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REN21 Renewable Energy Policy Network for the 21st Century

SADC RENEWABLE ENERGY AND ENERGY EFFICIENCY

STATUS REPORT

2015

PARTNER ORGANISATIONS

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.

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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.

The SADC Treaty was signed to establish SADC as the successor to the Southern African Coordination Conference (SADCC). This Treaty sets out the main objectives of SADC: to achieve development and economic growth, alleviate poverty, enhance the standard and quality of life of the peoples of Southern Africa and support the socially disadvantaged through regional integration. These objectives are to be achieved through increased regional integration, built on democratic principles, and equitable and sustainable development.

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FOREWORD

Fellow citizens, partners and colleagues,

We are excited to present the first edition of the *Southern African Development Community (SADC) Renewable Energy and Energy Efficiency Status Report*, which presents a comprehensive regional perspective on the renewable energy and energy efficiency market and industry developments in recent years.

The SADC region is facing significant energy challenges related to the needs to: urgently increase access to modern energy services, especially in rural areas; increase energy security, especially for the power sector; address the human health and environmental challenges of current energy systems; and develop electricity infrastructure to meet rising demand. Across the region, many existing power generation assets have reached the end of their economic life and are in urgent need of replacement.

Climate change, in the form of increased frequency of extreme weather events such as floods and droughts, is already negatively affecting existing energy systems. The region needs to make critical decisions across its energy sectors to ensure that there is increased access to energy in all sectors. Ageing assets need to be replaced, and new assets need to be climate-resilient as well as to produce sufficient power to meet growing demand. Accordingly, renewable energy and energy-efficient technologies and services are an integral part of the new energy dynamic in the region.

SADC recognises that regional integration is central to addressing the existing energy challenges and that it will create new opportunities for renewable energy and energy efficiency technologies and services across the region. This is captured in various regional policy documents, including the SADC Protocol on Energy (1996), the Energy Sector Plan of the SADC Regional Infrastructure Development Master Plan (RIDMP, 2012) and the Regional Energy Access Strategy and Action Plan (REASAP, 2012).

Against this background, on 24 July 2015, SADC energy ministers approved the establishment of the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE). SACREEE will contribute to the development of thriving regional renewable energy and energy efficiency markets by addressing gaps related to policies and regulations, capacity building, technology co-operation and the promotion of investments.

To meet the objectives of the United Nations Secretary-General's initiative on Sustainable Energy for All, the SADC region will need to, among others, rapidly develop and harness existing renewable energy resources and embrace energy efficiency, as a matter of priority. For this to happen, the full range of renewable energy and energy efficiency activities in the SADC region needs to be understood by all SADC citizens, as well as by policy makers and regulators, local and global investors, developers and project promoters. This, in turn, hinges on the availability of up-to-date, reliable information.

SADC RECOGNISES THAT REGIONAL INTEGRATION IS CENTRAL TO ADDRESSING THE EXISTING ENERGY CHALLENGES AND THAT IT WILL CREATE NEW OPPORTUNITIES FOR RENEWABLE ENERGY AND ENERGY EFFICIENCY TECHNOLOGIES AND SERVICES ACROSS THE REGION.

An 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 *SADC Renewable Energy and Energy Efficiency Report* contributes to this process by providing a comprehensive overview of the status of renewable energy and energy efficiency markets, industry, policy and regulatory frameworks, and investment activities in the region. The report draws on information from national and regional sources to present the most up-to-date summary of sustainable energy in the region.

We sincerely hope that the first edition of this report will provide a solid basis for developing renewable energy and energy efficiency in the SADC region. The report presents the region as one set for a dramatic increase in renewable energy and energy efficiency activities, which will become a magnet for investments in these sectors. Accordingly, SACREEE's activities to promote regional efforts in this regard will lead to increased energy access, improved energy security and a reduction of the environmental externalities associated with existing energy systems.

This will provide a basis for inclusive and sustainable industrialisation across the region and for the attainment of major sustainable development objectives.

Looking ahead, SACREEE will ensure that this report will be updated regularly, and will work with all of our partners, especially SADC member states, which have been instrumental in providing the data used in this report.

Pradeep Monga
Director and Special Representative of the Director General on Energy
UNIDO

Over the past decade, the share of people who lack access to modern energy services has fallen by nearly 10 percentage points – down from almost 25% – even as the global population has expanded significantly. Renewables have played a role in this improvement. These advances, however, are not spread evenly geographically. Large areas of Africa remain without access to modern energy services, and Africa is the only region in the world where the share of population electrified is less than the growth in the total population.

Renewables are uniquely positioned to provide needed energy services in a sustainable manner – more rapidly and generally at lower cost than fossil fuels. Their potential for the African continent is significant.

A decade ago, markets for modern renewable energy technologies were concentrated mainly in Europe and the United States. Today, renewables deployment is widely spread. Renewable energy technologies are viewed not simply as tools for improving energy security and mitigating and adapting to climate change. They are recognised increasingly as investments that provide both direct and indirect economic advantages by reducing dependence on imported fuels, improving local air quality and safety, advancing energy access and security, propelling economic development and creating jobs.

Developments in 2014 continued to demonstrate the important role of renewable energy in the energy mix. Despite rising energy use, global carbon dioxide (CO_2) emissions associated with energy consumption remained stable, illustrating a "decoupling" of economic growth and the rise in CO_2 emissions. This was due primarily to the increased use of renewables coupled with energy efficiency measures. This decoupling also demonstrates that renewables can play a central role in meeting sub-Saharan Africa's energy needs.

REN21 is committed to tracking the development of renewables worldwide. In addition to its annual flagship publication – the *Renewables Global Status Report* – REN21 works with regional partners to shed further light on renewables development in different world regions. The *SADC Renewable Energy and Energy Efficiency Status Report* complements earlier regional status reports on China, India, and the MENA and ECOWAS regions.

Launched at the South Africa International Renewable Conference (SAIREC), 4-7 October 2015, this report will help raise awareness about the extraordinary potential of the African continent to become a leader in renewable energy development and deployment. It will also be useful for the newly established SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), serving as a baseline for renewable energy and energy efficiency in the region.

We would like to thank UNIDO and all partners involved for the excellent collaboration throughout the production of this report. We hope that you find the information contained in this report informative.

Christine Lins
Executive Secretary
Renewable Energy Policy Network for the 21st Century (REN21)

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

BACKGROUND

The Southern African Development Community (SADC) is one of the oldest regional economic communities on the African continent. It has developed into a progressive regional institution providing guidance to 15 member states, covering a wide range of economic, social and geographic characteristics.

SADC is now becoming a key player in the international trend towards development of renewable energy resources as well as energy efficiency. The *SADC Renewable Energy and Energy Efficiency Status Report* supports SADC's efforts to increase the deployment of renewable energy and energy efficiency in Southern Africa by providing a comprehensive regional review of renewable energy and energy efficiency developments, evolving policy landscapes, market trends and related activities, achievements in renewable energy on- and off-grid, and opportunities for the financing of these activities.

With an expanding population of 298 million, SADC accounted for approximately 32% of sub-Saharan Africa's total population of 926 million in 2014. Three countries – the Democratic Republic of Congo (DRC), South Africa and Tanzania – together account for more than 60% of the region's population. Country GDPs vary widely, from USD 1.3 billion (Seychelles) to USD 349 billion (South Africa), as does GDP per capita, ranging from USD 342 (Malawi) to USD 15,347 (Seychelles). There are also differences in levels of socio-economic development, as measured by the United Nations Human Development Index (HDI): from a low of 0.338 (the DRC) to a high of 0.771 (Mauritius), reflecting the huge disparities in income, education, social services and infrastructure among these countries.

In the energy sector, SADC has focused on two areas: improving access to modern energy services for off-grid populations, and increasing the security and stability of energy supplies generally. To achieve its goals, SADC has developed a series of guiding documents, including the SADC Energy Protocol, the Regional Indicative Strategic Development Plan (RISDP) and the Regional Infrastructure Development Master Plan (RIDMP). A Regional Energy Access Strategic Action Plan (REASAP) was approved in 2011, setting broad goals for improving access to modern forms of energy as well as specific policy mechanisms to achieve increased access. A Renewable Energy Strategy and Action Plan (RESAP) should be approved in 2016, and SADC energy ministers recently gave approval in principle to the formation of a SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), selecting Namibia as the host country.

Despite both regional and national efforts to diversify energy resources, biomass remains by far the major source of energy in most SADC member states. Traditional biomass (*e.g.*, wood and charcoal) accounts for more than 45% of final energy consumption in the region, and if modern biomass (*e.g.*, bagasse for boilers in the sugar industry) is included, the overall biomass share reaches more than 57%. Traditional biomass use exceeds 70% of final energy consumption in the DRC and 60% in Mozambique, Tanzania and Zambia.

Key challenges for the SADC region include energy access, health and environment, energy security, infrastructure and financing.

Expanding access to modern energy services, including electricity and modern cooking fuels, is an urgent priority. Electricity access rates vary widely, from 9% in the DRC to 100% in Mauritius. In countries such as Tanzania and Zimbabwe, there are wide disparities in access between urban and rural areas (71% vs. 7%, and 80% vs. 14%, respectively), which suggests that there are still large areas which remain underserved by grid electricity despite strong regional efforts to address this.

Health and environmental concerns are based mostly on the adverse effects of extensive fuelwood cutting, with its consequences for deforestation; and on the persistent use of biomass for cooking and heating in the domestic sector, which affects indoor air quality and hence the general health of populations using these fuels. More than 153,000 people die each year from household air pollution in the SADC member states, caused mainly by burning of solid fuels for cooking.

Energy security was a key issue driving the formation of SADC in 1980, and it remains critical today. However, the motivation has changed, and the main concern now is ensuring that SADC member states are linked by reliable and secure interconnections that permit the exchange of power between the northern, hydro-dominated region and the southern, fossil fuel-dominated region. More than 6,000 MW of new transborder connections are anticipated to be completed in 2014-15 alone.

Infrastructure development, which includes new generation capacity as well as transmission and distribution capacity, is expected to increase significantly in the next 5-10 years. According to a 2015 update of the RISDP, SADC will have a total investment portfolio for electricity generation of between USD 114 billion and USD 233 billion for the period 2012-2027. The related transmission investment costs to support new generation capacity

are estimated at USD 540 million, not including already planned transmission interconnectors and national backbone lines.

On the financing side, several major hydropower projects are nearing financial closure. Planning for the 4,800 MW Inga III project in the DRC is nearly finalised as Eskom, the South African utility, has agreed to off-take 2,500 MW of the energy generated, and preliminary agreement has been reached among the investors for the proposed Mphanda Nkuwa dam in Mozambique.

RENEWABLE ENERGY MARKETS AND TRENDS

SADC's main source of renewable energy for electricity generation is large-scale hydropower. However, interest in solar (particularly photovoltaics) and wind energy technologies is growing, ranging from small-scale household PV panel arrays, to large-scale operations such as the 138 MW Jeffrey's Bay wind farm in South Africa.

The use of renewable energy in the SADC power sector is increasing rapidly, and renewables now account for approximately 23.5% of generation, including commercial biomass and hydro, of which hydro is by far the major source. Current potential hydro resources in the region amount to just under 41,000 MW (not including major expansion on the Congo River). Installed hydro capacity is just under 12,000 MW, representing about 21.5% of total electricity capacity; of this, 97.6% is large-scale hydro.

The existing projects and those planned for development in the six riverine countries – Angola, the DRC, Malawi, Mozambique, Zambia and Zimbabwe – have a total potential capacity of 21,580 MW. Of this total, 61% is undeveloped at present. The largest operational projects are Cahora Bassa in Mozambique (1,920 MW), Inga I and II in the DRC (1,775 MW), Kariba Dam shared by Zimbabwe and Zambia (1,470 MW), Kafue Gorge in Zambia (900 MW) and Capanda Dam in Angola (520 MW). Lesotho, Mauritius, Malawi, Zimbabwe, South Africa and Swaziland are all actively developing small-scale and micro hydro resources.

In its study of infrastructure requirements for the African Clean Energy Corridor, the International Renewable Energy Agency (IRENA) has estimated the solar power potential of the SADC region at approximately 20,000 terawatt-hours (TWh) per year. By comparison, current installed solar capacity is less than 1% of this figure. This suggests that there is a massive opportunity to expand solar in the region, particularly as the economics of this power source become increasingly competitive.

The Renewable Energy Independent Power Producers Procurement Programme (REIPPPP) has been a key factor in the development of solar in South Africa, which is now a global leader in applying this technology to on-grid power supply. In the four REIPPPP rounds to date (up to April 2015), solar PV has accounted for 1,899 MW, and CSP for 400 MW.

Botswana, Malawi, Namibia and Tanzania also are developing large-scale solar PV projects, and Swaziland and Zimbabwe are joining this trend. Small-scale off-grid projects, often linked to local mini-grids, are gaining traction in several countries, including Tanzania which has been a leader in this area due to its innovative use of standardised power purchase agreements (PPAs).

IRENA has estimated the wind energy potential of the SADC region to be approximately 800 TWh per year. As with solar, South Africa has led the way in wind development through its tender process. In 2014 alone, the country commissioned more than 500 MW of wind projects, and the latest tender announcement in April 2015 includes an additional 676 MW, for a total of 2,660 MW over the four tender calls since 2011. Mozambique, Namibia and Tanzania also are moving forward with large-scale wind farms, with Namibia the furthest along in this process due to the high wind potential in its coastal areas, notably Luderitz and Walvis Bay.

Biomass – for electricity generation as well as for industrial heating applications – is growing in importance in the SADC region. The potential for biomass-generated electricity is estimated at 9,500 MW, based on agricultural waste alone. Recent project examples include the 4.4 MW Bronkhorstspruit biogas generation project in South Africa, using methane from cow dung decomposition to fire a boiler and generator. Other examples include the generation of electricity from wood waste at pulp and paper plants in South Africa and the expanded use of surplus bagasse for power generation in the sugar industry in countries such as Malawi, Mauritius, Mozambique, South Africa, Swaziland, Zambia and Zimbabwe. South Africa and Mauritius also have pioneered in the use of methane from municipal waste for power generation.

The development of mini-grids and of distributed energy more generally is moving forward in the region. Tanzania has been a leader in this regard, providing a standardised PPA using an avoided-cost feed-in tariff (FIT). This has stimulated a wide range of private sector projects that are expected to expand electrification and increase access to energy services – using mainly solar mini-grids – to some 16 villages in its first phase, including 11,000 households, 2,600 businesses, 42 public offices, 32 schools, 12 health centres and 77 religious buildings. Tanzania's Rural Energy Agency also has more than 90 off-grid projects in the pipeline, most of them involving mini-grids and solar PV or mini-hydro.

Namibia is gradually developing innovative off-grid projects, such as the Gobabeb Training and Research Station, a solar PV installation of 26 kW and two diesel generators of 50 kVA. Botswana has installed a number of solar PV off-grid mini-grids during the past 10 years, in most instances hybrid with diesel generator sets, providing a total capacity of 50 kW.

Similar mini-grid projects are under way in the DRC, Malawi, Mozambique, South Africa, Zambia and Zimbabwe. Many are being developed by private companies, such as regional concessionaires in Botswana and South Africa, or by large international non-governmental organisations (NGOs). The number of players in the distributed energy field in SADC is expanding rapidly, with 18 different organisations identified as key players in this report.

The use of renewable energy sources in transport is also growing, although it is confined for the immediate future to the use of ethanol and biodiesel for transport fuel – an established practice in Malawi and Zimbabwe, with Angola, Mozambique, South Africa, Swaziland and Zambia also establishing mandates for regular blending of ethanol and biodiesel with fossil fuels. South Africa has developed a progressive strategy which includes both biofuel substitution and increased efficiency in transport.

ENERGY EFFICIENCY AND ITS LINKAGES TO RENEWABLE ENERGY

Energy efficiency is prospering in the SADC region, although its development lags behind that of renewable energy. Importantly, several member states and their utilities have turned to energy efficiency as a means of reducing demand and thereby delaying the requirement for new generation capacity. For example, replacing incandescent bulbs with compact fluorescent lamps (CFLs) or light-emitting diodes (LEDs) can reduce demand during peak evening hours, as can the introduction of solar water heaters or the use of hot water load control.

Energy efficiency is a complement to renewable energy. Reducing energy demand nationally or in specific communities or regions through energy efficiency will improve the financial feasibility of renewable energy options.

Energy intensity (in megajoules (MJ) per USD of GDP) is often used as a proxy indicator for energy efficiency and varies widely among SADC member states. The highest energy intensities are found in the DRC, Mozambique and Zimbabwe, at 19.1, 17.9 and 17.5 MJ per USD of GDP, respectively. The SADC average is 9.4 MJ per USD of GDP, which is much lower than that of ECOWAS at 14.5 MJ, and lower than the sub-Saharan average of 12.4 MJ.

A wide variety of energy efficiency activities exists in the SADC region, ranging from basic CFL replacement programmes to time-of-use tariffs, solar water heating, demand market participation, standards and labelling, hot water load control, awareness programmes, and energy audits in the industrial and building sectors. Thirteen of the SADC member states have instituted CFL replacement programmes, with awareness programmes and time-of-use tariffs being the next most common initiatives. Only two countries – Namibia and South Africa – have instituted demand market participation.

The Southern African Power Pool (SAPP) has been very active in this area, developing a specific programme for CFL replacement involving 11 utilities, and initiating an expanded Energy Efficiency Framework covering four technologies: CFLs, commercial lighting retrofits, solar water heating and distribution transformer retrofits, resulting in an expected demand reduction of 4,500 MW by the end of 2015 and 7,000 MW by the end of 2018.

Several national utilities – NamPower, SNEL, TANESCO, ZESA and ZESCO – have developed demand-side management (DSM) programmes on their own, based on the SAPP initiative but more extensive. Two countries – Mauritius and South Africa – have developed full national energy efficiency programmes with appropriate policy initiatives to support them.

Efficiency also has been improved by reducing transmission and distribution losses in the national grids. Average losses for the region are around 19%, although on a country basis this varies from as low as 4% to as high as 56%. This is another focus of SAPP's work and is expected to reap substantial benefits over the next 5-10 years as utilities improve line and transformer maintenance and eliminate illegal connections.

Several countries are moving forward with appliance and equipment labelling and standards programmes. South Africa already has designed such a programme, which is being implemented on a voluntary basis in 2015 but will soon become mandatory. Namibia is developing a similar labelling programme.

Two national initiatives, in Botswana and Namibia, have addressed energy efficiency in buildings. Both of these programmes involved donor-supported energy audits and the development of national standards or guidelines for improving building energy efficiency. Neither was fully implemented after donor funding ended, but both countries plan to continue the work on their own.

Energy efficiency is also a major goal of improved cookstove programmes, which are found in all member states with the exception of Mauritius and Seychelles. Substantial effort has gone into establishing these programmes, particularly in countries where forest resources are being depleted rapidly, such as Malawi, Mozambique and Tanzania. Initiatives have ranged from the establishment of local production centres (often run by women's or community groups), to industrial production of portable cookstoves in Mozambique, to setting up franchise systems for distributing foreign-produced cookstoves with higher efficiencies, such as in Botswana and South Africa. There are also efforts to introduce efficient furnaces for rural industries which depend on wood for process heating, such as the tobacco and tea industries in Malawi, Tanzania and Zimbabwe.

POLICY LANDSCAPE

The increase in renewable energy and energy efficiency initiatives in the SADC region has been driven in large part by electricity supply shortages in several key countries, but also by the changing economics of wind and solar energy and by the emergence of new policy concepts such as FITs, net metering, auctioning of power supply to independent power producers (IPPs) and renewable energy certificates (RECs). In response, SADC member states are developing their own targets and policies to expedite the development of renewable energy and energy efficiency projects and to offset their dependence on fossil fuels.

Identifying targets and developing appropriate policies for sustainable energy is a relatively recent phenomenon in the region. The SADC Energy Protocol (1996) recognised "new and renewable energy", "energy efficiency and conservation" and "wood fuels" as separate sub-sectors, for each of which a set of target activities was established in an Annex to the Protocol. The Protocol included measures such as 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.

The 2003 SADC Regional Indicative Strategic Development Plan (RISDP) defines specific quantitative targets for infrastructure development (including energy). For the 15-year period, 2004-2018, a target of 70% of rural communities with access to affordable modern form of energy has been set.

Four SADC countries – Lesotho, Malawi, South Africa and Tanzania – have been designated as "partner countries" for the Global Alliance for Clean Cookstoves and are leading the way in improving the sustainability of biomass energy use in the region. In energy efficiency, progress has been slower, but SAPP has taken the lead in creating targets and programmes for its member utilities and has achieved a significant reduction in demand, which appears to be sustainable.

Several SADC member states, including Namibia, South Africa and Zimbabwe, have developed national energy efficiency strategies. South Africa also implemented an Energy Efficiency and Demand-Side Management (EEDSM) programme in 2010 through the national utility, Eskom, with offerings in the commercial, industrial and mining sectors. The EEDSM programme includes incentives and rebates to encourage the uptake of efficiency in various economic sectors, including residential, and is supported by other government policy initiatives, including a proposed carbon tax and mandatory development and monitoring of energy management plans for industry.

The SADC Secretariat embarked on an ambitious planning exercise in 2011 through the development of a Renewable Energy Strategy and Action Plan (RESAP), which is under revision and is expected to be approved sometime in 2016. Earlier research for RESAP suggested several targets for renewable energy for the period 2020-2030, including targets of 175 MW of biomass and 500 MW of solar-generated electricity by 2020. Both of these targets have been exceeded already, thanks mainly to the South African REIPPPP. A further target aimed at increasing the renewable energy contribution to electricity supply from 17% in 2008 to 27% in 2020 and 29% in 2030.

By contrast, IRENA, in a recent planning study for SAPP, has proposed a target of 46% renewables by 2030, and SADC has indicated that 24,062 MW of new capacity will be added by 2019, of which 70% will be from renewables.

The RESAP research also suggests that penetration of improved cookstoves might reach 5% of SADC households in 2015, 10% in 2020 and 20% in 2030 – up from less than 1% in 2014. In addition, the study estimated that production of ethanol, under a conservative scenario where only surplus molasses is used as feedstock, could reach 605.8 million litres in the seven countries that have major sugar industries: Malawi, Mauritius, Mozambique, South Africa, Swaziland, Zambia and Zimbabwe. This represents approximately 1.9% of 2008 petrol consumption in these countries on an energy basis, and 3% on a volume basis – a fairly conservative target that already has been exceeded in countries with established biofuels industries, such as Malawi and Zimbabwe.

Renewable energy targets have been set by all 15 member states, although some – such as the DRC and Lesotho – have set only very general targets for improved access and grid extension, which do not necessarily require the use of renewable energy. Although most member states have kept their renewable energy targets non-specific, Mauritius and Mozambique have broken down their targeting into specific technology categories, with different targets for wind, solar, hydro and biomass. South Africa has engaged in a similar technology-specific targeting through REIPPPP, which sets "allocations" for each technology in each bidding period.

Targeting of biomass energy for power generation is not common in the region. Malawi, Mauritius, Mozambique, South Africa, Swaziland, Zambia and Zimbabwe all have targeted expanded use of bagasse for grid electricity, and are negotiating the changes with both existing and new companies in the sugar industry. Mauritius has targeted a 17% share of electricity from bagasse in 2025 (compared to 15.5% in 2015 and an overall target of 35% from renewables).

Several countries also have set long-term targets for the use of renewables in power generation. For example, Mozambique has identified "potentials" for different renewable energy sources (*e.g.*, 23 TW for solar, 18 GW for hydro) and then targeted a "priority" amount (*e.g.*, 597 MW for solar, 5.4 GW for hydro) to be achieved by 2025. Tanzania has set an overall target for electricity output from renewables, from a current 370 gigawatt-hours (GWh) per year to 2,000 GWh per year by 2020, but it has not provided interim targets for implementation.

All SADC member states have introduced specific policies and programmes to encourage renewable energy development. However, some types of policy either are not being implemented in any SADC country, or are found in only one or two. The most common policies are feed-in tariffs (typically limited to below utility-scale sizes), followed by biofuels mandates, capital subsidies and grid code reviews. There are so far no examples of energy production payments, electric utility quota obligations, or public investment, loans or grants.

Generally speaking, FIT programmes and the necessary support policies such as grid code revisions remain in the early stages of development, with most countries still deciding whether to favour competitive bidding or to establish a conventional FIT system with promotional tariffs. Some countries are opting for a mix of the two and/or including the option of net metering for some kinds of projects.

Mauritius, for example, established FITs for IPPs of 50-400 kW in 2010, as well as a net metering scheme with an overall cap of 2 MW (recently increased to 5 MW) and a limit of 50 kW for independent generators. Botswana is considering a FIT programme for smaller facilities (under 5 MW), with a bidding system for larger facilities. Zimbabwe's FIT (due for approval in 2015) will be based on a tariff near the levelised cost of energy for each technology (like those in most countries) but tariffs will vary according to technology and size of facility, as they have with most FIT programmes worldwide. Namibia is in final stages of implementing a FIT programme for projects under 5 MW in size, with a bidding process for larger projects.

Tanzania, which often is cited as a model for policies that motivate small-scale distributed renewables, has developed a Small Power Producer (SPP) programme which includes model PPAs, standardised tariffs, and streamlined interconnection and licensing requirements, for projects up to 10 MW capacity. Tariffs are based on the avoided cost of electricity supply to the main utility,

TANESCO. South Africa has likewise adopted a Small Projects Programme (up to 5 MW capacity) with simpler rules, using a ceiling price for different technologies; it thus acts like a FIT but has a competitive element.

Biofuels mandates are found in Malawi and Zimbabwe, where they are expressed in terms of the blending target for a particular type of biofuel, such as E15 for ethanol and B5 for biodiesel. Angola, Mozambique, South Africa and Zambia also have introduced mandates of this kind.

Two other policy initiatives – grid code revisions and renewable energy certificates (RECs) – are being implemented in several SADC member states. Grid codes are being revised to suit the needs of renewable energy incentive programmes (*e.g.*, FITs) in Namibia, Zambia and Zimbabwe. South Africa is experimenting with RECs as a way to finance small-scale renewable energy and energy efficiency projects, and the operators of the REC programme have been asked to extend its activities to include one other member state. As of July 2015, 133,775 megawatt-hours (1 MWh = 1 REC) had been transacted in the South African REC programme.

INVESTMENT FLOWS

The renewable energy sector continues to be an attractive market for public and private investors, and gross investment in renewables is closing the gap on fossil fuels. Overall, Africa attracted USD 8 billion in renewable energy investment in 2014 (compared to USD 5.3 billion in 2013), about 3% of global investment. Within the African figure, three countries in southern Africa – Mauritius, South Africa and Tanzania – accounted for USD 5.8 billion, with South Africa alone accounting for USD 5.5 billion.

Although South Africa is a dominant force in renewable energy investment, small and large investors also are targeting renewable energy investments in countries such as Mozambique and Tanzania –where progressive regulatory regimes have been put in place – as well as Angola, Botswana, Namibia and Zimbabwe, where FITs are either approved or soon to be approved. Including prospective investment in new large-scale hydro in the DRC, Mozambique, Zambia and Zimbabwe, it is expected that investments in renewables outside of South Africa will surge in the coming years.

Discounting projects already financed, such as through South Africa's REIPPPP, there remains some 27,000 MW of renewable electricity generation projects in the regional pipeline, of which 24,000 MW is large-scale hydro projects.

Attracting investment in these projects is becoming easier as interest in Africa and in renewable energy in particular increases. Bloomberg New Energy Finance ranked six SADC member states – Botswana, Mozambique, South Africa, Tanzania, Zambia and Zimbabwe – against 48 countries globally and 15 in sub-Saharan Africa. Of the six, two – South Africa (no. 3) and Tanzania (no. 21) – received high rankings for investment potential. Within these six, total investments in new renewable energy totalled USD 10.2 billion in the period 2006-2013.

SADC renewable energy projects are attracting both public and private investment. South Africa's REIPPPP has a large number of private investors, ranging from multinational paper companies and wind turbine and PV cell manufacturers to local private banks. Public sector investment comes from a variety of sources, including the World Bank, the Global Environment Facility (GEF), the African Development Bank (AfDB), the Development Bank of Southern Africa (DBSA), South Africa's Industrial Development Corporation (IDC), as well as public utilities such as Eskom.

The AfDB has been particularly active in the renewable energy field, both through its own funding mechanisms and through various specialised funds such as the Sustainable Energy Fund for Africa (SEFA) and the Climate Investment Funds, in particular the Clean Technology Fund (CTF). The AfDB together with the World Bank are strong players in the Scaling Up Renewable Energy in Low Income Countries Program (SREP), for which Lesotho, Malawi, Mozambique and Zambia have been selected as second-phase pilot countries.

DBSA, along with IDC and the Public Investment Corporation, have provided major support to South Africa's REIPPPP, contributing ZAR 6.7 billion (approximately USD 558 million) in loans and an additional ZAR 1.3 billion (approximately USD 108 million) in grants under its Black Empowerment programmes, for the first two REIPPPP bidding phases. DBSA also has been the executing agency for the first phase of the Energy and Environment Partnership (EEP), a grant programme developed by the Finnish, Austrian and UK governments to stimulate development of small energy efficiency and renewable energy projects in east and southern Africa.

Finally, financing is available for renewable energy and energy efficiency through the various climate finance mechanisms, including market-based mechanisms such as the Clean Development Mechanism, the United Nations/World Bank-implemented Climate Investment Funds and the GEF, which has joined with the AfDB to create the Africa Climate Technology and Finance Center and Network (ACTFCN), supporting the deployment and scaling-up of both climate change mitigation and adaptation technologies.

01

REGIONAL OVERVIEW

01 REGIONAL OVERVIEW

The Southern African Development Community (SADC) region[i] has enormous renewable energy resources that can serve as a strong basis for improved energy access within the region and across Africa as a whole. The International Renewable Energy Agency (IRENA) has estimated the potential of electricity generation from new (identified) large-scale hydropower projects in the region (excluding the Grand Inga) at 38,657 megawatts (MW), while small-scale hydro potential is 3,420 MW, solar PV is 2,195 terawatt-hours (TWh), solar thermal is 1,093 TWh, biomass is 8,470 MW and wind energy is 153,180 MW.[1]

South Africa is emerging as a leader in the development of renewables, with an ambitious target of commissioning 17.8 gigawatts (GW) of newly generated electricity from renewable energy sources between 2010 and 2030.[2] Other countries in the region are rapidly putting in place the necessary regulatory and financial mechanisms and moving forward with a variety of renewable energy projects.

With proper planning and financing, a large portion of the region's growing demand for electricity and for access to modern energy services can be met sustainably. Increased development of renewables also will allow the region to access strategic low-carbon markets and investments, contributing to green growth and sustainable economies.

In addition to increasing the share of renewable energy in the energy mix, there are opportunities to implement energy efficiency measures in the region to offset rising energy costs, lessen the impact of insufficient generation capacity and address the growing demand for modern energy services in communities presently without grid access. Energy efficiency improvements often present the most cost-effective solutions for overcoming these challenges, offering a less-expensive alternative to building new generation capacity to meet increasing demand.

The SADC region has demonstrated its commitment to the advancement of renewables through such actions as the development of the SADC Energy Protocol (SEP), the Regional Infrastructure Development Master Plan (RIDMP), the Regional Indicative Strategic Development Plan (RISDP), the SADC Renewable Energy Strategy and Action Plan (RESAP), currently in draft form pending ministerial review, and the Regional Energy Access Strategy and Action Plan (REASAP). These policy documents will serve as useful guidelines for increased renewable energy deployment in SADC member states; however, a more pro-active approach is needed to ensure that supportive policies are developed in all of the member states and that access to innovative financial resources is improved substantially. Increased local learning, strengthening or creation of transnational linkages, and development of bankable projects also are required, as well as an enhanced process of policy transfer and harmonisation among member states.

To achieve this ambition, it is necessary to map the current range of renewable energy and energy efficiency activities within the SADC region, in order to showcase these efforts to stakeholders both within and outside the region as well as to attract global investors and potential promoters of new energy solutions. Mapping the status of renewable energy and energy efficiency will not only provide information for potential investors, but also provide concrete evidence of the potential economic and social benefits in those countries where uptake of renewables so far has lagged.

The *SADC Renewable Energy and Energy Efficiency Status Report* reinforces regional and national efforts to strengthen data collection and knowledge sharing by providing a comprehensive regional review of renewable energy and energy efficiency developments, market trends and related activities, evolving policy landscapes, investments in renewable energy and improvements in energy access. It draws on data from the work of SADC, its member states and its subsidiary bodies, as well as the Common Market for East and Southern Africa (COMESA[ii]), the other major regional organisation, and a broad network of contributors and researchers across the region.

i. The 15 member states of the SADC region are Angola, Botswana, the Democratic Republic of Congo (DRC), Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

ii. Although COMESA's membership includes countries in East Africa and only a portion of SADC's membership, the two organisations have worked together and recently agreed to form a single "Tripartite Free Trade Area", which also includes the East African Community. The Free Trade Area was launched in June 2015. See Taylor Hill, "Africa's New Free Trade Zone: The Tripartite Free Trade Area (TFTA)", globalEDGE Blog, 11 June 2015, http://globaledge.msu.edu/blog/post/23952/africa%27s-new-free-trade-zone--the-tripartite-free-trade-area-%28tfta%29.

POPULATION AND ECONOMY

The 15 SADC member states exhibit a wide diversity of demographic and socio-economic characteristics. With a population of just over 298 million, SADC accounts for approximately 32% of sub-Saharan Africa's total population of 926 million (see table 1).[3] Three countries – the Democratic Republic of Congo (DRC), South Africa and Tanzania – together account for more than 60% of the region's population. Average regional population growth, at 1.88%, is relatively low by developing country standards.

Average population density is also low, at 30 persons per square kilometre (km^2), mainly because large areas of the southern half of the region are arid or semi-arid and unable to support intensive agriculture and dense settlement. The countries with the lowest population densities are Botswana (3.61 persons per km^2) and Namibia (2.63 persons per km^2). The share of the population living in urban areas in SADC member states is just over 35%, ranging from a low of 17% in Malawi to a high of 57% in South Africa. This compares to urban shares of 43% in the member states of the Economic Community of West African States (ECOWAS), and under 20% in East Africa.[4]

TABLE 1 | Overview of population statistics in the SADC region, 2013

	Population (thousands)	Share of total SADC population	Physical area (km^2)	Population density (persons/km^2)	Population growth rate	Urban population
Angola	19,000	6.37%	1,247,000	15.24	2.78%	36%
Botswana	2,102	0.71%	582,000	3.61	1.26%	52%
DRC	75,620	25.37%	2,345,095	32.25	2.50%	32%
Lesotho	1,909	0.64%	30,355	62.89	0.34%	18%
Madagascar	23,827	7.99%	587,051	40.59	2.62%	n/a
Malawi	15,317	5.14%	118,484	129.27	3.33%	17%
Mauritius	1,259	0.42%	2,040	617.16	0.66%	44%
Mozambique	24,366	8.17%	799,380	30.48	2.45%	37%
Namibia	2,172	0.73%	825,615	2.63	0.67%	33%
Seychelles	90	0.03%	455	197.58	0.87%	n/a
South Africa	52,980	17.77%	1,219,912	43.43	-0.48%	57%
Swaziland	1,093	0.37%	17,364	62.95	1.14%	24%
Tanzania	50,586	16.97%	945,087	53.53	2.80%	36%
Zambia	14,580	4.89%	752,612	19.37	2.88%	36%
Zimbabwe	13,192	4.43%	390,757	33.76	4.36%	35%
SADC	**298,093**	**100.00%**	**9,863,207**	**30.22**	**1.88%**	**35%**
Sub-Saharan Africa	**926,000**	**32.2%**				

Note: n/a means "not available".
Source: See endnote 3 for this section.

