usage by 2% by 2030; no sector targets set.
Zimbabwe	No targets established

[1] Angola and the DRC have provided no information on targets.

Source: see endnote 88 for this section.

The EELN has now been supported by a grant from the UK Department of Foreign Affairs and International Development, which established the Private Sector Energy Efficiency Programme (PSEE) as an implementation arm, offering subsidised assistance for small and medium-sized enterprises and large businesses to help organisations identify potential energy savings (via energy audits) and also assisting large companies to design and implement their own energy efficiency initiatives, policies objectives and strategic alignment activities. More than 700 medium-sized businesses and more than 35 large businesses had been assisted by the PSEE as of the end of 2017.[95]

NATIONAL ENERGY EFFICIENCY POLICIES

SADC Member States are moving forward with innovative policies to address the need for more efficient uses of energy. Some of the key innovations already in place include the replacement of inefficient incandescent bulbs with CFL and LED lighting (in the residential sector), the development of demand-side management programmes for the commercial and industrial sectors, "ripple control" (load management) for hot water heating and encouraging the use of improved cook stoves in rural and peri-urban areas.

Table 22 on page 88 summarises the current energy efficiency support policies in SADC Member States.[96] A star indicates a new or revised policy since 2015.

In **Botswana**, the National Energy Efficiency Strategy (NEES4B), which targets a 25% decrease in total final energy consumption in 2023 relative to 2017, was yet to be finalised as of mid-2018. Since 2015 the government has implemented the following programmes:

- load shedding in commercial buildings and industries;
- mandatory standards that are to be inserted in the technical booklet for building efficiency (Energy Management for Industry and Buildings);
- building efficiency guidelines, which are at the development stage;
- exemption of solar water heaters from import duty; and
- demand-side management programmes that focus on load curtailment.[97]

Eswatini has completed a draft Energy Efficiency Policy that was awaiting stakeholder validation as of mid-2018. The overall goal of the policy is to ensure that energy efficiency plays its full role in the development of the country as an energy resource in the energy mix and to ensure achievement of the United Nations' Sustainable Development Goals at least cost to the country/consumers. This policy framework provides a detailed outline for the development of strategies and programmes to advance the country's agenda on Energy Efficiency and Energy Conservation, considered to be a valuable energy management resource and effective measures to mitigate the environment impacts resulting from growing energy demand. The policy also provides

much-needed guidance to influence the enactment and review of legislation. The policy addresses governance and operational issues to enhance the implementation of energy efficiency measures, with a focus on improvements in the residential, commercial, industrial and transport sectors.

Activities undertaken as of mid-2018 include the adoption of ISO 50001, Energy Management Systems – Requirements with guidance for use into a Eswatini National Standard, now known as SZNS ISO 50001. The purpose of this National Standard is to enable organisations to establish the energy management systems and processes necessary to improve energy performance, including energy efficiency, use and consumption. Implementation of this National Standard is intended to lead to reductions in greenhouse gas emissions and other related environmental impacts and energy cost through systematic management of energy. This National Standard specifies energy management system requirements, upon which an organisation can develop and implement an energy policy and establish objectives, targets and action plans that take into account legal requirements and information related to significant energy use.[98]

In **Mauritius**, the Programme National d'Efficacité Energétique (PNEE) was launched in 2015, aiming at annual energy efficiency cost savings of EUR 30 million (USD 35 million) in the industrial and tertiary sectors.[99] A successful pilot and demonstration phase showed potential savings on fuel bills of between 10% and 40%.[100] PNEE aims to develop a quality energy efficiency market, through awareness raising campaigns and provision of subsidies to energy audits in the private sector, improving the competitiveness of Mauritian companies, reducing needs for power generation infrastructures (~40 MW) and imports of fossil fuels, and reducing 173,000 tons of CO_2 emissions annually.[101]

Developed by AFD and the private sector organisation Business Mauritius, and cofounded by the EU (through SEforALL), the programme planned to carry out 100 energy audits by the end of 2017.[102] It is divided into eight projects, ranked by sectors of activity (textile, hotel, supermarket) or by the use of energy (cooling system, steam, compressed air, pumps, hot water). The first audits started in 2015, and the PNEE now involves more than 50 partner companies (hotel, textile, cooling system, steam, compressed air, supermarkets).[103]

Three success factors have been identified: 1) a truly public-private partnership between the Ministry of Energy and Public Utilities and Business Mauritius; 2) energy audits ensured by a technical assistance and 3) financial support through

TABLE 22.
Energy Efficiency Support Policies in SADC Member States, as of Mid-2018

	Type of policy						
	Demand-side management: Industrial-commercial (including power factor correction)	Demand-side management: residential (lighting, ripple control)	Efficient cooking and heating	Reduce distribution and transmission losses	Transport efficiency	Energy efficiency standards	Voluntary programmes
Angola		■					
Botswana	★	★	■	★		★	
DRC							
Eswatini	★	★	★		★	★	★
Lesotho			■				
Madagascar		★	★		★		
Malawi	★	★	■				
Mauritius	■	★		■			
Mozambique		★	■				
Namibia	■	★	■		★		★
Seychelles	★	★					
South Africa	■	■	■	■	■		■
Tanzania	★		■		★		
Zambia	★	★	■	★		★	
Zimbabwe	■	★	■				

■ policy in place in 2015 or earlier ★ either new policy or revised policy

Source: see endnote 96 for this section.

SUNREF, a green credit line offered by AFD to Mauritian banks for implementation after energy auditing. This programme is to be replicated by the IOC Energy Programme (funded by the EU) in other IOC Member States (Madagascar and Seychelles), in partnership with AFD. [104]

The government of Mauritius also has a separate solar water heater grant scheme – launched for 16,480 households for an amount of USD 4 million – that was in phase four as of 2017.[105]

In **Mozambique**, a draft Energy Efficiency Regulation was circulated for comments in late 2017. Aside from the replacement of 550,000 incandescent lamps by CFLs in Nampula, Nacala and Pemba provinces, Mozambique has not yet developed targets or specific interventions for energy efficiency, and as such there have not been any activities in the commercial/industrial sector nor have there been any mandatory energy management activities.[106] Electricity is relatively cheap compared with prices in the rest of the region and is relatively stable, meaning few blackouts. Therefore, the typical drivers of energy efficiency policy are not in existence.

In **Namibia**, demand-side management initiatives include a virtual power station (VPS) and a demand reduction campaign.

In **Seychelles**, the Minister of Environment, Energy and Climate Change announced in October 2017 the launch of the Smart Energy in Public Spaces programme, focusing on energy efficiency in state buildings and street lighting with a target of installing 10,000 LED street lamps by 2020 across the three main islands of Seychelles (Mahé, Praslin and La Digue).[107] In addition, a Seychelles Energy Efficiency and Renewable Energy Programme is helping families and small businesses gain access to low-interest loans to invest in energy-efficient electrical appliances and renewable energy.[108]

As part of the continuing effort to promote energy-efficient technologies in Seychelles, the Ministry of Finance, Trade and Blue Economy – in partnership with stakeholders including the Ministry of Environment, Energy and Climate Change and the Seychelles Energy Commission (SEC), and all the commercial banks – offers a VAT Exemption for goods imported to be used in the process of conservation, generation or production of renewable or environmentally friendly energy sources as endorsed by the SEC.

The Seychelles Renewable Energy and Energy Efficiency Programme (SEEREP) is a subsidised loan scheme to promote energy-efficient appliances and renewable technologies in the residential sector to not only reduce their electrical consumption (and energy bill) but also to reduce their carbon footprint by

- replacing inefficient or old appliances,
- making informed purchase when buying new efficient appliances, and
- buying renewable energy products (solar PV system, solar water heater).

This loan targets the residential sector, and most of the commercial banks offer this facility. The maximum amount available under the loan is SCR 150,000 (USD 11,000) per household, with only a 5% rate of interest.[109] The duration of repayment may vary from 0 to 5 years with no personal contribution up to SCR 75,000; for loans above this amount, a personal contribution of 2.5% is required.[110]

The Small and Medium Enterprises Loan scheme (SME) is another loan scheme that aims to encourage business development and entrepreneurship in various sectors. The SEEREP loan also forms part of the SME loan scheme, and all businesses having a turnover of less than SCR 6 million (USD 443,000) are eligible to use this scheme, which can be utilised only to buy energy-efficient appliances or renewable technologies.[111] For the development of the energy efficiency programme, the SEC will develop a registry of products that are compliant with the future MEPS.

South Africa was the first SADC Member State to mount a series of nationwide energy efficiency programmes, directed at a range of economic sectors. Although the initiative for these initiatives came from government, it was the national utility, Eskom, that took up the cause. Faced with serious capacity shortages in 2008, Eskom developed the Standard Offer mechanism for buying demand-side resources, i.e., load reductions. This was first implemented in 2011, and by 2013, 245 projects had been registered for the standard offer, realising demand savings of 118 MW and energy savings of 478.6 GWh.[112] Together with two associated programmes, the residential mass roll-out and the standard product and performance contracting programmes, a savings of 3,600 MW was achieved.[113]

Due to the financial constraints experienced by Eskom since 2014, these programmes had all been put on hold as of mid-2018, and Eskom's involvement in energy efficiency programmes has been rolled back while increasing effort is devoted to addressing capacity shortages through the government's IPP programme.[114]

The South African Revenue Service (SARS) issued Interpretation Notes to the Regulations on the tax deduction available for energy efficiency savings under section 12L[i] of the country's Income Tax Act. A major highlight of the revisions was an upward review of deductions from 45 cents per kWh to 95 cents per kWh or kWh-equivalent of energy efficiency savings.[115] For years of assessment commencing on or after 1 March 2015, the deduction is calculated at 95 cents per kWh or kWh-equivalent of energy efficiency savings.[116]

The **Tanzanian** government received assurance from the EU for collaborating with the Ministry of Energy in facilitating the development of a National Energy Efficiency Strategy. This is to be done through the EU Technical Assistance Facility for the SEforALL initiative – Eastern and Southern Africa. Reportedly the facilitation started with a consultation workshop[ii] to discuss the scope and process for developing the 20-year Energy Efficiency Strategy for Tanzania.[117]

[i] Section 12L became effective on 1 November 2013 and applies to years of assessment ending before 1 January 2020.
[ii] The workshop also discussed advantages and challenges of energy efficiency, and the importance of the Energy Efficiency Strategy in achieving the overall goals of the 2015 National Energy Policy.

