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Renewable Energy Opportunities for DBSA in SADC

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Context

The Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) has been carried out within South African to broad acclaim and the opportunity for exploration of the feasibility of extending this model to the region exists. Various SADC countries have embarked on renewable energy programmes, however not as sophisticated as the South African programme. There is a belief that by providing a focused and programmatic approach the impact might be bigger and thus provide a catalytic investment opportunity for the bank.

This paper will provide an analytical report on the state of renewable energy initiatives in the SADC region, together with a country by country audit of energy provision and an outline of opportunities for exploration by the Development Bank of Southern Africa. The value to the bank would be to provide a track record of renewable energy projects that will act as a baseline for partnering and investing.

The following countries form part of the Southern African Development Community:

- Angola
- Botswana
- Democratic Republic of Congo
- Lesotho
- Madagascar
- Malawi
- Mauritius
- Mozambique
- Namibia
- Seychelles
- South Africa
- Swaziland
- United Republic of Tanzania
- Zambia
- Zimbabwe

The following chapters will provide an overview of each countries energy sector as well as their commitments or milestones towards a renewable energy mix. This paper will also touch on renewable energy projects that have reached financial close on the continent and a possible pipeline of renewable energy projects that need funding.

Energy Market overview in SADC Countries

1. Angola

The civil war had virtually destroyed Angola's infrastructure. However in just the past decade, strong government commitment propelled infrastructure development, buoyed by strong revenue streams from mineral exports and a peaceful environment that has attracted significant private sector investments. For example, by 2013, over 2,000 km of roads and 1,333 km of railway had been constructed or rehabilitated and the installed power generation rose from 830MW in 2002 to over 1,700 MW in 2013.

Key participants in the Power Sector in Angola: The Ministry of Energy and Water (MINEA) is responsible for the energy sector policy development, coordination and oversight. The main power utility company in Angola is the Empresa Nacional de Electricidade (ENE) which manages the transmission network and operates over 80% of power generation facilities and distribution system outside of Luanda. In the capital, power distribution is managed by the Empresa de Distribuição de Electricidade (EDEL). To facilitate design and development of large hydropower projects in the Kwanza river basin, MINEA established a Gabinete de Aproveitamento do Médio Kwanza (GAMEK) that currently owns hydropower plants totalling 520MW and is implementing the 2,000MW Laúca Hydropower Project. The sector has a national regulatory agency, Instituto Regulador do Sector Eléctrico (IRSE) established in 2002. Sonangol is constructing a total of 900MW of combined cycle thermal power plant.

Regional Grid Integration: The GoA in collaboration with Government of Namibia is undertaking feasibility studies for the 600MW Baynes power project and a transmission line linking the Angola power grid to Namibia, and by extension to the Southern Africa Power Pool. However, the current General Electricity Law does not provide for cross-border power exchange or transit power. The proposed revisions to the General Electricity Law provides clear definition of international transmission interconnectors, import, export and transit power, making it possible for Angola to implement regional grid interconnection projects and benefit from regional power trade while providing electricity wheeling services to neighbouring countries.

Power pool membership has many inherent advantages such as, sharing surplus cheap energy across borders, moderating the effect of climate change as countries are impacted differently by seasonal variations especially for hydro, and most importantly enhancing stability and security of electricity services. The policy advice under the Power Sector Reform Support Program (PSRSP) will include support for Regional Power Planning in line with the Bank's Regional Integration Strategy.

Institutional setup and status of the power sector: ENE, EDEL and GAMEK form a vertically integrated market structure, albeit with significant overlaps in their objectives and no contractual and commercial agreements. The electricity infrastructure is characterised by:

- inadequate generation capacity;
- very low levels of electricity access, averaging 30% nationwide and less than 9% in rural areas, posing major constraints to the delivery of social services;
- limited revenue collection, as over 80% of the consumers are not metered;
- technical and commercial losses that account for over 55% of the electricity energy supplied; and
- a high cost of electricity production and distribution (approximately US$ 220/MWh), well above the average consumer tariff (US$ 38/MWh).

The sector lacks a clear regulatory framework, capacity and skill to manage its operations effectively.

Power Sector Development Plan and Rationale for Reforms: GoA needs to urgently mobilize vast resources to address perennial power shortages, expand and modernise its electricity infrastructure, improve customer connection and metering, and reduce technical and commercial system losses. However, with ENE, EDEL and GAMEK operating as pseudo vertically integrated companies without any contractual obligations prevents effective sector re-capitalization and motivation for these companies to run efficiently and profitably.

The Government's National Power Security Strategy and Policy (NESSP, 2011) was the first step in establishing and prioritising the needed actions. The key priority actions recommended by the NESSP include: (a) restructure the sector and allow public-private partnerships (PPP) to become a viable business model, (b) promote contractual relationship among sector participants, (c) accelerate implementation of investment programs, and (d) promote empowerment of the IRSE. The NESSP also recommends the development of policies that allow the use of endogenous energy resources, ensuring the convergence between the principles addressing energy security, efficient technologies, efficient management and promotion of environmentally sustainable power development9.