TABLE 2 | GDP in the SADC region, 2013

	GDP at current market price (million USD)	Annual growth in GDP per capita, 2010-2014	GDP per capita (USD)
Angola	135,249	3.6%	7,118
Botswana	14,788	4.9%	7,034
DRC	32,011	5.6%	423
Lesotho	2,195	4.3%	1,150
Madagascar	10,796	-0.4%	453
Malawi	5,080	2.0%	332
Mauritius	11,954	3.0%	9,495
Mozambique	15,764	4.8%	647
Namibia	12,586	3.1%	5,795
Seychelles	1,387	4.2%	15,427
South Africa	349,007	0.6%	6,588
Swaziland	3,776	1.3%	3,454
Tanzania	33,284	4.1%	724
Zambia	26,835	3.3%	1,841
Zimbabwe	13,490	1.3%	1,023
SADC	**668,202**	**3.0%**	**2,277**

Source: See endnote 5 for this section.

SADC economies vary widely in both size and complexity. South Africa is by far the largest economy, with a gross domestic product (GDP) of USD 349 billion in 2013 (see table 2), placing it second on the continent behind Nigeria.[5] It also has the largest mining and industrial sector, with highly sophisticated manufacturing and metallurgical industries. Angola follows with a GDP of USD 135 billion, a function of its extensive oil and diamond resources.

Swaziland, Lesotho and Seychelles, three of the four smallest countries in the region, have GDPs of USD 3.8 billion, USD 2.2 billion and USD 1.4 billion, respectively, with Seychelles having the region's highest GDP per capita.[6] Despite relatively strong economic growth, GDP per capita diverges widely, from a low of USD 332 in Malawi to nearly USD 9,500 in Mauritius and nearly USD 15,500 in Seychelles.

Per capita GDP increased by 3.0% per year in SADC over the period 2010-14, a relatively high rate compared to many developed countries. During this period, Botswana, the DRC, Lesotho, Mozambique, Seychelles and Tanzania showed a growth in GDP per capita in excess of 4%, whereas Madagascar showed negative growth and South Africa registered only 0.6% growth.[iii]

The relative contribution to GDP of key economic sectors also varies widely, but some similarities exist. The service sector dominates in most SADC countries: Botswana, Namibia, Seychelles and South Africa all have service sectors that contribute more than 60% of GDP. In Angola, by comparison, the industry sector contributes more than 50% of GDP, a function of the country's dependence on oil and gas production.[7]

The region's social and economic development profile is also extremely varied. Comparing SADC countries on the United Nations Development Programme's (UNDP) Human Development Index, only Mauritius and Seychelles achieve a high ranking in 2014 (over 0.7), while nine countries are ranked in the lowest category (less than 0.5) (see figure 1).[8]

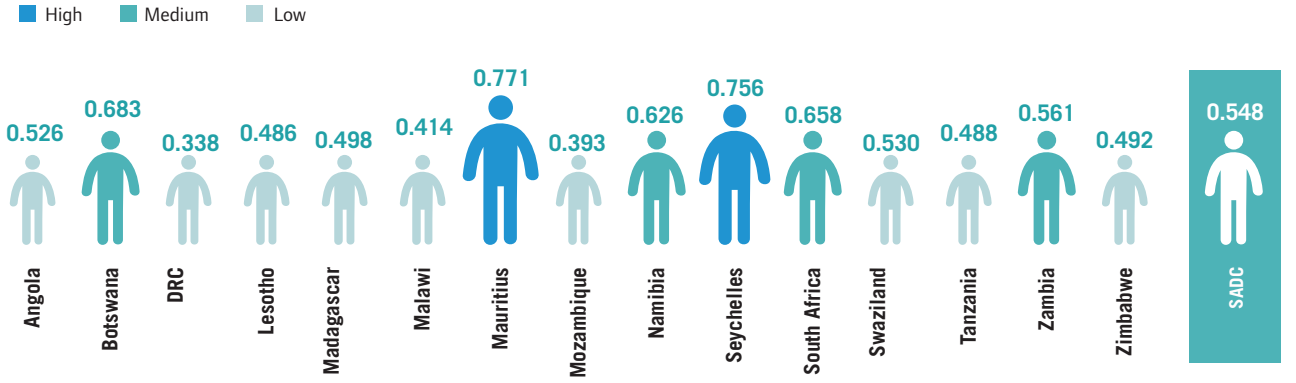
RENEWABLE ENERGY IN THE ECONOMY

As in most regions of sub-Saharan Africa, traditional biomass fuels have a massive impact on the final energy consumption profile of the SADC region (see table 3).[9] Biomass – including wood, charcoal and some animal waste – is used primarily for cooking and heating in the domestic sector. Traditional biomass[iv] use accounts for more than 45% of final energy consumption in the region; if modern biomass[v] is included, the overall contribution of biomass rises to over 57%.

The two exceptions to this pattern are Mauritius and Seychelles, where biomass resources are either scarce or used for process heat and power generation (in Mauritius, bagasse, or the waste cellulose from sugar production, accounts for 15% of that country's final energy consumption). Traditional biomass use is lowest in South Africa, at 13.7%, because it is replaced by coal, paraffin (kerosene) and liquefied petroleum gas (LPG) in much of the country. In the remaining 12 SADC countries, biomass used for domestic cooking and heating comprises between 23% and 73% of final energy consumption.[10]

iii. Zimbabwe's relatively low GDP growth in 2013 contrasts with its very rapid growth – between 10% and 12% annually – in the period 2010-12.
iv. Some experts argue that traditional biomass (wood and charcoal used for cooking and heating) is not truly "renewable" and therefore should not be included in calculating the share of renewable energy in final energy consumption. This issue has been addressed by the United Nations Framework Convention on Climate Change, which has allowed improved cookstove projects to qualify for the Clean Development Mechanism if they demonstrate that they reduce the use of non-renewable biomass.
v. See glossary for the definition of modern biomass energy.

FIGURE 1 | Ranking of SADC member states on the UNDP Human Development Index, 2014



Source: See endnote 8 for this section.

SADC countries vary widely in the type of fuel used for domestic energy. South Africa uses large amounts of bituminous coal for cooking and heating in areas close to coal mines (as well as LPG for households with higher incomes) and uses paraffin in both rural and urban areas. Madagascar, Malawi, Mozambique, Tanzania and Zambia use mostly charcoal, produced in small, low-efficiency earth kilns in rural areas and then sold through traders into 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. The growing use of charcoal for cooking in urban areas of countries such as Malawi and Mozambique has had a substantial impact on rural fuel supply areas – greater than the impact of fuelwood use, since the charcoal production process is highly inefficient.[11]

The share of fossil fuel use is relatively small in most SADC member states (compared to use of traditional biomass), but it is still significant in several countries. South Africa relies on fossil fuels for 87% of final energy consumption (a high percentage of which is either coal for power generation or coal-based liquid fuels), while Botswana uses fossil fuels for 65% and Angola for 39%. By comparison, fossil fuels account for only 9.5% of final energy consumption in Mozambique and 8.8% in Zambia.[12]

THE SADC REGION HAS DEMONSTRATED ITS COMMITMENT TO THE ADVANCEMENT OF RENEWABLES THROUGH SUCH ACTIONS AS THE DEVELOPMENT OF THE SADC ENERGY PROTOCOL (SEP), THE REGIONAL INFRASTRUCTURE DEVELOPMENT MASTER PLAN (RIDMP), THE REGIONAL INDICATIVE STRATEGIC DEVELOPMENT PLAN (RISDP) AND THE SADC RENEWABLE ENERGY STRATEGY AND ACTION PLAN (RESAP).

TABLE 3 | Share of renewable energy in total final energy consumption (TFEC) in SADC member states, 2012

	Share of renewable energy in TFEC (%)				Share of renewable energy in TFEC by source (%)								Share of renewable energy of:		TFEC (PJ)
	1990	2000	2010	2012	Traditional biomass	Modern biomass	Hydro	Liquid biofuels	Wind	Solar	Geo-thermal	Other	Electricity capacity	Electricity generation	
Angola	72.3	75.5	54.9	57.2	53.3	1.3	2.6	0.0	0.0	0.0	0.0	0.0	49.7	70.9	474
Botswana	47.1	35.7	26.4	23.9	23.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	–	85
DRC	92.0	97.2	96.2	96.0	73.6	19.3	3.1	0.0	0.0	0.0	0.0	0.0	–	99.6	950
Lesotho	–	100.0	100.0	40.5	35.2	0.0	5.3	0.0	0.0	0.0	0.0	0.0	100.0	–	47
Madagascar	86.4	78.5	82.8	78.4	43.7	33.1	1.5	0.0	0.0	0.0	0.0	0.0	30.3	32.6	119
Malawi	86.1	76.9	81.3	78.7	35.1	36.6	6.9	0.1	0.0	0.0	0.0	0.0	99.3	57.4	63
Mauritius	51.9	14.6	6.9	34.0	1.3	15.1	1.3	0.0	0.1	0.0	0.0	0.2	24.5	22.2	67
Mozambique	93.1	92.5	89.6	88.4	66.7	9.1	12.6	0.0	0.0	0.0	0.0	0.0	89.8	99.9	312
Namibia	38.9	38.2	30.2	32.9	13.2	0.0	19.6	0.0	0.0	0.1	0.0	0.0	67.1	97.8	65
Seychelles	–	–	–	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	–	5
South Africa	16.6	18.2	18.7	16.9	13.7	2.9	0.2	0.0	0.0	0.1	0.0	0.0	2.7	1.0	2,777
Swaziland	84.3	46.8	35.7	39.9	24.4	8.5	7.0	0.0	0.0	0.0	0.0	0.0	40.3	–	37
Tanzania	94.8	94.3	90.7	88.2	68.4	19.2	0.6	0.0	0.0	0.0	0.0	0.0	66.8	29.1	800
Zambia	82.9	89.9	90.7	88.2	66.4	11.7	10.0	0.0	0.0	0.0	0.0	0.0	99.6	99.7	292
Zimbabwe	64.1	70.2	80.8	75.6	66.0	5.0	4.6	0.0	0.0	0.0	0.0	0.0	36.8	60.0	363
SADC	**70.0**	**66.3**	**63.2**	**56.1**	**45.0**	**12.4**	**5.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**58.9**	**60.9**	**6,456**

Note: TFEC = total final energy consumption; PJ = petajoules. "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. A dash ("–") means that no data are available for the country or item in question. The percentage share of renewables for South Africa is low for two reasons: 1) the total FCE for the country is high and 2) figures are prior to the REIPPPP.
Source: See endnote 9 for this section.

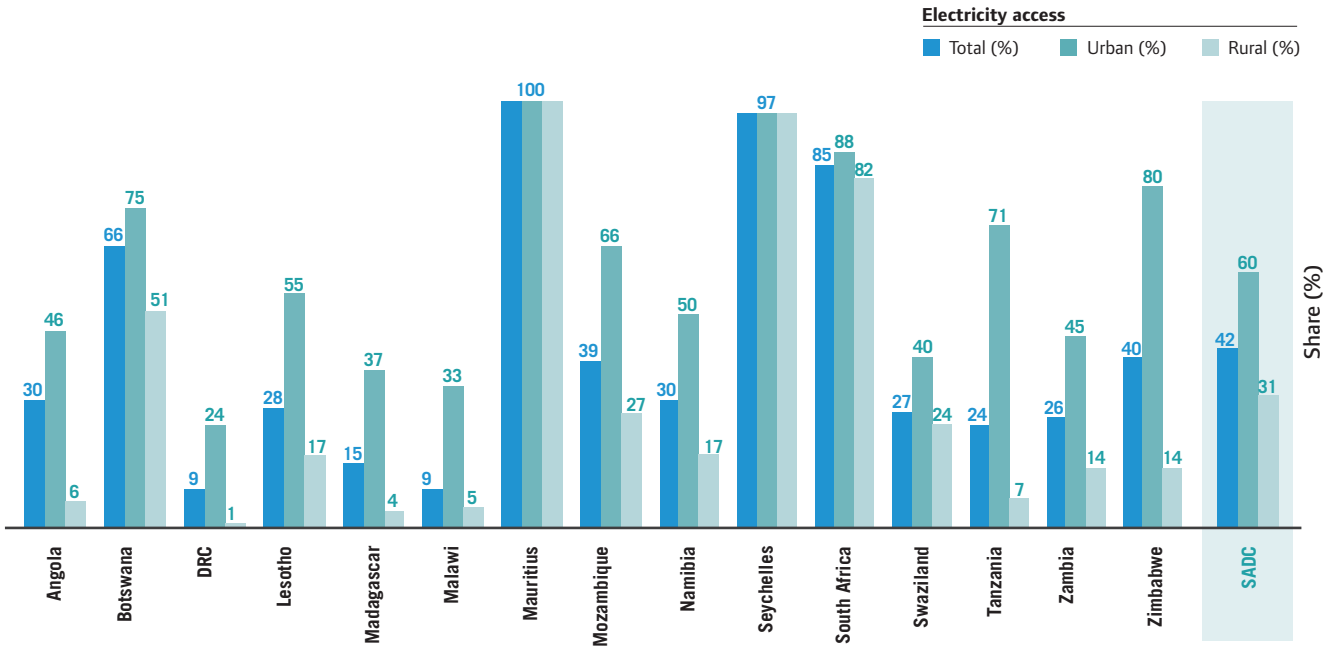
REGIONAL ENERGY CHALLENGES

The SADC region's main challenges in the energy sector are similar to those of other parts of sub-Saharan Africa: energy access, health and environment, energy security, infrastructure and financing.

Energy Access

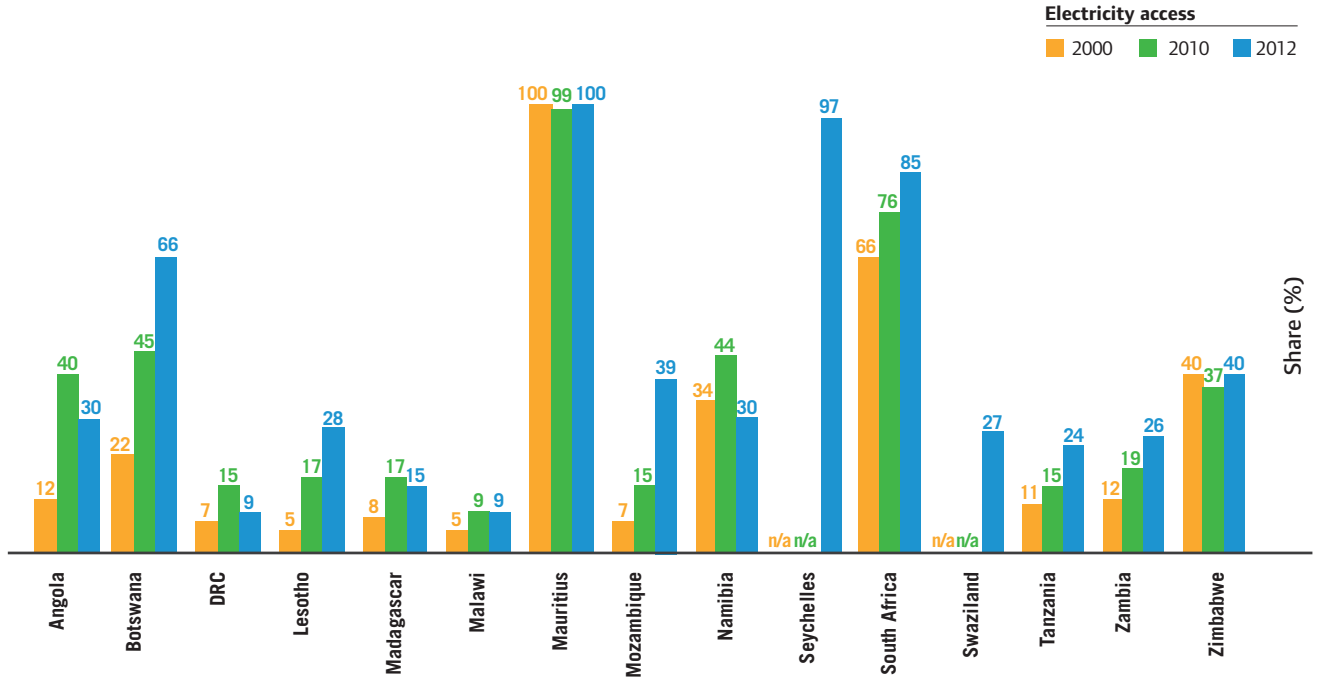
Access to grid-based electricity has improved over the past decade, thanks to ambitious grid extension programmes in several countries, such as Botswana, Mozambique and South Africa. Figure 2 shows the share of the population with access to electricity in rural versus urban areas of SADC member states as of 2012.[13] Figure 3 shows the change in electricity access over the 12-year period from 2000 to 2012.[14] With a few exceptions, member states have shown an increase in electricity access over this period.[15]

FIGURE 2 | Share of electricity access in rural versus urban areas in SADC member states, 2012



Source: See endnote 13 for this section.

FIGURE 3 | Change in electricity access in SADC member states, 2000-2012



Note: n/a means "not available".
Source: See endnote 14 for this section.

Improvements in off-grid access are also evident in the expanded use of renewable energy technologies in rural areas, galvanised by specialist rural electrification agencies in several member states and by the emergence of entrepreneurs selling micro-scale clean energy products. Tanzania has emerged as a key market in this respect, but a huge untapped potential remains for scaling solar in other SADC countries that have large off-grid populations. BPC Lesedi in Botswana and the Rural Energy Agency in Tanzania are examples of organisations developing off-grid projects, and the Regional Energy Regulators Association (RERA) is creating standards for local mini-grids.[16] However, energy access remains a major challenge facing the region into the next decade.

The SADC Regional Energy Access Strategy and Action Plan (REASAP), approved by the SADC energy ministers in 2010, 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 people in the SADC region have access to adequate, 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 halve this again in successive five-year periods until there is universal access for all end-uses.[17]

The goals set out in REASAP are broadly quantitative but will be difficult to monitor, as there is no clear-cut plan for measuring progress. The REASAP study does, however, include a detailed discussion of possible technical and policy options for increasing access, focusing on renewables and mini-grids as an alternative to grid extension.[18]

TABLE 4 | Impact of cooking with solid fuels on household air pollution (HAP) in SADC member states, 2012

	Share of population using solid fuels for cooking	Number of people affected by HAP	Number of households affected by HAP	Number of deaths per year from HAP	Number of child deaths per year from HAP
Angola	56%	11,659,494	2,372,053	7,804	2,843
Botswana	37%	741,447	176,535	311	27
DRC*	93%	61,105,736	12,431,590	53,202	27,582
Lesotho*	62%	1,271,958	269,843	1,896	788
Madagascar*	98%	21,848,036	4,458,783	16,375	3,628
Malawi	97%	15,429,289	3,588,207	13,250	5,852
Mozambique	96%	24,195,259	5,498,923	12,858	6,373
Namibia	55%	1,242,666	263,629	1,056	142
South Africa	13%	6,654,610	1,411,761	7,623	1,283
Swaziland*	62%	763,211	161,913	714	183
Tanzania	96%	45,871,783	9,361,588	20,353	12,012
Zambia	83%	11,682,332	2,376,699	8,629	4,190
Zimbabwe	70%	9,607,022	2,038,109	9,158	3,915
SADC		**212,072,843**	**44,409,633**	**153,229**	**68,818**

Note: HAP includes principally carbon monoxide (CO) and particulate matter (PM), according to the World Health Organization (WHO). Both are products of incomplete combustion and are hazardous to health. The table does not include data for Mauritius and Seychelles. An asterisk (*) indicates that the figures have been estimated by the WHO.
Source: See endnote 20 for this section.

Health and Environment

Improvements in electricity access and access to modern cooking fuels can bring health and environmental benefits. At present, most SADC member states – with the exception of Mauritius and Seychelles – depend heavily on traditional biomass and other solid fuels such as coal for cooking, with attendant negative effects on the health of women and children, who tend to spend more time near open fires and traditional cookstoves.[19]

According to the World Health Organization, an estimated 212 million people within the SADC region (excluding Mauritius and Seychelles) – or 71% of the population – are affected by household air pollution from indoor smoke, small particle pollution, carbon monoxide and nitrogen oxides, primarily as a result of cooking and heating with solid fuels (see table 4).[20] This results in the deaths of an estimated 153,229 people each year, about 45% of them children. (See sections 3 and 4 for more on the distribution of cooking fuels within individual SADC member states.)

In addition to impacts on household air pollution, extensive coal use in several SADC countries affects overall environmental quality. Botswana and South Africa, for example, remain heavily dependent on coal for power generation and are increasing their use of coal for both power generation and industrial heat[vi] – creating an enormous potential for adverse health impacts from airborne pollution (sulphur and nitrogen oxides), while also increasing their greenhouse gas emissions (see sidebar 1).[21]

Sidebar 1. South Africa's greenhouse gas emissions

South Africa is the twelfth largest emitter of carbon dioxide (CO_2) in the world, responsible for nearly half the CO_2 emissions for the entire African continent and for about 1.6% of global emissions. Total South African greenhouse gas emissions in 2010 amounted to 579 million tonnes of CO_2-equivalent, excluding land use. This represents approximately a 25% increase since 2000 and is 50% above 1994 levels.

CO_2 accounts for around 80% of South Africa's emissions. The energy sector, including electricity generation, petroleum refining and transportation, alone was responsible for more than 85% of the country's emissions, with the power sector holding the largest share at 69%, due to South Africa's heavy reliance on coal for electricity generation.

Source: See endnote 21 for this section.

Energy Security

Energy security can be improved through increased electricity interconnections among SADC member states and/or by improving the reliability of existing power systems. At present, transboundary connections are the most significant factor in strengthening energy security, and the existence of a regional power pool – the Southern African Power Pool (SAPP) – has helped to ensure that such linkages increasingly are implemented on a least-cost basis.

Transboundary electricity transmission links are not new to southern Africa. In the late 1950s, an electricity line was constructed from the DRC to Zambia's Copperbelt Province, the country's mining hub. Also in the late 1950s, the Kariba Dam was built as a joint project between North and South Rhodesia (now Zambia and Zimbabwe), with power stations located on both sides of the river border. In the 1980s, new interconnections between Zambia/Zimbabwe and Botswana were built to reduce Botswana's dependence on South Africa for its power needs.

Table 5 provides examples of regional interconnections implemented in recent years as well as several new projects that are under way or planned.[22] An additional 6,026 MW of capacity is expected to be available in the region soon, due to a combination of new generation projects and interconnections implemented in 2014.[23]

vi. Botswana is planning a major expansion (600 MW) of its existing coal-fired power plant at Morepule, and a major 1,200 MW coal-fired station at Mmabula has been in the planning stages for several years but has yet to reach financial closure. South Africa is commissioning two 4,800 MW coal-fired plants in 2015 and issued tenders in January 2015 for private developers to construct additional coal-fired stations. See CNBCI, "South Africa Tenders for Coal-fired Power Plants", 12 February 2015, http://www.cnbcafrica.com/news/southern-africa/2014/12/12/eskom-power-cuts-blackouts/#.

> AT PRESENT, TRANSBOUNDARY CONNECTIONS ARE THE MOST SIGNIFICANT FACTOR IN STRENGTHENING ENERGY SECURITY, AND THE EXISTENCE OF A REGIONAL POWER POOL – THE SOUTHERN AFRICAN POWER POOL (SAPP) – HAS HELPED TO ENSURE THAT SUCH LINKAGES INCREASINGLY ARE IMPLEMENTED ON A LEAST-COST BASIS.

TABLE 5 | Key electricity interconnections planned and completed in the SADC region

Project	Countries connected	Capacity	Date of commissioning	Current status
Matimba – Insukamini	Zimbabwe/South Africa	400 kilovolts (kV)	1989	Functioning
Cahora Bassa to RSA	Mozambique/South Africa	535 kV DC	1997	Functioning
Cahora Bassa to Zimbabwe	Mozambique/Zimbabwe	400 kV	1997	Functioning
RSA – Namibia	Namibia/South Africa	400 kV	1999	Functioning
Motraco	South Africa/ Mozambique	2 x 400 kV	2000	Functioning
ZiZaBoNa	Zimbabwe/Zambia/ Botswana/Namibia	300-600 kV	2016-2017	Financial feasibility under way
Livingstone – Katima Mulilo	Namibia/Zambia	220 kV	2015	Operational
Mozambique Backbone	Internal but links Mphanda Nkua to regional grid	400 kV AC + 800 kV DC	2019	Economic and SEIA studies completed
Zambia – Tanzania – Kenya Interconnector	Zambia/Tanzania/Kenya, the first major East-Southern Africa link	400 kV	2016-2018	Some components completed, others under way

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 2015* (Harare, Zimbabwe: 2015), www.sapp.co.zw/docs/Annual%20report-2015.pdf.
Source: See endnote 22 for this section.

Infrastructure Development

In addition to electricity interconnection projects to improve energy security, there is a need to increase electricity capacity to meet increasing demand. SADC has made important strides in both of these areas by developing a Indicative Strategic Development (RISDP) in 2003 and a Regional Infrastructure Development Master Plan (RIDMP) in 2012. An update of the RISDP was issued in April 2015.

The energy plan outlines a total investment portfolio for electricity generation of between USD 114 billion and USD 233 billion for the period 2012 to 2027. The related transmission investment costs to support new generation capacity are estimated at USD 540 million, not including planned transmission interconnectors and national backbone lines.[24]

The majority of generation investments are for fossil fuel and hydropower plants. Combining the SAPP plan (for transmission and distribution only) and the priority scenario data from the South Africa Integrated Resource Plan for Electricity 2010-2030 (for all projects), the share of coal-based generation capacity added between 2012 and 2027 will be 31% coal, 24% hydro, 15% wind, 11% solar PV and concentrating solar power (CSP), 11% nuclear, 5% distillate[vii] and 3% natural gas.[25]

SAPP estimates show that by 2025, the region will have to double its generation capacity to meet increased demand. The energy mix also would change significantly, with coal still dominant at 56%[viii] (down from 74% in 2009) and hydro at 34% (from 20% in 2009). The RIDMP energy plan proposes that additional capacity beyond 2027 should be based on a combination of hydro, wind and solar. Apart from hydropower, SADC estimates that the major renewable energy capacity addition will be from wind energy, followed by solar PV, CSP and biomass.[ix]

Overall, SADC forecasts that renewable energy capacity in the region will increase by 13,719 MW in 2017, 10,345 MW in 2022 and 8,243 MW in 2027.[x] Most of the additional capacity will be from hydropower, and the majority of these developments will occur in the DRC, Mozambique, Zambia and Zimbabwe.[26]

Initial efforts to expand the DRC's capacity at the Inga site on the Congo River (associated with the creation of a western transmission corridor through Angola and Namibia to South Africa) were delayed when the DRC decided instead to use the additional Inga power for an aluminium smelter.[27] Since that time, the DRC has announced that the smelter is no longer planned and that the country will build the Inga III hydro project (rated at 4,800 MW) and sell the power to South Africa, which has agreed to off-take 2,500 MW of the total.[28] In this new scenario, transmission would be via a strengthened central corridor through Botswana, Zambia and Zimbabwe to South Africa.[29] On the strength of South Africa's commitment, this long-awaited project is about to proceed.

The share of hydropower in SADC's future power infrastructure may be much larger than is indicated by the above figures, because further expansion of the Inga hydro facility in the DRC (expansion beyond Inga III, usually referred to as "Grand Inga") could itself result in an additional 40 GW of capacity.[30] However, significant political and financial obstacles to this larger project remain.

Financing

Obtaining timely and effective financing for energy projects in the SADC region presents a significant challenge. Projects such as Inga III – involving run-of-river technology with a small diversion dam and limited flooding[xi] – have been delayed for over 20 years. This is due in part to the caution of major investors such as the World Bank, the African Development Bank (AfDB) and others to commit to long-term financing until agreement is reached among the potential buyers of the power, as well as to perceived uncertainties about the political stability of the host nation. The risks involved in transmitting power over long distances and through multiple jurisdictions also have contributed to these delays.[xii]

SADC and its subsidiary organisations such as SAPP have provided a neutral facilitator for such negotiations and have been instrumental in promoting large-scale hydro. As noted earlier, financial closure for Inga III has now been realised, and financing for Mozambique's Mphanda Nkua project also may be imminent, although the commissioning of both projects is probably three to five years away or more.

vii. Distillate is a liquid or liquefiable petroleum product that is used to generate heat or power; it can include fuel oils (*e.g.*, diesel), petrol and even LPGs.

viii. It is possible that the coal contribution will be reduced further if major gas fields in Mozambique and Tanzania are developed and used for power generation.

ix. Geothermal energy, an important renewable source in East Africa, is not expected to make any significant contribution to SADC's renewable capacity before 2027. Tanzania is conducting a feasibility study on its geothermal resources.

x. 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 SAPP in 2013.

xi. The final design of Inga III is still being discussed, with the most recent proposal to create a project that would not block the main stream of the river but instead would divert the flow into a 12-kilometre open canal. The diversion would be located upstream of the intake works for Inga I and II. At the end of the canal, a 145-metre-high dam and a power station will be constructed. There would be a small reservoir behind the dam wall, although this could be expanded in a later phase. See International Rivers, "The Inga 3 Hydropower Project", http://www.internationalrivers.org/campaigns/the-inga-3-hydropower-project.

xii. The decision to terminate the Western Power Corridor (WPC) project, which was linked to Inga III's development, was based in part on uncertainty around completion of Inga III and in part on the difficulty of negotiating wheeling tariffs with intermediate countries. Prospects for the Western Corridor have been renewed with the realisation that Angola itself could be a net exporter of electricity if its major hydro projects go ahead.

For other forms of renewable energy – solar, wind and biomass – feed-in tariffs (FITs) or a competitive tendering system are the most common option, and financing typically is driven by a combination of public and private sector actors. FIT programmes have been introduced in Namibia (for wind, solar and biomass projects less than 5 MW)[xiii] and in Tanzania (for small hydro less than 10 MW), and they soon will be introduced in Botswana, Mozambique and Zimbabwe. The experience of South Africa in deciding against a proposed FIT and moving instead to competitive tendering for utility-scale projects has provided a useful alternative, allowing other countries to compare the risks as well as potential rewards of these two approaches to renewable energy financing.[31] [xiv]

Many of the international climate and clean energy funds are in early stages of development, and SADC member states are only beginning to realise how funding of this kind could accelerate the introduction of energy efficiency and renewable energy technologies.

As an example of their commitment to renewables and to improving the regulatory and financial environment for their development, 37 of the 42 African countries have opted in to the Sustainable Energy for All (SE4All) initiative of the United Nations, including all of the SADC countries. These countries have now completed a rapid assessment/gap analysis, which will be followed by an SE4All Action Agenda and Investment Prospectus.[32]

A more detailed discussion of international (including SE4All) and domestic financing for renewable energy and energy efficiency projects is found in section 5. Further details of projects under way and planned are provided in section 2.

PLATFORMS FOR REGIONAL ENERGY COOPERATION

SADC, the main regional body, has developed over time into a complex organisation with several subsidiary bodies. The following sub-sections provide a brief description of the history and functions of SADC itself and its key energy subsidiaries.

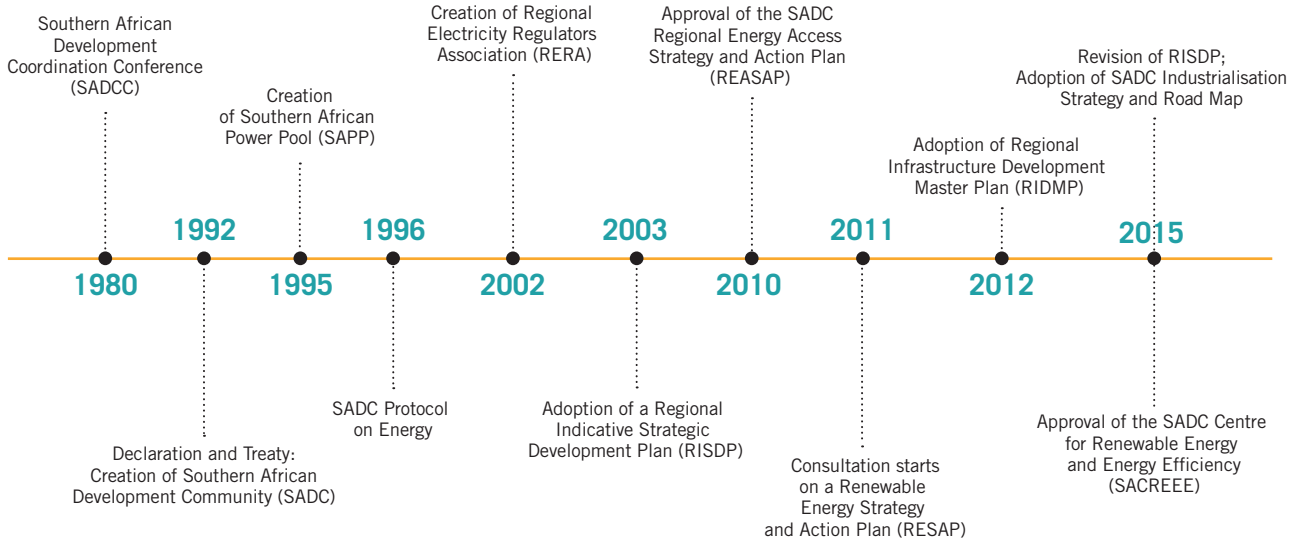
SADCC and SADC

The Southern African Development Community (in its original form as the Southern African Development Coordination Conference, SADCC) 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) and later – with the streamlining of management structures in 1995 – from 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 Botswana and Zambia and Zimbabwe and Botswana, and the implementation of regional fora or "sub-committees" for key sub-sectors including electricity, coal, biomass, renewable energy and energy conservation.

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.

FIGURE 4 | Milestones for energy co-operation and integration in SADC



xiii. The Namibia FIT is still subject to final government approval, but it has been agreed to by the Energy Regulatory Board, including procedural and technical details. Design of the Namibia FIT program was completed in July 2014. However, the Namibian Cabinet has yet to promulgate the programme. See U.S. Agency for International Development, "Completion of AIP Activities in Lesotho, Mozambique and Namibia", 30 January 2015, https://www.fbo.gov/index?s=opportunity&mode=form&id=97a225a5efdce0e16d374ae4acf3e8a5&tab=core&_cview=0.

xiv. The role of FIT programmes in renewable energy development is discussed in greater detail in section 4.

In addition to activities co-ordinated from its headquarters, SADC has developed two other organisations in the energy field: the Southern Africa Power Pool (SAPP) and the Regional Energy Regulators Association (RERA), both of which are considered to be subsidiary components of the Secretariat. A third subsidiary organisation, the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), was recently approved by the SADC energy ministers (see below).