06

INVESTMENT FLOWS

06
INVESTMENT FLOWS

OVERVIEW

Globally, renewable energy investments have fallen significantly since 2015[i] , and southern Africa is no exception.[1] While reduced investment in this region is due in part to delays in finalising PPAs for projects in South Africa (the regional leader in grid-scale renewables), delays in policy implementation and financial closure in several other Member States also have been a factor.

An estimated USD 279.8 billion was invested in renewable energy globally in 2017, 2% higher than in 2016 but still well below the all-time high of USD 323.4 billion reached in 2015.[2] This brought cumulative renewable energy investment since 2004 to USD 2.9 trillion.[3]

The downturn in the value of investments is also a function of the rapid decline in capital costs of most renewable energy technologies. For example, the average capital cost for solar PV projects starting construction in 2016 was 13% lower than in 2015, while for onshore wind power the drop was 11.5%, and for offshore wind power it was 10%.[4] In South Africa, tendered costs for solar PV and wind power declined substantially from Bid Window 1 to Bid Window 4, to the point where these technologies are now cheaper than Eskom's average cost of supply and far below the cost of its new coal power stations.[5]

Recent renewable energy auctions in Zambia (explained further below) have resulted in some of the lowest prices for solar PV installations in the world. These cost reductions are particularly significant for efforts to attract renewable energy investment in Africa, where remoteness, lack of local manufacturing capacity, lack of local financing and weak regulatory incentives have traditionally led to higher costs than in Europe, Asia or the Americas.

Despite these caveats, the recent real decline in investment is undisputed. For example, sub-Saharan Africa attracted USD 4.9 billion in renewable energy investment in 2015 but only USD 2 billion in 2016, a decline of around 60%.[6] This represented only about 1% of global renewable energy investment in 2016, suggesting that the continent is yet to attract major investment in this area.[7] Of the USD 4.9 billion in 2015 and USD 2 billion in 2016, foreign investment comprised USD 2.0 billion and USD 1.2 billion, respectively.[8]

No African country was listed in the top 10 for renewable energy asset investments in 2017, according to UNEP-Bloomberg's *Global Trends 2018* report.[9] Substantial delays in implementation of REIPPPP projects in South Africa, which until 2015 had attracted by far the greatest amount of renewable energy investment in Africa and stood fifth internationally, were a major factor. Compared to 2016, in 2017 South Africa fell from fifth to sixth place in Bloomberg's Climatescope rankings of competitiveness and recorded an 88% drop in renewable energy investment[ii].[10]

Figure 7 on page 92 summarises the Climatescope rankings, in both renewable energy investment and related policy, in eight SADC Member States from 2012 through 2016.[11] South Africa continues to dominate investment and generation in the renewables sector, despite the downturn in 2016 (when only USD 300 million in investments was finalised, compared to USD 5.4 billion in 2012).[12] Although still leading the continent by a substantial margin, this rapid decline has worried investors who had previously targeted South Africa as a lower-risk jurisdiction within Africa because of its mature financial markets, stronger governance, independent judiciary and strong energy infrastructure.

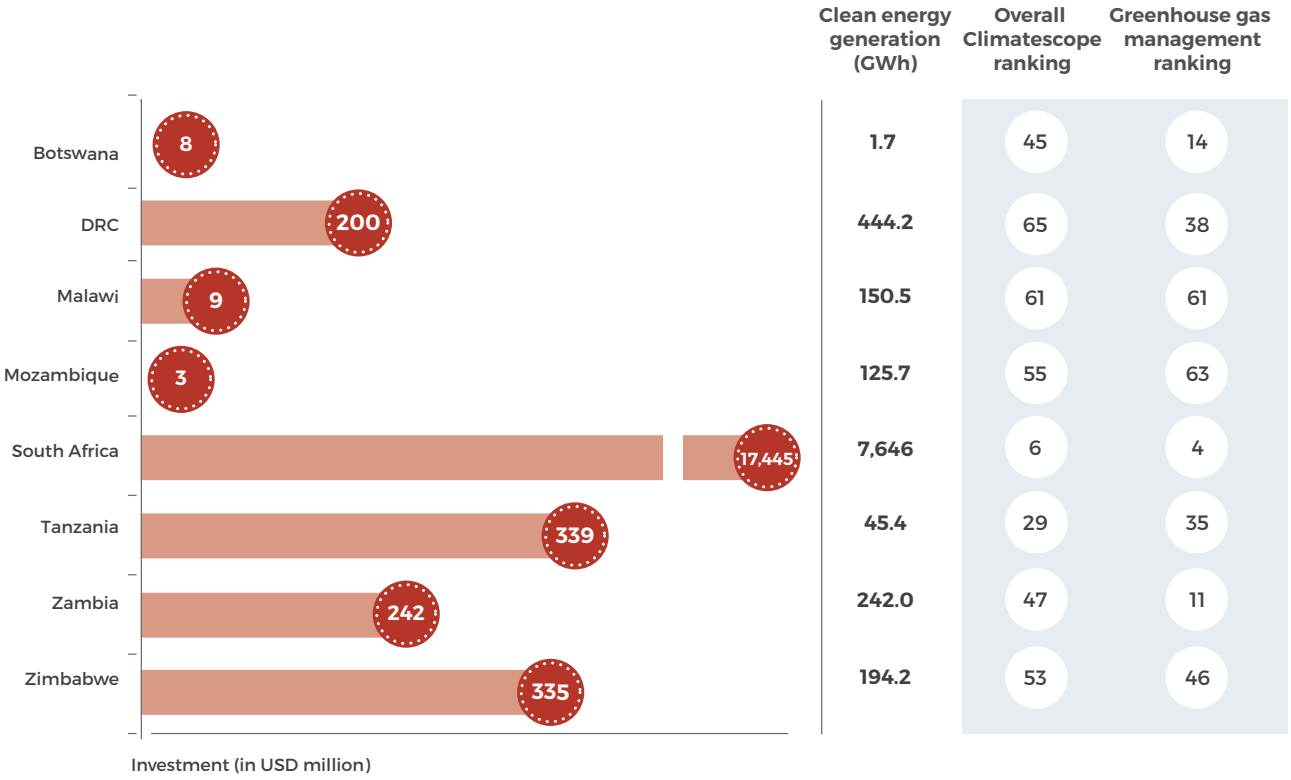
Despite these setbacks, South Africa's dominance in the investor community is likely to continue, as the 2016 draft of the country's Integrated Resource Plan advocates a three-fold increase in generation from all sources by 2050.[13] Whether generation from renewable energy will be a factor in this expansion, and if so by how much, will not be determined until finalisation of the new draft IRP, which was expected in 2018.

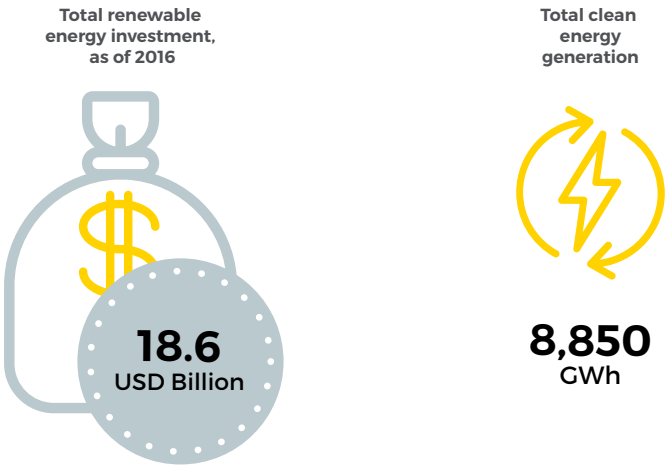
[i] The exception to this statement is the off-grid solar sector, investment in which has doubled annually between 2012 and 2016, with annual investments touching USD 317 million in 2016. In 2016-2017, there has been a sales slowdown, but cumulatively USD 922 million has been raised since 2012. See https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/2018_Off_Grid_Solar_Market_ Trends_Report_ Full.pdf.

[ii] The estimated total investment in renewable energy through all seven bid windows as of mid-2018 was ZAR 201.8 billion (USD 13.6 billion), of which ZAR 48.7 billion (USD 3.3 billion) was from foreign investors and financiers. (Noma Qase, IPP Office, Department of Energy of the Republic of South Africa, personal communication with REN21, July 2018)

FIGURE 7.

Renewable Energy Investment and Generation in Selected SADC Member States, as of 2016





Source: see endnote 11 for this section.