To convert the strategy document into implementable actions, the GoA adopted the Electricity Sector Transformation Program (PTSE), with key deliverables being the sector diagnostic study; submission of the optimum electricity market model; and a sector reform roadmap. The PTSE feasibility study recommended restructuring the market into a classic single-buyer model, unbundling the power utility into Generation, Transmission and Distribution core activities, establishing commercial contracts between the markets.

Currently, the installed grid generation is less than 33% hydro and the remainder comprising diesel power. The government objective is to rapidly eliminate the use of diesel based generation by 2025.[i]

2. Botswana

Botswana's electricity sector is dependent on large scale thermal coal power plants utilising domestic coal from reserves estimated at 200 billion tonnes. However, demand for electricity often exceeds supply resulting in load shedding, use of back-up diesel power plants, and electricity imports through the Southern African Power Pool (SAPP).

Electricity Demand and Electrification Rates

Over a third of country's electricity demand is from the mining sector, followed by the commercial sector, the residential sector and then the government. Peak demand has been recorded at 610 MW for the 2014/15 period. The largest share of distributed electricity in 2015 was consumed in the mining sector (34%), followed by the commercial (30%) and residential sector (27%) with governmental usage accounting for 9%.

Access to electricity in Botswana is estimated at 53% of the total population, comprising over two thirds of the urban population, approximately 69%, and 32% of the rural population. In 2015 the national utility reported having over 350,000 customers.

Electricity Generation

Botswana has shifted from a country that was highly dependent on South African electricity to one that produces the majority of its electricity on its own. However, the country's coal-based power stations, Morupule A and B, have been facing technical issues with strong implications for electricity production. The Morupule B plant has a name plate capacity of 600 MW, though continues to perform below the capacity factor target of 89%, producing at 66.5% over the latest full reporting period of the Botswana Power Corporation (BPC). In addition, a series of complications have led to delays in the planned refurbishment of the 132 MW Morupule A Power Station. Shortfalls have been met in part through back up diesel plants, load shedding, and imports from neighboring countries. The back-up plants Matshelagabedi (70 MW) and Orapa (90 MW) are now owned by BPC, the latter purchased in 2015 following a rental period. Imports represented a significant 42% of national power consumption, totaling 1,509 GWh against total consumption of 3,580 GWh. At 34%, the South African utility Eskom has become a major supplier of energy consumed in the country, with further Southern African Power Pool (SAPP) inflows from Mozambique, Namibia and Zambia. At least one grid-connected solar PV plant (1.3 MW) was commissioned in Phakalane in 2012, as a result of Japanese-Botswana cooperation.

Transmission and Distribution

The electricity grid in Botswana consists of power lines ranging from 11 kV to 400 kV. At present, power from the existing Morupule Power Station is transmitted via 33 kV and 220 kV power lines.

A single 400 kV power line from the Matimba Power Station in South Africa feeds into the Botswana electricity network at the Phokoje Substation.

There are currently no specific plans to unbundle BPC, the power utility that oversees the transmission and distribution in Botswana. The main challenges in the electricity transmission and distribution network are a lack of grid access in the Northwest and Southwest Regions.

Electricity tariffs in Botswana have historically been heavily subsidized, leading to a challenging commercial environment for both the BPC and potential future private developers. The 2015 annual report of the BPC highlights concerns around the current tariff rate and received subsidy from the government in terms of the long-term prospects for the corporation.

Off-Grid Electrification

Off-grid electrification initiatives in Botswana are limited though pilot initiatives have been initiated in the country. The Rural Photovoltaic Electrification Project (Re-Botswana) was initiated under UNDP and ended in 2014. Beyond public sector-driven pilots, there are emerging private installers of isolated systems, ranging from solar home systems through to larger systems powering public institutions and tourist lodges.

3. Democratic Republic of Congo

The Democratic Republic of the Congo (DRC) is the 11th largest country in the world, with a land mass about one-fourth that of the United States. The population is 80 million, of which 12 million live in the capital Kinshasa. GDP in 2015 was estimated at $38 billion. The DRC has one of the lowest rates of electrification in the world. Based on 2013 data, DRC's national electrification access rate was just 9%, with 1% in rural areas and 19% in urban areas. The DRC's installed generation capacity of just under 2,500 MW is 99% hydropower. Most of this generation is concentrated at the Inga site (1,775 MW), where the government is developing the Inga 3 project of at least 5,000 MW.

Currently, the DRC utilises just 2% of its estimated 100,000 MW of hydroelectric potential, around 40,000 MW of which is concentrated at the Inga site on the Congo River. The government has been unable to meaningfully increase generation capacity in recent years and has allocated most available power to the fast-growing mining sector, especially mines in the copper belt, although new mine development has been frozen until more power becomes available, with a current shortfall of 300 MW in the copper sector alone.

In order to address the power constraint on economic growth, the government approved a new Electricity Code in 2014 which authorized the establishment of a regulatory agency and a rural electrification agency, while opening the power sector to private investment. The Electricity Code

is in the process of implementation, which is supported by various development partners including USAID.[ii]

4. Lesotho

Electricity Generation

Lesotho's energy supply is mainly concentrated in the Muela hydroplant with an installed capacity of 72MW. There are also four mini-hydro plants with a combined installed capacity of 3.25MW. Energy demand, 145MW is satisfied from both domestic generation and through imports from Electricidade de Mocambique (EDM) in Mozambique, accounting for 60% of imports, and ESKOM in South Africa within the Southern African Power Pool (SAPP).