Southern African Power Pool

SAPP was created in 1995 in response to concerns expressed by SADC member states that because of the lack of strong interconnections, the region was for practical purposes divided 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 (Botswana, Lesotho, Namibia, South Africa and Swaziland), where base load was supplied primarily by thermal generation.[33]

The existence of SAPP has led to unique forms of co-operation, such as the financial and technical assistance given by Namibia to rehabilitate and maintain the Hwange Power Station in Zimbabwe, paid for by the transfer of 150 MW of power to the Namibian grid. This led to a more recent agreement to transfer an additional 80 MW to Namibia that will pay in part for expansion of the Kariba South Bank hydro station.[34]

SAPP also has been a leader in identifying demand-side management (DSM) opportunities for its member utilities. In 2014, it expanded this programme to include development of a virtual power station (VPS), which will incorporate the use of information technology, advanced metering, automated control capabilities and electricity storage to match short-interval load fluctuations to achieve upwards of 6,000 MW of demand savings.[35] SAPP's DSM and energy efficiency programmes are discussed in greater detail in section 3.

Currently, the regional demand/supply situation remains precarious. Despite continuing efforts to improve interconnections and to facilitate trading of electricity between member utilities, the region recorded a capacity shortfall of 4,278 MW in early 2014.[36] The countries with the largest shortfall (available capacity less suppressed/forecast demand) in 2013 were South Africa and Zimbabwe, although overall only Angola and Mozambique showed a surplus of capacity.[37]

Despite continuing shortfalls, generation capacity in SADC has increased by an average of 1,100 MW annually since 2004. In 2013, a total capacity equivalent to 1,361 MW was commissioned from rehabilitation and new projects in Botswana (450 MW), South Africa (402 MW), Zambia (230 MW), Mozambique (100 MW), Malawi (64 MW), Tanzania (60 MW) and the DRC (55 MW).[38] This included independent power projects in Malawi, Mozambique, South Africa (mostly solar) and Zambia.[39] In 2014 mainland member states commissioned a total of 1,999 MW from Angola (150 MW); South Africa (1654 MW) and Zambia (195 MW) from rehabilitation and new projects.[xv]

The role of SAPP in meeting the region's electricity needs is likely to expand in the coming years as more interconnections are commissioned, making cross-border electricity trading increasingly attractive (see sidebar 2). Substantial improvements are expected both in north-south interconnections (which will improve stability by linking hydro- and thermal-based areas) and some east-west interconnections (*e.g.*, Malawi-Zambia and Zambia-Tanzania), which will increase the diversity of supply in the northern (hydro-based) region.

Sidebar 2. More on SAPP: goals and future development

The original goal of SAPP was to optimise the use of available energy resources in the region and for member countries to support one another during emergencies. As its first achievement in 1996, a new 400 kilovolt (kV) connector was commissioned on the Botswana-Zimbabwe border, strengthening north-south power links.

SAPP worked initially through a series of bilateral agreements between member utilities. In 2001, this was changed to a "Short-term Energy Market", in 2009 to a "Day-Ahead Market" and in 2010 to use of periodic "Energy Imbalance Settlements". In 2012-2013, SAPP was responsible for trading 60.8 gigawatt-hours (GWh) of electricity, out of a total regional supply of 1,267.6 GWh.

SAPP is still evolving from a broker of co-operative agreements between utilities to an overseer of a fully competitive electricity market. As the region itself is faced with frequent capacity shortfalls, the role of SAPP has become more challenging. It is now addressing the huge differences among tariffs in the region, arguing for the introduction of fully cost-reflective tariffs in the near future.

SAPP will also continue to facilitate bilateral agreements between countries, as these agreements are an important part of the electricity market.

xv. SADC/UNIDO personal communication with REN21, 25 August 2015.

Regional Electricity 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 countries had regulatory bodies, and these had little power to enforce action in such key areas as tariffs and capacity development. Today, 12 of the 15 SADC countries have either electricity or overall energy regulators in place (soon to include Botswana, which is developing a combined energy and water regulator).[40] RERA's formal membership so far is limited to regulators in only 10 of the 12 countries.[41]

To date, RERA has focused primarily on information sharing and on policy dialogue in new areas of endeavour, such as a recent study of opportunities for developing mini-grids in the region.[42] It has also facilitated discussions around new interconnections. Efforts to harmonise electricity supply industry (ESI) policies are under way but will take longer to implement.

The role of both RERA and SAPP in promoting renewable energy solutions is less developed, although SAPP has indicated to SADC ministers that it expects to achieve a renewable energy mix in the regional energy grid of at least 32% of total energy produced by 2020, which should rise to 35% by 2030.[43] These figures assume a very large role for hydropower expansion in Angola, the DRC, Mozambique, Tanzania and Zimbabwe.

The completion and approval of the SADC Renewable Energy Strategy and Action Plan (RESAP) will facilitate more-detailed planning for renewables regionally and will ensure that the SADC member states have a clearer vision of the potential role of renewables in their national energy master plans.[xvi] Regional bodies such as RERA and SAPP also will be consulted as new targets and programmes for renewables are developed.

SADC Centre for Renewable Energy and Energy Efficiency

SACREEE was approved by a meeting of the SADC energy ministers on 24 July 2015, during which the ministers also approved the selection of Namibia as the host country.[44] It was subsequently endorsed by the SADC Council of Ministers, August 2015. The United Nations Industrial Development Organization (UNIDO) has provided support for SACREEE[xvii] from the beginning, including completing a detailed preliminary study and roadmap in 2013.[45]

> **CURRENTLY, THE REGIONAL DEMAND/SUPPLY SITUATION REMAINS PRECARIOUS. DESPITE CONTINUING EFFORTS TO IMPROVE INTERCONNECTIONS AND TO FACILITATE TRADING OF ELECTRICITY BETWEEN MEMBER UTILITIES, THE REGION RECORDED A CAPACITY SHORTFALL OF 4,278 MW IN EARLY 2014.**

SACREEE's mandate is as follows: "...to promote market-based adoption of renewable energy and energy efficiency technologies and services in SADC member states. The centre is expected to contribute substantially to the development of thriving regional renewable energy and energy efficiency markets through knowledge sharing and technical advice in the areas of policy and regulation, technology co-operation, capacity development, as well as investment promotion."[46] SACREEE's role in the development of renewable energy and energy efficiency is expected to be similar to that of the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) in West Africa, which was consulted during the development of the SACREEE concept and work plan.

xvi. At the time of writing, RESAP was still under review, and a final version was not made available to the authors.
xvii. Financial assistance is also being provided by the Government of Austria, through UNDIO.

02

RENEWABLE ENERGY MARKETS AND TRENDS

02 RENEWABLE ENERGY MARKETS AND TRENDS

The SADC region is faced with a number of energy challenges related to energy access, security, infrastructure and financing. Other concerns include the region's continued dependence on fossil fuels for the majority of its power generation requirements, as well as the reliance of a large share of the population on biomass energy for cooking and heating, with the attendant problems of rapid deforestation and risks to health. These challenges, along with the continuing threat of severe power shortages and load shedding in the region, have prompted governments and utilities to accelerate the quest for more diversified and sustainable resources in the electricity sector.

This section reviews the region's response to these challenges, examining several key developments and trends in renewable energy. These include the increased use of renewables for power generation and the development of sustainable approaches to cooking, as well as innovations in biofuels and in commercial biomass energy.

The signs of progress are promising. Major hydropower projects, long delayed for lack of funding, are beginning to move forward, as are plans for many smaller hydro projects. Numerous medium- to large-scale solar and wind projects are already in place or reaching financial closure, supported by tariff innovations and fiscal incentives. Meanwhile, the growing threat from non-sustainable exploitation of forest biomass to feed the demand for wood and charcoal for cooking has prompted a re-thinking of overall energy policy, resulting in a shift towards providing "modern energy services"[i] and developing off-grid solutions rather than simply extending the grid. Improved cookstoves, which users have long resisted because of high prices and reliability issues, are becoming a realistic alternative in several SADC member states, boosted in part by carbon financing.

MAJOR HYDROPOWER PROJECTS, LONG DELAYED FOR LACK OF FUNDING, ARE BEGINNING TO MOVE FORWARD, AS ARE PLANS FOR MANY SMALLER HYDRO PROJECTS.

RENEWABLE ENERGY CAPACITY

The main source of renewable energy for electricity is, and will remain for some time, large-scale hydropower, as produced at the Cahora Bassa, Inga, Kafue and Kariba hydroelectric facilities. However, interest in solar (particularly PV) and wind energy technologies is growing, ranging from small-scale household PV panel arrays to large-scale operations such as the 138 MW Jeffrey's Bay wind farm in South Africa and the 96 MW solar array project at Jasper in the Northern Cape, South Africa. New project developments in Botswana, Mozambique, Namibia, Tanzania and Zimbabwe are also demonstrating government commitment to using renewable energy for on-grid power.

i. The term "modern energy services" refers to "household access to electricity and clean cooking facilities (*e.g.*, fuels and stoves that do not cause air pollution in houses)", per the International Energy Agency, "Energy poverty", http://www.iea.org/topics/energypoverty. By definition, this does not include traditional biomass cooking devices.

Several countries – the DRC, Lesotho, Malawi, Mozambique, Zambia and Zimbabwe – already have significant renewable energy contributions to electricity capacity and generation, due primarily to the development of large-scale hydro (see table 6).[1] Namibia, Tanzania and Swaziland also have fairly high levels of generation from hydro sources (67%, 66% and 40%, respectively). These countries, however, continue to use large amounts of fossil fuel-based generation, and both Namibia and Swaziland import fossil-based electricity from South Africa and Zimbabwe.

There has been a clear upwards trend in renewable capacity during the period 2000-2013: 26% overall for the region, and as high as 225% in Angola due to vastly increased hydro capacity. Overall, table 6 reflects the huge disparity between hydropower and the other renewable energy resources. For some countries – Angola, the DRC, and Lesotho – hydro is the only resource for which data are available or are large enough to be reflected in the totals.[ii] Large figures for solid biomass in Mauritius and South Africa, as well as for Swaziland and Tanzania, are due mostly to power generation using bagasse in the sugar industries of those countries.

TABLE 6 | Renewable energy capacity in SADC member states, 2014

	Technology type								Total	Percentage change 2000-2014
	Large-scale hydro	Medium-scale hydro	Small-scale hydro	Pumped storage	Solar PV	Onshore wind	Biomass/ waste	Biogas		
	MW									
Angola	861	16	1	0	0	0	0	0	878	225%
Botswana	0	0	0	0	1	0	0	0	1	100%
DRC	2,360	50	6	0	0	0	0	0	2,416	1%
Lesotho	72	3	2	0	0	0	0	0	77	0%
Madagascar	130	34	1	0	3	1	0	0	169	55%
Malawi	346	4	1	0	1	0	17	0	369	21%
Mauritius	42	17	2	0	18	1	271	0	351	32%
Mozambique	2,182	3	1	0	1	0	0	0	2,187	0%
Namibia	332	0	0	0	5	0	0	0	337	35%
Seychelles	0	0	0	0	0	6	0	0	6	600%
South Africa	653	30	3	1,590	922	570	242	13	4,023	60%
Swaziland	55	6	2	0	0	0	75	0	138	48%
Tanzania	553	14	6	0	11	0	62	0	646	8%
Zambia	2,244	11	2	0	2	0	43	0	2,302	26%
Zimbabwe	680	6	2	0	5	0	97	0	790	6%
SADC	**10,510**	**194**	**29**	**1,590**	**969**	**578**	**807**	**13**	**14,690**	**26%**

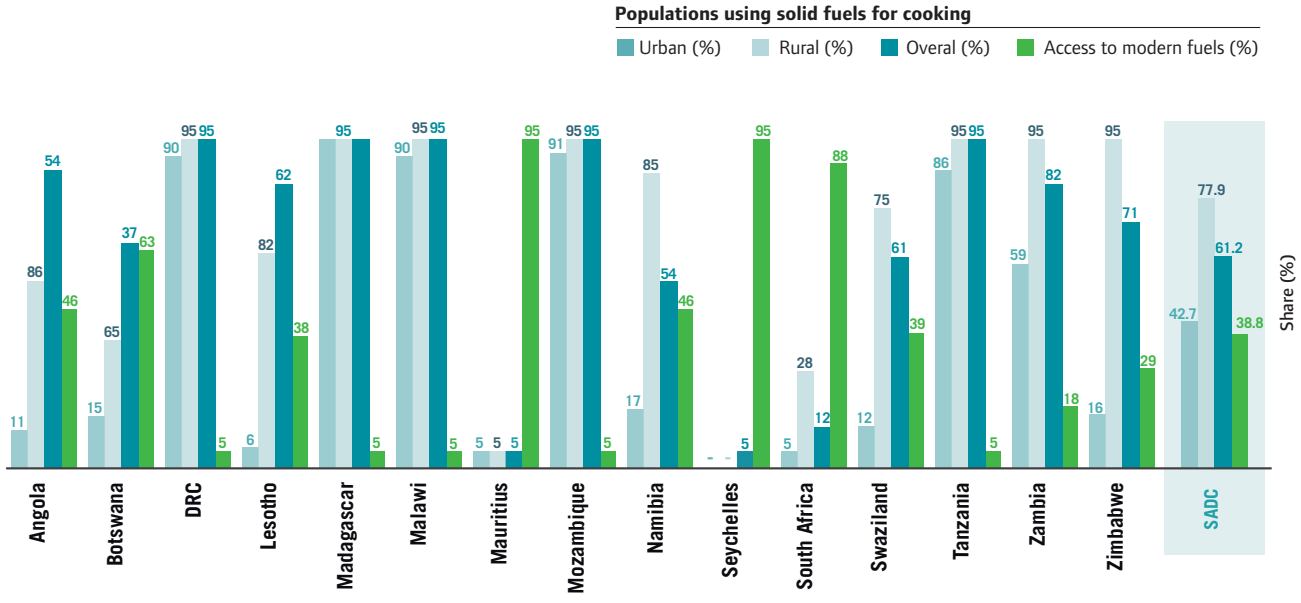
Note: An entry of "0" means either that there is no use of the technology in that country, or that this use is very small and therefore not registered statistically.
Source: See endnote 1 for this section.

ii. This may reflect the fact that the numbers are very small, *e.g.*, PV supply to single houses or schools.

COOKING

Biomass used for cooking remains the dominant energy source in most SADC countries. Figure 5 illustrates the average use of solid fuels (including both biomass and coal) for cooking in all 15 member states, plus the share of the population that has access to "modern" fuels (*i.e.*, other than traditional solid fuels).[2]

FIGURE 5 | Share of the urban and rural populations using solid fuels for cooking in SADC member states, 2013



Note: The dash ("-") for Seychelles indicates that no rural/urban breakdown is available.
Source: See endnote 2 for this section.

Although these figures are not strictly comparable,[iii] they demonstrate the broad differences among SADC member states in cooking fuel use. The countries with the highest shares of wood and charcoal consumption for cooking are the DRC, Madagascar, Malawi and Mozambique, followed closely by Swaziland and Tanzania. By comparison, the countries with the lowest shares are Mauritius and South Africa, both of which have well-established retail distribution strategies and high rates of access to electricity, LPG, paraffin and coal.

The regional average for use of solid fuels in 2013 in SADC (61.2%) was somewhat lower than for the ECOWAS region (85.7%), due primarily to low usage in Mauritius, Seychelles and South Africa. Not counting these three countries, the SADC figure rises to 80.9%, closer to the ECOWAS average.

The use of wood and charcoal for cooking fuels is not exclusively a rural problem; traditional biomass fuels also are used in urban areas, where the environmental and health problems are compounded by close living conditions. Load shedding and lack of connections has prompted increased use of both propane (LPG) and wood fuel for cooking in urban areas of countries such as Zimbabwe.

Charcoal is the usual fuel of choice for urban cooking because it is commercially available in urban markets and is much more compact from an energy-content perspective, making it ideal for use in smaller urban dwellings. The inefficiencies of the traditional mud kilns used to manufacture charcoal in most countries can lead to even higher rates of deforestation than would be the case for wood.[3] Meanwhile, the harvesting and production of charcoal often are concentrated in areas close to cities, resulting in increased pressure on adjacent forest biomass.

iii. Data are taken from different years depending on data availability for each country.

Improved cookstoves have been available in Africa since the late 1970s, primarily through innovations around the original Jiko stove in Kenya. The earliest examples in the SADC region are in Tanzania, which adopted the Jiko design in the 1980s, a market that has since diversified into a wide range of household and commercial/institutional stoves. Since the late 1990s, the technology options have grown rapidly throughout the region, partly in response to rising concerns about indoor air pollution and resulting health problems, and more recently because of the availability of carbon credits via the Clean Development Mechanism and other carbon crediting systems.[4]

Improved cookstoves are now available in all 15 SADC member states, although the method of distribution and the level of market acceptance vary greatly. A number of large donor-funded projects have attempted to establish local stove production centres and distribution networks.[iv] Several manufacturers in both Malawi and Tanzania are producing high-efficiency stoves for rural hospitals and schools.

Another innovation – "hot bags" that store heat around the cooking pot and thus reduce the need for continuous firing – is popular in rural South Africa, where it is seen as a stepping-stone technology to be supplemented eventually by improved cookstoves, or alternatively as a way to reduce the amount of fossil fuels required for specific cooking activities. A more thorough discussion of improved cookstove technologies can be found in section 3.

Fuel-switching – the replacement of wood and charcoal by modern fuels such as ethanol or propane – is not well represented in the SADC region. Mozambique hosted a large agricultural project, CleanStar Mozambique, beginning in 2010, which involved dedicated production of ethanol from cassava, tied to a plan to market cookstoves that were able to use the ethanol from the project. But the stove component of the project went into liquidation in 2014 after failing to achieve the required level of sales to sustain production. The ready availability of charcoal in the urban marketplace, as well as user familiarity with the basic charcoal stove, made the double switch to a new fuel and a new stove technology unworkable.[5]

A UNDP study on the use of ethanol in cookstoves in Malawi concluded that while ethanol was much more expensive than wood or charcoal, it would be competitive with paraffin and propane. Moreover, increasing household use of ethanol would enable the production companies to direct their surplus production to domestic use rather than export it for lower-value uses.[6]

Ethanol gel stoves also are being promoted as an alternative to biomass stoves and are found in several countries, notably Botswana, Malawi, Namibia, South Africa and Zimbabwe. No information on their market penetration is currently available.

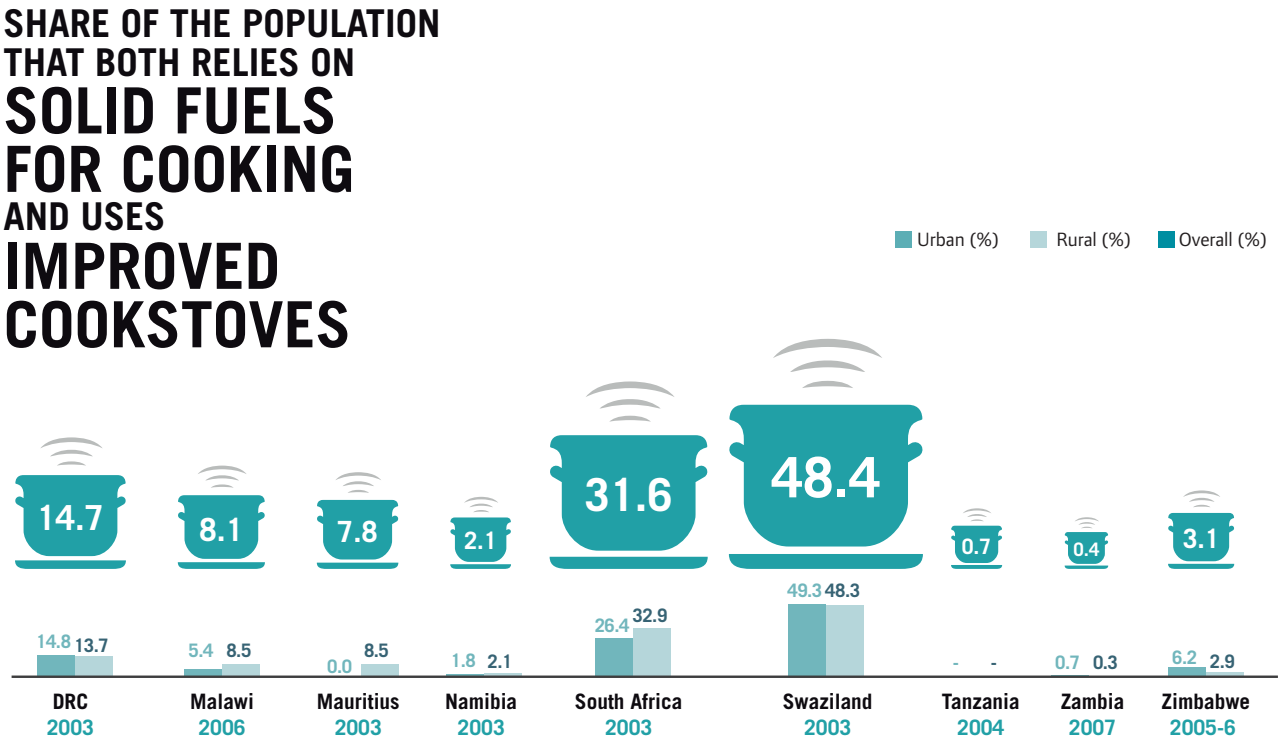
IMPROVED COOKSTOVES ARE NOW AVAILABLE IN ALL 15 SADC MEMBER STATES, ALTHOUGH THE METHOD OF DISTRIBUTION AND THE LEVEL OF MARKET ACCEPTANCE VARY GREATLY. A NUMBER OF LARGE DONOR-FUNDED PROJECTS HAVE ATTEMPTED TO ESTABLISH LOCAL STOVE PRODUCTION CENTRES AND DISTRIBUTION NETWORKS.

Figure 6 provides estimates on the penetration of improved solid fuel cookstoves in nine SADC member states, using data from a variety of sources and years.[7] According to these data, South Africa and Swaziland are by far the most successful in distributing improved cookstoves, followed by the DRC and Malawi. This likely reflects differences in distribution systems and the fact that in the first two countries, cookstoves have become a full-time business, with local manufacturing and design. In the DRC and Malawi, the relatively high figures relate more to the large number of donor-funded projects that have been active in these countries, and to growing concerns about forest depletion, than to the success of particular marketing strategies or technologies.

Lacking any alternative cooking fuels (and none that is locally sourced), Malawi has become a major focal point for stove design innovation as well as for marketing. Malawi was one of the main beneficiaries of the ProBEC project, funded for over a decade (until 2011) by a wide range of donors. ProBEC focused on using local women's groups and other small community and regional organisations to fabricate and market portable clay stoves, designed for simplicity of use and ease of replacement. The project also experimented with larger-scale, industrial production of charcoal stoves in Mozambique and commercial/institutional stoves in Malawi and Tanzania.[8]

iv. Examples include the ProBEC project, which established major stove production centres in Malawi, Mozambique and Tanzania, as well as smaller centres (based mostly on artisanal production) in Zambia and Zimbabwe.

FIGURE 6 | Use of improved cookstoves in selected SADC member states, 2003-2007



Note: Disaggregated data for 2008 and later are not currently available for the above countries. The dash ("–") for Tanzania indicates that no rural/urban breakdown is available.
Source: See endnote 7 for this section.

An example of an integrated approach to this issue in Malawi is the Hestian Rural Innovation project, which promotes both so-called rocket barns for the tobacco industry – a re-designed curing barn with a commercial-sized rocket stove replacing the traditional inefficient curing furnace – and an artisanal clay stove based on the ProBEC model for households. The project had distributed 105,000 improved cookstoves to rural Malawi households by the beginning of 2015. It also claims a 70% reduction in wood consumption for tobacco barns and an 80% reduction for cookstoves.[9 v]

Another example, from the DRC, is a large CDM programme of activities (PoA) that is disseminating improved cookstoves and was registered with the UNFCCC in 2014. This PoA has a potential mitigation target of 36,167 tonnes of CO_2-equivalent per year, equal to some 12,000 stoves.[10] Distribution of stoves has been ongoing since 2013.

Also in the DRC, the Mikalili efficient fuelwood cookstoves project is aiming to switch from non-renewably logged trees for production of charcoal to a sustainable energy supply by using briquettes and minor quantities of small sticks of renewably harvested fuel wood, based on the Envirofit G33001 efficient cooking system (manufactured partly in Germany). This system will be distributed to 39,000 households in Mont N'Gafula – a low-income municipality of Kinshasa – beginning in 2015.[11]

v. It is difficult to verify numbers for this project; the numbers given are from the project's own documents.

POWER SECTOR

Globally, the share of renewables in the power sector is increasing gradually. This also is the case in the SADC region, although the pace and scale of the renewable energy contribution is anticipated to be smaller because the region has major fossil fuel resources (mostly coal, some gas) that already are a significant source of power and are expected to grow in importance. The current share of renewable energy in the region's power capacity is around 23.5%, including commercial biomass and hydro. This compares with 28.5% renewable capacity in the ECOWAS region.[12]

HYDROPOWER

Potential

Current potential hydropower resources in the SADC region are just under 41,000 MW (this only includes Inga III and not "Grand Inga"). All but one member state (Botswana) has potential for significant hydro developments, several of which are very large-scale and are considered to be critical to the region's power development. However, significant advances also exist in identifying potential small-scale hydro, as well as in rehabilitating older small hydro dams that had been abandoned in the rush to use fossil fuels for power generation in the last century.

Installed capacity

Table 7 provides the status of current and planned hydro projects in each SADC member state, including (for current projects) four size classifications: macro (10 MW and larger), mini (below 10 MW), micro (below 300 kW) and pico (below 10 kW).[13] Total installed hydro capacity in the region is just over 12,000 MW, representing about 21.5% of total electricity capacity. Of this, 97.6% is large-scale hydro.

TABLE 7 | Capacity of current and planned hydro plants in SADC member states

	Operational (MW)				Under development (MW)	Potential (MW)	Total (MW)
	Macro (> 10 MW)	Mini (1-9 MW)	Micro (100-999 KW)	Pico (< 100 KW)			
Angola	1,200	0	0	0	5,435	209	6,844
DRC	1,860	0	0	0	5,517.5	39,000	46,377.5
Lesotho	72	0.54	0.09	0	1,200	95	1,367.63
Madagascar	153	10	1	1	0	117	282
Malawi	280.7	5.9	0	0	0	6.25	292.85
Mauritius	41	19	0	0	0	0	60.04
Mozambique	2,182	1.8	0.42	0.1	1,501.2	0	3,685.53
Namibia	332	0	0	0	0	612.25	944.25
South Africa	2,233	195.3	1.88	0.05	1,491.3	824.63	4746.16
Swaziland	34.2	7.7	0	0	0	9	50.9
Tanzania	549	14.2	1.9	0.01	0	0	565.11
Zambia	1,822	21.5	0	0	727	0	2570.50
Zimbabwe	1,050	6.1	0.34	0.01	5	0	1061.45
SADC	**11,808.9**	**282.05**	**5.63**	**1.2**	**15,877**	**40,873.12**	**68,847.92**

Note: Data on Angola and the DRC are from media reports and have not been corroborated; data from Madagascar are taken from the SREF Expression of Interest and are approximate; definitions given for macro, mini, micro and pico are arbitrary and may be different from those of other studies.
Source: See endnote 13 for this section.

Most of the region's large-scale hydro resources are found in three river systems: the Zambezi, including the Kafue and Shire Rivers; the Kunene, found only in Angola; and the Congo River in the DRC. The existing projects and those under development in riverine countries – Angola, the DRC, Malawi, Mozambique, Zambia and Zimbabwe – have a total potential capacity of 21,580 MW. Of this, 61% is undeveloped at present. South Africa's Orange River system also is important, as it serves as the outflow from the hydro projects in Lesotho's highlands and also is the location of at least one new project approved under South Africa's REIPPPP, as well as several other projects under development (see below).

The largest operational projects are Cahora Bassa in Mozambique (1,920 MW), Inga I and II in the DRC (1,775 MW), Kariba Dam shared by Zimbabwe and Zambia (1,470 MW), Kafue Gorge in Zambia (900 MW) and Capanda Dam in Angola (520 MW). A 1,245 MW extension to Cahora Bassa is planned to be completed by 2018, as is a 300 MW upgrade to Kariba South in Zimbabwe (a similar capacity upgrade on Kariba North was completed in 2013). There also are plans to expand the Kafue Gorge project in Zambia by building a new station south of the old one (750 MW).

Angola has a large hydropower potential, and the amount of hydro currently under development is on par with that of the DRC. Angola has a rapidly growing industrial sector that will increase demand substantially, as well as a very low rate of energy access, which is bound to improve; however, even expanding electricity access to 60% or more from current levels and increasing industrial use will not require anywhere near the potential of the Kunene River alone. Additional river systems on Angola's development list have yet to be assessed for financial or hydrological feasibility.

Although upgrades and extensions are important for keeping older hydro stations operational and for providing additional power to national and regional grids, the main thrust of SADC's work is to support the development of new projects on existing river systems. Several such large-scale projects are on hold pending financial closure. For example, there are now firm plans to expand Inga to incorporate a third stage (Inga III, at 4,800 MW), making it by far the largest hydroelectric project on the African continent.

Additionally, Zambia and Zimbabwe are jointly seeking financing for Batoka Gorge (1,600 MW), which is upstream of Kariba and has been the subject of vigorous debate over its possible impact on system hydrology. Mozambique has completed a preliminary financing agreement for Mphanda Nkuwa (1,500 MW), downstream of Cahora Bassa. But because these projects are extremely large and have significant political and economic risk associated with them, they are not expected to be operational in the near future.

SAPP has established priority lists for both large (>1,000 MW) and small (<1,000 MW) generation projects (of all types, based on the SAPP definition).[14] The 4 highest-ranked large projects are all hydropower (see table 8), as are 11 of the 18 small projects (see table 9), including the highest-ranked project, Kariba South Extension in Zimbabwe.[15]

The importance of hydropower to the SADC integrated grid is clear. All four large-scale hydro projects are directly linked to the SAPP network, as are all but one of the small-scale projects. The region's governments and utilities have agreed that expanding the amount of hydropower is the easiest and quickest way to achieve significant increases in renewable energy. Other renewable sources have not yet been prioritised in the SAPP list because they will have a relatively small impact on capacity and because too little information is available to potential investors.

As a result, the focus of SAPP (and by implication SADC) has been primarily on integration, *i.e.*, strengthening the regional grid to prepare for additional large increases from hydro and also from new coal-fired projects, while also extending the regional power pool to include countries such as Tanzania, which currently is connected only to the East African grid; Malawi, which has no regional connections; and Angola, which has only a small interconnection via Namibia.[vi]

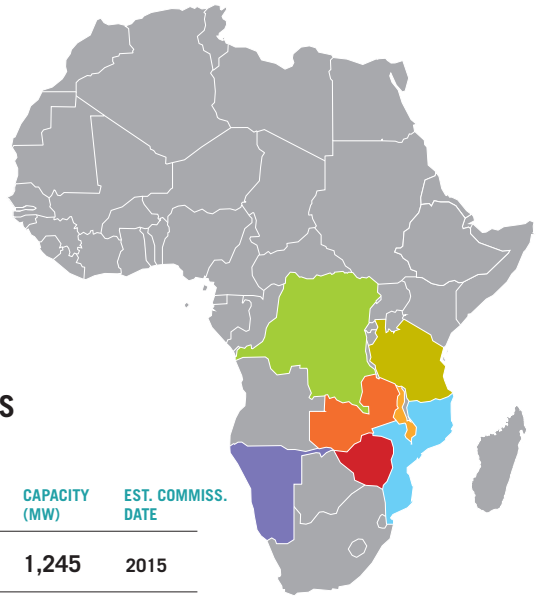
Despite these obstacles, SAPP has committed to achieving a renewable energy mix in the regional grid of at least 32% by 2020 and 35% by 2030. It was agreed that by 2015, all SADC member states and SAPP should have assessed their grid capacity for renewable energy and identified requirements for grid upgrades to accommodate renewable energy inputs, and that all member states should have undertaken strategic environmental assessments for the various renewable energy sources in their countries.[16]

Several member states have made significant gains in the areas of mini- and micro-hydro. For example, Mauritius has a substantial hydro resource, totalling 60 MW of power from a variety of large and small facilities: 30 MW at Champagne, 11 MW at Tamarind Falls, 4 MW at Le Val, 1.2 MW at La Ferme, 1.2 MW at Reduit, 1 MW at Cascade Cecile, 1 MW at Ferney, 940 kW at Magenta, 350 kW at La Nicoliere, 350 kW at Midlands, 200 kW at Riche en Eau and 100 kW at Britannia.[17] Most of these units were built before the 1990s, although Midlands and La Nicoliere were added since that time.[18] Feasibility studies are ongoing for additional low-head and micro-hydro projects.

In the Mulanje area of Malawi, the 60 kW Bondo micro-hydro micro-grid installation project powers 400 homes, businesses and community facilities. The project was commissioned in May 2013, with the support of the Mulanje Rural Energy Association (MuREA). Malawi also has a substantial amount of hydropower "in the pipeline", based on expansion and rehabilitation on the Shire River, the main source of hydro for the country. Current operational capacity is 280 MW of large-scale hydro plus 6 MW of small-, micro- and pico-scale hydro; another 6.25 MW is listed as "potential".[19]

vi. The Western Power Corridor, mentioned in section 1, failed to gain support earlier but may do so now as Angola begins to develop its vast hydro resources and searches for export markets, and as alternative transmission routes are considered for the Inga project.

TABLE 8 | Large-scale hydro projects on the SAPP priority list



LARGE-SCALE
HYDRO PROJECTS

RANK	COUNTRY PROJECT NAME	CAPACITY (MW)	EST. COMMISS. DATE
1	MOZAMBIQUE HCB North Bank	1,245	2015
2	MOZAMBIQUE Mphanda Nkuwa	1,500	2017
3	ZAMBIA / ZIMBABWE Batoka Gorge	1,600	2022
4	DRC Inga III	4,320	2018

TABLE 9 | Small-scale hydro projects on the SAPP priority list

SMALL-SCALE
HYDRO PROJECTS

RANK	COUNTRY PROJECT NAME	CAPACITY (MW)	EST. COMMISS. DATE
1	ZIMBABWE Kariba South Extension	300	2016
4	NAMIBIA Baynes	360	2018
7	ZAMBIA Lnsemfwa Lower	255	2016
8	DRC Busanga	240	2016
9	ZAMBIA Kalungwishi	220	2016
10	DRC Zongo 2	120	2016
13	TANZANIA Rumakali	520	2018
15	ZAMBIA Mambilima Falls 1 & 2	425	2019
16	ZAMBIA Mpata Gorge	543	2023
17	MALAWI Lower Fufu	100	2015
18	TANZANIA Ruhudji	358	2017

Note: The rank number refers to the overall SAPP priority list, which also includes fossil fuel generation projects. In these tables only hydro projects have been listed.
Source: See endnote 15 for this section.