No southern African countries apart from South Africa (rated number four) scored well on greenhouse gas management in the Climatescope ratings.[14] This is likely a reflection of the lack of supportive policies and of consistent foreign direct investment, rather than of a lack of opportunities for carbon mitigation. However, it does suggest that these countries are not taking advantage of the many new financing opportunities arising from the Paris Agreement and related climate change initiatives (see below for further discussion of these opportunities).

Low rankings should not be taken as evidence that investor interest is lacking. Countries such as Mozambique and Tanzania continue to develop progressive regulatory regimes that are attracting significant investment, while, as noted in section 5,

TABLE 23.
Pipeline of Renewable Energy Projects Approved But Still Requiring Financing in SADC Member States, as of Mid-2018

	Technology						
	Small-scale hydro (<100 MW)	Large-scale hydro (≥100 MW)	Wind (MW)	Solar (MW)	Geothermal (MW)	Biomass (MW)	Total (MW)
Angola	65	1,470	78				1,613
Botswana				100			100
DRC		4,950		20			4,970
Eswatini	34.45	140		35		37	246
Lesotho	10	1,200	50	20			1,280
Madagascar	51	300		35		5	391
Malawi	60	460	200	303			1,023
Mauritius			29	97			126
Mozambique	39	236	330	585		10	1,200
Namibia		300		232		20	552
Seychelles				15			15
South Africa	4.7		1,363	913		42	2,323
Tanzania	293	3,135	450	209	5,000		9,087
Zambia	214.65	3,868		500			4,583
Zimbabwe	33.3	1,200		303			1,536
SADC	**805**	**17,259**	**2,500**	**3,367**	**5,000**	**114**	**29,045**

Source: see endnote 18 for this section.

FIT and auction programmes are being developed in Botswana, Mauritius, Zambia and Zimbabwe to entice new investors to these countries. To the extent that these programmes are able to offer contracts denominated in US dollars or other hard currencies, they should help to reduce risk for foreign investors by ensuring that investments are protected against currency fluctuation.

This is the case for the Zambia auction programme, but, as IRENA has noted, protection of this kind also exposes the Zambian government to significant currency risk.[15] From an investor perspective, the fact that the contracts issued by the Zambian programme are backed by the World Bank and include some payment guarantee (but no price escalation) also helps to mitigate risk.[16] (See the sub-section "FITs and Auctions" below for a more detailed comparison of FIT and auction programmes.)

On the other hand, basic electricity tariffs in many Member States are still not cost-reflective, making it difficult to ensure that FITs, when they are finally implemented, are high enough to attract investment[i]. This is one of the challenges being addressed by KfW in its GET FiT programme for Zambia, which is also expected to be implemented in several other SADC Member States.

RENEWABLE ENERGY PIPELINE

In addition to the numerous renewable energy projects already in place (see section 2), a large number of projects are "in the pipeline", most of which represent significant financing opportunities. This is of considerable importance to institutional investors, as they are more likely to commit to a project – and by implication a country or region – if they can identify a promising group of future opportunities. In short, presenting a strong pipeline of projects can be as important in attracting foreign investment as promoting a single "marquee" project.[17]

The pipeline presented here includes both projects that had been approved by Member States as of mid-2018 but were awaiting financing, as well as several projects that were at advanced planning stages but not yet fully approved. These projects are listed in table 23, broken down by country, technology type and MW of expected capacity.[18]

In the case of South Africa, data from that country's IPP Office as of mid-2018 show that out of a total of 92 renewable energy projects approved, 28 projects were listed as "no financial

[i] SADC energy ministers decided in 2004 to set 2013 as the date for all Member States to achieve cost-reflective tariffs. As of 2015 only Namibia and Tanzania had done so, and the target date has been shifted to 2019.

close yet", i.e., approved but still seeking financing; only these latter projects are included in the table, comprising a total of 2,323 MW of capacity.[19] Of these, all but two projects were from Bid Window 4, for which contracts were signed only in April 2018. The largest capacity gap was for wind power with 1,353 MW still requiring financial closure; 913 MW of solar (both CSP and PV) was also awaiting closure.[20] Four of the wind projects seeking financing in Bid Window 4 achieved financial closure in early August 2018, reducing this gap significantly, and most of the newly approved projects were expected to achieve closure soon thereafter.[21]

As expected, large-scale hydroelectric projects (17,259 MW) dominate the regional pipeline, led by projects in the DRC, Angola and Tanzania; but solar (3,367 MW) and wind (2,500 MW) power projects also represent significant opportunities[i].

Tanzania leads all Member States with 9,087 MW of projects in the pipeline, including 5,000 MW of geothermal energy. This target for geothermal development was set by Tanzania and reflects preliminary work done under the Geothermal Risk Management Facility[ii] mentioned in the Policy Landscape section. Tanzania was initially the only SADC Member State involved in this process, although others (the DRC, Zambia) were added later. In its fifth round of submissions as of mid-2018, the Facility provides grants for geothermal infrastructure, surface studies, drilling and "continuation activities".[22]

INTERNATIONAL FINANCING SOURCES

Despite the recent decline in renewable energy investment, the SADC region can still become a significant target for international project financing. Table 24 shows that more than 30 organisations and funds were providing financing opportunities for projects in at least one SADC Member State as of mid-2018.[23] These range from private investment funds dedicated to renewable energy (e.g., LionWorks) to private funds that cover infrastructure generally (e.g., Actis Infrastructure), to funds sponsored by developed-country governments or international funding agencies (e.g., SEFA and SREP). Based only on this incomplete list, as much as USD 10 billion may be available from various investment funds for renewable energy projects in the region; however, this figure is hypothetical as it depends on projects meeting the technical and financial criteria established by investors.

[i] Renewable energy projects generating electricity for on- or off-grid use (including for mini-grids) are the only projects covered in the table. Small, distributed energy projects that are not part of a mini-grid are not included because information on projects of this kind is often unreliable and it is difficult to ascertain the status of financing.

[ii] The GRMF is jointly sponsored by the African Union Commission, the German Federal Ministry for Economic Cooperation and Development (BMZ) and the EU-Africa Infrastructure Trust Fund (EU ITF) via KfW.

TABLE 24 .
Funding Sources for Renewable Energy in Southern Africa, as of Mid-2018

Fund name	Type	Size of investment (millions)	Size of fund (millions)	SADC Member States	Technology focus
Impact Assets Emerging Markets Climate Fund	Equity or debt	USD 0.5 to USD 5		n/a	
Scaling Up Renewable Energy in Low Income Countries Program (SREP)	Grant	USD 1 to USD 30		Lesotho, Madagascar, Malawi, Tanzania, Zambia	
responsAbility – Energy Access Fund	Equity and quasi-equity	USD 0.5 to USD 3		None to date	
Danish Climate Investment Fund (KIF)	Equity	EUR 2 to EUR 50		None to date	
Proparco FISEA: Invest and Support Fund for Businesses in Africa	Equity	EUR 1 to EUR 10			
Vital Capital II Equity	Equity	USD 10 to USD 50		Sub-Saharan Africa except South Africa	
FMO Infrastructure Development Fund	Direct investment debt and equity	EUR 5 to EUR 50		South Africa, Zambia	
GroFin SGB Fund	Debt	USD 0.1 to USD 1.5		South Africa, Tanzania, Zambia	
Energy Access Ventures (FMO)	Equity/debt	USD 0.5 to USD 4	USD 90	Tanzania	
Actis Infrastructure	Equity	USD 10 to USD 50		Sub-Saharan Africa	
African Renewable Energy Fund (AREF)	Equity	USD 10 to USD 30	USD 100		

Sustainable Energy Fund for Africa (SEFA)	Grant or equity	USD 1 to USD 3		Madagascar, Mauritius, Tanzania, Zambia	
Energy and Environment Partnership South & East Africa	Grants and catalytic funding	EUR 0.1 to EUR 1	EUR 25	Botswana, Eswatini, Lesotho, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia	
IRENA/ADFD Project Facility	Debt	USD 5 to USD 15			
OFID – Energy Poverty Program	Grant	USD 0.1 to USD 2			
Berkeley Energy (AREF)	Equity	USD 10 to USD 30	USD 200	Tanzania	Small-scale hydro
DI Frontier Investment Equity	Mezzanine capital (e.g., convertible debt or preferred shares) and short-term debt financing	USD 3 to USD 10			
DEG – Direct Investments	Equity, mezzanine, debt and long-term loans	EUR 10 to EUR 30		Mozambique, South Africa, Tanzania, Zambia	Renewable energy in general
Lion Works	Equity	n/a	USD 750	Angola, Mozambique, South Africa, Tanzania, Zambia	Renewable energy in general
World Bank/Public-Private Partnerships	Long-term Loans	USD 6,300	n/a	Mozambique, Namibia, Zambia	
African Development Fund (AfDB)	Long-term loans/ grants	USD 1.4 max.	n/a	All SADC Member States	Renewable energy in general
EU-Africa Infrastructure Trust	Interest rate subsidies, investment grants, equity or quasi-equity investments or participations	n/a	n/a	All SADC Member States except South Africa	Renewable energy in general
Infrastructure Investment Programme for South Africa	Debt and mezzanine financing	n/a	n/a	South Africa only	Energy generation capacity including renewable energy
SADC Project Preparation and Development Facility (SADC/DBSA)	Assistance in project identification, preparation and feasibility studies developing bankable projects to investors and lenders	n/a	n/a	All SADC Member States	Some renewable energy, mostly power infrastructure

n/a = not available or not applicable.