The industrial sector consumed 35% of the electricity demand in 2010 and this was followed by the domestic sector, which consumed 31% of the total electricity. The commercial sector (17%) and general purpose energy consumption (16%) are both about half of the industrial and household sector consumption respectively. The household electricity access in Lesotho has already been indicated to be averaging 26% nationally divided into 65% for urban households and 6% for rural households.

Transmission and Distribution Network

Lesotho Electricity Company and the Lesotho Electrification Unit, which also manages the National Rural Electrification Fund (NREF), are responsible for the development of the transmission network in the country. The Government of Lesotho has established the revamping of the electricity distribution network as one of the main priorities to fulfill its strategic development objectives. It is needed to increase the safety and reliability and to expand connections to households and potential growth areas. The poor maintenance and aging of infrastructure has caused frequent power cuts. The Lesotho Electricity Corporation states that it aims to add 120MW of supply capacity to the grid by 2017. The main project in the pipeline is the Kobong Transmission Line (400kV) which is due in 2017. Furthermore, the Ministry aims to ensure guaranteed access of all licensed renewable energy electricity generators (IPPs) of at least 500 kW to the transmission grid at a prescribed fee.

5. Madagascar

Madagascar has only 356 MW (hydro) and 150 MW (thermal) of installed generation capacity to serve a population of more than 24 million people. The average solar energy potential is estimated 2, 000KW/m2/year, with additional potential for wind energy across multiple regions.

The majority of its existing capacity comes from hydroelectric and diesel power plants in limited and poor condition. Madagascar has one utility, the State Power Authority (JIRAMA). More than 10 independent power producers (IPPs) account for an increasing percentage of the total electricity production.

Over the past 20 years, electricity demand has increased by about 5 percent per year. Based on 2015 data, Madagascar's national electrification rate reached only 15 percent of the national need (53 percent in urban areas and 6.5 percent in rural areas). Despite high resource potential and opportunities, Madagascar's power sector faces significant challenges, including the need for improved distribution and transmission capacity. For the last three years (2013 -2015), Madagascar has ranked last globally in the World Bank's Doing Business indicator regarding the difficulty, delay, and cost of getting electricity, in large part due the nearly 450 days to get a new connection.[iii]

6. Malawi

At 9%, Malawi currently has a remarkably low national electrification rate. While electricity has reached almost 25% of urban households, rural electrification lies only at 5%. Only 7% of the population has access to modern cooking fuel and more than 98% from rural areas (roughly 85% of country's total population) still use fuel wood for cooking. Malawi's energy supply is dominated by biomass (firewood, charcoal, agricultural and industrial wastes) accounting for 84% of the total primary energy supply.

The total installed electricity capacity (2010) is 515 MW (Hydro 94% and Thermal 6%). The national power utility Electricity Supply Corporation of Malawi (ESCOM) is stretched with regular day-to-day occurrence of load shedding (power interruptions); this is due to the dependency on hydro power stations on the Shire River now being considered a risk due to declining levels of water flow.

Wood and charcoal use for cooking is highly unsustainable and is estimated to destroy around 75,000 hectares of natural forests across Malawi annually. Malawi has great solar potential with an average of 3,000 hours of sunshine per year.[iv]

7. Mauritius

The primary sources of energy for Mauritius are dominated by high carbon emission fossil fuels, oil and coal. In the absence of fossil fuel reserves, the Mauritian economy depends heavily on imports of petroleum products like light fuel oil (distillate) and kerosene (used mainly in the transportation sector), Heavy Fuel Oil (for power generation and industries' processes) and Liquefied Petroleum

Gases (LPGs) (for cooking). This has made the country's electricity supply highly vulnerable in view of the volatility of the prices of oil products, more so during times of crisis.

According to Statistics Mauritius, 2,575 GWh of electricity were generated in 2013 representing a 3.2% increase in consumption compared to 2012. Peak power demand capacity increased from 430.1 MW to 441.1 MW for the same period and renewable energy (R.E) accounted for 20.6% of total production. While bagasse remains the key source of renewable energy (16.4%), the remaining 4.2% of electricity generation came from hydro, wind, landfill gas and solar photovoltaics (PV) in 2013. In 2014, some 18 GWh of electricity were produced from solar energy. Currently wind and solar projects with a total installed capacity of 49 MW are under way.

Mauritius imported 86 % of its fuel requirement in 2014 whereby petroleum products accounted for 55 % and coal for 31 % of the total energy imports. The import bill of petroleum products and coal in 2014 was USD 900 million which is around 18.1 % of the total import bill. Imported coal is mainly used to supplement local bagasse (by-product of sugar cane) for power generation by IPPs (mainly sugar factory owners) and which accounts for about 60 % of the island's total electricity generation.

In order to meet the challenges ahead and adapt to environmental concerns around carbon emissions and climate change, the Government of Mauritius has set up a programme to diversify the country's energy supply, improve energy efficiency, reduce carbon emissions to a sustainable level and raise the renewable energy contribution in the energy mix to 35% by 2025. With the diversification of the Island's energy mix, renewable energy will play an increasingly important role. In this regard, the Mauritius Renewable Energy Agency (MARENA) has been established under the auspices of the Department of Energy and Public Utilities, to promote the use of Renewable Energy and increase its contribution in the country's energy mix.