In addition to the proposed Batoka Gorge and Kariba South Extension, Zimbabwe is pursuing small-scale hydro development. The country is home to 19 licensed independent power producers (IPPs), 7 of which are supplying hydro and biomass-based (bagasse) power to the national grid. The hydro plants are located mostly in Manicaland Province and include Pungwe B (15 MW), Pungwe A (2.7 MW), Duru (2.2 MW) and Nyamingura (1.1 MW). The state-owned Zimbabwe Power Company (ZPC), a subsidiary of the utility Zimbabwe Electricity Supply Authority (ZESA), also intends to build a 30 MW hydro plant on the Gairezi River in Nyanga. Several other smaller projects in the pipeline include a 5 MW Great Zimbabwe Hydro plant in Masvingo Province, as well as the Kondo Dam, Osborne Dam, Rusitu and Tsanga hydro plants.[20]

The donor-funded Himalaya 100 kW micro-hydro plant was commissioned in Zimbabwe's Marange District (Manicaland Province) in April 2015. The plant will benefit 110 households at two irrigation schemes covering over 25 hectares, ensuring continued water and power supply in the area. Three micro-hydro schemes totalling 65 kW are already in place, powering schools and some households.[21]

The potential for IPPs, especially small hydro stations, has been proven to exist on both irrigation dams and perennial rivers, especially in eastern Zimbabwe where the unique mountainous terrain is conducive for such plants. The existing IPPs have a combined capacity to produce over 40 MW (and more if the 30 MW Gairezi scheme is included), helping to meet Manicaland Province's power demand of approximately 130 MW, showing the potential for hydro (and IPPs) to contribute towards addressing Zimbabwe's energy demands.[22]

In South Africa, where developed hydro capacity has been relatively small due to the dominance of coal, Eskom operates four large hydro stations (the 360 MW Gariep, 240 MW Vanderkloof, 42 MW Colley Wobbles and 11 MW Second Falls) and two small stations (the 6 MW First Falls and 1.6 MW Ncora). The Thaba Chweu Local Municipality owns a grid-connected station (the 2.6 MW Lydenburg), and the private sector owns four stations connected to the national grid (the 4 MW Merino, 3 MW Sol Plaatje,[vii] 2 MW Freidenheim and 300 kW Clanwilliam).

As part of the REIPPPP, a new hydro station has been built on the Orange River at Kakamas: the Neusberg hydropower plant, with an installed capacity of 12.57 MW. Additionally, at least six new hydro sites are under development along the Orange River (the 30 MW Orange Fall, 22 MW Torquay, 18 MW Slypsteen, 15 MW Boegoeberg, 10 MW Riemvasmaak 1 and 9.9 MW Riemvasmaak 2). The 4.4 MW Stortemelk plant (REIPPPP bidding window 2[viii]) is currently under construction, and the 5 MW Kruisvallei plant (REIPPPP bidding window 4) is in the preparation phase.[23]

Municipalities are involved in hydropower as well. For example, the City of Cape Town is running four hydro installations at its water purification plants. Nationally, there is a trend towards integrating hydropower into water transfer and distribution systems in South Africa.[24]

A substantial number of micro- and pico-hydropower systems can be found in the KwaZulu-Natal and Eastern Cape provinces. These latter systems primarily supply individual farms without providing electricity to neighbouring communities.[25] [ix]

Lesotho has five small-scale hydropower plants – Mantsonyane (2 MW), Tlokoeng (670 kW), Katse (540 kW), Tsoelike (400 kW) and Semonkong (180 kW) – but only the Katse and Semonkong plants are currently operational. Lesotho's main current hydro source is the 72 MW Muela hydro plant, built as part of the Highlands Water Project. There is potential for as much as 400 MW additional hydropower in Lesotho, but a more realistic assessment is 95 MW.[26]

Swaziland also has significant small-scale hydro potential, in addition to the 60.6 MW already operational. Potential sites could increase hydro capacity by 141.5 MW, although this figure includes the large-scale Ngwempisi project at 120 MW.[27]

Mozambique is pursuing small-scale and mini-hydro despite having one of the region's major large-scale hydro resources, at Cahora Bassa. About 614 kW of micro- and small-scale systems is under development, in addition to 248 kW of micro-scale and 1.85 MW of small-scale hydro already in operation.[28] Two additional stations (Chicamba and Mavuzi) are under rehabilitation and will increase their combined output from 63 MW to 86 MW.[29]

SOLAR

Potential

In its study of infrastructure requirements for the African Clean Energy Corridor, IRENA estimated that the SADC region has the potential to generate approximately 20,000 TWh of electricity from solar energy per year.[30] The current installed solar capacity is less than 1% of this figure.

Installed capacity

The region's largest single solar PV project – the 96 MW Jasper project in the Northern Cape of South Africa, commissioned in 2014 – is just slightly smaller than the smallest hydro project on the SAPP priority list: Lower Fufu in Malawi. Larger solar PV projects are in the works in South Africa, including the 100 MW Xsina CSP project, approved in REIPPPP window 3 in November 2013.

In South Africa's four REIPPPP bidding windows to date (up to April 2015), solar PV accounted for 632 MW, 417 MW, 435 MW and 415 MW, respectively, for a total of 1,899 MW, and CSP accounted for 150 MW, 50 MW and 200 MW, for a total of 400 MW, although not all of this capacity has been commissioned.

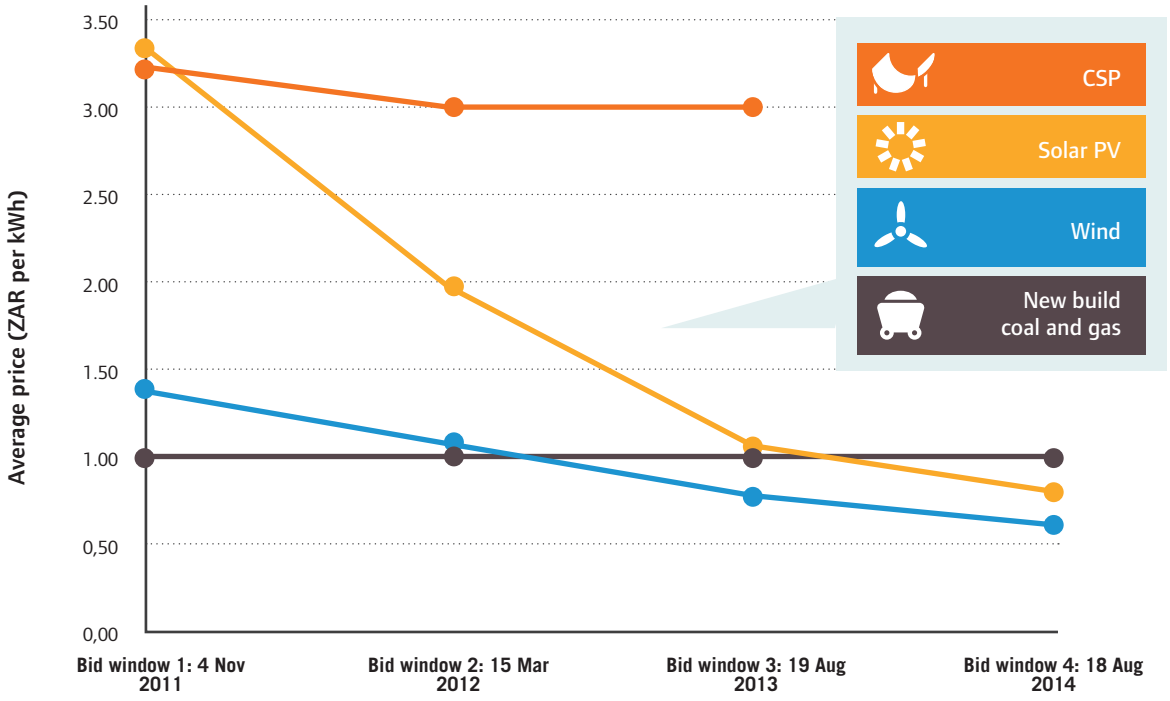
As the South African example illustrates, strong government support for renewables has the effect of both increasing investor interest and reducing the price to the utility. Since 2012, the country has become one of the most important destinations for clean energy investment, and in the first quarter of 2015 it was one of the world's bright spots, attracting USD 3.1 billion.[32] The average price per megawatt-hour (MWh) of solar PV declined sharply between REIPPPP window 1 in 2011 and window 4 in 2015 – from ZAR 3,288 (USD 274) to ZAR 786 (USD 65)[x] – making PV, as well as wind, cheaper than either new-build coal or gas-fired power plants (see figure 7).[xi] These dramatic cost reductions demonstrate that renewable energy can be a viable alternative to fossil fuel-based generation.

Other countries are following suit. Namibia is moving forward with the largest rooftop solar PV project in Africa: a 1.1 MW hybrid project being initiated in 2015 by Namibia Breweries of Windhoek, in consortium with a German/Chinese PV manufacturer. The project uses an integrated energy management system that integrates solar energy into a local diesel-powered grid maintained by the company for its own use.[33] (Namibia Breweries also is planning a biomass energy project using cattle manure at its subsidiary company, Namibia Dairies.)

In May 2015, NamPower, the Namibian utility, commissioned a 4.5 MW grid-connected solar PV park near Omburu, which includes 30,000 ground-mounted panels and covers 15 hectares.[34] HopSol, a German solar developer, is developing PV systems for shopping centres and small businesses throughout Namibia.[35]

vii. The Sol Plaatje and Merino plants are operated as a single project called Bethlehem Hydro and are owned by NuPlanet, which also registered these projects with the CDM, yielding up to 40,000 tonnes of CO_2-equivlalent savings per year.
viii. The term "window" refers to the stage of the South African renewable energy bidding process, starting with window 1 in 2011-12. This is explained further later in this report.
ix. South Africa also has a number of pumped storage hydro facilities, using off-peak (typically fossil fuel-generated) electricity to run pumps to fill reservoirs linked to hydro stations, which can then generate during peak periods with the re-used water. These are not included in this report because many are older and require partial use of fossil fuels.
x. A 12:1 exchange rate from ZAR to USD has been used throughout this report.
xi. The average price per kWh in window 4 is ZAR 0.79 (USD 0.06) for solar PV, compared to ZAR 1.00 (USD 0.085) for new-build coal and gas.

FIGURE 7 | Average price of selected energy technologies in REIPPPP bid windows 1-4, 2011-2014



Source: Centre for Scientific and Industrial Research, "Actual financial costs and benefits of renewables in South Africa", presentation at the African Utility Week, CSIR Energy Centre, Cape Town, 14 May 2015, p. 4.

Botswana has a single solar PV "pilot" project, funded by the Japanese government. The 1.3 MW facility has been operational since 2012.[36] The country is now moving forward with detailed feasibility studies for a project that has been in the planning phase for over 10 years but never realised: a 200 MW CSP/parabolic collector project. Possible sites being considered are Jwaneng, Letlhakeng, Maun, Selebi-Phikwe and Serowe. The rural energy services company BPC Lesedi, known for its innovative franchise-based approach, plans to use ground-mounted PV arrays to connect renewable energy to the 25% of Botswana's villages that are not grid-electrified, the 49% of unconnected households in grid-electrified villages, and the 99 settlements that are not electrified.[37]

In Tanzania, the government's openness to mini-grids and its unique FIT programme (based on an avoided-cost tariff; see below) led to a first solar PV project in 2013. The result is 208 kW of PV panels providing electricity to 45 secondary schools, 10 health centres, 120 dispensaries, municipal buildings and businesses across 25 village market centres in the Kigoma region, which currently are without access to the electricity grid.[38] A later project in Kigoma by NexGen, signed in 2014, was to develop a 5 MW off-grid solar plant in the main town of the region.[39] All of Tanzania's solar programmes to date have been off-grid, and many are part of mini-grids, often with hybrid systems.

Zimbabwe, where the FIT programme is awaiting final government approval, is moving forward on a project-by-project basis. Planned projects include a 100 MW solar farm in Gwanda, a 50 MW solar plant in Marondera in the east of the country, and two 10 MW grid-connected PV arrays in the Harare and Melfort areas. To date, none of these projects has reached financial closure. A deal also has been signed for the manufacture of mobile PV panels connected to agricultural pumping systems, a joint UK/Zimbabwe project.[40]

Zimbabwe's Rural Energy Agency (REA) has been active in implementing renewable energy projects using solar PV targeting rural institutions such as clinics and hospitals, schools and chiefs' homesteads. Non-profit development organisations such as Oxfam, Practical Action and SNV are active as well in promoting and supporting off-grid solar PV. A tender for a 100 kW community off-grid system was recently published, and another off-grid system has been commissioned in Manicaland.[41]

Load shedding in Zimbabwe has led to a proliferation of small imported individual solar home systems, which are used for water pumping but also for lighting and for powering small appliances such as radios and charging mobile phones. This is crucial as mobile phones are deemed critical not only for information and communication, but also for financial transaction purposes, particularly among "un-banked" residents of urban and especially rural communities. Mobile phone companies are facilitating this growth, coupling both the product and the service accessed through multi-use solar lanterns sold at solar-powered kiosks.

The inadequacy or absence of electrical power has spurred interest in the use of solar PV for street lighting and traffic light control as well, helping to manage traffic congestion (when the power goes down) in Harare City. Many other municipalities also are now tendering for the installation of solar street lighting systems.

Swaziland, which has some of the highest electricity tariffs in the SADC region, closed a deal for a 100 MW solar ground array near the main commercial centre, Manzini. The array, scheduled to be completed in late 2015, will feed directly into the grid and, because of Swaziland's relatively small demand (approximately 200 MW), will supply 50% of the country's electricity needs, complementing the current 60 MW of hydropower available. A PPA has been signed with the national utility, Swaziland Electricity Company (SEC), and the array will be built on public land.[42]

Malawi, with one of the lowest rates of grid access in the region (9%), has been providing solar power for its many remote, under-serviced areas, with donor assistance. In January 2015, a Chinese-funded project was announced to provide 250 solar street lights and 533 sets of mobile solar PV systems for rural areas, especially health clinics.[43]

Malawi's Community Energy Development Programme, supported by Strathclyde University in the UK, also notes three separate projects: 1) solar PV installations targeting health and education facilities in Chikwawa district, including the Gumbwa Primary School and a health centre, which received a PV mini-grid system in 2014; 2) a programme of PV solar Installations at rural schools in the Balaka district, which was scheduled for implementation in 2014; and 3) a combined programme of regional efficient cookstove manufacture and distribution, forestry management and solar PV for schools, co-managed by Concern Universal-Malawi.[44]

The DRC, which has a potentially massive solar resource, has yet to implement a large-scale PV or CSP system. However, the country has acquired many smaller, stand-alone PV systems in remote areas. The country's 836 solar power systems, with a total capacity of 83 kW, are located in Nord-Kivu (170 systems), the two Kasaï provinces (170), Bas-Congo (170), Equateur (167) and Katanga (159). In addition, the 148-system Caritas network has a total power capacity of 6.31 kW.[45] Other opportunities for renewable energy are under investigation, and the country has applied for assistance from the SREP program to develop pilot projects in areas including solar, wind, bioenergy and waste energy.[46]

Mozambique's 1998 National Energy Strategy targeted several sustainable energy options, with solar-generated electricity playing a key role. Actual implementation has lagged, however. O Fundo de Energia (FUNAE), charged with promoting renewable energy in rural areas, has been responsible for a range of solar technologies and aims to deliver the electrification of schools, clinics and villages using PV, wind and mini-hydro systems. To date, the electrification of 115 villages, 298 schools and 300 clinics has been completed successfully.[47]

Investment by private companies is lagging because Mozambique has yet to finalise a FIT scheme or a standardised set of procedures for power purchase agreements with IPPs.[48] FUNAE also has announced the construction of three off-grid 400-500 kW solar PV stations in Niassa Province, serving three local communities. With these projects, the total capacity of PV systems installed by FUNAE since 2000 will reach 2,250 kW.[49] Mozambique also commissioned a 5 MW per year PV manufacturing plant in 2013.[50]

Despite its high solar profile, Zambia has yet to initiate a large-scale power generation project of any kind, and none is planned. Most work in this sector to date involves small-scale PV in off-grid contexts. For example, the National Energy Strategy reports that systems have been installed in at least 250 schools and chiefs' palaces and at 400 households under an energy service company pilot project. The REA has several initiatives aimed at increasing the use of solar energy, including a 60 kW solar mini-grid to supply approximately 50 households at Mpanta in Luapula Province, which is already operational.[51] Copperbelt Energy Corporation in Zambia is developing several grid-connected PV projects, the first being a 15 MW project in Copperbelt Province. The Zambian government also has issued a tender for 30 MW of solar PV, to be located in other parts of the country.[52]

Mauritius has significant potential for solar energy and held an initial competition for new renewable energy projects, in which 4 of the 56 bids received were accepted. The first, the Bambous solar PV plant, began operating in mid-2014 in the western Rivière Noire district. With peak output of 15.2 MW, it was the first utility-scale solar facility to be built in the country. It will be followed by two 2 MW solar PV plants planned by India's Astonfield Renewable Resources, which has a PPA with the Central Electricity Board but is still finalising permits and local approvals. At least three other 2 MW solar plants are in the pre-construction phase, due for completion in 2015 or early 2016.[53]

Mauritius recently issued a call for new proposals for "Installation of Renewable Energy Technologies for Power Generation", including wind, solar PV, sustainable biomass, hydro, ocean and waste, with the aim of increasing the share of renewable energy in the generation mix from the current 18% to 35% by 2025.[54] A solar-diesel hybrid system, installed in a large shopping centre in Flacq, Mauritius, was commissioned in March 2015. The system has an overall capacity of 1.2 MW and will supply an estimated 1,800 MWh annually, according to the developer – resulting in annual diesel savings of around 500,000 litres.[55]

Madagascar has limited its initiatives to date to small, community-based solar, including a 75 kW off-grid solar plant in two villages and a 3.2 kW micro-grid based on solar PV installed by a private company.[56] The country is, however, developing a solar map with support from the World Bank's Energy Sector Management Assistance Programme (ESMAP) and has completed an Expression of Interest for SREP that identifies expanded solar energy as one of its target areas.[57]

Seychelles also has been slow to support solar energy, but it has moved to motivate private companies and homeowners to build small PV arrays, for which they will receive a 35% rebate on the installed cost.[58] The total capacity from rooftop solar PV (residential and commercial) reached 0.92 MW by the end of 2014, of which 0.66 MW was installed in that year alone.[59]

WIND

Potential

IRENA estimates that the SADC region has the potential to generate approximately 800 TWh of electricity annually from wind.[60] As with solar, current installed capacity is less than 1% of this figure. Unlike solar, however, this potential is not widely distributed but rather is concentrated in coastal regions (more on the west than the east coast) and in mountainous countries such as Lesotho. Nevertheless, several SADC countries – Angola, Lesotho, Namibia and South Africa – have enormous wind energy potential, and all are proceeding with development of this resource.

Installed capacity

South Africa has commissioned the largest functioning wind projects in southern Africa. These include the 138 MW Jeffrey's Bay project in the Eastern Cape (the second largest in Africa after the Tarafaya wind farm in Morocco) and the 138 MW wind farm commissioned in late 2014 at Cookhouse, Eastern Cape. The Sere wind farm, operational since early 2015, has a capacity of 106 MW. In 2014 alone, South Africa commissioned more than 500 MW of wind projects.

In the four REIPPPP bidding windows to date, wind energy accounted for 634 MW, 563 MW, 787 MW and 676 MW, respectively, for a total of 2,660 MW.[61] During that same period, the price per MWh for wind projects dropped from ZAR 1,363 (USD 113) to ZAR 619 (USD 52) – as with solar, a very significant reduction[xii], making South Africa's costs for wind comparable with those in many developed countries.[62]

Namibia has issued three licences for wind farms, but so far only a small 3.2 KW pilot facility at Luderitz, built in 2002, has been implemented.[63] Several major licensees have since decided not to proceed due to bureaucratic delays and the difficulty of obtaining PPAs. Namibia now intends to develop a 72 MW wind farm at Luderitz, although disputes over risk-sharing have held up construction. An additional 60 MW facility is planned but yet to be confirmed for Walvis Bay. Namibia's very high coastal wind profile and modern infrastructure is likely to attract more investments of this kind in the near future.

In Mozambique, a small wind turbine (300 kW) was installed by FUNAE at Praia in Inhambane Province, used as a pilot to assess the potential for onshore wind. The country also has established a Renewable Energy Atlas that includes wind profiles, which is expected to help accelerate wind developments in the country by providing investors with information on the best areas for wind generation.

IRENA ESTIMATES THAT THE SADC REGION HAS THE POTENTIAL TO GENERATE APPROXIMATELY 800 TWH OF ELECTRICITY ANNUALLY FROM WIND. AS WITH SOLAR, CURRENT INSTALLED CAPACITY IS LESS THAN 1% OF THIS FIGURE.

In Tanzania, the National Development Corporation (NDC) recently entered into an agreement to build the country's first large-scale grid-connected wind energy project: a 50 MW wind farm in Singida Region (west of Dar es Salaam), with financing from EXIM Bank of China. NDC has a 60% stake in the project, while the national utility TANESCO owns 20% and Power Pool East Africa Limited has the remaining 20%.[64]

Mauritius already has a 1.28 MW wind farm on Rodrigues Island and is adding two additional projects, a 29.4 MW facility at Plaine Sophie (expected to be operational in late 2015 or early 2016) and a 9 MW facility at Plaine des Roches, both of which are under construction and are grid-connected. When completed at the end of 2015, the country's total wind generation capacity will reach 39.7 MW.[65]

In Seychelles, a 6 MW wind farm near Port Victoria on the main island of Mahé has been in full production since 2013 and supplies some 2.2% of the country's power needs. The farm was funded by the United Arab Emirates and Masdar but is owned and operated by the national utility, PUC.[66]

Madagascar is home to a few small, village-level wind energy projects, most of which are 20 kW or less, but large-scale wind development is still a distant prospect.[67] (The current wind capacity is 157 kW, according to a recent submission to SREP.[68]) The government has called for proposals for 25 MW of wind power, but it faces strong criticism from the renewable energy

xii. The average price per kWh for wind in window 4 is ZAR 0.62 (USD 0.05), compared to ZAR 1.00 (USD 0.085) for new-build coal and gas.

community, which feels that developing solar and hydro resources is more realistic and potentially much lower in cost.[69]

The DRC, Zambia and Zimbabwe have completed preliminary assessments of wind energy and have determined that the potential for development of this resource is minimal, except possibly for pumping applications.

BIOMASS

Potential

The potential for biomass-generated electricity in the SADC region is estimated at 9,500 MW, based on agricultural waste alone.[70]

Installed capacity

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

A recent and pioneering example is South Africa's 4.4 MW Bronkhorstspruit biogas project, which uses methane from cow dung decomposition at a large feedlot near Pretoria to fire a boiler and generator, selling the electricity directly to an industrial customer (see sidebar 3).[71] Other operational examples include the use of waste biomass to generate electricity at pulp and paper companies in South Africa (Mondi and Sappi) and the use of bagasse to generate heat and co-generate electricity in the sugar industry – the latter a long-standing practice that is now being expanded to provide surplus electricity to the grid.

Sappi's 25 MW biomass-to-energy project at Ngodwana in Mpumulanga Province was selected in bidding window 4 of South Africa's REIPPPP in April 2015, joining two other biomass

Sidebar 3. South Africa launches first biogas-to-electricity plant

The 4.4 MW Bronkhorstspruit biogas power plant in Gauteng Province of South Africa, supplying clean energy to a leading automotive manufacturer, entered production in June 2015. The facility is seen by many as a benchmark for waste-to-electricity independent power production for South Africa and a potential forerunner to additional biogas-based green energy projects in the country within 10 years. The project's developer, Sean Thomas of Bio2Watt, said that currency fluctuations and South Africa's environmental regime were key project hurdles. He also chose to avoid applying for support from South Africa's REIPPPP, relying instead on a blend of private loans and public financing from sources including the Energy and Environment Partnership (EEP).

A recent article in Creamer Media noted: "Securing the environmental approvals proved not only time consuming but also challenging, owing to the novelty of the technology (which is the first of its kind in South Africa). The environmental approval system also made few allowances for project size or its potential environmental spin-offs."

Thomas was able to persuade the Tshwane municipality, the local electricity distributor and the project's location, to allow Bio2Watt to 'wheel' its power through the municipal network to BMW South Africa's Rosslyn factory, also within Tswane's municipal boundaries. BMW agreed to pay a small premium for the green electricity produced, as Bio2Watt was able to guarantee provision of at least 25% of BMW's electricity needs for 10 years, the length of the initial PPA. BMW has an option to extend this contract after 10 years, subject to a new price negotiation. Bio2Watt is optimistic that this will happen, but if not, it expects no problem selling its electricity to other consumers.

The facility is located next to a cattle feedlot on a farm near Bronkhorstspruit, a rural town east of Pretoria. The feedlot services an average of 20,000 head of cattle and 12,000 sheep daily on the property. The manure generated by the livestock was originally fed into a series of open settling ponds, but the project has developed a system of capturing the waste and extracting the methane generated by the breakdown of the manure. Methane is a combustible gas, which is then used to power a turbine, which drives the generator. A total of 300 tonnes of organic material is required daily, and the output of the feedlot often falls below that, so the developer also has secured a supplementary feedstock (in the form of chicken abattoir waste, ice cream waste, food sludge, fruit and vegetable waste and paper recycling sludge).

The main methane collection and generation facility was built by Bosch Projects, which has an exclusive licence agreement for the ComBigaS technology, developed in Denmark. Its sister company, Bosch Munitech, will operate and maintain the facility for an initial period of five years, while Bosch Holdings, the parent company, holds an equity position. In addition to funding from EEP, the Industrial Development Corporation of South Africa and the Norwegian development fund, Norfund, have provided assistance.

This project, although unique in the region at this time, could be duplicated elsewhere provided that sufficient volumes of organic feedstock can be supplied cheaply and that the utility is willing to allow a wheeling arrangement or direct purchase through a feed-in tariff.

Source: See endnote 71 for this section.

energy projects totalling 34 MW in all, selected in the previous three bidding windows.[72] Only one of the two previously selected projects was a biomass project, the other being a landfill gas project.[73] So far, no biogas projects have been selected in any of the four bidding windows, as the Bronkhorstspruit project was developed outside of the REIPPPP. The only technology class with lower representation in the REIPPPP so far is CSP.[74]

Mauritius has announced the development of two municipal waste-to-energy projects, due to be completed in 2017 and producing 36 MW of electricity using ultra high temperature (UHT) gasification technology.[75]

Expanding electricity generation from bagasse in the private sector is an important element in renewable energy expansion plans in Mauritius, Mozambique, Swaziland and Zimbabwe. Mauritius in particular has a long history of buying surplus electricity from the sugar industry, and almost all of the country's sugar mills are involved. The total installed capacity within the sugar industry is 243 MW, and in 2013, 16.3% of generated electricity in the country came from bagasse.[76]

RURAL ELECTRIFICATION

Rural electrification is a major focus of programme development in the SADC region, and it is closely associated with the issues around distributed generation (see sidebar 4).[77] Increasingly, member states are looking at the option of distributed generation and mini-grids as part of their rural electrification programmes.

Several SADC countries 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 include:

- Mozambique's FUNAE, set up as a financially and administratively autonomous agency to develop renewable energy projects, mostly off-grid.
- Tanzania's Rural Energy Agency, which administers the Rural Energy Fund, in turn supported by a 5% levy on commercial energy sales (REA is independent of TANESCO, the national utility).
- Zambia's Rural Electrification Authority, tasked with carrying out the country's Rural Electrification Master Plan.
- Zimbabwe's Rural Electrification Agency, which operates through a fund derived from an electricity tariff levy and is administered by a board that reports to the Minister of Energy.
- Mauritius's recently established Renewable Energy Agency (MARENA), which will be responsible for "creating an enabling environment" for renewable energy in the country.[78]

Malawi has developed a slightly different approach, creating a Rural Electrification Fund which is administered by the Malawi Energy Regulatory Authority and funded by a levy on the tariff. In Namibia, the government has created a Rural Electrification Programme funded by NamPower, the national utility, again through a special fund maintained by a tariff levy.[79] 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.

Sidebar 4. Distributed energy and distributed generation

The term "distributed energy" refers to the provision of electricity from dispersed, generally small-scale systems that are close to the point of consumption. According to BloomEnergy, "Generating power on-site, rather than centrally, eliminates the cost, complexity, interdependencies, and inefficiencies associated with transmission and distribution."

Distributed energy is not always equivalent to off-grid energy, and some forms of non-electrical energy, such as biomass-fuelled cookstoves and solar hot water systems, are by definition distributed even if they are utilised in households where grid energy is also available. In addition, large centralised grid systems, mini-grids and isolated single-household systems may all have distributed components, but only mini-grids and isolated systems are entirely distributed by nature.

Distributed generation can include fossil fuel-based generation, such as small diesel generators that provide energy to a local "mini-grid" or are part of a hybrid system that also includes solar and/or wind. In this report, diesel mini-grids and hybrid systems are included as part of the discussion of distributed energy and generation, as are forms of distributed energy that are entirely outside of any grid system, such as solar lighting.

Some renewable energy projects discussed earlier in this report – such as small-scale PV systems in Mozambique, Namibia, Tanzania and Zambia – are examples of distributed generation.

Source: See endnote 77 for this section.

Table 10 summarises the trends in rural electrification and indicates which countries have appointed specialised agencies to deal with it, and what targets have been established to expand rural electrification. Countries with specific rural electrification targets include Angola, Botswana, the DRC, Madagascar, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe.

Many countries have specifically included renewable energy as part of efforts to meet their rural electrification targets. For example, Zimbabwe has included solar PV and biogas generation, and Zambia includes mini-hydro development, solar PV systems and solar/biomass mini-grids.[80] Botswana's programme offers rural households the option of several renewable energy technologies, from improved cookstoves and solar hot water to pico PV systems.

Lesotho has received support from UNDP through a Renewable Energy-Based Rural Electrification Programme and also from Japan for using renewable energy in income-generating activities in off-grid areas.[81]

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 and capacity constraints that hamper their ability to meet government targets for grid extension. To improve the rate of uptake, most countries offer subsidies of some kind for installation of off-grid systems, recognising that rural households rarely have the capacity to pay for the technologies themselves.

TABLE 10 | Rural electrification targets and programmes in SADC member states

	Rural electrification target	Programme name/data source
Angola	1.2 million households by 2016	Rural Electrification Programme 2012
Botswana	400,000 people by 2021	National Decentralised Rural Electrification Programme (BPC and BPC Lesedi)
DRC	50% access by 2025	International Finance Corporation/Lighting Africa
Lesotho	100% access to modern energy services by 2030	Global Environment Facility and Government of Japan funding for off-grid renewable energy programmes
Madagascar	10% access in rural areas and 74% in urban areas by 2011	National Energy Strategy and Policy and Madagascar Action Plan
Malawi	30% access by 2030 (from 9% currently)	Rural Electrification Fund, administered by MERA
Mauritius	100% access achieved	
Mozambique	10.3 million people by 2014, of whom 3.7 million will be serviced by off-grid PV (from 1.3 million total currently)	FUNAE and Electricidade de Mozambique
Namibia	2,157 localities, about 52,000 new connections, 810 schools and 360 clinics by 2031	Namibian Rural Electrification Master Plan, administered by NamPower
Seychelles	100% access by 2030	
South Africa	More than 5.2 million households and 12,000 schools connected to the grid between 1994 and 2010; 100% access by 2019 (original target was 2012)	Integrated National Electrification Programme (Eskom)
Swaziland	100% access by 2019	Rural Electrification Unit within SEC, supported by the Government of Taiwan
Tanzania	30% access by 2030 (from 18% currently)	2012 Power System Master Plan (PSMP), Rural Energy Agency
Zambia	30% access by 2030 (from 3% in 2012); 1,217 growth centres electrified by 2030	Rural Electrification Authority
Zimbabwe	100% access by 2040, with initial focus on rural schools and health centres	Rural Electrification Agency

Zimbabwe offers a 100% subsidy for schools and health centres, although in practice this has proved to be too generous, and a lack of funds has slowed the implementation process. The Zambian programme similarly offers a 100% subsidy, but because the country's tariffs are the lowest in the region, the levy has generated insufficient funds to meet the electrification target. Implementation has been limited to 80 small grid-extension projects and 300 small PV systems for chiefs' palaces, schools and clinics.[82]

Tanzania is 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 (for more on this programme, see section 3 and the discussion on mini-grids below). The country's renewable energy development also has been assisted by private entrepreneurs operating outside of the government framework, developing innovative solar projects using a pay-as-you-go (PAYG) approach for off-grid projects. Tanzania has set a relatively modest target of 30% access by 2030, recognising that a transition to the use of IPPs will take time to mature.

In the DRC, SNV introduced the use of palm oil-based biodiesel for rural electrification in early 2014. Currently, three active biodiesel producers operate in the Gemena region, and about 10 mini-grids provide electricity to some 500 households, using pure plant oil (PPO) as a main fuel. A separate project in 2015 is expected to install up to 20 micro-hydro sites feeding local grids.[83]

Mini-grids

Development of mini-grids is progressing rapidly in the SADC region, as utilities increasingly recognise their practicality in bringing modern energy services to rural and marginal urban populations. For many countries, mini-grids already exist in the form of small local grids supporting diesel generation, but the concept of hybrid or renewable energy-only mini-grids is now gaining traction throughout the region.

RERA has been especially active in this area, carrying out a detailed study on regulatory constraints on mini-grid development in the region in 2013. The study report differentiated between vertically integrated off-grid mini-grids and mini-grids supplied by the main grid (also called small power distributors, or SPD) and noted that the latter are "likely to be the easiest and most viable mini-grids to develop in SADC".[84]

The RERA study noted that Tanzania has been a leader in this area, with the most advanced policy and regulatory framework for mini-grids and small power projects.[xiii] The Energy and Water Utilities Regulatory Authority (EWURA) has developed a FIT methodology and standardised PPA and process guidelines that have helped developers conclude agreements with TANESCO to supply power using biomass, mini-hydro and solar power plants.[85]

Tanzania's Rural Energy Agency has 90-plus off-grid projects in the pipeline,[xiv] most of them involving mini-grids. Examples include:

- Four mini-grids are planned for Malolo, in the Morogoro region in the southern highlands some 170 kilometres west of Dar es Salaam. Ruaha River Power Company will build, own and operate the mini-grids, which will have a combined generation capacity of 300 kW. Each will deliver 75 kW of power to a combined total of some 2,500 residential, commercial and light industrial customers via pre-payment meters, using a 25 kW hybrid biomass gasifier and a 25 kW diesel generation plant, together with a more than 4 kilometre low-voltage distribution network.[86] The first power deliveries were planned for 2015, pending final approval of the preliminary environmental impact assessment.[87]

- A project being developed by Jumeme Rural Power Supply Limited, a Tanzanian-German-Austrian joint venture, and funded by the African Development Bank's Sustainable Energy Fund for Africa, is expected to expand electrification and increase access to energy services. It will use mainly solar mini-grids and focus on some 16 villages in its first phase, including 82,000 residents, 11,000 households, 2,600 businesses, 42 public offices, 32 schools, 12 health centres and 77 religious buildings.

- TANESCO operates 21 diesel-based off-grid stations supplying isolated mini-grids with capacities ranging from 400 kW to 12 MW. Thirteen new sites are proposed for hydro mini-grids.