Source: see endnote 23 for this section.

Note that financing that is focused specifically on climate change or on carbon mitigation is not included in table 24. A more detailed discussion of climate financing is provided at the end of this section[i].

Despite increased interest in financing renewable energy projects, most investors have used a blended approach to financing, classifying renewable energy investments in emerging and frontier markets as high-risk and preferring to share the risk with other investors. Such blended investments may include direct equity investments, loans (debt), mezzanine financing[ii] (e.g., through preferred shares or debt convertible to shares), catalytic funding (grants or loans intended to stimulate further investment) and concessional loans. By far the most common forms are mezzanine financing and straight equity financing, as most of the organisations listed are so-called private equity firms that prefer to invest as enterprise partners. The role of banks, including both private and development banks, is to package a combination of loans and equity financing, plus concessional financing if necessary, to ensure that each party to the deal is comfortable with the level of risk they are taking on[iii].[24]

Several of these financing sources are already involved in projects in the SADC region. Among the most active is the Sustainable Energy Fund for Africa (SEFA), which in 2017 was supporting seven projects in five different Member States, ranging from solar PV and wind power to energy-efficient cooling using deep-ocean water (see table 25).[25] Only one of the projects – Tanzania's Makambako wind project – involves an actual equity investment, with most others being supported via grants for project preparation and "enabling environment".

Globally, private finance plays a key role in renewable energy development, particularly in South Africa where a high proportion of the investment in the REIPPPP is private or public-private.

[i] With the sole exception of South Africa, SADC Member States have very low CO_{2-e} emissions, and some (e.g., Botswana) are even "carbon neutral", meaning that their emissions are more than balanced by their sequestration capacity. The low incidence of mitigation activities is therefore due in part to a lack of emissions-intensive industries that would provide opportunities for mitigation projects.

[ii] Mezzanine financing, sometimes called mezzanine debt, "is a hybrid of debt and equity financing that gives the lender the rights to convert to an ownership or equity interest in the company in case of default, after venture capital companies and other senior lenders are paid." See Investopedia, https://www.investopedia.com/terms/m/mezzaninefinancing.asp.

[iii] Blended financing also recognises that there are differences in the level of risk which different entities are willing to accept. Governments, for example, might be happy to take a larger portion of the risk because their objectives are different from private investors, and a private or institutional investor from Africa might accept higher risk than a European counterpart because they understand conditions on the ground. (Jordan Berger, personal communication with REN21, June 2018).

TABLE 25.
Approved Sustainable Energy Fund for Africa Projects in SADC Member States, 2017

	Project name	Project type	Support type	Project size
Madagascar	Noisy Be	Hydro/solar PV	Project preparation	5 MW
Mauritius	Deep Ocean Water Applications	Energy efficiency	Project preparation	45 MW
Mozambique	Renewable Energy Promotion	n/a	Enabling environment	n/a
Tanzania	Jememe Rural Power Mini-Grid	Solar PV	Project preparation	5 MW
Tanzania	Makambako	Wind	Equity investment	50 MW
Tanzania	Renewable Energy Facility	n/a	Enabling environment	n/a
Zimbabwe	Oxygen Rooftop	Solar PV	Project preparation	20 MW

Note: n/a = not applicable (may be more than one technology).

Source: see endnote 25 for this section.

The African Development Bank is also a major funding source for renewable energy in the region, both directly through its lending facilities and in its capacity as the manager of various programmes dealing with renewable energy, of which SEFA is one. Others include the Africa Hub for SEforALL, the Green Mini-Grid Market Development Programme, the African Green Climate Fund and the African Green Bond Fund.

For example, the Green Climate Fund approved in April 2018 a USD 50 million loan and a USD 2.5 million grant for Zambia's Renewable Energy Financing Framework, covering 100 MW of renewable energy projects under that country's REFiT policy.[26] With its Green Bond Fund, the AfDB has supplemented conventional loan financing with funding for projects such as the Dar es Salaam Bus Rapid Transit project, the Xina Solar One CSP project in South Africa and the Ithezi-Tezhihydro power Project in Zambia.[27]

The AfDB's New Deal on Energy for Africa links a number of these programmes together with an aspirational target of connecting 75 million households through off-grid energy access.[28] In this connection, in January 2018 the AfDB announced a USD 30 million investment in the Facility for Energy Inclusion Off-Grid Energy Access Fund, including investments of USD 10 million from Calvert Impact Capital, USD 8.5 million from the GEF and EUR 6 million (USD 7 million) from the Nordic Development Fund (NDF).[29]

In addition the AfDB participates in the African Renewable Energy Fund, which develops and invests in grid-connected renewable energy projects (hydropower, wind, geothermal, solar, biomass and waste gas) of between 5 MW and 50 MW. Other investors in the fund include SEFA, the African Biofuel and Renewable Energy Company (ABREC), the ECOWAS Bank for Investment and Development (EBID), the West African Development Bank (BOAD), the Nederlandse Financierings-Maatschappijvoor Ontwikkelingslanden N.V. (FMO) and the Calvert Foundation. The Fund is managed by Berkeley Energy and has a target size of USD 200 million.[30]

Globally, private finance plays a key role in renewable energy development, particularly in South Africa where a high proportion of the investment in the REIPPPP is private or public-private. The latter includes collaborative involvement by public financing entities such as the South African Industrial Development Corporation (IDC) and the Development Bank of Southern Africa (DBSA).

The Spanish company Abengoa has been particularly active in this arena, investing in the Khi Solar One plant, a one-of-a-kind concentrated solar tower that employs heated steam. It has a capacity of 50 MW, allowing it to supply clean energy to about 45,000 South African households.[31] The plant was approved in Bid Window 1 of the REIPPPP and began commercial operation in February 2016. Abengoa also was involved in financing the 100 MW parabolic trough plant, !XiNa Solar One, approved in Bid Window 3 and under construction as of mid-2018, and Kaxu, a 100 MW CSP plant using molten salt for storage, also approved in Bid Window 1.[32] All three of Abengoa's projects have been based on a blend of private and public funding, with the public share coming from local community trusts as well as the IDC.

According to a 2017 analysis of the REIPPPP and similar renewable energy financing programmes in Canada and Mexico, successful projects typically obtain 70% of their financing through debt in the form of project finance from large banks, and then provide 30% equity for their projects, financed through venture capital funds, infrastructure funds, pension funds, development banks and multilateral financial institutions.[33] In the South African programme, the government first screened projects for non-financial criteria such as impact on economic development, job creation, potential for greenhouse gas displacement and the ownership structure of projects, and only then ranked them using financial and energy criteria.[34]

Numerous other private companies are involved in the REIPPPP and other South African renewable energy projects, including international project developers such as Enel Green Power, Solafrica, Skypower Canada, SunEdison and Solairedirect. South African developers such as Old Mutual, Emvelo and Mulilo Renewable Energy also are active in this market, as are international project financiers and equity firms such as the U.S. Overseas Private Investment Corporation, Investec, Actis Africa, Deutsche Bank, local banks such as Absa Bank and Standard Bank, and equipment suppliers such as First Solar, ABB, Energia Ercam, Siemens and Vestas.[35]

In other Member States, involvement of the private sector has been more limited, replaced by greater reliance on concessional financing from development banks and other public entities. There are some promising examples of private sector involvement, however. Investment in Namibia's only wind farm to date, the 5 MW Ombepo project at Luderitz, has been 95% financed by a private company, Innosun, with a 5% ownership share for the local town council.[36] Innosun is owned by a consortium of Namibian and French investors.[37] Meanwhile, all solar PV projects in Namibia, including those using net metering, are private sector-financed.[38]

The private sector also is involved in developing improved cook stove projects in some Member States, although some of these companies are so-called non-profit or benefit corporations that are linked to various donor and non-governmental organisations.

Private companies have been heavily involved in other kinds of small-scale renewable and distributed energy projects, especially in Tanzania. For example, Hecate Energy Africa LLC developed a 50 MW PV solar project in Dodoma, and Husk Power Systems, originally based in India and Nepal, obtained funding in 2018 for the installation of 200 biomass-powered mini-power plants in Tanzania.[39] Mobisol, a German company, used mobile banking services and PAYG to install more than 40,000 solar home systems by 2018, many in Tanzania.[40] NextGen Solar, a US company, had installed 70 MW of solar power plants in Tanzania as of mid-2018.[41] Notably, all of these companies have been enrolled as part of the US private sector programme Power Africa, which also includes major African banks such as Nedbank Capital and specialist African investment groups such as Investec.[42]

REGIONAL FINANCING SOURCES

In the SADC region, the public sector has played an important role in funding renewable energy development. Local and regional development financial institutions such as DBSA, IDC South Africa and the Public Investment Corporation of South Africa have all funded renewable energy projects in the region, as has IDC Zambia. As noted in the 2015 *Status Report*, the SADC region has no dedicated home-based financing facilities for renewable energy comparable to the ECOWAS Renewable Energy Investment Initiative (EREI), so these general-purpose institutions have played a key role in moving sustainable energy investment forward.