The Electricity Production Landscape

The electricity production landscape in Mauritius is characterized by the Central Electricity Board (CEB) and the various Independent Power Producers (IPPs). CEB is governed by the Electricity Act of 1939 and its business focuses on transmission, distribution and commercialization of electricity. The CEB is a parastatal body responsible for the 40% of the country's total power requirements from four thermal power stations and ten hydroelectric plants. The remaining 60% is produced from the IPPs, mainly private generators from the sugarcane industry using bagasse and imported coal.

8. Mozambique

Electricidade de Moçambique (EDM) is 100% owned by the State, with the responsibility to generate, transport, distribute and commercialise electricity throughout the country. Mozambique

is a large country with generation sources distant from load centers. Hidroeléctrica de Cahora Bassa (HCB) is the main source of generation in the country. Power transmission is mainly ensured through three high voltage corridors; there is supply to the Southern Region/Maputo via South Africa through an HVDC line - Cahora Bassa power plant is the main source.

Although Mozambique is fortunate to have substantial untapped natural energy resources including hydro-power, coal, natural gas, bio-fuels and petroleum, in recent years a failure of planning to provide adequate power for the rapid economic growth which the country is now realizing has today resulted in a situation where many areas experience regular blackouts, and others face the prospect of load-shedding for years into the future.

Government policy has focused on prioritizing the extension of the national grid to rural, economically disadvantaged citizens with the limited resources that have been made available to the national energy utility Electricidade de Moçambique (EDM). This policy objective succeeded by January 2012 in achieving a total number of 1,024,000 connected customers in all regions and provinces of the country. At the same time construction of extensive new power transmission infrastructure was realized, reaching across more than 5360 km with transmission capacity of about 5500 MVA across the national territory.

However, the grid extension effort has left the country with a critically under-maintained legacy network with scant backup provisions and a high degree of reliance on a single energy source, namely hydro power. Natural disaster and operating failures have led to total blackouts for periods of weeks in each of the past two years, with substantial losses to the national economy. In addition, Mozambique suffers from administrative, transmission and distribution losses totaling 27% of power generated which further exacerbate the country's increasingly acute energy shortage.

A situation ripe for investment in generation and distribution by private operators, alone or in conjunction with public entities has been compromised by inappropriate tariff structures and a slow process of legal and regulatory reform that has failed to keep up with the pace of demand growth. The tariff subsidy extended to all customers irrespective of their location entails EDM operating at a loss, a situation compounded by the increasingly frequent requirement to purchase expensive power from a small number of independent power producers (IPPs) or from foreign sources. While several projects are underway or pending approval, there exists an urgent need to accelerate the construction of additional and alternative sources of power and the necessary transmission infrastructures to deliver power to load centers with cost effective rates.

Mozambique's accelerated development zones could be catalysts for an intensified generation effort but require more flexible interpretation of existing incentive regulations to bring forth the necessary supply. Policies aimed at unbundling integrated national power utilities, introduced in other sub-Saharan economies have helped bring forth resources and added a dynamism to national power sectors which their governments had previously failed to provide, although not all such initiatives may be suitable in the Mozambican context. The lack of a developed domestic capital

market for potential investors and limited access to overseas finance adds further to the urgent need for government to act.[v]

9. Namibia

The power sector in Namibia has undertaken a number of reforms aimed at attracting IPPs by providing a stable investment environment. Such reforms include the horizontal unbundling of regional distribution companies and the establishment of transparent tariff setting procedures, all overseen by the sector regulator, the Electricity Control Board (ECB). While the country's generation mix is comprised primarily of hydropower, the majority of electricity is imported from Southern Africa Power Pool (SAPP). Recently, the Government of Namibia has taken steps to increase generation from other generation sources through a renewable energy feed-in-tariff (REFIT) for a total of 70 MWs and an upcoming solar procurement for 37 MWs. With the support of USAID, the REFIT was adopted by ECB to grant 14 licenses to IPP developers for 5 MW projects by establishing a predictable enabling environment for renewable energy integration.

10. Seychelles

Seychelles depends as high as 99.5% of its primary energy consumption on imported oil. The existing energy policy (Seychelles Energy Policy 2010-2030) focuses on the need to reduce this dependency through increased Energy Efficiency, promotion of Renewable Energy with targets of 5% and 15% in national electricity production by 2020 and 2030. With plan to further increase the use of RE beyond the set targets to 100% by 2050, the energy sector is expected to experience excessive growth in the coming years.

Although there are no official stand on the new RE targets, this indicates the direction the new energy policy is going to be. Such ambitious targets will require a progressive but profound change of the power system and infrastructure such as the introduction of large scale RE plants (large scale solar PV plants, large scale offshore wind farm, marine RE, biomass plants), distributed generation, grid stabilising technology such as battery and pump storage, the introduction of smart grid and smart meters, etc. This will be Seychelles energy transition to a low carbon energy sector.