- Devergy, a Tanzanian project financed by EEP, is a social energy utility that provides affordable electrical services for low-income populations not connected to the grid. The service is based on a plug-and-play village-sized micro-grid that provides solar power to households and businesses, allowing users to connect lights and appliances such as radios, televisions and refrigerators. A pay-per-use approach is employed, where users top up their energy accounts by buying Devergy credit over their mobile phones.[88] (See the later discussion on distributed energy for descriptions of similar projects.)

In Namibia, where mini-grids also are receiving a great deal of attention, the programme is largely piggy-backed on existing diesel mini-grids. Examples include:

- Gobabeb Training and Research Station is supplied with 24 hours of electricity from solar energy, with diesel generators as back-up. Gobabeb is one of the largest solar hybrid mini-grids in southern Africa, with a solar installation of 26 kW and two diesel generators of 50 kilovolt amps (kVA). The station continuously supplies between 30 and 70 residents.

xiii. The Tanzania programme makes a distinction between on-grid and off-grid tariffs and uses an avoided-cost methodology to determine the final tariff – the only use of this methodology in Africa at present. This substantially reduces risk to the off-taker (TANESCO) while still providing a fair and stable price for the developer.
xiv. These are distinct from the on-grid projects being developed under Tanzania's Standardized Power Purchase Agreement programme (SPPA).

- Tsumkwe mini-grid is a pre-existing diesel-only mini-grid for the community of Tsumkwe in the Otjozondjupa region. The Namibian government provided a 202 kW-peak solar PV array with 766 kWh of battery storage capacity. The project also repaired, upgraded and expanded the current 11 kV mini-grid and initiated mechanisms for access to alternative thermal fuels (such as LPG) and energy-efficient appliances. The direct beneficiaries are over 100 households, 20 different institutions and several small businesses.[89]

Botswana has a long history of using mini-grids for both diesel and renewable generation in remote areas. For example, the 5.7 kW Motshegaletau solar mini-grid was installed in 1998, and after one year of operation, ownership of the project was passed to the Central District Council, a local government authority that now acts as the service provider. Consumers are on a fee-for-service scheme, with customers wiring their houses and paying a BWP 500 (USD 50) connection fee. The tariff charged is the same as that for grid electricity.[90]

The Botswana Ministry of Local Government has installed several solar PV off-grid mini-grids during the past 10 years, primarily hybrid with diesel generator sets. The country's three functioning mini-grids have a total capacity of 50 kW.[91] However, no more recent examples of mini-grid installations exist in Botswana.

Malawi has two diesel mini-grids implemented by ESCOM and a few hydro-based mini-grids run by private developers or communities. There are also six hybrid solar/wind mini-grids (20-24 kW) operated by communities.[92]

Mozambique has 69 diesel mini-grids implemented by FUNAE but managed by local management committees. Many have stopped operating due to lack of funds for maintenance. Solar PV is the most promising renewable energy source, with 53 identified solar-hybrid power (SHP) potential sites and 15 SHP projects under construction or planned by the government. Three solar hybrid mini-grids have been implemented by FUNAE (using a South Korean loan), and a few smaller solar mini-grids have been supported by donors and NGOs without FUNAE involvement.[93]

The DRC, despite having the highest hydro potential in Africa, still maintains 42 diesel-based power plants, of which 27 are isolated supplying mini-grids (39 MW) run by both public entities and private IPPs, and 4 are hydro-based mini-grids. Planned electrification projects include 347 centres over 20 years, including a three-year action plan to have 11 micro-hydro schemes connected to mini-grids.[94]

Zambia is planning three additional mini-grid projects in 2016 after implementing mini-grid projects using both hydro and solar in 2014.[95]

Zimbabwe has developed a total of 14 micro-hydro-based mini-grids in Manicaland Province. Built by Practical Action and the GIZ Energizing Development programme, the mini-grids all use a micro-hydro turbine linked to an existing grinding mill and a local community-owned distribution grid, with an average of some 30 connections per grid.[96]

South Africa has been relatively inactive in mini-grid development because of its aggressive grid extension policy and much higher electricity access rate than other SADC countries (with the exception of Mauritius and Seychelles).[xv] South Africa developed a pilot hybrid solar/wind mini-grid at Lucingweni in 1999, but the project's unsuccessful experience has hampered new initiatives on mini-grids in the country.[97]

DISTRIBUTED ENERGY

The field of distributed energy is extremely diverse, and the actors in this field include not only national governments and parastatal organisations such as utilities and rural energy agencies, but also a wide variety of local and international NGOs as well as the private sector and (primarily in South Africa) municipal authorities.

To date, the regional dimension has been somewhat limited, as organisations such as SADC, SAPP and COMESA have not come forward with specific plans or strategies for distributed energy. This may change as SADC finalises its Renewable Energy Strategy and Action Plan (RESAP) and as the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE) becomes a permanent part of the institutional landscape in the region.

At present, large donors and donor-linked organisations as well as large international companies and some smaller supplier-entrepreneurs are the prime movers in distributed energy in the region. Table 11 summarises the activities and technology types of a variety of these organisations, and sidebar 5 provides a more detailed description of the work of one organisation, SNV,[xvi] in Zambia.[98]

TRANSPORT SECTOR

Solutions for the transport sector are lagging behind other aspects of renewable energy in the SADC region. For the most part, advances in this area have depended on the development of biofuels – ethanol and biodiesel – as partial substitutes for fossil fuels in passenger and freight vehicles.
Countries with a strong tradition of producing ethanol from sugar cane (Malawi, South Africa, Zimbabwe) are accelerating

xv. As a study of mini-grid potential in South Africa explained: "A mini-grid investment needs to remain isolated from grid supplies for a considerable period into the future in order to justify and protect the investment. Even though a substantial number of households do not have electricity (about 29%), there are not many zones left that are sufficiently far away from the electricity grid to give some form of guarantee in terms of a 7-10 year operating safety barrier." See e7/Scottish Power, *Community Electricity in Rural South Africa: Renewable Mini-grid Assessment* (Glasgow: 2003), p. 33, http://www.globalelectricity.org/upload/File/South-Africa_Mini_Grid_Assessment.pdf.

xvi. SNV originally stood for Stichting Nederlandse Vrijwilligers, or Netherlands Volunteers Foundation, but has operated as SNV (Netherlands Development Organisation) since 1993.

TABLE 11 | Selected actors in distributed renewable energy in the SADC region

Organisation	Main activity	Target countries	Specific DRE work	Affiliations
Beyond the Grid	Increasing access to modern energy services	Tanzania	Supporting Virunga Power in introducing local mini-grids	Power Africa
Endev	Solar, pico-hydro, biogas, improved cookstoves	Madagascar, Malawi, Mozambique, Tanzania	Distributor and project developer	Multi-donor
Envirofit	Improved cookstoves and heating devices	Tanzania	Manufacturing, product development, implementation, carbon financing	None
Global Village Partnership	Improved cookstoves, micro- and mini-grids, small-scale solar PV, biogas, biofuels	Malawi, Tanzania	Project development and management, product development and testing	Multi-donor
Hestian Rural Innovations	Improved cookstoves, efficient tobacco barns	Malawi, Zambia	Project developer	Multi-donor
Kisangani Smith Group	Sawdust and efficient wood stoves	Tanzania	Product development and manufacture	None
Kukhanya Energy Services	Electrification services for rural households using solar PV	Concessionaire for Kwazulu-Natal and Eastern Cape, South Africa	Installation of PV systems	Total Africa
Lighting Africa	Product testing and quality control standards for solar lighting	Tanzania	Promoting quality solar lighting solutions	International Finance Corporation
M-Kopa	Solar home systems	Tanzania	Using pay-per-use model and focusing on off-grid communities	None
Mobisol	Small/scale solar home systems with mobile phone payment system	Tanzania	>10,000 solar home systems installed in rural Tanzania	None
Nuron Raps Utility (NuRa Energy)	Solar home systems, improved cookstoves	Concessionaire for Western Cape	Installation and maintenance	Government of South Africa
Off Grid Electric	Distributing solar LED systems to rural communities	Tanzania	Aiming to install 100,000 off-grid solar systems for USD 6 installation fee with monthly usage payments	None
Practical Action	Small-scale developments in energy, water and sanitation	All, but focused on Zimbabwe	Mini-grid studies, PV-based pumping systems	Multi-donor
REEEP	Mini-hydro, municipal demand-side management, rural mini-grids	All	Funding of small renewable energy and energy efficiency projects	Support from UK and other governments
Restio Energy	Improved cookstoves, solar lighting, power supplies for off-grid solar	Concessionaire for Mpumulanga	Installation and maintenance	Government of South Africa
SNV	Solar lamps, improved cookstoves, biofuels, biogas	DRC, Mozambique, Tanzania, Zambia, Zimbabwe	Project development and management	None
Tanzanian Traditional Energy Development Organisation (TATEDO)	Solar lanterns, improved cookstoves, multi-use platforms	Tanzania	Product development and manufacture	Multi-donor
ZaraSolar	PV panels, batteries, inverters, charge controllers, solar lights, power kits and lanterns, solar refrigerators	Northern Tanzania	Product distribution	None

Source: See endnote 98 for this section.

Sidebar 5. SNV's programmes in Zambia

In 2013, SNV's Biofuels for Lighting project in Zambia supported five oil-producing enterprises comprising 78 members, including 42 women, which now have the capacity to produce and market jatropha oil for lighting in all five project districts. These enterprises received oil-extracting machines for oil production from the Department of Energy, as well as working capital loans to procure jatropha seed and packaging materials for oil.

Collectively, the enterprises procured 7,590 million tonnes of jatropha seed from small-scale farmers to be used for oil production, resulting in 676 litres of oil to be sold to the market for lighting. Furthermore, five lamp-producing enterprises, comprising 40 members, were established in the five project districts and are formally registered with the government. These enterprises received working capital loans for production materials for jatropha lamps and commenced lamp production, producing and selling 760 lamps in 2013.

Under the Improved Cook Stoves project, SNV supported local artisans to make improved cookstoves and developed the supply chain to enable the artisans to produce and sell the environmentally sustainable cookstoves to rural residents. A total of 4,325 improved cookstoves were produced and sold, reaching 21,625 people.

The Domestic Biogas Programme, launched by SNV in 2013, evolved into the Biogas Milk Chilling project in 2014. In line with this change, SNV trained 17 masons in biogas construction and maintenance in 2013 in partnership with Lusaka Vocational Training Centre.

Source: See endnote 98 for this section.

production of ethanol from waste molasses and are also exploring dedicated cane-to-ethanol production systems. Malawi and Zimbabwe are both mandating, or planning to mandate, increased ethanol blend ratios and are exploring the possibility of operating fleet vehicles on pure ethanol in the next two to three years. Other countries with small sugar industries (Angola, Mozambique, Tanzania, Zambia) are monitoring developments and considering a conversion to low blends of ethanol to offset imported fuel costs. Angola launched the 32 million litre per year BIOCOM plant in late 2014 to produce ethanol exclusively for vehicle transport.[99]

The biodiesel industry has developed more slowly. Biodiesel "took off" in several SADC countries from 2005 to 2010 as international companies such as BP, D1 Oil and Oval Biofuels obtained long-term land leases from governments in Malawi, Mozambique and Zambia and began planting large areas with *jatropha curcas*, an oil-bearing tree that originated in Central America. Many of these programmes were based on very limited information on soil quality, weather conditions and nutrient requirements, and they suffered from a lack of fuel distribution and refining capacity.

As a result, several international investors in Mozambique and Zambia have since withdrawn from the market, leaving a massive gap in biodiesel production.[100] Problems with insect infestation, low yields and larger-than-expected water requirements have plagued the jatropha industry, and efforts are now under way regionally and internationally to undertake selective breeding to produce jatropha varieties that are better suited to southern and central African conditions.[101]

There are signs of a recent upswing in regional biodiesel production. For example, in 2014 the Copperbelt Energy Corporation announced that it had built a 1 million litre per day biodiesel facility in Kitwe, Zambia, which would be used entirely to supply the company's own equipment.[102] A 2014 review of the status of the biofuels industry in southern Africa indicated that sustainable jatropha biodiesel projects can still be found in Madagascar, Malawi and Mozambique.[103]

South Africa also has been involved in biofuels development and published a Biofuels Industrial Strategy in 2006, which was revised following public consultation and finalised in 2007. The purpose of the strategy was to stimulate the development of a production, refining and distribution industry in the country, aimed at achieving a 2% displacement of fossil fuels within five years.[104] After failing to meet this target through fiscal incentives such as rebates on the fuel levy, the government decided instead to make blending mandatory, commencing in late 2015. The target will be B5 for biodiesel,[xvii] and between E2 and E10 for ethanol in petrol.[105]

More recently, South Africa's government energy research arm, South African National Energy Development Institute (SANEDI), has developed a Green Transport Programme with the following strategic focus areas:

- Piped compressed natural gas (CNG) and refuelling infrastructure;
- Landfill gas and municipal waste harvesting for municipal fleets and public transport;
- Liquefied petroleum gas (LPG);
- Biodiesel and micro-emulsification technologies and refuelling infrastructure;
- Electric vehicles and recharge infrastructure.[106]

The South African National Energy Efficiency Strategy had already established a goal of a 9% reduction in transport fuel use by 2015, based on a range of different actions including fuel efficiency labelling of vehicles and promoting a modal shift from road to rail transport.[107]

xvii. South Africa decided to ban jatropha as a biodiesel source crop because of concerns that it was an invasive species. See Department of Minerals and Energy, Biofuels Industrial Strategy of the Republic of South Africa (Pretoria: 2007), http://www.energy.gov.za/files/esources/renewables/biofuels_indus_strat.pdf%282%29.pdf.

03

ENERGY EFFICIENCY

03 ENERGY EFFICIENCY

REGIONAL OVERVIEW

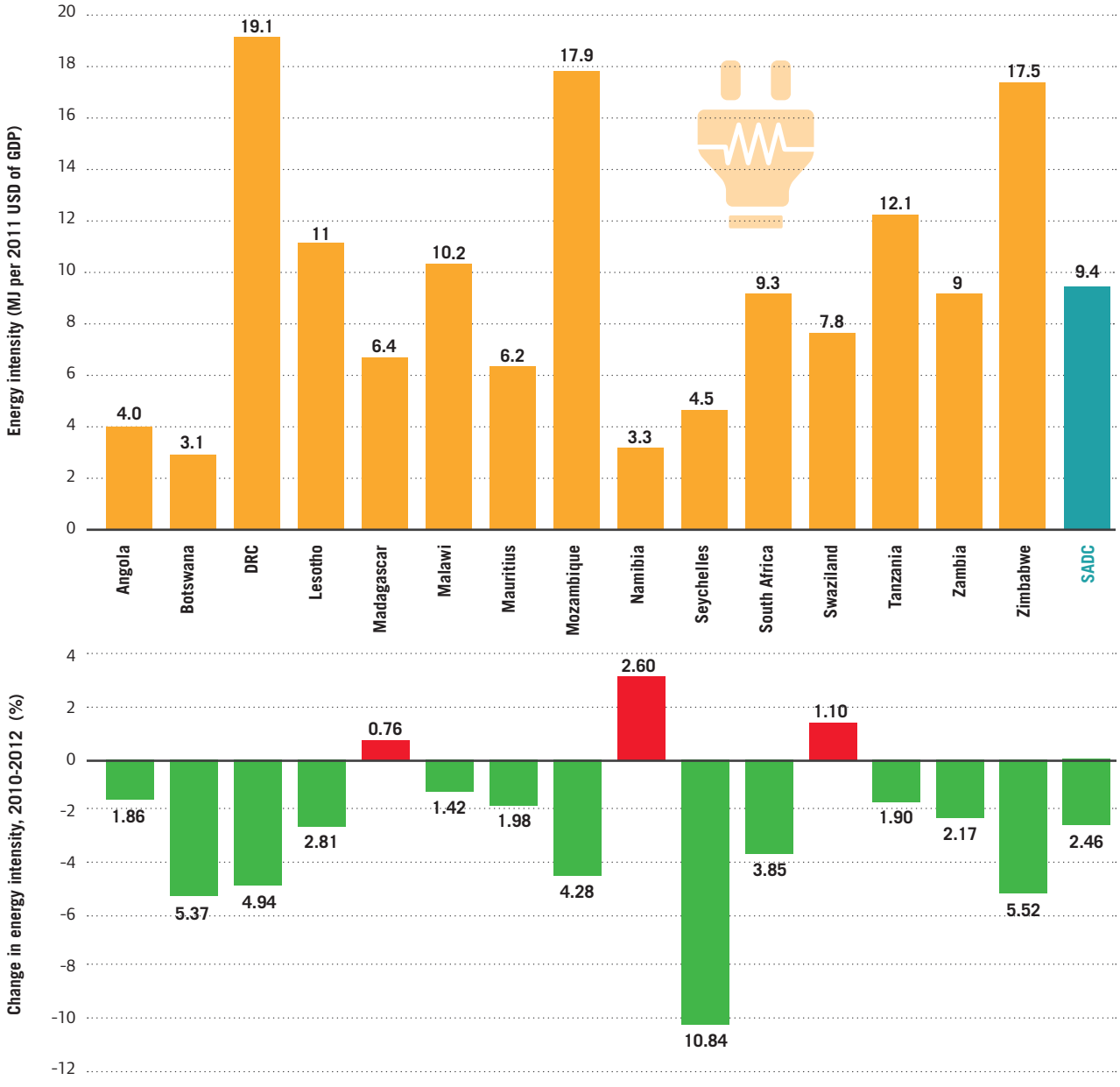
SADC member states are facing a major energy crisis. Rising energy costs have combined with insufficient supply and, in some member states, with a surge in demand for additional energy from the grid and for improved energy services generally. In this context, several member states and utilities have turned to energy efficiency as a means of reducing demand and delaying the requirement for new generation capacity. Although this is not a region-wide phenomenon, it is a growing one and deserves separate treatment in this report.

Energy efficiency is a complement to renewable energy. Reducing energy demand nationally or in specific communities or regions will improve the financial feasibility of renewable energy options. For example, providing rural communities with efficient lighting technologies, such as compact fluorescent lamps (CFLs) or light-emitting diodes (LEDs), reduces the amount of electricity required by households and increases the number of households that can receive power from solar, wind or hybrid systems, while also reducing the cost of delivering this service. Similarly, encouraging the adoption of solar hot water systems reduces demand for electricity at peak hours, a goal that also can be achieved by hot water load control, *i.e.*, turning off hot water heaters ("geysers") during peak periods through remote switching. In both cases, peak demand is reduced and the argument for renewable energy becomes stronger.

SADC member states vary widely in the efficiency of energy use. Although there is no standard measure of national energy efficiency, energy intensity often is used as a proxy indicator, measuring the amount of energy (in megajoules, or MJ) required to produce one US dollar of GDP. Figure 8 shows the energy intensities of the 15 SADC member states as well as the change in intensity from 2010 to 2012.[1] The highest energy intensity is found in the DRC, Mozambique and Zimbabwe. The SADC average intensity of 9.4 MJ per USD of GDP is well below that of ECOWAS (14.5 MJ) and lower than the sub-Saharan average (12.4 MJ).[2]

There are also substantial improvements in energy intensity from 2010 to 2012, with only three countries showing an increase in intensity: Madagascar, Namibia and Swaziland.

FIGURE 8 | Energy intensity in SADC member states 2011, with corresponding change in energy intensity, 2010-2012 (%)



Source: See endnote 1 for this section.

Table 12 provides a summary of major energy efficiency and demand-side management (DSM) activities in SADC member states. The most common initiative by far is the exchange of incandescent light bulbs for CFLs, which has occurred in 13 of the 15 countries.[i] Support from SAPP has been instrumental in expanding this initiative, but member states also have developed their own programmes and are continuing after the SAPP work ends. The least common initiative is demand market participation, which requires strong technical collaboration between utilities and their main customers.

The SADC Secretariat has included energy efficiency in its overall mandate, although support for programmes in this area has been very limited. As noted in section 2, the SADC Energy Protocol recognised "energy efficiency and conservation" as a separate sub-sector for policy development and programming. Measures such as reducing commercial energy intensity and involving utilities in energy efficiency schemes were included in the Protocol.[3] Later, the 2003 SADC Regional Indicative Strategic Development Plan (RISDP) called for an "efficient and least-cost infrastructure system that will unleash the potential of communities".[4]

TABLE 12 | Energy efficiency and demand-side management (DSM) activities in SADC member states and utilities

	Programme type													
	CFL exchange	Energy-saving awareness	Demand market participation	Time-of-use tariff	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	Standards and product labelling
Angola	X													
Botswana	X					X	X							
DRC	X													
Lesotho	X													
Madagascar														
Malawi	X													
Mauritius	X	X				X			X				X	X
Mozambique	X													
Namibia	X	X	X	X	X	X	X	X		X		X		X
Seychelles														
South Africa	X	X	X	X	X	X	X	X	X					X
Swaziland	X			X					X	X		X		
Tanzania	X	X		X						X	X	X	X	X
Zambia	X	X		X		X		X	X	X	X	X	X	X
Zimbabwe	X	X		X	X		X	X	X	X	X	X	X	

Note: The "X" indicates the presence of the listed programme type in the country.
Source: The information in this table is gleaned from a large variety of member state policy documents and media accounts. Endnote references are supplied in the text wherever a specific programme or activity is discussed.

i. SADC Ministers responsible for Energy unanimously agreed to phase out incandescent bulbs by the end of 2016. UNIDO, personal communication with REN21, 25 August, 2015.

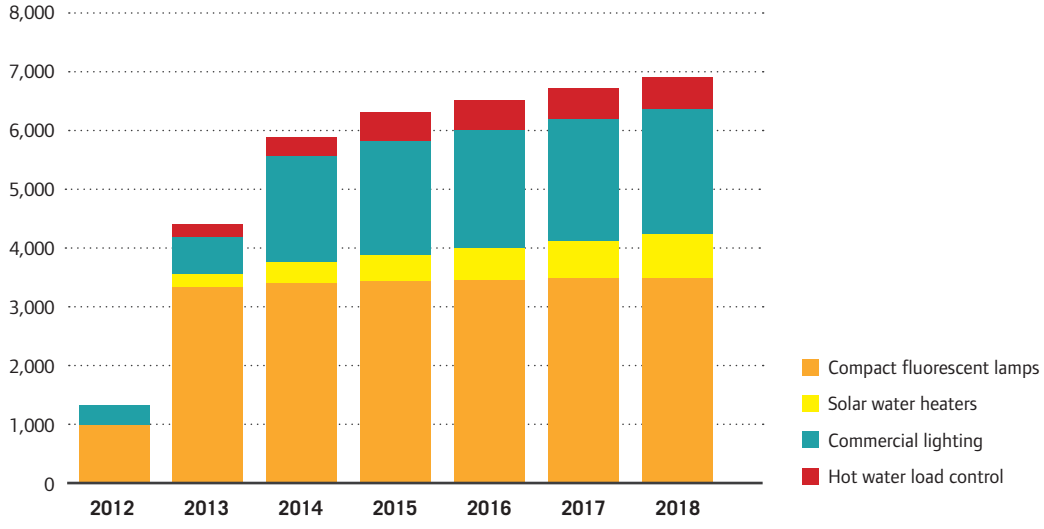
Beyond these general goals, neither the Protocol nor the revised RISDP sets out specific mechanisms for improving energy efficiency, and a series of projects on industrial energy efficiency supported by SADC and the Canadian government in the 1990s was completed without any clear plan for sustaining the achievements. As of the writing of this report, there had been no interim efforts to monitor progress on energy efficiency; however, the RISDP was updated in April 2015 at a SADC Extraordinary Summit to include a review and adjustment of targets and a new target date of 2020.[5]

SAPP has been involved in energy efficiency and DSM as well, as part of its effort to reduce load among its member utilities. This was assisted by a Needs Assessment Study undertaken by the EU Energy Initiative Partnership Dialogue Facility (EUEI-PDF) in 2012, involving discussions with 11 of the SADC utilities in addition to SAPP itself.[6] The results of the survey indicated that most utilities favoured load-reduction strategies rather than energy efficiency *per se*. This in turn led to a substantial DSM initiative by SAPP, co-ordinated through the member utilities.

The survey identified several national-level programmes that provided a useful guide for future development. For example, the Swaziland Energy Regulatory Authority (SERA) was identified as a good example of a utility implementing projects using time-of-use tariffs and pre-paid metering.

SAPP itself has agreed to move forward with further demand-side initiatives, including the development of a SAPP Energy Efficiency Framework that outlines a DSM programme covering four technologies: CFLs, commercial lighting retrofits, solar water heating and hot water load control.[7] These programmes are aimed at "hard wiring" the energy savings and demand reduction on the grid, resulting in an expected demand reduction of 4,500 MW by the end of 2015 and 7,000 MW by the end of 2018 (see figure 9).[8]

FIGURE 9 | Projected demand reduction under the SAPP DSM programme, 2012-2018



In February 2015, SAPP initiated a Regional Roadmap for "Leapfrogging to Efficient Lighting, Appliances and Equipment in SADC". As a result of this document, SAPP members have agreed to prioritise lighting, refrigerators, air conditioners, water heaters and distribution transformers as high-impact opportunities that offer the most cost-effective and fastest way to save energy in the region.[9]

NamPower and the Electricity Control Board of Namibia are actively involved in CFL replacement (see below) and have initiated demand market participation as well as time-of-use tariffs. In addition, some municipalities are introducing hot water load control for domestic hot water systems.

The Zambian utility, ZESCO, has been involved in CFL replacement and aims to distribute 1 million CFLs, resulting in up to 66 MW in demand savings. A plan to roll out energy audits for major customers was initiated in 2013 in conjunction with the Zambian Association of Manufacturers, covering preliminary audits of 21 organisations.[10] Additional planned activities in Zambia include a power factor improvement programme, an efficient street lighting programme, time-of-use tariffs for maximum demand customers, and transmission line upgrades to reduce losses. All of the ZESCO programmes are subject to funding through the electricity tariff, which is one of the lowest in the SADC region. A move towards cost-reflective tariffs is planned but will take several years to implement.

In Tanzania, TANESCO has undertaken a review of energy efficiency and demand management opportunities, but so far it has implemented only small improvements to transmission and distribution losses and power factor correction. Additional planned projects are yet to be implemented. A CFL roll-out was planned for 2015 (distributing 815,000 high-quality CFLs to residential customers of TANESCO), but funding had not been obtained as of the time of this writing.

In Zimbabwe, the national utility ZESA has implemented a CFL roll-out, with project performance monitoring and verification provided by the University of Zimbabwe. Commercial lighting upgrades are now planned and will commence with ZESA's own premises (for which a tender has been advertised). Under the pre-payment meter programme the utility has installed 580,000 towards a target of 800,000 meters for residential customers. The utility also plans to install 80,000 pre-payment meters for energy-intensive non-residential customers. A time-of-use tariff and rehabilitation of an existing hot water load control programme are also envisaged.

The energy regulator ZERA also is sponsoring a National Energy Efficiency Audit (NEEA) that has identified a wide range of efficiency options and the means to implement them. To increase energy efficiency awareness, some utilities are running annual competitions for organisations and companies that perform well in the area of energy efficiency. Examples include ZESA's scheme to reward exceptional effort in efficient energy use by individuals, students, companies or other institutions.

The DRC's national utility, SNEL, is in the process of establishing a standing committee responsible for energy efficiency and DSM, scheduled to be operational in 2016.

Mauritius has instituted a National Energy Efficiency Programme, including a voluntary labelling scheme, incremental duty on sub-standard appliances, pre-paid meters and distribution loss reduction. An Energy Efficiency Management Office has been in operation since 2012.[11] Mauritius also is home to one of the region's most innovative energy efficiency projects – the sea water air conditioning (SWAC) system – which is being financed by the Sustainable Energy Fund for Africa via the African Development Bank (see sidebar 6).[12]

Sidebar 6. Sea water air conditioning (SWAC) in Mauritius

In December 2013, the Sustainable Energy Fund for Africa approved a USD 1 million project preparation grant to support Sotravic Ltd. in developing and installing a sea water air conditioning (SWAC) system in Mauritius. This innovative low-carbon technology uses cold ocean water for cooling, helping to substantially lower air conditioning costs.

The SWAC system is expected to contribute to an annual reduction of 40,000 tonnes of CO_2 emissions, create 40 direct green jobs for skilled local engineers and technicians, and potentially create many more indirect jobs in downstream businesses such as aquaculture, pharmaceuticals and the bottling of specialty water. It also will be the first such project in Africa, with a high demonstration effect for other coastal cities on the continent.

When completed, the project will replace energy-intensive traditional air conditioning systems in buildings, substituting systems that currently use the equivalent of 30 MW of electricity with a cold ocean-water cooling system that requires only 4 MW of electrical power to operate. This will result in a greater generation reserve margin for Mauritius, which depends heavily on fossil fuels to ensure a reliable power supply.

Source: See endnote 12 for this section.

SACREEE and National Initiatives

The development of the recently approved SADC Centre for Renewable Energy and Energy Efficiency will help raise the profile of energy efficiency for both policy and programming in the region. The implementation plan for SACREEE calls for the organisation to support a variety of efficiency measures, including:

- Sustainable supply and demand for clean cooking fuels;
- Design, components and construction methods for energy-efficient buildings;
- Industrial heat applications;
- Efficiency in electricity generation, transmission and distribution, including DSM;
- Industrial processes (electric motors, furnaces, refrigeration, etc.);
- Capacity building and demonstration of energy efficiency implementation in energy-intensive sub-sectors common to SADC; and
- Recommendations on setting up national energy efficiency institutions and energy efficiency policy.[13]

Although these ambitious objectives will require considerable time to implement and will require continued support from the member states after donor support ends,[ii] SACREEE will raise awareness of energy efficiency options and improve overall understanding of how these can be translated into national policies and programmes.

ii. The initial operational period of SACREEE is only 42 months, after which donor support will be re-evaluated.

The absence until now of a strong regional presence in energy efficiency has not deterred some member states from pursuing progressive and effective programming in this area. There is, however, still a lack of coherent national strategies to deliver energy efficiency programmes, and little financial and technical support to ensure their sustainability. In this regard, South Africa has led the way, developing a strong national energy efficiency strategy and involving government, the national utility and the private sector in implementing the strategy.[iii] SAPP also has been a player in this area, involving some of its member utilities in aggressive efficiency programmes, although for the most part without a national strategy to support them.

A few other member states – notably Botswana, Namibia and Zimbabwe – are pursuing the development of national energy efficiency policies and strategies, and many more have supported the development of improved biomass cookstoves, a key area that often has been neglected in the past. These national initiatives are discussed in more detail in later sections.

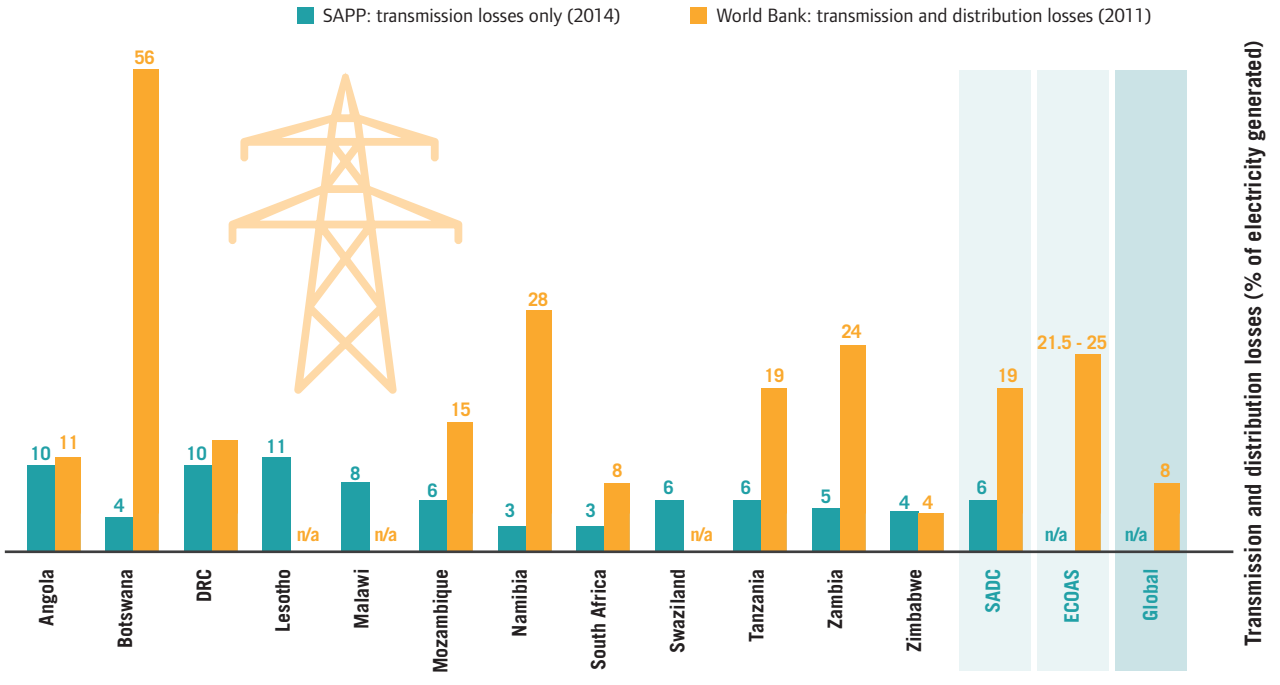
Efforts to stimulate such national energy efficiency planning and to provide strong technical support to member states undertaking such initiatives will be a major focus of SACREEE's work.

ELECTRICITY TRANSMISSION AND DISTRIBUTION

All SADC member states have national electricity utilities that are vertically integrated, meaning that they are responsible for generation, transmission and (in most cases) local distribution. With a few exceptions, these utilities also have an effective monopoly on electricity supply in their respective countries. As SADC's utilities are increasingly challenged to meet growing demand, improving efficiency in transmission and distribution has become an important target for policy development and a key part of annual budgeting.

Utility efficiency is usually measured by quantifying transmission and distribution "losses", or the percentage of electricity lost between the generator and the end-user. As figure 10 shows, these losses are significant in the SADC region, although they are not as high as losses in the ECOWAS region.[14] Looking at transmission losses only, the SADC average is 6%. Including distribution losses, the figure rises to 19%, which is still less than the ECOWAS average of 21-25% but is well above the global average of 8%.

FIGURE 10 | Transmission and distribution losses as a share of electricity generated in SADC member states



Note: n/a indicates that data are not available. Zimbabwe data are confirmed by SAPP and the World Bank, but are subject to significant year-to-year variation, *e.g.*, 24.4% in 2002 and 3.7% in 2008.
Source: See endnote 14 for this section.

iii. Additional details of South Africa's efficiency targets and the utility's DSM programmes are provided in section 4.

These figures include both technical losses – typically due to poor maintenance or to inefficient or undersized power transmission infrastructure – and non-technical losses, which include electricity theft from illegal connection, vandalism of electrical equipment as well as unpaid bills from connected consumers. Paradoxically, such non-technical losses create a serious financial problem for utilities, reducing the funding available to invest in improvements to the existing grid network, as well as delaying upgrades and extensions. Non-technical losses are a huge problem in the region, as low-income households on the grid often lack the finances to pay connection charges, resulting in a spider's web of informal and illegal connections that are difficult for the utility to control.