As of the end of 2016, DBSA had contributed to 2,512 MW of new renewable energy capacity as part of South Africa's REIPPPP.[43] All of these projects – including five commercial solar panel, nine solar PV and five wind power projects – were operational and delivering power to the national grid as of mid-2018. DBSA has provided funding in the form of senior debt, mezzanine debt and black empowerment funding, spending a total of some USD 14.9 billion on energy projects as of 2016.[44] Among the most recent DBSA-funded REIPPPP projects is the 100 MW Kathu CSP project in Northern Cape province, discussed in sidebar 7.[45]

SIDEBAR 7.
Kathu CSP Project in South Africa's Northern Cape

This project, which was awarded in Bid Window 3.5 of South Africa's REIPPPP in 2014, achieved financial closure in May 2016 and was scheduled to be operational by September 2018. This project used an extremely innovative and complex approach to financing. The shareholders consist of Engie (formerly GDF Suez), the Government Employees Pension Fund (Pubic Investment Corporation or PIC), SIOC Community Development Trust, Investec Bank Limited, Lereko Metier and the Kathu Local Community Trust.

DBSA, together with Absa Bank, Investec, Nedbank and Rand Merchant Bank, were the mandated lead arrangers on the project. The total project cost is estimated at ZAR 13.6 billion (USD 913 million). DBSA's exposure under the project is ZAR 2.06 billion (USD 138 million), comprising ZAR 1.7 billion (USD 114 million) of the commercial facilities and ZAR 368 million (USD 25 million) of Empowerment Financing, which enabled both the SIOC Community Development Trust and the Kathu Local Community Trust to acquire equity stakes in the project.

Source: see endnote 45 for this section.

The Energy and Environment Partnership is a small grant programme developed by the Finnish government and supported by the Austrian and UK governments to stimulate the development of small energy efficiency and renewable energy projects in eastern and southern Africa. EEP Africa covers 11 of the 15 SADC Member States (Botswana, Eswatini, Lesotho, Malawi, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia and Zimbabwe) and provides early stage grant and catalytic financing to innovative clean energy projects, technologies and business models. It offers two financing windows:

- *EEP Innovation* provides early-stage grants and repayable grants between EUR 200,000 (USD 232,000) and EUR 1 million (USD 1.2 million), co-financing up to 70% of the project budget;
- *EEP Catalyst* provides follow-on risk sharing finance to select projects in the form of concessional loans of up to EUR 2 million (USD 2.3 million), covering up to 25% of new investment.[46]

Between 2010 and 2015 EEP Africa funded 153 projects, of which 102 were in the SADC region. By the end of 2017 the total had reached 225 projects, of which 138 were located in SADC Member States.

Between 2010 and 2015 EEP Africa funded 153 projects, of which 102 were in the SADC region.[47] By the end of 2017 the total had reached 225 projects, of which 138 were located in SADC Member States (not counting several regional projects covering both southern and eastern Africa).[48] The range of technologies funded included: solar PV (42%), solid biomass (17%), biogas (11%) and cook stoves (11%), with the remainder being solar thermal, hydropower, wave energy, liquid biomass, waste energy and wind.[49] Total funding was EUR 25 million (USD 29 million) for the first phase (2010-2013) and more than EUR 35 million (USD 41 million) for the second phase (2013-2017).[50]

Of the supported projects in SADC Member States, only five had not yet completed the EEP co-funded activities as of the end of 2017.[51] The majority of projects supported were pre-feasibility or feasibility studies and had moved on to the implementation phase.

Examples of EEP projects in 2018 included:

- In Botswana, the Kgalagadi Resources Development Company was implementing a pilot solar PV village concept.[52]
- In South Africa, Waste Transformers was implementing a waste-to-energy project, and uMgungundlovu Municipality in KwaZulu-Natal was undertaking a feasibility study for the Mkhomazi run-of-river hydroelectric facility.[53]
- In Tanzania, Sustainable Energy Solutions was implementing a shared solar project with Tanzania Esso, using solar PV technology, and Husk Power Systems was undertaking a project to scale up the Geita Biomass Gasification project in five neighbouring villages in Geita District.[54]

As of mid-2018 the EEP Africa programme was in its third phase and had transitioned into an open-ended multi-donor trust fund and climate facility, managed by the NDF and fully aligned with sustainable development goals and the Paris Climate Agreement. Another call for proposals was expected to be open towards the end of 2018.

FITS VERSUS AUCTIONS

For most SADC Member States, efforts to finance increased renewable energy capacity require consideration of two options: feed-in tariffs and capacity auctions. These were discussed in section 2 from a policy viewpoint (as an incentive), but it also is important to see them as a form of financing.

Particularly for small-scale projects, a FIT is often more attractive than auctions because it does not involve complex and costly negotiation, and it guarantees the developer a fixed price over a stipulated period, thus mitigating investment risks for all parties. On the other hand, Member States increasingly have seen auctions as a way of attracting lower prices and hence lowering risk for both the country and the utility. FITs have increasingly given way to capacity auctions, in which Member States publish an "allocation" (the term used in South Africa) against which parties can bid, taking account of both cost and, in some cases, social criteria.

Zambia offers a particularly interesting example of how an auction system can work to mitigate risk. As noted in section 2, Zambia was the first African country in which the World Bank's Scaling Solar programme was implemented, with IDC Zambia officially engaging the IFC as lead transaction advisor. The Scaling Solar programme aims to provide a one-stop shop including advisory services, standardised contracts, and a "stapled offer" of investment products (financing) and risk management services/products (guarantees and insurance) for which bidders are free to apply.[55]

The IFC together with other advisors drafted a set of template documents including a PPA and government support agreement. These agreements offered a fair, balanced and bankable allocation of risk between the government and private parties, based on which the IFC and others would offer project-specific financing and guarantees. The goal of the programme was to make privately funded grid-connected solar projects operational within two years of award and at competitive tariffs to mitigate Zambia's power shortage, estimated at 560 MW in 2015.[56]

In May 2016 Zambia completed its first solar auction, designed to develop two solar PV projects of up to 50 MW in the Lusaka-South Multi-Facility Economic Zone. The auction was very competitive and attracted a total of 48 solar power developers, of which 11 pre-qualified to submit full bids and seven produced final bids.[57] Two winning bidders were announced in June 2016: Neoen/First Solar, with 52 MW at USD 60.2 per MWh, and Enel Green Power, with 34 MW at USD 78.4 per MWh.[58] The bid prices were much lower than expected, and among the lowest in the world at the time.[59]

NEW BUSINESS MODELS

As with renewable energy and energy efficiency developments globally, the need for financing in the SADC region has led to a variety of new (and adapted) business models. These are described briefly below.

Pay-as-you-go (PAYG) consumer financing: This is effectively a consumer financing model that takes advantage of mobile money systems and combines this with remote monitoring and control of solar systems to remotely disconnect a system in the event of default. Ownership of the system is transferred once the customer finalises their repayments. The model offers flexible customer repayment options and enables the business to easily and effectively manage a large portfolio of dispersed borrowers. With repayments typically ranging from six months to three years, proper cash flow management is essential.

Consumer financing (via partner financial institutions): In partnership with a financial institution the solar PV supplier provides products and associated services, while the financial institution provides the consumer financing and collects repayments.

Mini/micro-grid: The main advantage of mini grids over stand-alone solar systems is their ability for connected customers to increase their power and energy consumption without having to invest in additional capacity. They are technically most effective when a large number of customers can be connected within a short radius.

CLIMATE FINANCE

Climate finance funds, such as the Global Environment Facility, the Climate Investment Funds (CIF) and the Clean Development Mechanism, have continued to provide opportunities for financing renewable energy and energy efficiency projects in the region. The Paris Agreement of 2015 has presented many new opportunities for this kind of financing, at the same time greatly complicating the role of the CDM and causing many CDM-registered projects to be retired or to seek other buyers of their carbon credits – in effect creating gridlock for countries wishing to use this mechanism to finance projects[i].

The Paris Agreement also generated a plethora of new Nationally Determined Contributions. As explained in the Policy Landscape section, NDCs and their predecessors (INDCs and NAMAs) provide explicit targets and modes for achieving each country's contribution to the Paris Agreement targets, and they can in theory be linked to the use of climate finance to meet these targets.

As an example, Namibia asked for support for a project identified in its NAMA, "Rural Development through Electrification with Renewable Energies", subsequently receiving a grant in late 2015 of USD 70,000 for project preparation from UNDP's Millennial Development Goals Carbon facility.[60] As of 2018 the Namibian government was seeking USD 12 million for implementation of this project.[61]

The German development agency, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), has prepared a detailed strategy for linking climate finance to NDCs, called the Climate Finance Readiness Programme.[62] Recognising that the cost of implementing all NDCs would probably exceed USD 4.4 trillion, the GIZ programme has developed a framework for prioritising actions and identifying funding gaps that may impede the implementation of NDCs. It then provides assistance to individual countries on demand.

In response to the need for facilitating climate financing of NDC goals, the AfDB and WWF have developed the Africa NDC Hub, intended to support African countries in the development of strategies and implementation mechanisms for their NDCs.[63] This includes technical assistance on NDC strategy development, facilitating access to climate finance, scientific knowledge, capacity building, peer-to-peer learning and best practice sharing, monitoring and evaluation, and project origination. At the same time, the Economic Commission for Africa has implemented the African Partnership Facility for NDCs, with similar goals and methods to the NDC Hub.[64]

Financing through the GEF also has been a factor in both renewable energy and energy efficiency development in southern Africa, and this has continued since 2015. In 2016 the GEF provided USD 7.96 million in co-funding for renewable energy project preparation in Africa, supplemented by USD 115 million from the AfDB, and another USD 14.3 million for the Pilot African Climate Technology Finance Center and Network, supplemented by USD 95 million from the AfDB.[65] However, a large majority of GEF funding in southern Africa went to adaptation-related programmes rather than mitigation.