Electricity infrastructure

To date the generation capacity is sufficient for the demand, however with the upgrading of the transmission network there will be step increase in demand in addition to the current growth rate. As such and with aging current generation sets, there will be a need for a new power plant and this

will be done on a tender basis. There is also investment opportunities in the other electricity-related activities (transmission, distribution and supply). For example provision of electrical hardware to replace existing ones, upgrading current infrastructure to allow for more integration of RE, provision of stabilizing technologies to mitigate grid instability due to variable RE, etc.

11. South Africa

Electricity Sector

The South African electricity sector is dominated by the national utility Eskom, which is responsible for the majority of generation, transmission and distribution of electricity. South Africa is however also home to Africa's biggest IPPs market, which is envisioned to contribute 30% of South Africa's future generation capacity. 137 municipal power companies, that are buying 40% of electricity generated by Eskom to supply end users, hold negligible generation capacity. Generation is currently dominated by coal power, however this dominance is expected to decline in anticipation of increased investments in gas, renewables, and nuclear power. Being an integral part of the South African Power Pool (SAPP), South Africa is both importing and exporting power from and to its neighboring countries. The electrification rate in South Africa is comparatively very high for the region, standing between 85 and 90%.

Electricity Demand and Electrification Rates

Electricity Demand

Peak demand in South Africa has been 34,481 MW in 2015/2016 with Eskom transmitting/distributing 214,487 GWh to South African customers. Eskom's electricity is mostly sold to municipalities (42%) that further distribute electricity to end-users, followed by industrial consumers (23%) and mining (14%). When distinguishing electricity consumption by the type of end user, regardless if supplied by Eskom or municipalities, industrial (41%) and residential users (37%) are responsible for the bulk of electricity consumed.

Growth in electricity demand has been low (~1%), partially attributed to the economic slow-down faced by the South African economy. This has resulted in electricity demand forecasts being revised downwards, estimating peak demand of ~ 350,000 GWh by 2030 in the draft Integrated Resource Plan (IRP) 2016, as compared to a forecast of 450,000 GWh by 2030 in the IRP 2010. These revisions are shown in the figure below.

Demand Side Management

The South African economy is extremely energy intensive compared to international standards, with only a handful of countries having higher energy intensities. South African industrial energy efficiency is on average significantly lower than in other countries.

In 2015, ESKOM introduced load-shedding due to drought and insufficient investment having rendered existing capacity inadequate to meet demand. In addition to now heavily investing in expanding generation capacity, the Government is additionally promoting the adoption of solar water heaters (SWH) in households and commercial buildings. The National Development Plan targets an additional 4 million SWH to be installed, resulting in a target of 5 million SWH by 2030. Eskom is in parallel distributing energy efficient light bulbs (CFLs) and increasing awareness of energy efficiency measures. The Government has also introduced fiscal energy efficiency incentives for businesses and industries.

Electrification Rates

The Integrated National Electrification Programme (INEP) targets to achieve universal access (defined as 97%) by 2025 through grid connection (90%) and Solar Home Systems (7%) and has thus identified 300,000 households to be electrified with off-grid technologies.

In 2013, electrification rates in South Africa were reported to be 90% in urban areas and 77% in rural areas, leading to an overall electrification rate of 85%. Eskom reports that 158,016 households were electrified during the year (March 2015/ March 2016), reaching almost 90% of all households electrified nationwide.

Electricity Generation

Installed Capacity and Share of Generation

At present, electricity generation capacity is dominated by the state-owned utility Eskom, which holds 91% of the country's effective/nominal generation capacity. Remaining generation capacity is held by municipalities (1.77%) as well as Independent Power Producers (IPPs) that sell power to Eskom (7.21%).

South Africa, integral part of the South African Power Pool (SAPP) is furthermore trading electricity with Botswana, Lesotho, Mozambique, Namibia Swaziland, Zambia and Zimbabwe. Total imports were 9,703 GWh in 2015/2016 with exports of 13,465 GWh in the same period.

Eskom's generation assets are distinguished by coal (85.12%), gas (5.63%), hydro (4.67%), nuclear (4.34%) as well as wind (0.23%) power plants. Municipal generation assets consist of coal (64.4%) and gas (14.66%) fired power plants, as well as was pumped storage hydro power plants (20.91%). As per March 2016, Independent Power Producers (IPPs) availed 3,392 MW of

generation capacity to Eskom. Due to South Africa's successful procurement programme for renewable energy (Renewable Energy Independent Power Procurement Programme; REIPPPP), recently commissioned renewable energy power plants have contributed to a decrease in load shedding. IPP-owned renewable energy generation has gained traction with 2,145 MW of available capacity. Solar (inclusive of PV and CSP) and wind are responsible for 34.34% and 28.60% of IPP-owned capacity, respectively. Coal (13.56%), gas (17.33%), and others inclusive of cogeneration, landfill gas (5.87%), and hydro (0.29%) are relatively less relevant.