These challenges have spurred the adoption of pre-payment metering in Botswana, Malawi, Mauritius, Lesotho, Swaziland, South Africa and Zimbabwe, with the latter two countries having adopted this strategy since the late 1990s. In Zimbabwe, the utility has started to reap tangible increased revenue benefits, somewhat ameliorating the utility's poor financial performance. In Botswana, the programme has been expanded from Gaborone to Selebi-Phikwe.[15] In South Africa, the issue of informal connections became a massive political issue following the advent of democratic government, prompting the development in 2003 of a "free basic electricity" (FBE) allowance for households below a certain income level.[iv]

In addition to the problems of technical and non-technical losses, SADC utilities have to confront an ever-increasing maintenance backlog, which contributes to continued system instability and load shedding. This situation is particularly acute in Angola, Botswana, the DRC, Namibia and Zimbabwe, three of which (Botswana, Namibia and Zimbabwe) depend on South Africa (which is itself subject to major power shortages) for a portion of their power supplies.

As discussed in section 2, the rising use of distributed energy in the SADC region has the potential to reduce both transmission and distribution losses, as distributed generation is by definition closer to the point of final use. One other major source of improved transmission efficiency is the use of direct current (DC) for long-distance transmission – a technology employed so far only for the interconnector between Cahora Bassa and South Africa,[v] and more recently for part of the planned Mozambique Backbone transmission line between Tête and Maputo. DC transmission can reduce losses by as much as 30-50%, but it is suitable only for longer-distance transmission.[16]

STANDARDS AND LABELLING

The use of standards and labelling, particularly for electrical appliances, is another way for SADC countries to achieve greater energy efficiency. Energy labelling programmes for household appliances have been introduced in 54 countries[vi] around the world.[17] Labels affixed to appliances can describe the appliance's energy performance (energy consumption, energy efficiency, energy cost, or combinations thereof). Properly designed labels can assist consumers in making rational decisions and stimulate manufacturers to design products that achieve higher rating levels.[18]

Minimum efficiency performance standards (MEPS) are a complementary tool to appliance labelling. Once energy labelling is in place and there has been some shift in the efficiency levels in the market, MEPS can be enacted to remove the most inefficient products from the market.

To date, the major initiatives in this area have come primarily from South Africa, which identified the need for appliance labelling as far back as 1998. A 2013 re-assessment of appliance energy use by Eskom, the national utility, showed that the major energy consumers in households were hot water heaters/geysers (8 GWh), refrigerators (4.4 GWh) and lighting (3.4 GWh).[19]

The South African labelling programme, initiated in 2012, is intended to phase out the use of inefficient residential appliances by introducing a mandatory combination of both appliance labelling and MEPS, for appliances selected by the South African Bureau of Standards, the statutory body that administers standards in the country. The appliances included in the programme are air conditioners up to 5 kW, dishwashers and washing machines, electric ovens, refrigerators and freezers (including combinations), electric water heaters (geysers) and lighting.

The South African appliance labelling system (see figure 11) closely follows the European Union's labelling system, with rankings designated by colours and letters from "less efficient" to "most efficient."[vii] The programme initially will function as a voluntary system, eventually transitioning to a regulated system based on South African National Standard (SANS) 941, *Energy Efficiency of Electrical and Electronic Equipment*.[20]

Labelling and standards have been implemented in only one other SADC country, Mauritius, where a voluntary labelling scheme was initiated in 2014 for eight electrical appliances: dishwashers, air conditioners, refrigerators, ovens, lamps, clothes dryers, washing machines and televisions. The programme will become mandatory after an initial trial period.[21] Namibia, Zambia, and Zimbabwe also are considering such programmes, but no firm date has been set for implementation.

iv. The FBE currently is determined to be "50kWh per household per month for a grid-based system for qualifying domestic consumers, and 50Wp per non-grid connected supply system for all households connected to the official non-grid systems." This policy, coupled with an ambitious roll-out of pre-payment meters, has substantially reduced theft and also improved the efficiency of electricity distribution and revenue collection.

v. This interconnector is still under discussion and is not operational; it is properly referred to as the Songo – Apollo HVDC line, per Francis Masawi, Energy & Information Logistics, personal communication with REN21, 16 July 2015.

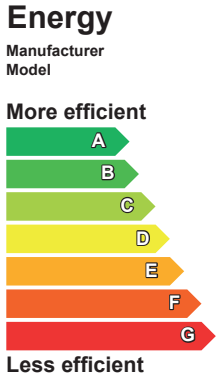
vi. This figure includes disaggregation of the EU countries, per Jenny Smith, CLASP, personal communication with REN21, 7 July 2015.

vii. The South African labelling system uses a lettering approach like the EU's; however, unlike the EU labels, it does not contain average kWh consumption estimates.

Most household appliances in the SADC region are either manufactured in, or distributed by, South African companies. Although the South African presence in this market has been mitigated somewhat by aggressive importing of cheaper appliances from China and South Korea, the potential exists to enforce the South African standards for importers and exporters as well. South Africa also has been developing standards for distribution transformers (SANS 207:1), but these had not been finalised as of the writing of this report.[22]

An independent study by the United Nations Environment Programme under the en.lighten Initiative has shown that conversion to energy-efficient refrigerators, air conditioners and distribution transformers could save the SADC region more than 22 terawatt-hours (TWh) (or 5%) of future electricity use (see table 13), which would allow for grid connection to an additional 10 million households and save consumers nearly USD 2 billion on electricity bills.[23] Such a shift would reduce greenhouse gas emissions by 9.5 million tonnes of CO_2-equivalent annually by 2030, equal to taking more than 5 million cars off the road.[24]

FIGURE 11 | Example of South African appliance efficiency label



Energy efficiency standards also have been applied to lighting and buildings in South Africa and a few other SADC countries. These, as well as standards for improved biomass cooking appliances, are discussed in detail in the following sub-sections.

TABLE 13 | Savings potential of energy-efficient refrigerators, air conditioners and distribution transformers (DTs) in SADC member states

	Country-level energy savings in 2030 (TWh per year)					
	Refrigerators	Air conditioners	Single phase DTs	3-phase DTs (75 kVA)	3-phase DTs (1,000 kVA)	Total
Angola	243.2	420.4	2.3	4.3	23.8	694.0
Botswana	32.1	224.6	1.1	2.0	11.1	270.9
DRC	539.3	413.7	2.0	3.9	21.5	980.4
Lesotho	17.3	25.7	0.2	0.3	1.8	45.3
Madagascar	41.1	285.2	0.3	0.7	3.7	331.0
Malawi	94.2	700.7	0.7	1.2	6.8	803.6
Mauritius	57.4	644.2	0.8	1.4	7.9	711.7
Mozambique	1,364.3	3,408.2	2.8	5.3	29.7	4,810.3
Namibia	83.7	420.0	1.1	2.1	11.4	518.3
Seychelles	–	–	–	–	–	–
South Africa	1,910.6	3,806.6	58.4	110.7	614.9	6501.2
Swaziland	15.4	57.6	0.3	0.6	3.5	77.4
Tanzania	687.2	3,657.9	3.0	5.7	31.7	4385.5
Zambia	539.5	1,475.0	1.8	3.4	18.8	2038.5
Zimbabwe	287.0	281.3	3.6	6.7	37.4	616.0
SADC	**5,912.3**	**15,821.1**	**78.4**	**148.3**	**824**	**22784.1**

Note: The dash ("–") for Seychelles indicates that data are not available.
Source: See endnote 23 for this section.

LIGHTING, BUILDINGS AND COOKING

Lighting

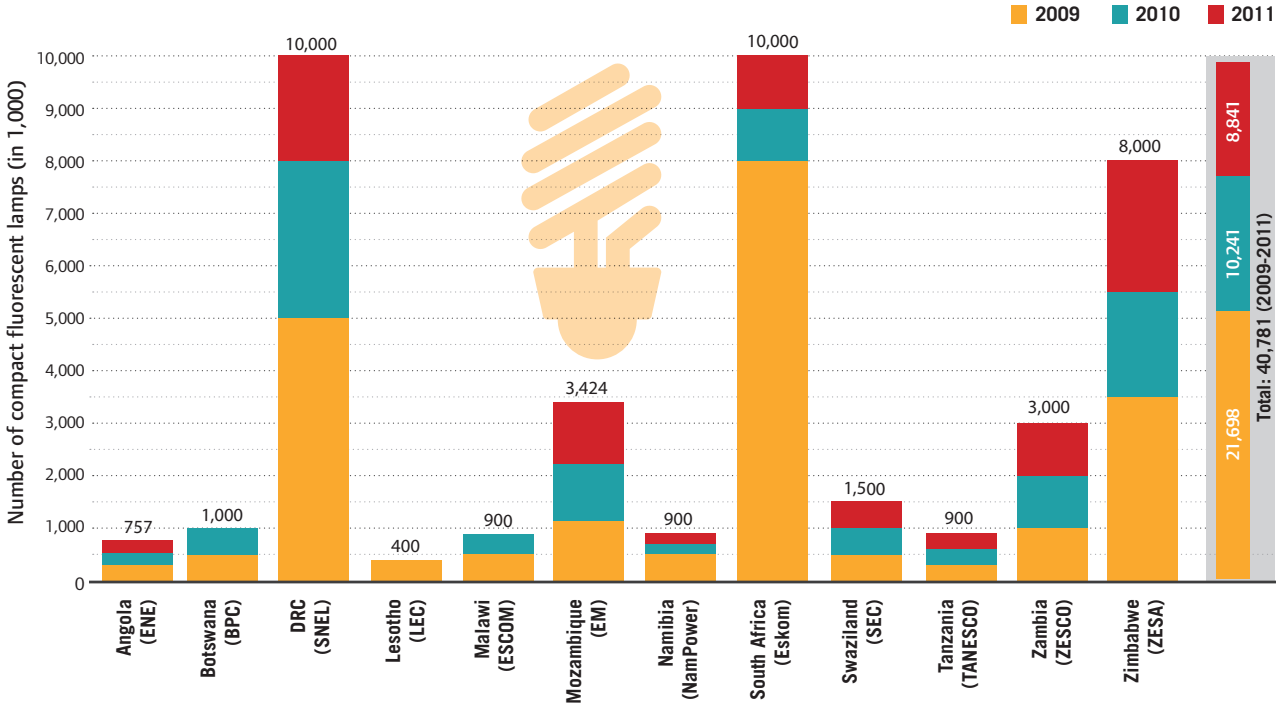
The introduction of efficient lighting technologies is a major area of achievement for the SADC region and was discussed from a technical viewpoint earlier in this report. Beyond national initiatives in several countries, the main regional driver behind efficient lighting has been SAPP, which has focused on CFL replacement as one of several means for SADC utilities to reduce demand. SAPP's CFL distribution project was essentially an effort to co-ordinate national targeting of CFL replacement, using utilities as the intermediary and reducing costs by acting as a single central buyer. This resulted in a massive distribution programme from 2009 to 2011, summarised in figure 12.[25]

It is important to note that this programme has not been implemented in all countries that stated their targets for CFL replacement, and that some countries – such as Botswana, Namibia and South Africa – already were implementing CFL distribution programmes before the SAPP initiative. For example, NamPower started promoting and distributing CFLs to customers free of charge in 2007, targeting mainly households, schools and eventually lodges and hostels. South Africa started promoting CFLs in 2008, when about 20 million CFLs were planned for door-to-door exchange programmes, free of charge to the consumer.

CFLs also were given to large commercial companies in South Africa to facilitate bulb replacement among employees, including at Eskom's major offices, and some CFLs were given to the South African National Defence Force. This allowed penetration of CFLs into higher-income groups, as the door-to-door programme was targeted mainly at lower-income groups. In 2008, a retail programme was launched where Eskom concluded agreements with large national retailers to sell CFLs at discounted prices.

In Tanzania, ZESA engaged three strategic partners that supply efficient lighting products, which have carried out promotions at shows and exhibitions such as the Zimbabwe International Trade Fair, the Harare Agricultural Show and similar provincial shows. By offering a promotional price, ZESA was able to sell some 250,000 CFLs by the end of 2008. The programme was expanded in 2012 to distribute 5.5 million free CFL bulbs through ZESA offices throughout the country, as replacements for incandescent bulbs. The programme is ongoing.

FIGURE 12 | Number of compact fluorescent lamps needed for replacement programme in SAPP member states, 2009-2011



Source: See endnote 25 for this section.

Other countries have mounted small-scale CFL programmes, although not all at the level anticipated by the SAPP programme. The following are examples of country-level programmes initiated under auspices other than SAPP, or as a supplement to SAPP commitments.

In Madagascar, the Lumitsits programme aims to install 600,000 efficient lamps in the eight largest cities, and 6,000 CFLs were distributed in Ambositra, the pilot city chosen for project implementation. The World Wide Fund for Nature (WWF) is responsible for carbon financing of the project, and the telecommunications company Telma heads the distribution of CFLs. As part of the promotional campaigns, both electronic and print media were used extensively to encourage the participation of end-users and stakeholders.[26]

The Electricity Supply Corporation of Malawi (ESCOM) procured CFLs at the beginning of 2012 and began a pilot programme in 500 households. By the end of July 2012, more than 540,000 CFLs were installed as part as the Efficient Energy Lighting Project (EELP), funded by the UK government. The programme targets the installation of 2 million CFLs. During the first phase of the programme, 1.3 million CFLs were distributed for no charge in exchange for inefficient incandescent lamps, and the remaining 700,000 will be sold at a subsidised price. The programme achieved a peak load shaving of 17.1 MW, or 20%.[27]

Mozambique is implementing two energy-efficient lighting projects. In May 2012, the public utility, Electricidade de Moçambique (EDM), began the "More Light with Less Energy" project, which aims to distribute 200,000 energy-efficient lamps to low-energy consumption EDM consumers throughout the country. The lamps were provided under official development assistance from the government of Portugal. EDM also is undertaking the replacement of street lighting with efficient lamps under the Green Street T5 project, which commenced in 2007 and has replaced more than 80,000 street lamps to date.

NamPower in Namibia is rolling out free distribution of 1 million LED bulbs and also subsidising 20,000 solar water heaters (SWHs) as part of its DSM campaign. Procurement of the bulbs and preparation for the 20,000 SWHs are at an advanced stage, and the roll-out of these programmes is scheduled for 2015. The 1 million LED campaign is expected to reduce peak demand by up to 30 MW, as well as stimulate the local energy-efficient lighting market. The SWH project is expected to reduce national peak demand by approximately 10 MW.[28] NamPower has identified the towns of Mariental, Otjiwarongo and Walvis Bay as the locations for a pilot phase; if successful, the installation of LEDs will proceed to the country's remaining towns. The utility plans to motivate the replacement of electrical water heaters with SWHs by providing a rebate of around 10% of the SWH installation cost.[29]

The SAPP initiative had the primary benefit of consolidating demand and using centralised purchasing power to drive costs down. It also ensured that the CFLs being purchased met a minimum standard, namely the specification developed by the Efficient Lighting Initiative (ELI) for integrated self-ballasted CFLs. This specification already was in use by some SAPP members, such as Eskom and NamPower. Eskom compiled a technical specification paper, which it circulated to all members, that also addressed power quality issues that might need continuous monitoring.[30]

Outside of CFL distribution and planned efficiency upgrades for the commercial sector where LED lighting will be promoted/introduced, there have been relatively few efficient lighting initiatives in the SADC region.

Buildings

Improving energy efficiency in existing and new buildings is a major area of development in the region, with Botswana, Namibia and South Africa having made progress in this regard. The South African initiative is by far the most complex, being tied to the development of both mandatory and voluntary standards. Examples of some of the country's main standards are provided in sidebar 7.

As with most standards developed by the South African Bureau of Standards, these will serve as models for adoption by other countries in the region. Although it is not yet clear if and when regulations will be introduced to make SANS 204, 50001 and 50010 mandatory, their development alone will have a huge impact on the energy efficiency of buildings in the region.

At the beginning of 2015, the South African Department of Energy was promulgating mandatory regulations through a statutory instrument titled "Draft Regulations, Registration and Reporting and Submission of Energy Management Plans" to compel energy-intensive users to provide information for the purposes of monitoring and adhering to energy efficiency practices.[31]

Botswana and Namibia were hosts to major donor-funded projects on energy efficiency in commercial and institutional buildings in 2010 and 2011, and both developed guidelines for energy-efficient design. The Namibian project also led to the formation of a Green Building Council in Namibia (GBCNA), affiliated to the World Green Building Council (WorldGBC) and providing training to 23 energy auditors, resulting in international certification as energy engineers for 15 of them. However, both projects failed to achieve their major objectives of creating sustainable programming in buildings' energy efficiency; for example, the Namibian programme resulted in retrofits of only 5 buildings against a target of 20, due to inadequate funding and lack of support from building owners.[32]

The Namibian design guidelines are expected to be incorporated in the national building codes, and currently are under review by the government.[33] The design guidelines for the Botswana project have not been implemented to date.

The Green Building Council of South Africa (GBCSA), also a member of the WorldGBC, has been championing energy efficiency and environmental sustainability in the property sector. It is the official certification authority under the Green Star Rating System for South Africa, which covers different market sectors including office, retail, multi-unit residential, public and education buildings, as well as others that are in development such as building interiors and existing buildings' performance. GBCSA undertakes a number of activities that culminate in annual conferences to promote improvements and positive change, focusing mainly on the property industry and lately including the residential sector.[34]

Sidebar 7. South African national standards for energy efficiency

SANS 10400XA: A 'deemed to satisfy' standard which prescribes minimum requirements for energy usage in new buildings. For example, a minimum of 50% of the annual average heating requirement for hot water must be provided by means other than electric resistance heating.

SANS 204: A voluntary standard for new buildings, which has more demanding requirements than 10400 and can be viewed as 'best practice'. The intention is for the 10400 to be upgraded to 204 over time, and for SANS 204 to be enforced through incorporation into the building code.

SANS 50001, published in 2010, specifies requirements for establishing, implementing, maintaining and improving an energy management system, whose purpose is to enable an organisation to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy use and consumption.

SANS 50010, published in 2011, provides a methodology for the determination of energy savings that may be used in a range of voluntary or regulatory processes which may require the impact of interventions on energy use to be calculated.

Both SANS 50001 and **50010** allow the Department of Energy to develop and promulgate the necessary regulations (under the National Energy Act) to have them become a mandatory requirement. They also have been written to respond to the existing energy efficiency tax incentives as well as future tax incentives introduced by the Treasury.

Note that pursuant to the above regulations, the Department of Energy (DOE) is currently developing an Energy Efficient Monitoring System (EEMS) to track the efficient consumption of energy within South Africa and the trends involved. The regulations are expected to come into effect the later half of 2015. The DOE will require reliable data from all legal entities operating in the most intensive sectors of the economy and will set thresholds, which if exceeded will potentially result in penalties.

Cooking

This category includes efficient wood- and charcoal-burning cookstoves, as well as stoves that use alternative forms of biomass such as wood pellets.

An improved wood- or charcoal-burning cookstove is any cookstove that improves combustion efficiency as measured by reductions in the amount of fuel used to achieve a certain result, *e.g.*, boiling water or preparing a set meal. This typically is expressed as a percentage: for example, the open, three-stone fire that is the traditional source of cooking energy in Africa is usually given a default efficiency value of 10%, meaning that only one-tenth of the energy available in the wood goes directly to the cooking outcome. By comparison, an improved cookstove would have an efficiency value of 20% or greater, the minimum allowed for registration of a cookstove project for carbon credits. Some advanced cookstoves have combustion efficiencies in excess of 35%.

Improved cookstoves can reduce fuel consumption. However, the lack of clear international performance and quality standards has prevented widespread adoption of these stoves. At present, improved cookstoves programmes are present in every SADC member state, but with few exceptions, these programmes are funded primarily by outside entities such as the UN and the World Bank, or by a wide variety of international NGOs (some of which, such as the Global Village Energy Partnership [GVEP] and SNV, have global programmes). The structure of these programmes is broadly similar:

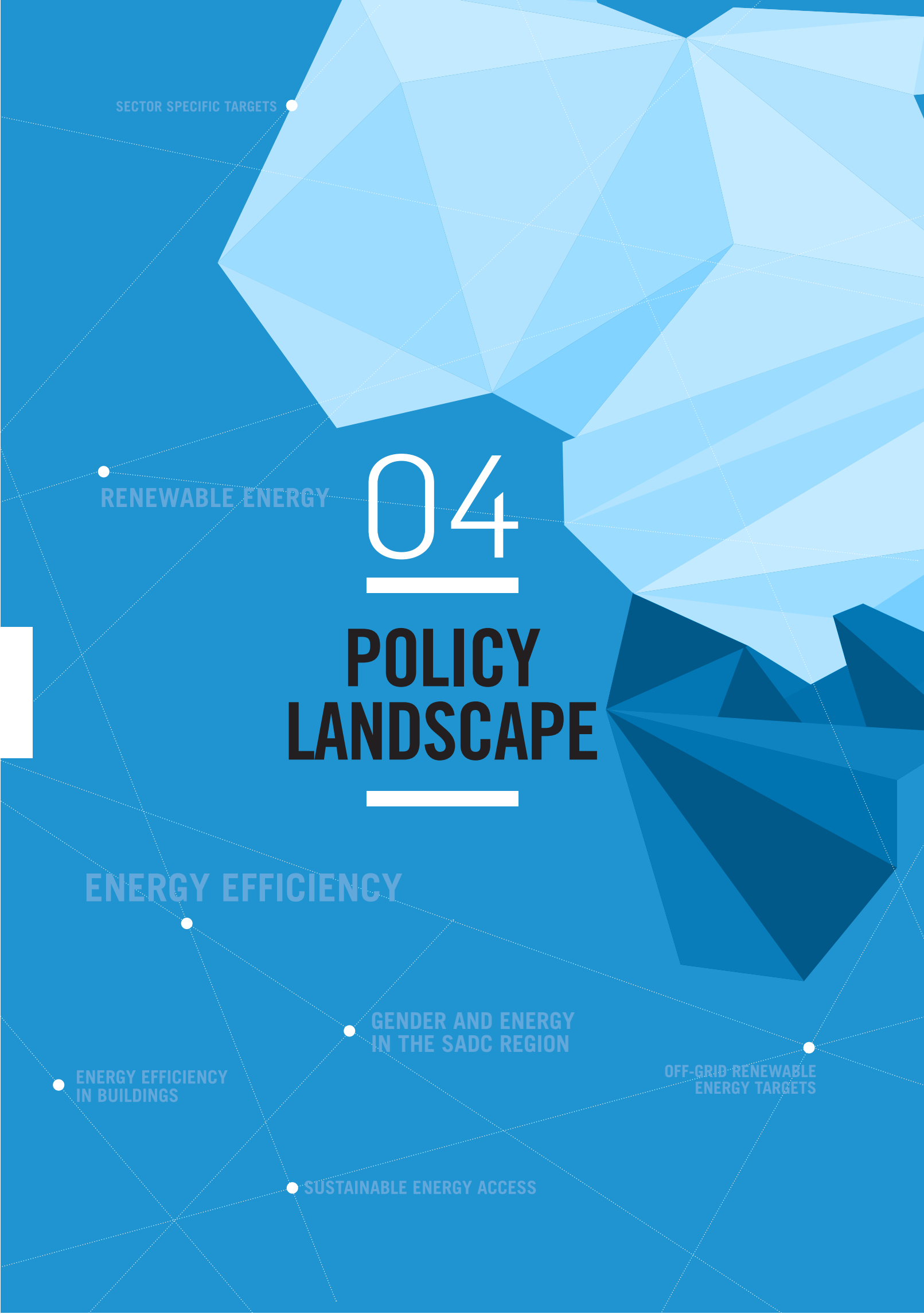
- There is a preference for locally produced, artisanal stoves, as these bring the co-benefits of increased employment and cash income. Examples of such programmes include GVEP's Tanzania programme and ProBEC's programme in Malawi using local women's groups as both producers and retailers, as well as the successor Malawi project developed by Hestian.

- Local materials are employed where possible, although the demands of high-temperature operation and risk of breakage may require expert advice in determining the right clay composition and the correct firing temperature (for ceramic stoves). Examples of this include the Mozambican POCA stove – which required the importation of special clay from Zimbabwe and the use of a commercial kiln for firing – funded by ProBEC.

- Many international organisations (*e.g.*, Envirofit, mentioned in section 4) are promoting metal stoves with high-temperature ceramic liners manufactured outside of Africa because they are more durable than local clay stoves and achieve much higher efficiencies. Because of higher costs, stoves of this type invariably require special financing, such as through carbon credits or subsidies, to make them accessible to local markets.

The absence of a co-ordinated regional or national effort to promote and/or manufacture improved cookstoves is a major gap in SADC's efforts to promote energy efficiency. Exceptions include Botswana's efforts to sell imported high-efficiency stoves through the BPC Lesedi programme, and Swaziland's efforts to develop a local stove manufacturing facility. Both projects demonstrate that achieving the scale of innovation required to make a significant impact on biomass consumption requires co-ordination at a regional level, augmented by both international technical assistance and a scaled-up carbon financing programme.

The ProBEC project, in its final two years of operation, attempted to do this by developing a programmatic CDM project and then inviting international carbon developers to take over the project – a process that would have led to a sharing of carbon revenue with the SADC Secretariat to support further programme development. This effort failed due primarily to increasing uncertainty in carbon markets following the 2009 climate change conference in Copenhagen, but also because private developers were unwilling to share revenue with a regional body unless risk also was shared.[35]


SECTOR SPECIFIC TARGETS
RENEWABLE ENERGY
04
POLICY LANDSCAPE
ENERGY EFFICIENCY
GENDER AND ENERGY IN THE SADC REGION
ENERGY EFFICIENCY IN BUILDINGS
OFF-GRID RENEWABLE ENERGY TARGETS
SUSTAINABLE ENERGY ACCESS

04 | POLICY LANDSCAPE

Although the SADC region is endowed with substantial renewable energy resources, major policy initiatives to capitalise on these resources have been implemented only in the past 10-15 years. The awakening of interest in renewables has been driven in part by electricity supply shortages in several countries, but also by the changing economics of wind and solar energy and by the emergence globally of new policy concepts such as feed-in tariffs, net metering, auctioning of power supply from IPPs and renewable energy certificates (RECs). SADC member states are developing their own targets and policies to expedite the development of renewable energy and energy efficiency projects and to offset their dependence on fossil fuels.

GLOBAL AND REGIONAL INITIATIVES

Member state efforts to develop targets and policies have been assisted by involvement in the Sustainable Energy for All (SE4All) initiative of the United Nations. To date, 12 of the 15 SADC countries[i] have joined SE4All and have expressed an interest in initiating rapid assessments to help determine the main challenges and opportunities in achieving the initiative's goals.[1] In addition, 10 member states – Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe – have carried out the SE4All gap analysis.[2]

It is expected that the SE4All initiative will help SADC countries refine their energy policy frameworks and develop appropriate incentives for renewable energy and energy efficiency. SADC energy ministers have endorsed the initiative and instructed member states to "…adopt the African Guidelines for SE4All Action Plans".[3] The SE4All targets for 2030 have been acknowledged but are not necessarily reflected in local policy frameworks at present.

Three SADC countries – Mozambique (2012), Zambia (2013) and Swaziland (2014) – have undergone Renewable Energy Readiness Assessments (RRAs) via IRENA, and RRAs for Tanzania and Zimbabwe will be completed in 2015.[ii] Like the SE4All process, the IRENA assessments have helped countries sharpen their policy toolkits, identify areas where improvement is needed and set realistic targets for implementing renewable energy and energy efficiency.

Much of the work on developing sustainable energy solutions in the region has focused on systems for electricity generation, transmission and distribution. Increasing access to electricity and modern energy services is a key policy concern for all SADC countries, as is improving efficiency through reduced transmission and distribution losses.

Identifying targets and policies for sustainable energy is a relatively recent phenomenon in the SADC region (essentially from 2003 onwards), although a regional dialogue over energy policies began in the late 1980s.

The publication of the SADC Energy Protocol in 1996 provided an initial guideline for programming, although the term "sustainable energy" had not yet been introduced. Specifically, the Protocol recognised "new and renewable energy", "energy efficiency and conservation" and "wood fuels" as separate sub-sectors, for each of which a set of target activities was established in an Annex to the Protocol. The Protocol included measures such as developing appropriate financing mechanisms and introducing favourable tax regimes for renewable energy and energy efficiency, targeting reductions in commercial energy intensity and involving utilities in energy efficiency schemes. However, it did not suggest specific mechanisms for implementing these broad targets, nor did it set specific quantitative targets or establish any formal monitoring of target achievement.[4]

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. On the energy side, the target was for at least 70% of rural communities within southern Africa to have access to "modern forms of energy supplies".[5] 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".[6] The Annex to the 2003 RISDP suggests a slightly different set of targets: 70% of communities with access to electricity and 60% with access to new and renewable energy sources.[7]

i. Madagascar, Mauritius and Seychelles are not listed as SE4All "partner countries".
ii. IRENA also has published an infrastructure assessment for a Clean Energy Corridor in east and southern Africa (2014) and a study on "Planning and Prospects for Renewable Energy" within the Southern African Power Pool (2013).

The revised RISDP was adopted in April 2015 in response to concerns about the need to assess progress and make necessary adjustments. It establishes an Implementation Framework for the period 2015-2020 and an Industrialisation Strategy Roadmap, identifying energy as one of the main drivers of economic growth.[8] It also includes 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". However, it notes that, in practice, this goal has not been achieved by 2015.[9]

The overall target for energy access has similarly fallen short. The 2003 RISDP targeted 70% access to electricity by 2018; the revised RISDP notes that "half of the member states have access below 30%" in 2015.[10] Meanwhile, the Results Framework accompanying the revised RISDP does not include any references to renewable energy or energy efficiency, but it does emphasise the need for cost-reflective tariffs.[11] [iii]

Recognition of the need to improve the sustainability of biomass energy use in SADC member states is increasing gradually. A programme to establish national biomass policies and targets – the so-called Biomass Energy Strategies (BEST) programme – was initiated by joint German and EU funding during the period 2009-2014. Four SADC countries developed BEST plans during this period: Botswana (2009), Malawi (2009), Mozambique (2012) and Tanzania (2014). However, there has been little or no follow-up to the BEST programme to date, and it has not been integrated into the regional policy framework.

No SADC member states were identified as targets for strategic planning work under the first implementation phase of the Global Alliance for Clean Cookstoves (2010-14). However, in the second phase (2015-17), four countries – Lesotho, Malawi, South Africa and Tanzania – are designated as "partner countries" and are expected to: 1) make a national commitment to support the adoption of clean cookstoves and fuels within their borders, and 2) take a leadership role in employing clean cooking best practices and disseminating clean cookstoves and fuels. Participation in the Alliance is critical because countries such as Madagascar, Malawi and Mozambique have among the largest shares of traditional biomass energy use, exceeding 80% of primary energy.

The relative absence of national or regional targets and policies for addressing biomass energy use is of particular concern because there has been substantial progress globally in improving the efficiencies of biomass cooking devices as well as of commercial biomass use in industries such as tobacco, tea and sugar – which are also present in SADC countries such as Malawi, Mozambique, Tanzania, Zambia and Zimbabwe.[iv]

In energy efficiency, progress has been slower, but a SADC entity – the Southern African Power Pool (SAPP) – has taken the lead in creating targets and programmes for its member utilities and has achieved a significant reduction in demand, which appears to be sustainable. Several SADC member states, including South Africa (2005-8), Namibia (2013) and Zimbabwe (2014), also have developed national energy efficiency programmes and initiatives.

South Africa implemented an Energy Efficiency and Demand Side Management (EEDSM) programme in 2010 through the national utility, Eskom, with offerings in the commercial, industrial and mining sectors. The programme has been affected by insufficient allocation of resources but soon may restart as part of a suite of measures to improve the load shedding programme being implemented by Eskom. The EEDSM programme has included incentives and rebates to encourage the uptake of opportunities in various economic sectors, including residential and more recently municipalities.[12] It is now to be transformed into a more aggressive programme, supported by other government policy initiatives, such as a proposed carbon tax, development of monitoring and verification skills to assist municipalities, industries and commercial buildings in monitoring their energy management plans, and most recently a specific regulation requiring "all legal entities that consume energy" to prepare such plans including mandatory monitoring (see below for more on this regulation).[13]

The SADC Secretariat embarked on an ambitious effort in 2011 to develop a Renewable Energy Strategy and Action Plan (RESAP), which is still under development as officials and ministers ensure that the targets are achievable and appropriate to each member state. The initial consultant report on RESAP suggested a number of targets for renewable energy for the period 2020-2030, including targets for 175 MW of biomass power and 500 MW of solar power by 2020.[14] Significantly, both of these targets fall well short of targets for those SADC countries that are implementing large-scale power generation from renewable sources. Final approval of RESAP is expected in late 2016.

The consultant report also proposed that the renewable energy contribution to electricity supply of 17% in 2008 be increased to 27% for 2020 and 29% for 2030. These figures include large-scale hydropower and thus are distorted by the prospect of major hydro developments in the DRC, Mozambique, Zambia and Zimbabwe.[15] However, the figure for 2030 is much lower than the IRENA/SAPP optimal forecast of 46% by 2030, which is based on the assumption that the Grand Inga project will be in place by 2018 at the earliest and no later than 2025. Even partial implementation of Grand Inga would represent an addition of some 12,000 MW to regional capacity. SADC ministers have estimated an even larger increase of 24,062 MW of power added between 2015 and 2019, of which 70% will be from renewable energy sources.[v]

iii. The SADC energy ministers at their 21 July 2015 meeting agreed to "reaffirm their commitment to ensure that the SADC Region reaches full cost reflective tariffs by 2019". They also noted that "…so far only Namibia and Tanzania reached cost reflective tariffs." See Government of South Africa, "34th Meeting of SADC Energy Ministers, Sandton Convention Centre", press release (Johannesburg: 24 July 2015), http://www.gov.za/speeches/34th-meeting-sadc-energy-ministers-24-jul-2015-0000.

iv. Efficiency improvements in cookstoves are discussed in more detail in section 3.

v. As noted in the Press Release from the 34th Meeting of SADC Energy Ministers. See footnote iii.

SAPP also has committed to achieving a renewable energy mix in the regional grid of at least 32% by 2020 and 35% by 2030. For comparison, the renewable energy deployment rate in SADC was 20% in 2010, including all operational hydro projects.[16]

The RESAP consultant report also suggested that penetration of improved cookstoves alone might reach 5% of SADC households in 2015, 10% in 2020 and 20% in 2030 – from less than 1% in 2014. Given the lack of policy initiatives noted above, these figures seem highly optimistic, as improved cookstoves have not proven to be popular in the region, both because of their higher cost and because of perceived reliability problems. The regional ProBEC project, for example, achieved less than 1% penetration rates in most countries after 11 years, although it did succeed in making this issue more visible within SADC and in identifying and distributing more-efficient technologies. Recent projects, often financed by the sale of carbon credits, have been much more successful but are still reaching only a small minority of potential users.[17]

SADC has contributed to the ongoing policy dialogue on renewable energy in transportation (and in particular, the substitution of biofuels for fossil fuels) by preparing a "state of play" study on biofuels in the region, and by establishing a Framework for Sustainable Biofuels as well as a Decision Tool to guide biofuels development in the region; however, none of these studies provides targets for penetration of biofuels in the market, concentrating instead on providing examples of policies that would ensure the sustainability of biofuels development.[18] The SADC energy ministers have noted that the Secretariat will not be required to facilitate the development of national biofuels strategies and guidelines, due to capacity limitations.[19]

In the 2011 RESAP consultant report, the authors estimated that production of ethanol, under a conservative scenario where only surplus molasses is used as feedstock, could reach 605.8 million litres in the seven countries with major sugar industries: Malawi, Mauritius, Mozambique, South Africa, Swaziland, Zambia and Zimbabwe. This represents approximately 1.9% of 2008 petrol consumption in these countries on an energy basis, and 3% on a volume basis.[20] This compares with current blend rates of 10% in Malawi and 5-10% in Zimbabwe[vi] on a volume basis.