Some of the renewable energy and energy efficiency projects supported by the GEF in recent years are presented in table 26.[66]

In 2016 the GEF provided USD 7.96 million in co-funding for renewable energy project preparation in Africa, supplemented by USD 115 million from the AfDB, and another USD 14.3 million for the Pilot African Climate Technology Finance Center and Network, supplemented by USD 95 million from the AfDB.

[i] The proposed link between the Paris climate talks and the CDM is Article 6 of the Paris Agreement, which indicates that there will be provision for *internationally transferred mitigation outcomes*, i.e., some form of trading or other transaction by which countries may sell or otherwise transfer their carbon mitigation improvements to other countries or entities needing them to meet their targets. Unfortunately, more than two years into the implementation of the Paris Agreement, progress on this provision is still minimal and the role played by existing or planned CDM, Gold Standard and other voluntary mitigation projects is still unclear.

TABLE 26.
Recent Global Environment Facility-funded Projects in the SADC Region

Project	Purpose	Funding	Start-up
Promoting Sustainable Energy Access for Rural Communities in South-Eastern Angola	To catalyse investments in decentralised renewable energy systems to expand energy access for base-of-the-pyramid consumers and to reduce greenhouse gas emissions	**USD 21.6 million**	2018
Promotion of Waste-to-Energy Options for Sustainable Urban Management in the DRC	To promote waste-to-energy technologies for sustainable waste management in the DRC	**USD 20.1 million**	2018
Conservation and Improvement of Ecosystem Services for the Atsinanana Region Through Agroecology and the Promotion of Sustainable Energy Production	To optimise sustainable land use management, biodiversity conservation, renewable household energy security and climate change mitigation for the benefit of local communities in Madagascar	**USD 24 million**	2018
Increasing Access to Clean and Affordable Decentralized Energy Services in Selected Vulnerable Areas of Malawi	To increase access to energy in selected remote, rural areas in Malawi by promoting innovative, community-based mini-grid applications in co-operation with the private sector, social	**USD 24.6 million**	2014
Realising Energy Savings and Climate Benefits of Implementing Mandatory Energy Auditing in Coordination with HCFC Phase-out and HFC Avoidance	To operationalise the new national energy audit scheme of Mauritius by addressing and removing technical, institutional and financial barriers to the adoption of energy efficiency measures and exploit synergies to reduce emissions of ozone-depleting substances and promote avoidance of hydrofluorocarbons in the refrigeration and air conditioning sector.	**USD 22.5 million**	2017
South Africa Wind Energy Project (SAWEP) – Phase II	To assist the Government and industry stakeholders to overcome strategic barriers to the successful attainment of South Africa's Integrated Resource Plan target of 3,320 MW of wind power	**USD 3,554,250**	2015

Source: see endnote 66 for this section.

As of mid-2018, there was nothing in southern Africa comparable to the GEF Strategic Programme for West Africa, meaning that funding requests have occurred on a country-by-country basis rather than within an established regional funding framework.

In 2012 the GEF joined with the AfDB to create the Africa Climate Technology Finance Centre and Network (ACTFCN) supporting the deployment and scale-up of both climate change mitigation and adaptation technologies. Funding included a USD 9.09 million grant from the GEF Trust Fund and USD 5.25 million from the GEF Special Climate Change Fund.[67] ACTFCN focused exclusively on projects in the energy sector.[68] However, the facility was wound down in 2017.[69]

The Climate Investment Funds, a partnership between the international and regional multilateral development banks, of which the Clean Technology Fund is a part, aims to allocate USD 8 billion in an effort to leverage an additional USD 55 billion in financing to 48 select low- and middle-income countries globally.[70] Lesotho, Madagascar, Malawi, Tanzania and Zambia are included in the pilot phase of the Scaling Up Renewable Energy in Low Income Countries Program, for which USD 318 million was pledged.[71] Lesotho reached the scoping stage of SREP in 2015, but a full programme has yet to be developed. Malawi was the subject of a scoping mission in 2016, as was Zambia. Tanzania progressed from a 2013 scoping report to a full investment plan

and as a result received USD 21.7 million from the CIF for the Ngozi geothermal steam field in southwestern Tanzania, of which USD 5 million was a loan and the balance a grant.[72]

Despite the exclusion of carbon (mitigation outcome) trading from the initial drafts of the Paris Agreement, the CDM and voluntary carbon mechanisms such as The Gold Standard are still being used across the region to provide additional financial support to the development of renewables and energy efficiency. As of April 2018 there were 92 registered CDM projects in the region, up from only 20 in 2015.[73] All SADC Member States with the exception of Botswana had at least one project, and 68 of the projects were in South Africa.[74] The total expected emission reductions for all 92 projects by 2020 was 82.7 million tonnes of CO_2-equivalent.[75]

In addition approximately 60 Programmes of Activity (PoAs) in the region had received CDM approval or were pending approval as of April 2018.[76] Of these, 38 were in South Africa, with Malawi having the second largest number at 8.[77] PoAs cover a wide range of technologies, from improved cook stoves to wind farms, low- and high-pressure solar water heating and biogas. In South Africa alone, there were nine solar hot water PoAs (compared to six in 2015), as well as six solar PV and three wind PoAs[i].[78] All of these were focused on small-scale project activities that would otherwise be too small to warrant the preparation costs of a stand-alone CDM project.

Table 27 shows the number of CDM projects by country and the total emission reductions claimed for each country's projects as of April 2018. [79] Table 28 shows the number of PoAs by country, and type of technology for each.[80]

As of April 2018 there were 92 registered CDM projects in the region, up from only 20 in 2015. The total expected emission reductions for all 92 projects by 2020 was 82.7 million tonnes of CO_2-equivalent.

[i] PoAs are "open-ended", meaning that there is no limit to the number of projects that could be included, and therefore there is no way to predict precisely the overall impact on energy use or emissions. However all PoAs are required to provide estimates, and because they comprise small-scale projects, they are limited to 15,000 tonnes of CO_2-equivalent for each project, or its thermal equivalent.

TABLE 27.
Clean Development Mechanism Projects in SADC Member States, as of April 2018

CDM	No. of projects	Emissions reductions in 2020 (tonnes of CO_2- equivalent)
Angola	1	815
DRC	2	1,436
Eswatini	1	373
Lesotho	1	276
Madagascar	3	662
Malawi	2	436
Mauritius	4	995
Namibia	2	121
South Africa	68	68,117
Tanzania	4	1,600
Zambia	3	4,111
Zimbabwe	1	3,791
SADC	**92**	**82,732**

Source: see endnote 79 for this section.

TABLE 28.

Clean Development Mechanism Programmes of Activity in Selected SADC Member States, as of April 2018

Member State	No. of PoAs	Type of Programme of Activity
DRC	2	Improved cook stoves
Madagascar	2	Improved cook stoves
Malawi	8	6 for stoves, 1 for solar lamps, 1 for solar/wind/hydro
Mozambique	3	1 for stoves, 1 for afforestation, 1 for solar/hydro
South Africa	38	1 for agricultural residues: other kinds, 1 for lighting, 1 for solar lamps, 1 for stoves, 1 for building materials, 2 for lighting in service, 1 for energy efficiency in commercial buildings, 1 for co-generation, 1 for run-of-river, 2 for landfill power, 1 for manure, 3 for solar and wind, 1 for solar, wind and hydro, 2 for solar, wind and other, 6 for solar PV, 1 for solar thermal power, 9 for solar water heating, 3 for wind
Tanzania	3	1 for solar lamps, 1 for solar, wind and other, 1 for solar PV water disinfection
Zambia	3	1 for biomass briquettes, 2 for stoves
Zimbabwe	1	1 for lighting
SADC	**60**	

Note: PoA = Programme of Activity

Source: see endnote 80 for this section.