Eskom reported generation of 219,979 GWh in 2015/2016 with 9,033 GWh bought from IPPs and 9,703 GWh imported from other Southern African countries. It is further estimated that ~ 3,500 GWh was generated by municipalities. Eskom's electricity generation mix is heavily dominated by coal power (91%). When adding electricity generated by IPPs, municipalities, as well as from imports, the relative importance of coal drops to 85%

Planned Expansion to Generation Capacity

South Africa's Integrated Resource Plan (IRP) 2010, policy-adjusted IRP capacity scenario, targeted an increase in capacity to 89 GW from current 47 GW by 2030. The scenario that requires investment in 56,539 MW of new capacity (considering the planned decommissioning of existing capacity) envisions a shift away from coal-based power

Achieving the new capacity requirements is expected to be driven by investments made by the national utility Eskom as well as through IPPs – with the target for IPPs to provide 30% of the total capacity in 2030.

As of July 2016, the DoE through the REIPPPP, had already contracted 6,376.7 MW of renewable energy-based generation capacity, resulting in an additional 4,032.7 MW to be added to the already operational renewable energy IPPs.

Table 1: Total REIPPPP capacity contracted

Technology Capacity	(MW)
Biomass	51.5
Solar CSP	600
Landfill Gas	18
Wind onshore	3,366
Solar PV	2,321.8
Small Hydro	19.1
Total	**6,376.7**

All the IPPs from REIPPPP projects sell their electricity to Eskom. Average tariffs for Solar PV and Wind technologies have fallen to USD 72.9/MWh and USD 57.4/MWh respectively in bid window 4, a decrease of 72% and 46% in rand terms respectively from bid window 1.

However, Eskom had recently decided not to sign any further Power Purchase Agreements (PPAs) for renewable energy power producers that bid above a tariff of 62cR/kWh, as Eskom forecasts a generation surplus by 2022.

ESKOM is currently implementing Medupi and Kusile coal power plants, which will each add approximately 4.8 GW of power to the South African grid. The plants are under construction following various delays. The first 794 MW unit of Medupi is now online. Completion of all units is expected by 2020 for Medupi and 2022 for Kusile. In the DRC, the construction of the 4,800 MW Inga 3 hydropower project is expected to commence. South Africa is expected to import up to 2,500 MW from Inga 3 from 2030 onwards. Inga 3 forms the first phase of the ambitious 40 GW Grand Inga Project

Revised capacity additions in the new IRP 2016 are summarized in the table below. Despite general reduced capacity across all technologies, notable changes are that nuclear power is only included in the IRP beyond 2030, while the relative importance of gas, wind and solar technologies have increased.

Transmission and Distribution

Existing Transmission and Distribution Network

Eskom owns, operates and maintains 95% of the national transmission network and shares the distribution network with ~187 licensed municipal distributors. Transmission and distribution losses were 8.59% in 2015/2016. Given frequent blackouts in the recent past, partially as a result of aging infrastructure, Eskom has been focusing on the maintenance and refurbishment of the transmission and distribution network, in addition to network strengthening towards the achievement of N–1 Grid-Code compliance and the integration of new generation sources.

In order to give project developers an understanding of the available transmission and distribution capacity for integration of generators, Eskom Transmission published the Generation Connection Capacity Assessment for the 2016 Transmission Network (GCCA-2016), which has been recently updated (July 2015) to provide a 2022 view (GCCA-2022). The assessments have indicated a constrained transmission network, particularly in the Northern Cape, Eastern Cape and Western Cape provinces, where most of the successful RE-IPP projects are located.

Planned Transmission and Distribution Expansion

In order to allow integration of the committed generation capacity, ESKOM describes the envisioned transmission capacity requirements in its Transmission Development Plan 2016-2025.

In terms of enhancing the transmission network as well as connectivity with neighboring countries, South Africa is contributing to the implementation of the Mozambique-Zimbabwe-South Africa (MOZISA) transmission project.

The Cities of Johannesburg and Tshwane are currently implementing smart prepaid meters with certain municipalities engaged in setting up pilot schemes for smart grids. In that context, the South African National Energy Development Institute (SANEDI) has also established the South African Smart Grid Initiative (SASGI) with the objective of developing relevant policies and regulations.

Electricity Tariffs

Electricity is distributed through Regional Electricity Distributors (REDs), which buy electricity from ESKOM at a tariff set by the National Energy Regulator of South Africa (NERSA) and aim to offer electricity at a competitive price, with efficient service. ESKOM and municipalities operate within three tariffs types: residential, rural and urban. Urban and rural tariffs are applicable to all users not classified as residential. Under the three zones there are further tariff classifications, which are based on the specific power requirements of different consumers.

Off-Grid Electrification

South Africa's Integrated National Electrification Programme (INEP) intends to achieve universal access to electricity by 2025, with the objective of reaching 90% of the population through grid connections and 10% through SHS or other cost effective, non-grid RE technologies. INEP intends to achieve this through subsidizing grid connections, off-grid systems, and grid network infrastructure such as substations and HV inter-connections, through an annual budget of 400 million USD. The subsidy leads to ~200,000 grid connections and the distribution of 10,000 SHS per year. Companies can benefit from this subsidy by tendering to become concessionaires included in the INEP. In order to support poor households, the Government also provides 50 kWh/month of grid electricity per month to all households free of charge.

To roll out SHS, the Government has been utilising a concession approach for specific geographic locations, with a predetermined number of SHS allocated. A single concessionaire (tendered) is appointed to a designated area within which it has the exclusive right to supply SHS services for five years. The concessionaire is furthermore responsible to maintain installed systems per the terms of a 20-year contract.