No targets for biodiesel production were provided in the RESAP report, although there have been numerous efforts to commercialise biodiesel production from tree-seed crops such as jatropha as well as from sunflower and soya oil.

NATIONAL RENEWABLE ENERGY TARGETS AND POLICIES

Targets

On the national level, setting renewable energy targets is an increasingly important part of policy development. All 15 SADC member states have developed their own national targets[vii] for renewable energy (see table 14 for an overview), although Lesotho has limited its target to generic grid extension without reference to renewables, and the DRC has focused on energy access targets irrespective of the energy source. Angola, Botswana, Malawi, Zambia and Zimbabwe all have included energy access as part of their renewable energy targeting, both through targets for increased access to grid electricity and through targets for increased off-grid access (*e.g.*, through development of local mini-grids).

Several member states have developed specific policies that embody targeting as a key element in the policy. Generally, these focus exclusively on the use of renewable energy in the electricity sector and in a few cases on biofuels (*e.g.*, Zambia). Only three countries – Mauritius, Mozambique and South Africa – have developed targets for biomass energy use.

Targets for increasing the share of renewables (or in some cases the capacity amount) in electricity generation are more common than energy access targets. Most countries have, or are moving towards, specific targets for renewable electricity share, including Madagascar, Mauritius, Mozambique, Namibia, South Africa, Seychelles, Tanzania and Zimbabwe (the latter two providing a capacity target only). This process is made more difficult in countries that have major fossil fuel resources, such as Angola (petroleum) and Botswana, Mozambique and South Africa (coal), because existing infrastructure and expertise is keyed to fossil fuel generation. Still, the region has made enormous strides in the past decade in recognising the importance of renewable electricity in diversifying and stabilising power supplies.

Probably the best example of effective target-setting for renewable energy is South Africa, which established a target for renewable contributions to power generation in the early 2000s and exceeded that target by the specified date. 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).[viii] This was achieved by the end of the second bidding window in late 2012, at which point 2,457 MW had been approved. The third and fourth windows (2013 and 2014) added another 2,577 MW, and the government is now seeking an additional 1,800 MW from previously unsuccessful bidders in the first four windows.[ix]

vi. Zimbabwe has mandated a switch to E15 and even E20 in future, but there is resistance from consumers who fear that this will affect fuel efficiency and lead to corrosion of key engine parts.
vii. The term "target" is used here in both a quantitative sense, *e.g.*, the amount of GWh to be generated from renewable sources, and a qualitative sense, *e.g.*, government's intention to further develop solar energy to offset fossil fuel sources, as evidenced in energy planning documents.
viii. The 2010 Integrated Resource Plan (IRP) set a more ambitious goal of 17,800 MW by 2030.
ix. Success in the bidding process does not mean that the targets/allocations have been achieved, as implementation can lag the approval process. However, because of the very stringent financing and technical requirements imposed by the government, implementation is a reasonable certainty.

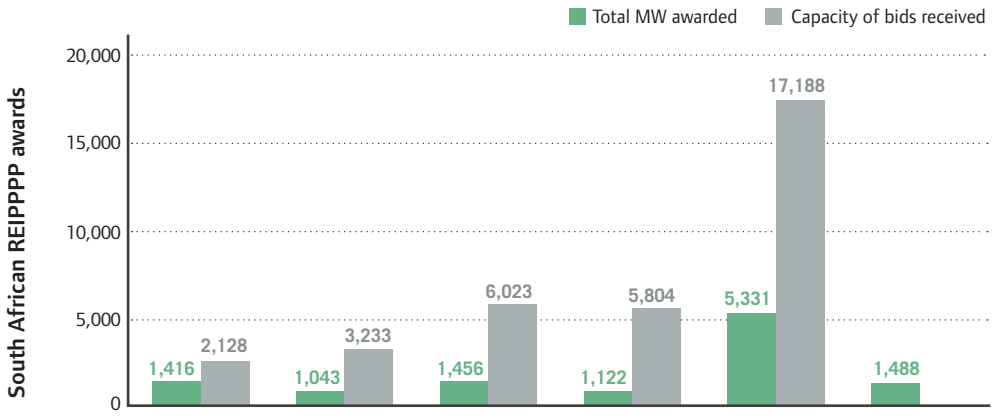
TABLE 14 | Renewable energy targets in SADC member states

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

* The targets noted here are those set by the South African government in its White Paper and 2010 IRP, and do not include the "allocation" targets set for the REIPPPP.

South Africa has used its "allocations" in the four windows of its REIPPPP bidding process as a means of targeting for renewables overall as well as for specific renewable energy technologies (see table 15).[21] For example, in bidding window 4, the overall target was 1,105 MW, but the actual energy value of winning bids was 1,121 MW, out of a total of 5,804 MW of bids submitted.[22] In some earlier windows, targets for MW from specific technologies were not fulfilled at all, such as the target for small-scale hydro in window 3.[23] The recent extension of bidding window 4 targets an additional 1,084 MW of renewable energy.[24] The expanded and accelerated ministerial determination on renewable energy of April 2015 granted an additional 6,300 MW for all renewable energy technologies.

TABLE 15 | Summary of South African REIPPPP awards as of May 2015



	Window 1 2011	Window 2 2012	Window 3 2013	Window 4 2015	Bids accepted	Remaining allocation
Solar PV	632	417	435	416	2,116	626
CSP	150	50	200	0	550	0
Wind	634	562	787	676	2,617	660
Biomass	0	0	16	25	16	19
Biogas	0	0	0	0	0	60
Landfill gas	0	0	18	0	18	7
Hydro	0	14	0	5	14	116

Source: See endnote 21 for this section.

Several countries have set long-term targets for specific renewable energy contributions to electricity, but they have not stipulated the rate of implementation, as, for example, the South African bidding system has. Mozambique has identified "potentials" for different renewable energy sources (*e.g.*, 23 TW for solar, 18 GW for hydro) and then targeted a set "priority" amount (*e.g.*, 597 MW for solar, 5.4 GW for hydro) to be achieved by 2025. Tanzania has set an overall target for electricity output from renewables, from a current 370 GWh per year to 2,000 GWh per year by 2020, but it has not provided interim targets for implementation. And Botswana, under its REFIT programme (still under review) has proposed a renewable capacity addition of 43.5 MW for projects between 5 kW and 5 MW (larger projects will be subject to a negotiated tariff) for the period 2011-2014.

Zimbabwe, which has several undeveloped large-scale hydropower resources, has targeted 150 MW of additional small-scale hydro by 2020 in its National Energy Policy (2012).[25] The government planning blueprint Zim Asset, issued in 2013, proposes a target of 300 MW from renewable energy sources, including 100 MW from solar.[26] To date, no solar projects have been commissioned, although several mini-hydro projects are already operational, including 21 MW of hydro by one company alone (Nyangani Renewable Energy).[27]

Mauritius has developed targets for bagasse, wind, waste, solar and geothermal, and Angola has a specific target for hydro capacity, while several countries (Angola, Malawi, Mozambique) have identified specific targets for biomass and biofuels.

Not surprisingly, targeting in most countries is influenced by resource availability and local expertise. For example, increased use of large-scale hydro for electricity generation is the dominant opportunity in six of the member states: Angola, the DRC, Lesotho, Mozambique, Zambia and Zimbabwe. Several other countries – Namibia, Swaziland and Tanzania – have greater potential for small-scale hydro, and this is reflected in their planning work. The potential availability of very significant hydro resources in the DRC is influencing renewable energy targets and policies in all of the SAPP-connected countries.

Wind is a major potential source of renewable energy in five countries – Angola, Lesotho, Mauritius, Mozambique, and South Africa – with Mauritius and Mozambique having specific wind power targets. Neither Angola nor Namibia has developed targets for wind energy, despite being the recipients of numerous proposals from private developers and having large wind energy potential. South Africa has included specific targets for wind energy only in its planning through the REIPPPP, rather than through the national strategy. For example, in window 1, 1,850 MW of wind energy was targeted, but only 634 MW was awarded; in window 2, 650 MW was targeted and 563 MW was awarded. In windows 3 and 4, the targets were exceeded: 654 MW was targeted in window 3 and 787 MW was awarded, whereas in window 4,590 MW was targeted and 676 MW was awarded.[28]

Geothermal energy is a relative newcomer to the renewable energy scene in the SADC region, having been formally identified in only one country, Tanzania. Other countries abutting on the Rift Valley formation – the DRC, Malawi, Zambia, Zimbabwe and possibly Mozambique – have included geothermal potential in their planning but have yet to identify specific targets. If substantial geothermal resources are confirmed in the latter countries, it could have a substantial impact on renewable energy policy and target development.

Targeting of biomass energy for power generation is less common in the region, perhaps reflecting a lack of experience with new technologies. The major source of biomass for power generation in the region is bagasse, which already is used for self-generation by sugar companies in seven member states: Malawi, Mauritius, Mozambique, South Africa, Swaziland, Zambia and Zimbabwe. All of these countries have targeted expanded use of bagasse for grid electricity and are negotiating the changes with both existing and new companies in the sugar industry. For example, Mauritius has targeted a 17% share of electricity from bagasse in 2025 (compared to 15.5% in 2014) and an overall target of 35% from renewables.[29] Although small, this target is based on substantially increased demand which will be met by a variety of renewable sources, including bagasse.

Targets for the transport sector are found in only one country, South Africa, where the National Energy Efficiency Strategy includes a target of a 15% reduction in final energy demand for transport use by 2015.[x] Targets have been set in several member states (Angola, Malawi, Zambia and Zimbabwe) for increasing production of renewable liquid fuels such as ethanol and biodiesel, which involves setting a mandate for blending rather than a specific quantity target.

Involving the sugar industry is key to setting and meeting targets for ethanol. Several countries are examining opportunities for ethanol production, either by expanding production in existing sugar plants (Malawi, Mauritius, South Africa and Zimbabwe) or by developing new plants (Mozambique, South Africa and Zambia). This requires establishing a blending rate (E5, E10, E15, E20, etc.) and then determining what level of production would be required to achieve this rate. Importantly, no SADC country has sufficient production capacity to go beyond an E20 blend. Botswana has explored using sweet sorghum as an alternative feedstock for ethanol but so far has set no targets.[30]

Targets for biodiesel (from vegetable and tree oils) are less common, as most countries are struggling with ethical concerns over the use of oil crops for fuel rather than food and have less experience in producing biodiesel than they do in producing ethanol. Botswana conducted a feasibility study in 2007, targeting production for B5 and B10 blends of 28 million litres and 56 million litres, respectively, by 2017.[31] However, this has been temporarily suspended as the country reviews the impact of biodiesel crops on agricultural production. Zambia has set a B5 target but has not yet enforced it. Zimbabwe, which developed a jatropha programme and a biodiesel plant in 2008, has set targets for biodiesel but has not succeeded in implementing large-scale production so far.

Policies and Programmes

In contrast to the relatively uneven distribution of renewable energy targets in the region, all SADC member states have introduced specific policies and programmes to encourage renewable energy development. Table 16 summarises all current renewable energy policies, including general energy policies that have guided the development of specific renewable energy policies.

Table 17 summarises the range of renewable energy support policies being used in SADC member states, including both regulatory policies and fiscal incentives and public financing. As the table shows, some types of policy either are not being implemented in any SADC country (such as utility quota obligations, energy production payments, and public investment, loans or grants) or are found in only one or two. Several policies are in preparatory stages and have been included in the table because of the high probability that they will be adopted (*e.g.*, the FIT programmes in Botswana, Namibia and Zimbabwe). The most common policies are FITs (typically limited to below utility-scale sizes), followed by biofuels mandates, capital subsidies and grid code reviews.

x. Note: this is an efficiency target, not a renewable energy target *per se*.

TABLE 16 | Renewable energy policies, programmes and laws in SADC member states

	Policies and strategies	Technologies included
Angola	General Electricity Law 1997	
Botswana	Draft Botswana National Energy Policy (2015), Biomass Energy Strategy, REFIT (2010, under review)	Biomass, solar PV, solar water heating, CSP, wind
DRC	Information not available	Biomass, hydro, solar, wind
Lesotho	Energy Policy Framework, 2002; Energy Action Plan, 2003	Improved cookstoves, hydro, solar PV, wind
Malawi	National Energy Policy (2003); Biomass Energy Strategy (2009); Draft Renewable Energy Strategy (2014); Rural Electrification Fund (REF) (2004); rural electrification regulations (2008); Rural Electrification Act (2004); Energy Act (2004); Electricity Act (2004)	Biomass, biogas, municipal waste, small-scale hydro, geothermal, solar, wind
Madagascar	Madagascar Action Plan; National Program promoting development of renewable energy sources for the period 2014-2019	Solar cookers, renewable-based power generation
Mauritius	Long-term Energy Strategy 2009-2025; Action Plan for the Energy Strategy 2011-2025	Ethanol from sugar cane, hydro, solar PV, wind
Mozambique	Master Plan for Off-Grid Energy (2008); National Biofuel Policy and Strategy (2009); Policy for Renewable Energy (2011); Biomass Energy Strategy (2013)	Improved cookstoves, biofuels, solar PV, solar water heating, wind
Namibia	White Paper on Energy Policy (1998); Off-grid Energisation Master Plan; Electricity Act of 2007 (Act No. 4 of 2007), REFIT Guidelines, drafted in 2014	Biomass, solar PV, wind
Seychelles	Sustainable Development Strategy 2010-2030; Seychelles Energy Act 2012	Biomass, waste, solar PV, wind
South Africa	1998 White Paper on Energy Policy; 2003 White Paper on Renewable Energy; Integrated Electricity Resource Plan (2010 update); Renewable Energy Independent Power Producer Procurement Programme (2011)	Bio-energy, waste, small-scale hydro, solar PV, onshore wind
Swaziland	National Energy Policy (2002); National Energy Plan (NEP, 2003) and the related National Energy Implementation Strategy (NEPIS, 2009); Renewable Energy Action Plan, 2007	Biomass, bagasse, hydro, solar PV, solar water heating, wind
Tanzania	Small Power Producer (SPP) Framework for facilities up to 10 MW. No REFIT yet. Biomass Energy Strategy (2014)	Biomass, waste, small-scale hydro, solar PV
Zambia	National Energy Policy 1994	Biomass, hydro, solar, wind
Zimbabwe	Rural Electrification Master Plan; Alternative Energy Strategy; Biomass Energy Strategy; Renewable Energy Strategy (in process)	Biomass, biogas, hydro, solar, wind

TABLE 17 | Renewable energy support policies in SADC member states

		Regulatory policies						Fiscal incentives and public financing		
	Renewable energy targets	Feed-in tariff/ premium payment	Net metering	Biofuels obligation/mandate	Grid code revisions	Tradable renewable Energy credits (RECS)	Tendering	Capital subsidy, grant or rebate	Investment or production tax credits	Reductions in sales, energy, Co_2, VAT or other taxes
Angola	X									
Botswana	X	X					X			
DRC	X									
Lesotho	X									
Madagascar	X									
Malawi	X			X						
Mauritius	X	X	X		X		X	X		
Mozambique	X			X	X					
Namibia	X	X	X				X			
Seychelles	X						X			
South Africa	X		X	X	X	X	X	X	X	X
Swaziland				X						
Tanzania	X	X						X		
Zambia	X	X		X	X			X		X
Zimbabwe	X	X	X	X	X		X	X		

Note: The "X" indicates the presence of the listed policy type in the country. No SADC member states have implemented electric utility quota obligations/RPS, energy production payments, or public investment, loans or grants.

Generally speaking, FIT policies remain in the early stages of development, with most countries still deciding whether to follow the South African example of competitive bidding or to establish a conventional FIT system with promotional tariffs; however, these options are not mutually exclusive, as the Tanzania case demonstrates. Mauritius established FITs for IPPs of 50-400 kW in 2010, as well as a net metering scheme with an overall cap of 2 MW (now increased to 5 MW) and a limit of 50 kW for independent generators.[32] This followed an earlier period in which negotiation with IPPs took place on an *ad hoc* basis.

Botswana is considering adopting a FIT programme for smaller facilities (under 5 MW), with a bidding system for larger facilities. Zimbabwe's FIT (due for approval in 2015) will be based on a tariff near the levelised cost of energy for each technology (like those in most countries); however, it will include purchase guarantees and a lengthy contract period of 25 years, so tariffs will vary according to technology and size of facility, as they have with most FIT programmes worldwide.[33]

Namibia's FIT programme, drafted in 2013, is awaiting final approval as this report is written. As with Botswana's FIT, it was designed primarily for facilities under 5 MW, but it has a detailed tariff schedule with different tariffs for different facility sizes (seven levels in all) and for biomass, solar and wind projects.[34] Namibia already has implemented a bidding system for projects larger than 5 MW, and it received 50 bids for construction of three solar PV power stations – with a combined capacity of 30 MW – in the Erongo, Otjozondjupa and Hardap regions. Finalisation of bids is awaiting government action on implementation agreements.[35]

Swaziland is developing a Renewable Energy and Independent Power Producers Policy (REIPPP) that will allow the country to fully realise its untapped renewable energy potential, in particular solar PV and co-generation from bagasse.[36] Swaziland does not have a FIT programme but is negotiating with potential developers on a one-on-one basis. The REIPPP is expected to be a combination of standardised PPAs and guidelines for submission of proposals.

In Tanzania, the Energy and Water Utilities Regulatory Authority (EWURA) has developed a new Small Power Producer (SPP) programme, offering model PPAs, standardised tariffs, and streamlined interconnection and licensing requirements. The regulations provide a legal basis for small renewable power developers to export excess electricity to the national utility (up to 10 MW capacity). Prices are based on the avoided cost of electricity supply to the main utility, TANESCO. As of the end of 2013, TANESCO had signed PPAs for 46 MW of on-grid renewable energy, and it holds Letters of Intent for an additional 31 MW.[xi]

EWURA recently announced a second phase of the SPP programme that includes a two-pronged approach to project approval: FITs for small-scale hydro and waste biomass (not grown biomass) projects, and competitive bidding for wind and solar projects. The capacity limit of 10 MW remains in place.[37] In addition, the country's Renewable Energy Agency (REA) initiated a programme to develop 60 mini-grid and stand-alone renewable energy projects and implemented the Lighting Rural Tanzania competition covering over 100,000 households.[38]

Several other countries – Angola, Zambia and Zimbabwe – have instituted specialised rural energy/electrification agencies or authorities similar to Tanzania's REA, which are playing key roles in both grid-based electrification development and off-grid, including mini-grids. Mauritius recently indicated that it will create a Mauritius Renewable Energy Agency (MREA), responsible for promoting renewables for electricity generation.[39]

Quota obligations or renewable portfolio standards (RPS), a popular policy globally for enforcing renewable energy contributions to power generation, have yet to be introduced in the SADC region, although several countries, including Namibia and Botswana, are reviewing the idea.

Net metering is an attractive alternative or complement to a FIT for smaller facilities such as household-level solar PV, as it does not require detailed contracts or financial analysis. Only two SADC member states – Mauritius and Namibia – have instituted net metering, but South Africa and Zimbabwe are planning similar programmes. In Namibia, net metering is limited to facilities with a "generation capacity" of 500 kVA or lower – effectively, small businesses and households. In Mauritius, the programme is limited to 5 MW and is designed primarily for household-scale renewable energy.

In South Africa, net metering is already in place in several towns in the Western Cape (where electricity distribution is handled through the municipality), and the national regulator is looking at developing regulations for "small-scale embedded generation", *i.e.*, household- and small business-size generation.[40] In the South African case, net metering is seen as a way to ramp up renewable energy supply without the long delays and complex bureaucracy typical of bidding systems.

Beyond the REIPPPP, which caters mostly to utility-scale projects, South Africa has adopted a Small Projects Programme (SPP) (up to 5 MW capacity), with simpler rules, as a means to encourage smaller PV and wind generation facilities that would not be involved in the regular bidding system.[41] Unlike REIPPPP, the SPP uses a ceiling price for different technologies, thus acting like a FIT but with a competitive element.[xii]

Biofuels mandates have been in existence since the mid-1980s in Malawi and Zimbabwe and are usually expressed in terms of the blending mandate or target for a particular type of biofuel, such as E10, E15 and even E20 for ethanol, and B5 or B10 for biodiesel. Angola, Mozambique, South Africa and Zambia also have introduced mandates, although enforcement is variable and not all mandates are embodied in formal government policy. Zimbabwe introduced a new blending mandate in 2013 through a statutory instrument targeting E5, and increased its mandate to E15 in 2014.[42]

Several SADC countries are considering **grid code revisions** to recognise renewable energy as a valid form of grid energy and to ensure that proper safeguards are in place for both parties to a PPA. Zambia introduced its first grid code only in 2013 following an initial draft in 2006 which was never formally adopted.[xiii] Mauritius has developed a grid code for renewable energy IPPs with capacity below 50 KW, and South Africa has made an extensive revision to its code in anticipation of the expansion of REIPPPP.[43] Zimbabwe is reviewing its grid code, and revisions to accommodate renewable energy are expected soon.

Renewable energy certificates (RECs) have been developed in only one SADC country, South Africa. The REC system was initiated in 2004 to provide a flexible mechanism for verifying and

xi. See SREP, "Investment Plan for Tanzania", May 2013, p. 15.
xii. This is similar to the approach used in window 1 of the REIPPPP, when a FIT with firm prices was first considered and then withdrawn and converted to a "price ceiling" for the bid process.
xiii. The recent IRENA RRA study for Zambia recommended further revision of the grid code to ensure that it includes "all aspects such as guidelines and standards for connecting and managing variable power sources, like solar and wind".

monitoring the use of renewable energy in the country while at the same time financing renewable energy projects. The REC market in South Africa is voluntary, and all market participants help to supervise the scheme. They automatically become members of RECSA, the association of voluntary REC market participants in South Africa, when they start to produce, trade or consume RECs in the country. There are approximately 100 active market participants in RECSA. A commercial company, zaRECs (Pty) Ltd., administers the voluntary REC market consistent with the rules of the European Union market specifications on behalf of members of RECSA.

The sources of RECs have been limited so far to South Africa. However, because RECs in South Africa are essentially a form of voluntary market instrument, usable primarily for "greening" projects or activities, there is in principle no reason why other SADC countries (or organisations within these countries) could not participate in the market. Already, the number of participant countries is growing through recognition of the international REC standard, and interest has come from Kenya, Namibia and Uganda. One emerging development is the potential to use the existing REC system for registration and issuance of offsets from small-scale renewable energy projects within the proposed South African Carbon Tax Offset system. Further financial instruments are being developed that will use the REC system for purposes of monitoring.

As of July 2015, 133,775 MWh (1 MWh = 1 REC) had been redeemed (traded) in South Africa's voluntary market. Certificates are readily available from rural solar PV, CSP, bagasse and hydropower facilities.[44] Importantly, RECs in the South African market are not generated solely by large- or utility-scale renewable energy projects, but also have been used as a source of financing for energy-efficient low-income housing.

Competitive tendering of renewable energy projects by governments or utilities is emerging as an attractive alternative to FITs.[xiv] For countries where tariffs are still not cost-reflective (*e.g.*, Zambia), or where the financial status of power utilities is in question, a FIT has the potential to tie utilities down to a lengthy financial commitment that they may not be able to meet (although some tendering systems may have the same limitation). Viewed from the developers' perspective, FITs also may be unnecessarily conservative in a situation where user tariffs frequently are being adjusted upwards, as is the case in South Africa.

Botswana and Namibia are considering tendering for larger, utility-scale renewable energy projects (generally 5 MW and above) and may consider retaining the FIT option for smaller projects. Tendering is more likely to be exercised after the initial FIT policies have been in force for several years. Depending on initial feedback from the implementation of FIT polices, It is expected that more SADC countries will supplement FIT programmes with tendering, and that the experience gained in the South African market will ensure that renewable energy developers have the confidence to submit strong proposals for projects in other countries in the region. Alternatively, a generous FIT regime may serve as an incentive for new developers who want more certainty of success than that offered by the competitive South African programme.

Capital subsidies, grants or rebates are relatively rare in the region, reflecting the financial limitations of many SADC countries. However, a number of countries have developed funding mechanisms for subsidising rural energy development. Zambia, for example, instituted a Rural Electrification Fund (REF) in 2004, ensuring that financial resources are provided for the development of rural electrification projects (both conventional and renewable energy). As mentioned earlier, the fund is drawn mainly from a 3% levy on every unit of electricity consumed, as well as from grants and loans from development partners, and is aimed at encouraging private sector participation by providing finances for project preparation studies and smart-capital subsidies. The REF can in principle provide a 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.[45]

Malawi, Tanzania and Zimbabwe also have rural energy funds which, like Zambia's, are designed to use the proceeds from special levies to co-fund projects, especially those for off-grid operation. It is important to note that these tariff-based subsidy programmes often can place an additional burden on utilities, some of which are already struggling to meet customer demand and achieve financial stability. Getting the right formula for financing rural electrification, whether through additional levies or increased connection fees, is therefore essential for sustainability. On the other hand, there is broad recognition that these programmes are necessary and effective and therefore are unlikely to be changed in the near future.

Mauritius implemented a solar water heater grant of USD 300 in 2008 which, although successful, was quickly oversubscribed (supplementary programmes were developed subsequently and are still functioning).[46] In South Africa, a solar hot water rebate programme was initiated in 2008 and was implemented through the utility Eskom; an estimated 330,000 low-pressure systems were installed as of the end of 2012, in addition to 85,000 high-pressure systems – lagging well behind the original government target of 1 million installed solar water heaters by 2014. Rebates varied according to the size of the system installed and its associated electricity saving potential or capability to replace electricity (efficiency). Rebates range from ZAR 3,280 to ZAR 8,964 (USD 273 to USD 747) depending on the system purchased.

Although South Africa did not achieve the specified target, a more ambitious target of an additional 1.3 million high-pressure solar hot water units has now been set by the Department of Energy, following an assessment that recognised the major implementation challenges, including local content and the need to convince people to switch from low- to high-pressure systems.[xv] The rebate programme, administered by Eskom, was handed over to the Department of Energy in mid-2015 for continued implementation.[47]

xiv. Tendering is the preferred strategy in cases where pricing uncertainties make it difficult to set a tariff that both motivates developers and yet protects the financial and material interests of buyers, *i.e.*, the utilities.
xv. A new implementation framework for solar hot water was approved by the Cabinet on 24 June 2015 (M. Balmer, GIZ-SAGEN, personal communication with REN21, 13 July 2015.)

NATIONAL ENERGY EFFICIENCY TARGETS AND POLICIES

At present, targets and policies on energy efficiency in the SADC region are found exclusively at the national level. These initiatives are discussed in detail in the following sub-sections.

Targets

Targets for energy efficiency range from broad national targets included in national Energy Master Plans, to specific programme goals. The most widely used measures are targets for encouraging the replacement of inefficient lighting. Targets for introducing standards and labelling for household appliances are relatively uncommon.

Table 18 provides a summary of energy efficiency targets by type of programme. Because most targets are qualitative rather than quantitative, the table is simply an indication of whether a particular policy target has been, or soon will be, implemented.

TABLE 18 | National energy efficiency targets in SADC member states

	Target type						
	Lighting retrofit	Reduce electricity distribution losses	Improved cooking devices	Load management	Standards and labelling	Financing	Revised building codes
Angola	X						
Botswana	X	X	X	X		X	X
DRC	X						
Lesotho	X		X				
Madagascar		X	X				
Malawi	X		X				
Mauritius	X			X			
Mozambique	X		X				X
Namibia	X			X			
Seychelles							
South Africa	X	X	X	X	X	X	X
Swaziland	X		X				
Tanzania	X		X				
Zambia	X		X				
Zimbabwe	X	X	X	X			

Note: The "X" indicates the presence of the listed target type in the country.

The most ambitious targeting exercise to date is that undertaken by the South African government, which developed two related documents: the National Energy Efficiency Strategy of the Republic of South Africa (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). The country also issued a series of policy initiatives related to Eskom's Power Conservation Programme, a voluntary programme primarily for large users.

The latest versions of these documents were prepared in response to Eskom's dwindling reserve margin and the threat of major power shortages in 2008. The original Efficiency Strategy proposed a target of 12% savings by 2015, against a 2005 baseline. This was not altered in the 2009 revision, but was simply re-stated as a "Final Energy Demand Reduction of 12% by 2015". In addition, the government stated that the targets were voluntary but reserved the option to make them mandatory in some sub-sectors.

The original 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. This is being monitored every few years by an NGO, the National Business Initiative.[48]

Policies and Programmes

SADC member states are moving forward with innovative policies to address the need for more-efficient uses of energy. Key innovations include the replacement of inefficient incandescent bulbs with CFLs (in the residential sector), the development of DSM programmes for the commercial and industrial sectors, hot water load management and encouraging the use of improved cookstoves in rural and peri-urban areas. In most countries, these policies are (as with renewable energy) in early stages of development and are presenting significant challenges in terms of financing and capacity building. Nevertheless, there is noticeable progress in most countries.

Although attracting great interest in the region, South Africa's approach to energy efficiency may not provide the best model for other countries. The country's power capacity dwarfs all others in the region, and its technical and management capabilities also are extremely high. The Standard Offer approach used in the commercial and industrial sectors requires participating companies to quantify their proposed load reduction and to commit to this in a formal contract. The mechanism 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. Combined 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.[49]

The South African programme depends for its success on having a mature energy services sector, in which energy service companies (ESCOs) act as the main initiators of such demand-side projects. ESCOs are not found in most other SADC member states, although there is some evidence that they are emerging in Namibia, Zambia and Zimbabwe.

In 2013, South Africa passed a regulation to promote energy efficiency in commercial buildings and industrial facilities. The new regulation provides tax incentives for businesses that can demonstrate measurable energy savings and specifies the process for determining the amount of energy savings achieved through efficiency measures.

After DSM programmes were suspended temporarily in 2014 due to insufficient funding, Eskom and NERSA, the national regulator, agreed to re-start the programmes, targeting a load reduction of 975 MW in 2015.[50] The EEDSM was superseded by the Eskom Integrated Demand Management (IDM) programme, which includes Mandatory Energy Regulations (expected to be implemented in August 2015) as well as the following components:

- An Energy Efficient Monitoring System (EEMS) for companies using more than 180 terajoules of energy from all sources during a calendar year.
- Compulsory registration for companies exceeding that threshold, and strict annual energy usage reporting.
- Required annual energy reporting.
- Submission of a detailed energy management plan for companies using 400 terajoules or more per year, which should include an energy baseline determined in accordance with SANS 50001, as well as areas of energy efficiency savings potential and energy performance indicators.

South Africa has several other private and government-driven energy efficiency programmes (see sidebar 8).

Namibia has undertaken a review of DSM through the national regulator (Electricity Control Board) and the national utility (NamPower). As noted earlier, NamPower has instituted a policy of CFL distribution, resulting in displacement of 900,000 incandescent bulbs and a savings of 14 MW of peak demand. A system of hot water load control for geysers and air conditioners also was instituted in the major cities, and time-of-use tariffs were introduced in 2009.[51]

Table 19 summarises the current energy efficiency support policies in SADC member states. There also has been significant progress in establishing DSM policies on a regional basis through SAPP, which has provided guidelines and training in DSM for its member utilities (see sections 3 and 5).

Several SADC member states have instituted efficiency policies and programmes for commercial buildings, focusing on lighting and HVAC systems as two main areas for improvement. The Namibia Energy Efficiency Programme in Buildings (NEEP), started in 2011 with UNDP funding, aims to promote the use of energy-efficient technologies and practices in the country's commercial and residential building sector. NEEP focuses on government buildings, hospitals, hotels, schools and some residential buildings, with the goal of introducing new standards for construction and retrofit that will improve building energy loads. Botswana has instituted a similar activity, resulting in publication of a set of energy-efficient design guidelines for buildings in 2010.

Policies for reducing electricity distribution losses are a key feature of several national plans, but these usually are implemented via the national utility. For example, TANESCO (the Tanzanian utility) has provided a capital allowance in its annual plans from 2012 forward for repair and maintenance of transmission and distribution lines, and expects to generate a financial surplus from reduced losses which also will serve to maintain new lines and generating stations.[52]

Zimbabwe has an Emergency Power Rehabilitation Project that includes reducing transmission and distribution losses as well as rehabilitating older power stations such as Hwange.[53] The project is funded by the Zimbabwe Multi-Donor Trust Fund (ZimFund), co-financed by AfDB and the Zimbabwe government.

Mozambique has included a programme to reduce transmission and distribution losses in its Electricity Master Plan, but like most such programmes in the region, it is dependent for funding on either donor support or generation of surplus revenues.

Sidebar 8. Other South African energy efficiency programmes

- The National Cleaner Production Centre, supported by UNIDO and hosted by the Council for Scientific and Industrial Research.
- The National Business Initiative Private Sector Efficiency Facility.
- The National Business Initiative "Energy Efficiency Accord", a voluntary programme initiated in 2004 with 40 major corporations as signatories.
- South African Revenue Service Renewable Energy and Energy Efficiency Incentives, comprising regulations pertaining to the 12L Energy Efficiency Tax Incentive (together with updated amendment) and the R&D Tax Incentive.
- A proposed Carbon Tax by National Treasury, which is structured to be revenue-neutral and targets energy-intensive users.

TABLE 19 | Energy efficiency support policies in SADC member states

	Policy type									
	Industrial commercial load reduction	Residential incentives (lighting, hot water load control)	Support for efficient cooking and heating	Building efficiency guidelines	Solar water heater subsidies	Mandatory energy management for industry and buildings	Reduced distribution losses	Transport efficiency standards	Biofuels production incentives/ tax credits	Voluntary business energy efficiency programmes
Angola	X									
Botswana	X	X	X	X	X					
DRC										
Lesotho			X							
Madagascar										
Malawi			X						X	
Mauritius	X				X		X			
Mozambique			X				X			
Namibia	X	X	X	X						
Seychelles										
South Africa	X	X	X	X	X	X	X	X	X	x
Swaziland										
Tanzania			X							
Zambia			X							
Zimbabwe	X	X	X						X	

Note: The "X" indicates the presence of the listed policy type in the country.

05

INVESTMENT FLOWS

05 | INVESTMENT FLOWS

GLOBAL OVERVIEW

The renewable energy sector continues to be an attractive market for public and private investors, and gross investment in renewables is closing the gap on fossil fuels. Globally, an estimated USD 270.2 billion was invested in renewable energy technologies in 2014, excluding large-scale hydropower. Although this figure is below the peak investment of USD 279 billion recorded in 2011, the trend over the 10 years since 2004 shows a 600% increase in renewable energy investment.