LIST OF ABBREVIATIONS

ABREC	African Biofuel and Renewable Energy Company
AC	Alternating current
ACP-EU	Africa, Caribbean and Pacific – European Union
AFD	Agence Française de Développement
AfDB	African Development Bank
BEST	Biomass Energy Strategy initiative
BMZ	German Federal Ministry for Economic Cooperation and Development
BRT	Bus rapid transit
CDM	Clean Development Mechanism
CFL	Compact fluorescent lamp
CHP	Combined heat and power
CIF	Climate Investment Funds
CNG	Compressed natural gas
CO_2	Carbon dioxide
$CO_{2\text{-}e}$	Carbon dioxide equivalent
COMESA	Common Market for Eastern and Southern Africa
CSP	Concentrated solar (thermal) power
DBSA	Development Bank of Southern Africa
DC	Direct current
DRC	Democratic Republic of the Congo
DRE	Distributed renewable energy
DREA	Distributed renewables for energy access
EBID	ECOWAS Bank for Investment and Development
ECOWAS	Economic Community of West African States
EDM	Electricidade de Moçambique
EELN	Energy Efficiency Leadership Network
EEP	Energy and Environment Partnership
EPC	Engineering, procurement and construction
ERB	Energy Regulatory Board
EREI	ECOWAS Renewable Energy Investment Initiative
EU	European Union
EUR	Euro
EWURA	Tanzanian Energy and Water Utilities Regulatory Authority
FEC	Final energy consumption
FIT	Feed-in tariff
FMO	Nederlandse Financierings-Maatschappijvoor Ontwikkelingslanden N.V.
FUNAE	Fundo de Energia (Mozambique)
GACC	Global Alliance for Clean Cookstoves
GBC	Green Building Council
GDP	Gross domestic product
GEF	Global Environment Facility
GET FiT	Global Energy Transfer Feed-in Tariff
GRMF	Geothermal Risk Mitigation Facility
GSR	Renewables Global Status Report
GW/GWh	Gigawatt/Gigawatt-hour
IDC	Industrial Development Corporation
IDM	Integrated demand management
IFC	International Finance Corporation
INDC	Intended Nationally Determined Contribution
IRP	Integrated Resource Plan
IPP	Independent power producer
IRENA	International Renewable Energy Agency
km^2	Square kilometre
kV	Kilovolt
kW/kWh	Kilowatt/kilowatt-hour
LEC	Lesotho Electricity Company
LED	Light-emitting diode
LPG	Liquefied petroleum gas
m^3	Cubic metres
MEPS	Minimum Energy Performance Standards
MJ	Megajoule
MW/MWh	Megawatt/Megawatt-hour
NAD	Namibian dollar
NAMA	Nationally Appropriate Mitigation Action
NDC	Nationally Determined Contribution
NDF	Nordic Development Fund
NEEP	Namibia Energy Efficiency Programme in Buildings
NEES	National Energy Efficiency Strategy of South Africa
PAYG	Pay as you go
PJ	Petajoule
PoA	Programme of Activity
PPA	Power purchase agreement
PSEE	Private Sector Energy Efficiency Programme
PV	Photovoltaic
REASAP	SADC Regional Energy Access Strategy and Action Plan
REC	Renewable Energy Certificate
REEESAP	Renewable Energy and Energy Efficiency Strategy and Action Plan
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
REF	Zambia Rural Electrification Fund
REFIT	Renewable Energy Feed-in Tariff
REN21	Renewable Energy Policy Network for the 21st Century
RERA	Regional Electricity Regulators Association
RISDP	Regional Indicative Strategic Development Plan
RIDMP	Regional Infrastructure Development Master Plan
RPS	Renewable Portfolio Standard
SACREEE	SADC Centre for Renewable Energy and Energy Efficiency
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SCR	Seychellois rupee
SEC	Seychelles Electricity Company
SEC	Swaziland (Eswatini) Electricity Company
SEEREP	Seychelles Renewable Energy and Energy Efficiency Programme
SEforALL	United Nations Sustainable Energy for All initiative
SEFA	Sustainable Energy Fund for Africa
SIEEP	SADC Industrial Energy Efficiency Programme
SPP	Small power producer
SREP	Scaling Up Renewable Energy in Low Income Countries
SSEG	Small-scale embedded generation
TANESCO	Tanzania Electric Supply Company Limited
TFEC	Total final energy consumption
TJ	Terajoule
TWh	Terawatt-hour
TZS	Tanzanian shilling
UNDP	United Nations Development
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USD	United States dollar
VAT	Value-added tax
WHO	World Health Organization
Wp	Watt peak
ZABS	Zambian Bureau of Standards
ZAR	South African rand
ZESA	Zimbabwe Electricity Supply Authority
ZETDC	Zimbabwe Electricity Transmission and Distribution Company

METHODOLOGICAL NOTE

This 2018 report is the second edition of the *SADC Renewable Energy and Energy Efficiency Status Report*. The development of this *Status Report* has been managed collaboratively by the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE) and REN21. This report builds on the first *Status Report* (published in 2015) which was led by REN21 in co-operation with the SADC Secretariat.

The 2015 *Status Report* mapped the existing range of renewable energy and energy efficiency activities in the SADC region. It also provided concrete evidence of potential economic and social benefits in those countries where uptake of renewables had lagged.

The 2018 report is intended to update these activities and to identify significant changes and emerging trends in the implementation of renewable energy and energy efficiency, as well as identifying market trends, evolving policy landscapes, sources of investment and improvements in energy access. It is meant to serve as a baseline report from which SACREEE can develop and build up a continuous data collection process to support information policy-making processes in the region.

The report draws on data from the work of SADC, its Member States and its subsidiary bodies including SACREEE, the Southern African Power Pool (SAPP) and the Regional Electricity Regulators Association (RERA), as well as the Common Market for East and Southern Africa (COMESA) and a broad network of contributors and researchers across the region.

During this work, SACREEE has acted as the chief liaison with Member States and other regional institutions. Country-level data were gathered from a variety of sources, including the SADC national focal points for energy, who responded to a data collection questionnaire. Additional data and information were drawn from official government sources, reports from regional and international organisations, input from the REN21 expert community as well as feedback from formal and informal reviews, additional personal communications with experts and a variety of electronic media. Member States were actively involved in the review process including participation in a final validation workshop.

This report attempts to provide the best data available. Where there was a discrepancy in data, information provided by the national focal point in the national questionnaire or the review processes has taken precedence. Explanations are provided in footnotes and endnotes.

Currency
All exchange rates in this report are as of 3 September 2018 and are calculated using the ONADA currency converter (http://www.onada.com/currency/converter/).

Hydropower
Small-scale hydropower is defined in this report as all systems under 100 MW. Large-scale hydropower includes all systems of 100 MW or higher.

GLOSSARY

BIODIESEL. A fuel produced from oilseed crops such as soy, jatropha, rapeseed (canola) and palm oil, and from other oil sources such as waste cooking oil and animal fats. Biodiesel is used in diesel engines installed in cars, trucks, buses and other vehicles, as well as in stationary heat and power applications.

BIOENERGY. Energy derived from any form of biomass, including bio-heat, bio-power and biofuel. Bio-heat arises from combustion of solid biomass (such as dry fuel wood or other liquid or gaseous energy carriers. The heat can be used directly or used to produce bio-power by creating steam to drive engines or turbines that drive electricity generators. Alternatively, gaseous energy carriers such as biomethane, landfill gas, or synthesis gas (produced from the thermal gasification of biomass) can be used to fuel a gas engine. Biofuels for transport are sometimes also included under the term bioenergy (see Biofuels).

BIOFUELS. A wide range of liquid and gaseous fuels derived from biomass. Biofuels – including liquid fuel ethanol and biodiesel, as well as biogas – can be combusted in vehicle engines as transport fuels and in stationary engines for heat and electricity generation. They also can be used for domestic heating and cooking (for example, as ethanol gels). Advanced biofuels are made from sustainably produced non-food biomass sources using technologies that are still in the pilot, demonstration or early commercial stages. One exception is hydro-treated vegetable oil (HVO), which is now produced commercially in several plants.

BIOGAS/BIOMETHANE. Biogas is a gaseous mixture consisting mainly of methane and carbon by the anaerobic digestion of organic matter (broken down by micro-organisms in the absence of oxygen). Organic material and/or waste is converted into biogas in a digester. Suitable feedstocks include agricultural residues, animal wastes, food industry wastes, sewage sludge, purpose-grown green crops and the organic components of municipal solid wastes. Raw biogas can be combusted to produce heat and/or power; it can also be transformed into biomethane through a simple process known as scrubbing that removes impurities including carbon dioxide, siloxanes and hydrogen sulphides. Biomethane can be injected directly into natural gas networks and used as a substitute for natural gas in internal combustion engines without fear of corrosion.

BIOMASS. Any material of biological origin, excluding fossil fuels or peat, that contains a chemical store of energy (originally received from the sun) and is available for conversion to a wide range of convenient energy carriers. These can take many forms, including liquid biofuels, biogas, biomethane, pyrolysis oil or solid biomass pellets.

BIOMASS PELLETS. Solid biomass fuel produced by compressing pulverised dry biomass, such as waste wood and agricultural residues. Torrefied pellets produced by heating the biomass pellets have higher energy content per kilogram, as well as better grindability, water resistance, and storability. Pellets are typically cylindrical in shape with a diameter of around 10 millimetres and a length of 30-50 millimetres. Pellets are easy to handle, store and transport and are used as fuel for heating and cooking applications, as well as for electricity generation and combined heat and power.

BRIQUETTES. Blocks of flammable matter made from solid biomass fuels, including cereal straw, that are compressed in a process similar to the production of wood pellets. They are physically much larger than pellets, with a diameter of 50-100 millimetres and a length of 60-150 millimetres. They are less easy to handle automatically but can be used as a substitute for fuelwood logs.

CAPACITY. The rated capacity of a heat or power generating plant refers to the potential instantaneous heat or electricity output, or the aggregate potential output of a collection of such units (such as a wind farm or set of solar panels). Installed capacity describes equipment that has been constructed, although it may or may not be operational (e.g., delivering electricity to the grid, providing useful heat, or producing biofuels).

CAPACITY SUBSIDY. A subsidy that covers a share of the upfront capital cost of an asset (such as a solar water heater). These include, for example, consumer grants, rebates or on-time payments by a utility, government agency or government-owned bank.

CLEAN COOK STOVE. Clean cook stove technologies address the negative health and environmental impacts associated with traditional cooking technologies, typical through improved combusting efficiency. While a number of clean cooking technologies meet this definition there is currently no definitive standard for what constitutes a clean cook stove.

CONCENTRATED SOLAR THERMAL POWER (CSP) (also called concentrated solar power or solar thermal electricity, STE). Technology that uses mirrors to focus sunlight into an intense solar beam that heats a working fluid in a solar receiver, which then drives a turbine or heat engine/ generator to produce electricity. The mirrors can be arranged in a variety of ways, but they all deliver the solar beam that heats a working fluid in a solar receiver, which the drives a turbine or heat engine/ generator to produce electricity. The mirrors can be arranged in a variety of ways, but they all deliver the solar beam to the receiver.