Off-grid technologies are provided on a fee-for-service basis, requiring customers to contribute a once-off connection fee (not exceeding R89) followed by a small monthly payment thereafter. This model was decided by the Government in order to ensure that concessionaires establish and maintain local presence in the areas they serve. The monthly service fee covers lifetime running costs, including the operation, maintenance, replacement of batteries, fee collection, customer service, support and management of the system. The Government subsidizes about 80% of the capital costs of the systems and 100% for those households that are classified as indigent, using the free basic services grant.

With EU support, the non-grid electrification programme is currently being redesigned to improve the quality of the service offering and strengthen institutional capacity, including the establishment of an off-grid electrification authority. The purpose of this proposed off-grid management authority is to ensure that the off-grid electrification programme is reinvigorated to ensure meaningful contribution to universal access as well as promoting off-grid energy access more generally. As such, the proposed enhancements to the programme include mini-grid/hybrid technology packages as well as biogas systems.

12. Swaziland

Electricity is generated in Swaziland through power plants owned and operated by SEC with a total installed capacity of 69.6 MW, of which 60.1 MW of hydropower and 9.5 MW are diesel. However, the hydropower plants are used only at peak time for two reasons. The first is to reduce expensive imports during these periods. The second reason is the limited storage capacity of the hydropower schemes and unsteady rainfall throughout the year. At the same time, the diesel power station is underused because of the high price of diesel fuel. In addition, the sugar industry (Ubombo Sugar and Royal Swaziland Sugar Corporation) has an installed capacity of 105.5 MW mostly for its own use (table 1). The plants are fuelled by bagasse and coal during the low season. Since 2011, Ubombo has started to supply power to the grid following an agreement with SEC.

In 2012, total electricity supplied was 1129.8 GWh, with the largest share imported from South Africa, Mozambique and the SAPP DAM. This amounted to 850 GWh (76%) complemented by SEC generation of 278.2 GWh (24%) (SEC, 2013). SEC is carrying out feasibility studies for hydropower plants on several sites along the Ngwempisi and Lower Maguduza Rivers. MNRE has also committed funds to develop the Lubovane Dam hydro generation project. If completed, these projects are expected to add generation capacity of up to 140 MW. Furthermore, a feasibility study has also been completed for the 300 MW coal-fired thermal power station. Royal Swaziland Sugar Corporation is undertaking a 30 MW cogeneration project for its own consumption.

13. United Republic of Tanzania

Tanzania currently has a national electrification rate of 11.5%. While electrification has reached almost 40% of the urban households, rural electrification still lies very low at 2%. Only 2.8% of the population has access to modern cooking fuel while fuel wood is used for cooking by more than 77% of the total population and almost 94% of the rural population.

Biomass based fuel accounts for almost 90% of the current energy supply. Total installed electricity capacity (2011): 1,051 MW (Hydro: 58.5% and Thermal: 41.5%). Droughts over the East Africa region have had severe effects on the electrical power supply in the country.

Blackouts and power rationing as a result of low water levels in the hydro-electric dams have forced the Tanzania Electric Supply Company (Tanesco) to rely on gas-powered generators and to look increasingly at thermal projects for future capacity increases.[vi]

14. Zambia

Zambia has 2,411 megawatts (MW) of installed capacity, virtually all of which is hydro. Currently, 25% of the urban population and 3% of the rural population have access to power. The Zambian government has targeted six distinct areas for mini-grid development (four hydro and two solar). In 1996, the Government of Zambia (GRZ) set a goal for universal electricity access for all Zambians by 2030. Energy has been identified as an important driving force behind economic development in Zambia, and the government has declared its commitment to developing and maintaining energy infrastructure and services. Although there are pockets of private sector activity in generation, transmission, and distribution, the vast majority of power in Zambia is operated ZESCO, the vertically integrated state-owned utility. Zambia expects to bring an additional 2,000MW of hydro and thermal power online 2016 and 2017.

15. Zimbabwe

Zimbabwe is seeking to revitalise its economy following a decade of collapse. The economic contraction led to a lack of new investment in infrastructure, especially in the power and water sectors. Inefficient and unreliable power supply acts as a drag on economic growth, while the cost of maintenance and upgrading of existing power infrastructure dwarfs allocated government resources. For example, persistent power cuts have been cited as being the principle obstacle to productivity in Zimbabwe's key mining sector. Only approximately 60% of installed capacity is operational. Zimbabwe imports around a third of its power and is also in arrears to many of its key suppliers.

The Global Competitiveness Report 2011-12 identified inadequate supply of infrastructure as being the third most problematic factor for doing business in Zimbabwe. Within infrastructure, the quality of electricity supply was the worst performing area for Zimbabwe, with only 8 of the 142 countries included in the report reporting a worse supply of electricity.

Over the years demand for electricity has risen, with an estimated national average peak demand of 2200MW per day compared to the current production output of an average of 1300MW. When the demand for electricity is high, the country's generating capacity is not sufficient to meet the demand and this triggers the need to enhance the generating capacity to meet this supply shortfall.