Overall, Africa attracted USD 8 billion in renewable energy investment in 2014 (compared to USD 5.3 billion in 2013) – about 3% of global investment.[1] In the first quarter of 2015, two of the top five asset finance transactions were in Africa.[2] Within the African figure, three countries in southern Africa – South Africa, Tanzania and Mauritius – accounted for USD 5.8 billion in investment, with South Africa alone accounting for USD 5.5 billion.[3]

South Africa's dominant position is perhaps not surprising. Its energy requirements – 41,990 MW of installed capacity at the end of 2013, and an additional 40,000 MW of demand by 2025 – far exceed those of the rest of the continent combined.[4] Facing critical capacity shortfalls, South Africa has embarked on an ambitious programme to increase renewable energy as well as conventional electricity capacity by allowing IPPs to enter the market.

Other SADC countries are also now attracting new investors, from both the private and public sectors. Investor interest in renewable energy is increasing rapidly in Mozambique and Tanzania – where progressive regulatory regimes have been put in place – as well as in Angola, Botswana, Namibia and Zimbabwe, where FITs either have been approved or soon will be approved. Although new investment is focused mostly on new large-scale hydro developments in the DRC, Mozambique, Zambia and Zimbabwe, interest in small-scale hydro, solar PV, CSP and wind is also increasing.

South Africa's main advantages are its sophisticated financial institutions, coupled with its use of tax incentives and other support mechanisms that make foreign investment more attractive. But Eskom's continuing financial challenges may also make it difficult to sustain the present rate of renewable energy build-out. Countries such as Tanzania are stepping into the breach by offering new kinds of incentives such as avoided-cost tariffs and simpler contracting arrangements.

Nevertheless, SADC countries each have their own unique challenges, and developing a FIT programme may not be sufficient to attract new investment unless other incentives are present, such as competitive tax regimes and reduced import barriers for renewable energy technologies.

RENEWABLE ENERGY PIPELINE

In addition to the many renewable energy projects already in place or approved for development with financing secure, a large number of projects are "in the pipeline"[i] in the SADC region. Table 20 summarises the total MW capacity of these projects by energy technology and country. As expected, large-scale hydro projects dominate the pipeline, led by Inga III in the DRC and the numerous Zambezi River projects. But solar and wind also are significant, particularly in South Africa, where an additional 1,084 MW of capacity has just been added for REIPPPP bidding window 4, and more is planned.[ii]

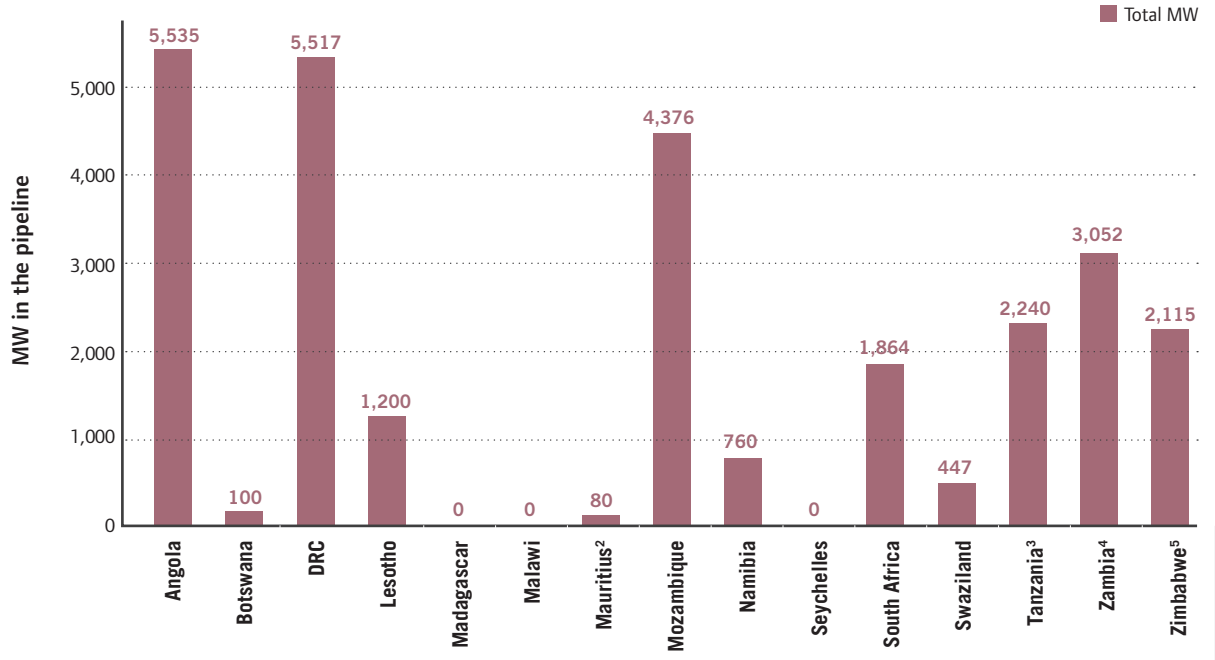
All REIPPPP projects are expected to have reached financial closure by a set date after bid award (in window 4, the date is Q4 2015); for this reason, it is assumed that REIPPPP projects are no longer in the pipeline if they have been selected in any of the four windows, including the extension of window 4, even if they are not yet operational. However the additional determinations of 1,800 MW to be acquired from a backlog of projects that did not qualify in the first four windows are treated as "in the pipeline".[iii] The additional 6,300 MW of projects that has now been requested for future windows is not included in the table, as it is uncertain when it will be realised.

i. This term often is used somewhat loosely to describe anything which has been discussed, either by governments as part of a broad national development strategy or by developers as part of a "wish list" of projects which could conceivably be funded but are nowhere near financial closure. Here, the term "pipeline" includes only projects which have at least reached the stage of feasibility or detailed planning studies but are not yet implemented.

ii. The successful bidders for this additional allocation were announced in June 2015; those selected were also bidders from the first round of window 4, and the new awards were for solar PV (six projects), wind (five projects), biomass and hydro (two each).

iii. As the ministry has not finalised the distribution by technology for the 1,800 MW addition, an arbitrary assumption has been made that 800 MW will go to wind, 600 MW to solar and 400 MW to biomass.

TABLE 20 | Renewable energy power projects in the pipeline in SADC member states, 2015



	Angola	Botswana	DRC	Lesotho	Madagascar	Malawi	Mauritius[2]	Mozambique	Namibia	Seychelles	South Africa	Swaziland	Tanzania[3]	Zambia[4]	Zimbabwe[5]	Total
Small-scale hydro (< 100 MW)											64.3			141	15	**220**
Large-scale hydro (> 100 MW)[1]	5,435		5,517	1,200				4,376	360			447	2,100	2,880	1,950	**24,265**
Wind	100						34				800					**934**
Solar		100					10		400		600			30	150	**1,290**
Geothermal													140			**140**
Biomass							36				400			1		**437**

[1] Large-scale hydro data from SAPP reviews; [2] Includes two waste-to-energy plants planned for municipalities; [3] Includes Lake Ngozi geothermal, at feasibility stage; [4] Includes Lunzua, Lusiwasi and Kapombo mini-hydro, 1 MW biomass at Kitwe and solar estimates from the IRENA RRA study; [5] Includes 150 MW solar PV project by Green Rhino energy and small-scale hydro on the Pungwe River.
Note: 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 such projects is often unreliable, and it is difficult to ascertain the status of financing.

Including large-scale hydro in the list also significantly increases the size of the pipeline for other countries, and minimises that of South Africa, which has no large-scale hydro resources (all current hydro pipeline projects for South Africa are less than 10 MW). Subtracting large-scale hydro potential (27,286 MW) from the pipeline capacity, the remaining sources total some 3,021 MW.

REGIONAL FINANCING SOURCES

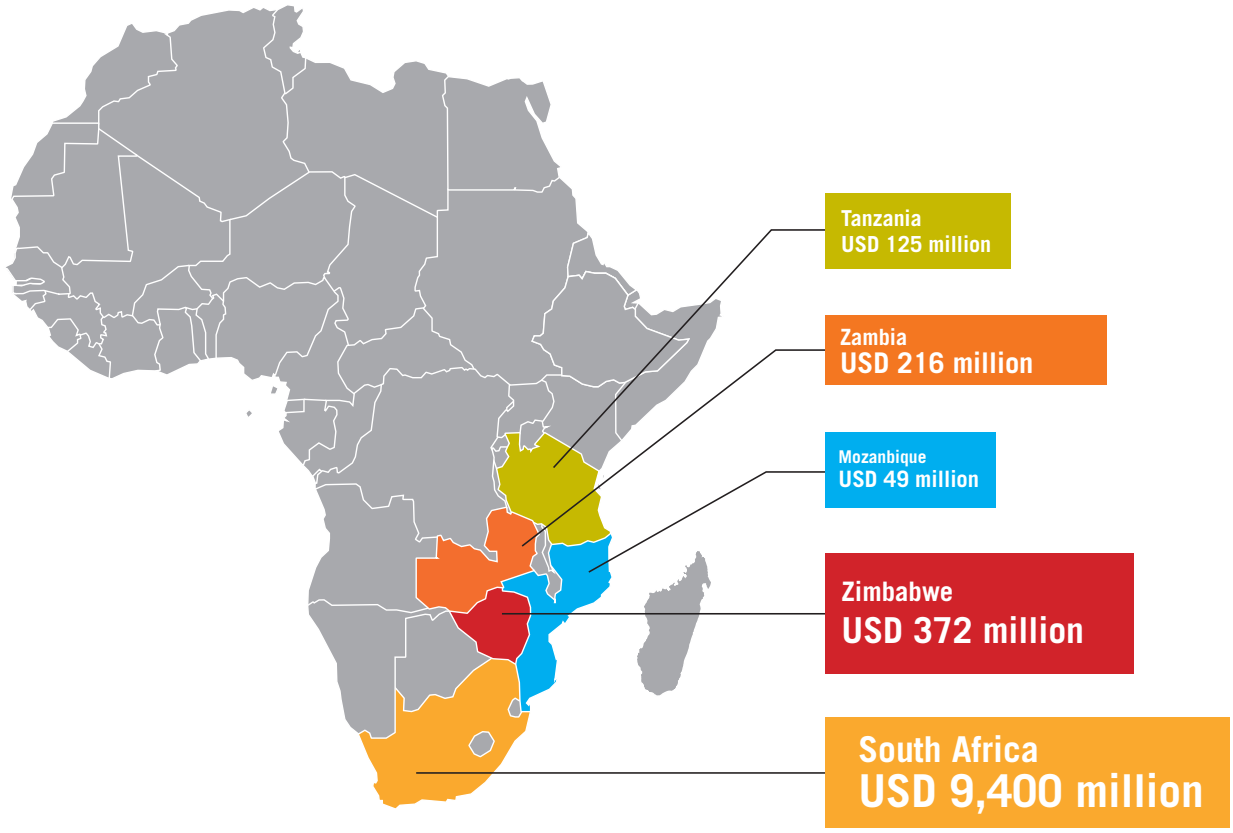
The renewable energy market is an increasingly attractive sector for both public and private investors in southern Africa. Although reliable data on investments in the sector are not available for all 15 SADC countries, Bloomberg New Energy Finance's 2014 *Climatescope* report ranks 6 member states – Botswana, Mozambique, South Africa, Tanzania, Zambia and Zimbabwe – against 48 countries globally and 15 in sub-Saharan Africa. Of the six member states, two – South Africa (no. 3) and Tanzania (no. 21) – rank high globally for investment potential. Investments in new renewable energy in the six SADC countries totalled USD 10.2 billion in the period 2006-2013 (see figure 13).[5]

Notably, no African countries apart from South Africa (ranked no. 6) scored well on greenhouse gas market activity and policy

indicators in the *Climatescope* rankings. This is because African countries have seen far less Clean Development Mechanism and other mitigation activity compared with Asia due to the current programme rules and a lack of well-developed projects and financing, while there are few national emissions reduction policies or corporate strategies in place.[6] A more detailed discussion of climate financing is provided later in this section.[iv]

Globally, private finance plays a key role in renewable energy development. In the SADC region, considerable effort has gone into encouraging private participation in the sector through a variety of initiatives and mechanisms, including FITs, tax incentives, customs rebates and even partial capital subsidies. Private finance has been particularly important in South Africa. The KaXu CSP project, discussed later, is a good example of this: financing for the project came from private commercial banks, international and regional development banks, and even the communities in which the project is located.

FIGURE 13 | Renewable energy investment in selected SADC member states, 2006-2013



The public sector also has played an important role in funding renewable energy development, with national governments, international development partners, multilateral development banks, and local and regional development financial institutions (such as the Development Bank of South Africa and the country's Industrial Development Corporation and Public Investment Corporation) all allocating funds to renewable energy development in the region. As noted earlier, several member state governments already are supporting the renewable energy sector by providing financial incentives and/or public financing to project development. The public sector also has acted as the principal arbiter in determining which firms will be allowed to develop projects and what the guidelines for investment shall be.

SADC itself aims to become a major player in project financing through its Development Finance Resource Centre (DFRC),

iv. With the exception of South Africa, SADC member states have very low CO_2-equivalent emissions, and some (*e.g.*, Botswana) are even "carbon neutral", *i.e.*, 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.

a subsidiary institution established in July 2003 to serve as a sub-regional centre of excellence to strengthen the SADC Development Finance Institutions (DFIs) Network and to enhance the capacity of the SADC DFIs to deliver on their mandates towards the achievement of the DFRC goals of economic growth, employment generation and poverty alleviation. Currently, the SADC DFIs Network has 34 members from 13 SADC countries.

The Development Bank of Southern Africa (DBSA) has been appointed by the SADC Secretariat as the implementation agent and fund manager for the Project Preparation and Development Facility (PPDF). This is designed to support non-recoverable Project Preparation Grants to carry out feasibility studies required to make investment decisions on infrastructure projects in eligible sectors. The PPDF will finance preparation of projects in the energy sector – including generation, transmission and distribution – among them projects supporting alternative and/or renewable energy. The PPDF will consider new (greenfield) projects as well as those in need of upgrading and/or rehabilitation.

The African Development Bank (AfDB) is a major public sector player and has been increasingly active in financing renewable energy. This is due in part to its role as an intermediary for a number of World Bank and UN funds, and to efforts to diversify its energy portfolio away from large fossil fuel projects and towards clean energy projects. The AfDB has a large energy sector portfolio and is increasingly active in southern Africa.

Regionally, southern Africa received USD 865 million (UA[v] 615.2 million), or 17.3% of total loans and grants approved by the AfDB in 2013, of which infrastructure investments – including energy, water and sanitation, and transportation – accounted for 62.6%.[7] Overall, energy accounted for 27.7% of the Bank's total loans and grants for infrastructure over the same period.[8]

Just over half (8 out of 15) SADC member states – the DRC, Lesotho, Madagascar, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe – are eligible for the AfDB's African Development Fund (ADF) concessionary window, which provides no-interest loans with a 50-year payback period (but includes a 0.75% annual service charge on outstanding balances).

The AfDB has been active in supporting renewable energy projects through its normal funding windows and through specialised windows such as the Sustainable Energy Fund for Africa (SEFA) and the various Climate Investment Funds, in particular the Clean Technology Fund (CTF). Examples of renewable energy projects in the SADC region funded partially or completely through the AfDB include:

- Under the CTF, the AfDB is co-financing the 100 MW Sere wind farm being developed by Eskom in South Africa's Western Cape. The AfDB itself is lending USD 45 million for the project, with an additional USD 50 million from the CTF via the AfDB.[9]
- The AfDB is providing support for a 100 MW CSP facility at Upington in South Africa's Northern Cape Province, also via Eskom, with a total value of USD 884 million (UA 628.7 million), of which the AfDB is providing USD 199 million (UA 140.8 million). The project also includes substantial financing from Eskom itself and from private sources as well as the European Investment Bank (EIB).[10] The International Finance Corporation (IFC) and the AfDB's private sector operations also have supported CSP projects in the context of South Africa's REIPPPP.
- Under SEFA, the AfDB is financing a USD 640,167 (UA 455,175) grant to assess the feasibility of using geothermal power for heat and electricity in Tanzania.[11]
- Through the ADF, the AfDB is funding a feasibility study for the Kholombidzo hydroelectric facility in Malawi, with a total value of USD 3.04 million (UA 2.15 million), of which the Bank is providing USD 2 million.[12]
- In Lesotho, the AfDB is supporting rehabilitation of the Manl'onyane mini-hydro station and installation of 350 solar home systems as part of the Mphaki Pilot Project. The AfDB is providing USD 15.5 million (UA 11 million) through the ADF, and the government and a private co-financier are providing USD 5.87 million (UA 4.18 million).[13]
- In Tanzania, the AfDB is using SEFA to support the development of solar-hybrid mini-grids in rural growth centres with a USD 420,000 preparation grant to Jumeme Rural Power Supply Ltd, a consortium of private and university organisations.[14] At the same time, the AfDB's African Legal Support Facility is funding development of a public-private partnership toolkit and regulations for energy projects in Tanzania.[15]
- The AfDB, via SEFA, is supporting private sector participation in renewable energy in Mozambique through a USD 740,000 technical assistance grant that will support implementation of a FIT regime, provision of standardised PPAs and guidelines for grid connectivity, and a mini-grid regulatory framework.[16]
- Finally, SEFA, via the AfDB, has approved a USD 1 million project preparation grant to support a private company – Sotravic Ltd – in developing and installing a sea water air conditioning system in Mauritius, an innovative energy efficiency project (see sidebar 6 in section 3).

Other multinational lending institutions, such as the World Bank and the EIB, also have prioritised the development of Africa's sustainable energy sector. Specialised funds for renewable energy deployment are playing an increasingly important role in supporting project development and catalysing financing in the region. For example, the multi-donor facility SEFA provides preparation grants and equity to bring small- and medium-scale renewable energy generation and energy efficiency projects to bankability.

v. The AfDB uses a Unit of Account (UA) equivalent as its reporting currency. The UA is equivalent to the IMF's Special Drawing Right (SDR). The conversion rate on 1 May 2015 was UA 1.0 = USD 1.40642.

The AfDB also hosts the African Renewable Energy Fund (AREF), a dedicated fund focused on sub-Saharan Africa with an initial USD 100 million of committed capital to support small- to medium-scale IPPs. AREF is targeting a final close of USD 200 million in 2015 to be invested in grid-connected, development-stage renewable energy projects, including biomass, waste gas, small hydro, geothermal, solar and wind. The AfDB and SEFA are the fund's lead sponsors, each contributing an equity investment of USD 25 million and mobilising USD 4.5 million from the Global Environment Facility (GEF). SEFA will also fund a USD 10 million Project Support Facility (PSF), which will provide resources to be deployed at an early stage to structure bankable deals. The total AfDB-mobilised package amounts to USD 65 million.[17]

The AfDB together with the World Bank are strong players in the Scaling Up Renewable Energy in Low Income Countries Program (SREP), for which Lesotho, Madagascar, Malawi, Mozambique and Zambia have been selected as second-phase pilot countries. This is expected to result in substantial financing from SREP for renewable energy projects in these countries.[18]

Currently, the SADC region has no home-based financing facilities for renewable energy comparable to the ECOWAS Renewable Energy Investment Initiative (EREI). A partial exception is DBSA, which was originally set up to finance infrastructure projects in South Africa's "homelands" during the apartheid era. DBSA is now a fully fledged regional development bank and has been involved in financing numerous renewable energy projects. The majority of this support has been funnelled into South Africa's REIPPPP, to which DBSA has contributed ZAR 6.7 billion (USD 558 million) in loans and an additional ZAR 1.3 billion (USD 108 million) in grants under its Black Empowerment programmes, for the first two REIPPPP bidding windows.[19]

More recently, DBSA joined with the EIB, IBRD and IFC to provide ZAR 1.4 billion (USD 130.4 million) to support development of the innovative KaXu CSP plant, a 100 MW parabolic trough plant in the Northern Cape Province of South Africa with molten salt storage and an estimated total cost of USD 860 million (see sidebar 9).[20]

DBSA also implemented the first phase (valued at USD 30 million) of the Energy and Environment Partnership, a grant programme developed by the Finnish, Austrian and UK governments to stimulate development of small energy efficiency and renewable energy projects in east and southern Africa. Between 2010 and 2015, EEP has funded 153 projects, of which 102 have been in the SADC region.[21] [vi] EEP projects must satisfy some or all of the following criteria to be supported:

Sidebar 9. Southern Africa's first CSP plant commissioned, others under construction

The Spanish company Abengoa and South Africa's Industrial Development Corporation (IDC) commissioned southern Africa's first 100 MW concentrated solar power plant in early 2015 , approved in window 1 of South Africa's REIPPP. The KaXu Solar One project uses parabolic trough reflectors to capture the sun's heat to power a steam turbine, and also incorporates a molten salt storage system that would generate the full 100 MW electricity for 2.5 hours on days when there is little or no solar radiation. The plant is located near the town of Pofadder in the Northern Cape Province.

KaXu Solar One is jointly owned by Abengoa (51% stake), IDC (29% stake) and KaXu Community Trust (20% stake). The estimated project cost is USD 860 million, financed by the International Bank for Reconstruction and Development (IBRD), the IFC and the EIB. The plant produces enough clean electricity to power 80,000 South African households, while preventing the emission of 300,000 tons of CO_2 annually.

A second CSP facility, the 100 MW Xina project, located nearby, is expected to be commissioned by 2017. Xina Solar One similarly uses parabolic trough reflectors and will be able to provide thermal energy storage for up to five hours. It will produce enough energy to serve more than 90,000 households and will prevent the emission of more than 398,000 tons of CO_2 annually when compared to a natural gas plant.

Another Abengoa project, also financed by IDC, is the 50 MW Khi Solar One project in Upington, which employs solar power tower technology, using saturated steam to drive a generator, and has two hours of saturated steam storage capacity. Khi Solar One will supply clean energy to approximately 45,000 households and prevent approximately 183,000 tons of CO_2 emissions per year.

The two latter projects have secured financing from the AfDB, DBSA, the Agence Française de Développement, the CTF, KfW and the World Bank.

Source: See endnote 20 for this section.

vi. The second phase of EUR 35 million is currently implemented by KPM. The number of projects includes both phases.

- provide sustainable energy services to the poor
- combat climate change
- demonstrate high innovation in delivering energy services
- facilitate technology transfer
- encourage co-operation and local stakeholder participation in projects.[22]

Financing renewable energy projects requires an innovative blend of loans from commercial and development banks, concessionary funding from sources such as the ADF, mezzanine financing from specialist groups looking for a long-term equity share, project preparation grants from international sources such as SEFA and local sources such as DBSA, and direct equity contributions from private developers. A blended approach is needed because renewable energy is still something of a novelty in the international finance sector and is viewed as sufficiently high-risk that conventional sources want to share the risk with other investors. As these projects reach maturity, and as investors become more fully acquainted with the risks and confident that the projects will reach the commissioning stage, less-complex financing may be possible.

South Africa's REIPPPP has contributed significantly to reducing investor uncertainty about renewable energy. However, as noted earlier, it also has led to a substantial imbalance regionally, with over 90% (USD 4.8 billion out of USD 5.3 billion) of renewable energy investments in Africa flowing to South Africa alone in 2014.[23] (Only one other SADC country, Mauritius, recorded as much as USD 200,000 in investments.[24 vii]) This is an area in which SACREEE, once established, can make invaluable contributions – for example by establishing a facility similar to ECOWAS's Renewable Energy Investment Initiative (EREII) and Renewable Energy Facility (EREF), to encourage the channelling of renewable energy investment funds towards the other SADC countries.[25]

Energy Efficiency Financing In South Africa

In South Africa, funding is available from the private sector and from quasi-governmental and government organisations specifically for energy efficiency projects. Although some projects are sufficiently attractive and already meet corporate investment criteria, others may require additional resources to meet with management approval. Examples of such resources include:

- The Green Energy Efficiency Fund (available through the IDC), which also supports renewable energy investments.
- DBSA's Green Fund and Renewable Energy Market Transformation (REMT) Fund.
- The four major commercial banks (Standard Bank, Absa-Barclays Africa, Nedbank and FNB) and also SASFIN and Investec now offer both renewable energy and energy efficiency financing, although it is conditional on variables such as tariff levels and excludes some sectors. For instance, the Mercantile Bank excludes activities/sectors that harm the environment and/or are considered immoral (*e.g.*, tobacco/cigarettes and casinos).

Other mechanisms for energy efficiency financing in South Africa include:

- Government incentives and grants (MECP, which is available through the Department of Trade and Industry for manufacturers, and for the Integrated Demand Management Programme available through Eskom).
- Funding through tax deductions: the South African Revenue Service allows for tax deductions for "Energy Generated through renewable energy, co-generation and energy efficiency"; biofuels are excluded where they negatively affect food security.

POTENTIAL OF CLIMATE FINANCE

As discussed in previous sections, climate finance has been used to support clean cookstoves projects in the SADC region; however, such projects represent only a small fraction of climate financing initiatives globally. In the past 5-10 years, the international community has established a variety of funds to support climate mitigation and "low-carbon" or "clean technology" developments generally, greatly expanding opportunities for financing renewable energy and energy efficiency projects.

The Global Environment Facility (GEF), set up following the 1992 Rio Earth Summit, has been a major contributor to projects in southern Africa. However, a high proportion of this funding focuses on adaptation rather than mitigation projects. Projects focused primarily on mitigation include:

- Lesotho: a renewable energy-based rural electrification programme (see section 4)
- Madagascar: a small-scale hydro development project
- Malawi: projects helping to remove barriers to renewable energy and to increase access to clean and affordable decentralised energy services
- Mauritius: programmes to remove barriers to energy efficiency, improve energy conservation in buildings and improve sugar-to-energy technology
- Namibia: development of a CSP project and a programme of energy efficiency in buildings

vii. Mauritius was identified as having the second highest renewable energy investment as a share of GDP globally. See REN21, *Renewables 2014 Global Status Report* (Paris: 2014), p. 16.

- Seychelles: support for grid-connected rooftop PV systems
- South Africa: funding for 13 mitigation projects, as well as several projects focused on "greening" the football World Cup in 2010
- Zambia: renewable energy-based mini-grids
- Zimbabwe: community- and household-level solar PV systems.[26]

Through the separate GEF Small Grants Programme, southern Africa has received funding for 1,667 different projects since 1992, approximately 25% of which have involved some form of climate change mitigation.[27] To date, there has been 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.

More recently, the GEF joined with the AfDB to create the Africa Climate Technology Finance Centre and Network (ACTFCN), supporting the deployment and scaling-up of both climate change mitigation and adaptation technologies. The AfDB will implement the project through the execution of a USD 9.09 million grant from the GEF Trust Fund and USD 5.25 million from the GEF Special Climate Change Fund. On the mitigation side, ACTFCN will focus exclusively on projects in the energy sector.[28]

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. Lesotho, Madagascar, Malawi, Tanzania and Zambia have been included in the pilot phase of SREP, for which USD 796 million has been pledged. Within this programme, Tanzania has received project preparation funding for geothermal and renewable energy development generally and also for advisory services for mini-grids. Programme development for the remaining four countries is still under way.[29]

The Clean Development Mechanism and voluntary carbon mechanisms such as Gold Standard have been used across the region to provide additional financial support to the development of renewables, while the Green Climate Fund – a financing mechanism developed by the UNFCCC to channel funding for mitigation and adaptation initiatives in developing countries – is still in an organisational phase and yet to be fully funded. Once in place, it is expected to provide a more efficient and direct mechanism for financing renewable energy and energy efficiency projects.[30]

There are currently 20 approved[viii] CDM projects in the region, 13 of which are in South Africa. Of the 20, seven are renewable energy projects and eight are energy efficiency projects. In addition, approximately 100 Programmes of Activities (PoAs) in the region have received or are pending CDM approval.[ix] (This figure is an approximation because many of these programmes cover more than one region of Africa or are registered globally.[x]) PoAs cover a wide range of technologies, from improved cookstoves and wind farms to low- and high-pressure solar hot water heating, heat-retention "wonder bags" and biogas. There are six solar hot water PoAs in South Africa alone, sponsored by a wide variety of organisations, from private developers to municipalities and commercial banks.[xi]

Of particular significance to carbon financing in the region is the development of a standardised baseline for CDM and other grid-connected carbon mitigation projects, including both renewable energy and energy efficiency projects. This concept, approved by the CDM Executive Board in May 2013, is applicable to all countries on the SAPP network[xii] and will apply to other countries as they are connected.[31] Projects meeting these criteria can use a grid emissions factor of between 0.98 and 0.99 tonnes of CO_2-equivalent per MWh (depending on the type of project and on other factors such as the number of crediting periods) for estimating baseline, project and leakage emissions.[32]

This is particularly helpful to member states, such as Namibia, that have a relatively low country emissions factor due to a preponderance of hydro in local generation capacity, but that import the majority of their electricity from South Africa, which has a more carbon-intensive electricity system. Because Namibian grid-connected renewable energy and energy efficiency projects can now use the increased SAPP grid emissions factor, they will be able to generate a greater number of carbon credits, making carbon financing more attractive as a supplement to other forms of financing.

Nationally Appropriate Mitigation Actions (NAMAs) – a mechanism developed by the UNFCCC to rationalise and channel mitigation activities in developing countries – will provide a basis for future carbon finance support as well. In the first round of NAMA development, following the Copenhagen climate conference in 2009, 48 countries submitted NAMAs outlining intended mitigation actions. Of these, six were SADC member states: Botswana, Madagascar, Malawi, Mauritius, South Africa and Swaziland (see table 21 for a summary of proposed activities).[33]

The low number of NAMA submissions in the remaining SADC countries is not clear, but the process is costly and not all

viii. "Approved" means projects are either under validation, validated or registered, according to the CDM Pipeline (www.cdmpipeline.org).
ix. Because of the significant time lag between project approval and actual generation of crediting (often 2-3 years), it is difficult to give precise dates for these projects; but they were all "operational" as of May 2015.
x. A PoA can be multi-country and simply defines the criteria for specific projects to be included in future, *e.g.*, projects for improved cookstoves or low-pressure solar water heaters.
xi. These new programmes are "open-ended", meaning that there is no limit to the number of projects that could be included, and no way to predict the overall impact on energy use.
xii. Botswana, the DRC, Lesotho, Namibia, South Africa, Swaziland, Zambia and Zimbabwe.

countries have received grants from the NAMA facility to cover the costs.

The NAMA concept allows for considerable flexibility, with some countries proposing actions in a wide variety of sectors, and others in only a few – or, in South Africa's case, committing only to an overall mitigation target (34% reduction in emissions against business as usual by 2020). Madagascar, Malawi and Swaziland have also placed heavy emphasis on reforming agricultural practices, including such options as better management of wastes and increased use of agricultural areas as carbon sinks. In Madagascar's case, forest restoration was included as well.[34]
A further development of the NAMA concept was the introduction of the opportunity to submit NAMAs at the Individual Action Level, *i.e.*, as detailed actions or groups of actions designed to help a country meet its mitigation objectives within the context of national development goals. The list of these NAMAs is much longer, but so far no such submissions have come from the SADC region.[35]

In principle, future funding through the Green Climate Fund could be tied to the registration and approval of NAMAs for specific countries or actions, so this represents a significant area for future development of carbon financing in the region. A call for "transformative NAMAs focused on mobilisation of capital investments for transformational change" was issued in April 2015 for submission by mid-July.[36]

TABLE 21 | Proposed activities in NAMAs submitted by SADC member states

	Activity type										
	Target only	Energy efficiency	Renewable energy (solar/wind/hydro)	Transport (incl. biofuels)	Building standards	Appliance performance standards	Waste-to-energy	Efficient lighting	Improved cookstoves	Biogas	Agriculture
Botswana		X		X	X	X					
Madagascar			X	X			X	X			X
Malawi			X	X				X	X	X	X
Mauritius		X	X								
South Africa	X										
Swaziland											X

Note: The "X" indicates the presence of the listed activity type in the country NAMA submission.
Source: See endnote 33 for this section.

ENDNOTES

01 | REGIONAL OVERVIEW

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LIST OF ABBREVIATIONS

ACCES	African Clean Cooking Energy Solutions Initiative
ACTFCN	African Climate Technology and Finance Center and Network
AEEP	Africa-EU Energy Partnership
AfDB	African Development Bank
AREF	African Renewable Energy Fund
BNEF	Bloomberg New Energy Finance
CDM	Clean Development Mechanism
CFL	Compact fluorescent lamp
CIF	Climate Investment Funds
CO_2	Carbon dioxide
COMESA	Common Market for Eastern and Southern Africa
CSP	Concentrating solar (thermal) power
CTF	Clean Technology Fund
DBSA	Development Bank of Southern Africa
DFRC	SADC Development Finance Resource Centre
DNI	Direct Normal Irradiance
ECOWAS	Economic Community of West African States
EEP	Energy and Environment Partnership
FIT	Feed-in tariff
FUNAE	Fundo de Energia (Mozambique)
GDP	Gross domestic product
GEF	Global Environment Facility
GW/GWh	Gigawatt/Gigawatt-hour
HVAC	Heating, ventilation and air conditioning
IDC	Industrial Development Corporation
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
kW/kWh	Kilowatt/kilowatt-hour
LED	Light-emitting diode
LPG	Liquefied petroleum gas
MEPS	Minimum Energy Performance Standards
MJ	Megajoule
MW/MWh	Megawatt/Megawatt-hour
NAMA	Nationally Appropriate Mitigation Action
NEEAP	National Energy Efficiency Action Plan
NEEP	Namibia Energy Efficiency Programme in Buildings
NFI	National Focal Institution
NREAP	National Renewable Energy Action Plan
NREP	National Renewable Energy Policy
PV	Photovoltaics
REA	Rural Electrification Agency
REC	Renewable Energy Certificate
REEEP	Renewable Energy and Energy Efficiency Partnership
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
REN21	Renewable Energy Policy Network for the 21st Century
RERA	Regional Electricity Regulators Association
RESAP	Renewable Energy Strategy and Action Plan
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
SADC PPDF	SADC Project Preparation and Development Facility
SAPP	Southern African Power Pool
SARDC	Southern African Research and Documentation Centre
SE4All	United Nations Sustainable Energy for All initiative
SEFA	Sustainable Energy Fund for Africa
TFEC	Total Final Energy Consumption
UA	Unit of Account
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USAID	U.S. Agency for International Development
USD	United States dollar
VAT	Value-added tax
WHO	World Health Organization
ZAR	South African rand
Zim Asset	Zimbabwe Agenda for Sustainable Socio-Economic Transformation

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 the 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 dioxide produced 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).

CAPITAL 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 one-time payments by a utility, government agency or government-owned bank.

CLEAN COOKSTOVE. Clean cookstove technologies address the negative health and environmental impacts associated with traditional cooking technologies, typically through improved combustion efficiency. While a number of clean cooking technologies meet this definition there is currently no definitive standard for what constitutes a clean cookstove.

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 to the receiver. There are four types of commercial CSP systems: parabolic troughs, linear Fresnel, power towers and 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/grains) 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 for 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 or to provide heat directly at various temperatures for buildings, 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 10 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 as final energy without any prior conversion.

PUBLIC COMPETITIVE BIDDING (ALSO CALLED 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 a 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 (SHS). 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 thermo-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 cookstoves, furnaces or open fires to provide heat for 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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