There are four types of commercial CSP systems: parabolic trough, linear Fresnel, power towers an dish/ engines. The first two technologies are line-focus systems, capable of concentrating the sun's energy to produce temperatures of 400 °C, while the latter two are point-focus systems that can produce temperatures of 800 °C or higher. These high temperatures make thermal energy storage simple, efficient, and inexpensive. The addition of storage – using a fluid (most commonly molten salt) to store heat – usually gives CSP power plants the flexibility needed for reliable integration into a power grid.

DISTRIBUTED GENERATION. Generation of electricity from dispersed, generally small-scale systems that are close to the point of consumption.

ENERGY. The ability to do work, which comes in a number of forms including thermal, radiant, kinetic, chemical, potential and electrical. Primary energy is the energy embodied in (energy potential of) natural resources, such as coal, natural gas and renewable sources. Final energy is the energy delivered to end-use facilities (such as electricity to an electrical outlet), where it becomes usable energy and can provide services such as lighting, refrigeration, etc. When primary energy is converted into useful energy, there are always losses involved.

ETHANOL (FUEL). A liquid fuel made from biomass (typically corn, sugar cane or small cereals/grans) that can replace gasoline in modest percentages for use in ordinary spark-ignition engines (stationary or in vehicles), or that can be used at higher blend levels (usually up to 85% ethanol, or 100% in Brazil) in slightly modified engines such as those provided in "flex-fuel vehicles". Note that some ethanol production is used for industrial, chemical and beverage applications and not fur fuel.

FEED-IN TARIFF (FIT). The basic form of feed-in policies. A guaranteed minimum price (tariff) per unit (normally kWh or MWh) is guaranteed over a stated fixed-term period when electricity can be sold and fed into the electricity network, normally with priority or guaranteed grid access and dispatch.

FINAL ENERGY. The part of primary energy, after deduction of losses from conversion, transmission and distribution, that reaches the consumer and is available to provide heating, hot water, lighting and other services. Final energy forms include electricity, district heating, mechanical energy, liquid hydrocarbons such as kerosene or fuel oil, and various gaseous fuels such as natural gas, biogas and hydrogen. Final energy accounts only for the conversion losses that occur upstream of the end-user, such as losses at refineries and power plants.

FISCAL INCENTIVE. An economic incentive that provides individuals, households or companies with a reduction in their contribution to the public treasury via income or other taxes, or with direct payments from the public treasury in the form of rebates or grants.

GENERATION. The process of converting energy into electricity and/ or useful heat from a primary energy source such as wind, solar radiation, natural gas, biomass, etc.

GEOTHERMAL ENERGY. Heat energy emitted from within the Earth's crust, usually in the form of hot water or steam. It can be used to generate electricity in a thermal power plant o to provide heat directly at various temperatures for building, industry and agriculture.

HYDROPOWER. Electricity derived from the potential energy of water captured when moving from higher to lower elevations. Categories of hydropower projects include run-of-river, reservoir-based capacity and low-head in-stream technology (the least developed). Hydropower covers a continuum in project scale from large (usually defined as more than 100 MW of installed capacity, but the definition varies by country) to small, mini, micro and pico.

INVESTMENT. Purchase of an item of value with an expectation of favourable future returns. In this report, new investment in renewable energy refers to investment in: technology research and development, commercialisation, construction of manufacturing facilities and project development (including construction of wind farms, purchase and installation of solar PV systems). Total investment refers to new investment plus merger and acquisition (M&A) activity (the refinancing and sale of companies and projects).

INVESTMENT TAX CREDIT. A taxation measure that allows investments in renewable energy to be fully or partially deducted from the tax obligations or income of a project developer, industry, building owner etc.

JOULE/KILOJOULE/ MEGAJOULE/ GIGAJOULE/ TERAJOULE/ PETAJOULE/ EXAJOULE. A Joule (J) is a unit of work or energy equal to the energy expended to produce one watt of power for one second. For example, one Joule is equal to the energy required to lift an apple straight up by one metre. The energy released as heat by a person at rest is about 60 J per second. A kilojoule (kJ) is a unit of energy equal to one thousand (10^3) Joules; a megajoule (MJ) is one million (10^6) Joules; and so on. The potential chemical energy stored in one barrel of oil and released when combusted is approximately 6 GJ; a tonne of oven dry wood contains around 20 GJ of energy.

MANDATE/OBLIGATION. A measure that requires designated parties (consumers, suppliers, generators) to meet a minimum, and often gradually increasing, target for renewable energy, such as a percentage of total supply or a stated amount of capacity. Costs are generally borne by consumers. Mandates can include renewable portfolio standards (RPS); building codes or obligations that require the installation of renewable heat or power technologies (often in combination with energy efficiency investments); renewable heat purchase requirements; and requirements for blending biofuels into transport fuel.

MINI-GRIDS. Small electric grids that serve entire communities through distribution networks. Until recently, most mini-grids relied on diesel fuel. Hydro-powered mini-grids are mature technologies, whereas gas-fired generator mini-grids, powered by agricultural waste or biogas, are maturing technologies. The use of inverter-connected mini-grids that incorporate a variety of renewable and other technologies (including battery banks) is developing rapidly.

MODERN BIOMASS ENERGY. Energy derived from combustion of solid, liquid and gaseous biomass fuels in efficient small domestic appliances to large-scale industrial conversion plants for modern applications of space heating, electricity generation, combined heat and power, and transport (as opposed to traditional biomass energy).

NET METERING. A regulated arrangement in which utility customers who have installed their own generating systems pay only for the net electricity delivered from the utility (total consumption minus on-site self-generation). A variation that employs two meters with differing tariffs for purchasing electricity and exporting excess electricity off-site is called "net billing".

POWER. The rate at which energy is converted per unit of time, expressed in watts (joules/ second).

PRIMARY ENERGY. The theoretically available energy content of a naturally occurring energy source (such as coal, oil, natural gas, uranium ore, geothermal and biomass energy, etc.) before it undergoes conversion to useful final energy delivered to the end-user. Conversion of primary energy into other forms of useful final energy (such as electricity and fuels) entails losses. Some primary energy is consumed at the end-user level a final energy without any prior conversion.

PUBLIC COMPETITIVE BIDDING (ALSO AUCTION OR TENDER). A procurement mechanism by which public authorities solicit bids for a given amount of renewable energy supply or capacity, generally based on price. Sellers offer the lowest price that they would be willing to accept, but typically at prices above standard market levels.

REGULATORY POLICY. A rule to guide or control the conduct of those to whom it applies. In the renewable energy context, examples include mandates or quotas such as renewable portfolio standards, feed-in tariffs, biofuel blending mandates and renewable heat obligations.

RENEWABLE ENERGY TARGET. An official commitment, plan or goal set by government (at the local, state, national or regional level) to achieve a certain amount of renewable energy by a future date. Some targets are legislated while others are set by regulatory agencies or ministries.

RENEWABLE PORTFOLIO STANDARD (RPS). An obligation placed by a government on a utility company, group of companies, or consumers to provide or use a predetermined minimum renewable share of installed capacity, or of electricity or heat generated or sold. A penalty may or may not exist for non-compliance. These policies are also known as: renewable electricity standards: "renewable obligations" and "mandated market shares", depending on the jurisdiction.

SOLAR HOME SYSTEM. A stand–alone system composed of a relatively small power photovoltaic module, battery and sometimes a charge controller, that can power small electric devices and provide modest amounts of electricity to homes for lighting and radios, usually in rural or remote regions that are not connected to the electricity grid.

SOLAR PHOTOVOLTAICS (PV). A technology used for converting solar radiation (light) into electricity. PV cells are constructed from semi-conducting materials that use sunlight to separate electrons from atoms to create an electric current. Modules are formed by interconnecting individual solar PV cells. Monocrystalline modules are more efficient but relatively more expensive than polycrystalline silicon modules.

SOLAR WATER HEATER (SWH). An entire system – consisting of a solar collector, storage tank, water pipes and other components – that converts the sun's energy into "useful" thermal (heat) energy for domestic water heating, space heating, process heat, etc. Depending on the characteristics of the "useful" energy demand (potable water, heating water, drying air, etc.) and the desired temperature level, a solar water heater is equipped with the appropriate solar collector. There are two types of solar water heaters: pumped solar water heaters use mechanical pumps to circulate a heat transfer fluid through the collector loop (active systems), whereas thermos-siphon solar water heaters make use of buoyancy forces caused by natural convection (passive systems).

SUBSIDIES. Government measures that artificially reduce the price that consumers pay for energy or reduce production costs.

TRADITIONAL BIOMASS. Solid biomass, including gathered fuel wood, charcoal, agricultural and forest residues, and animal dung, that is usually produced unsustainably and typically used in rural areas of developing countries by combustion in polluting and inefficient cook stoves, furnaces or open fires to provide heat from cooking, comfort and small-scale agricultural and industrial processing (as opposed to modern biomass energy).

WATT/KILOWATT/MEGAWATT/GIGAWATT/TERAWATT-HOUR. A watt is a unit of power that measures the rate of energy conversion or transfer. A kilowatt is equal to one thousand (10^3) watts; a megawatt to one million (10^6) watts; and so on. A megawatt electrical (MW) is used to refer to electric power, whereas a megawatt-thermal (MW^{th}) refers to thermal/heat energy produced.

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01 / REGIONAL OVERVIEW

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02 / RENEWABLE ENERGY MARKET AND INDUSTRY OVERVIEW

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06 / INVESTMENT FLOWS

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