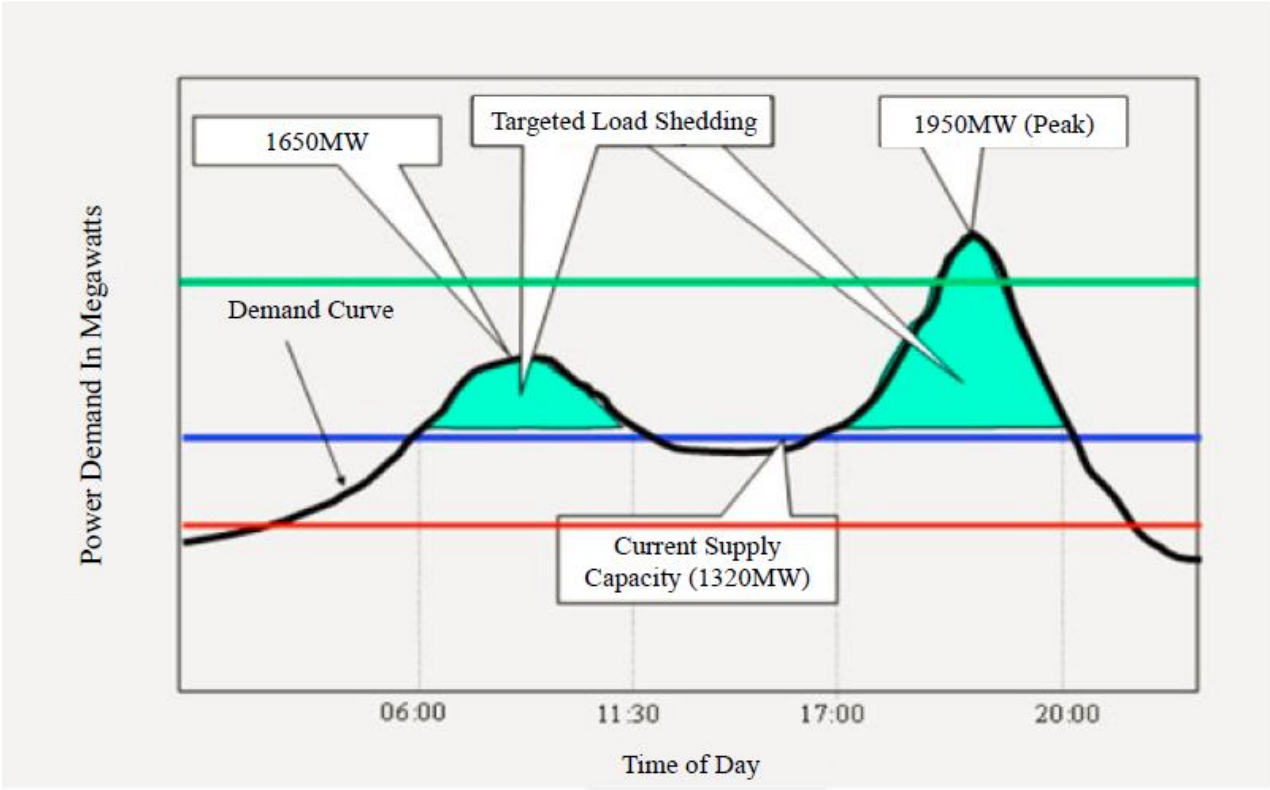

Figure 1: Zimbabwe Average Daily Load Profile

Currently there is shortage of peaking power in Zimbabwe, due to excess capacity provided by Eskom, Zimbabwe has been able to import power from South Africa albeit at a price it can barely afford. It is for this reason that Zimbabwe is struggling to pay back Eskom for the imported power, it is believed to owe Eskom in excess of R120 million. There is approximately a 700MW peak demand shortfall in Zimbabwe, without taking into account suppressed demand induced by load shedding schedules.

Ageing plant which results in frequent breakdowns and forced outages coupled with new connections in line with the country's electrification policies for rural and outlying areas has worsened the supply gap. This supply shortfall is managed by a combination of periodic load shedding and imports from other utilities in the region, such as Cahora Bassa (Mozambique), SNEL in Democratic Republic of Congo and ZESCO of Zambia.

However, the supply gap cannot substantially be met by imports due to:

- Inability to pay for imports from neighbouring countries;
- Regional and national transmission infrastructure bottlenecks limiting the transfer capacity of interconnectors and efficient wheeling arrangements between power brokers and consumers.

ZPC owns and operates five power stations in Zimbabwe, four being coal fired power stations and the fifth a hydro power station. Each power station holds a generation license issued by the ZERA.

The five power stations have a combined installed capacity of 1,960MW, as follows:

Table 2: ZPC Power Stations

Plants	Installed Capacity (MW)	Available Capacity (MW)
Hwange Thermal Power Station (coal-fired)	920	471
Kariba Hydro Power Station	750	740
Small Thermal Power Stations (including Munyati (coal-fired), Bulawayo (coal-fired) and Harare (coal-fired))	290	100

Zimbabwe's energy demand is expected to quadruple by 2050, reaching a peak of 8000MW. Should there be no additional imports or increase in local generating capacity, the supply-demand gap in the country is projected to increase from the 700MW (2014) to 1,215MW (2018). Zimbabwe needs additional capacity to cover Expanded Rural Electrification Programme, GDP Growth/ new Investments in the economy and for imports displacement.

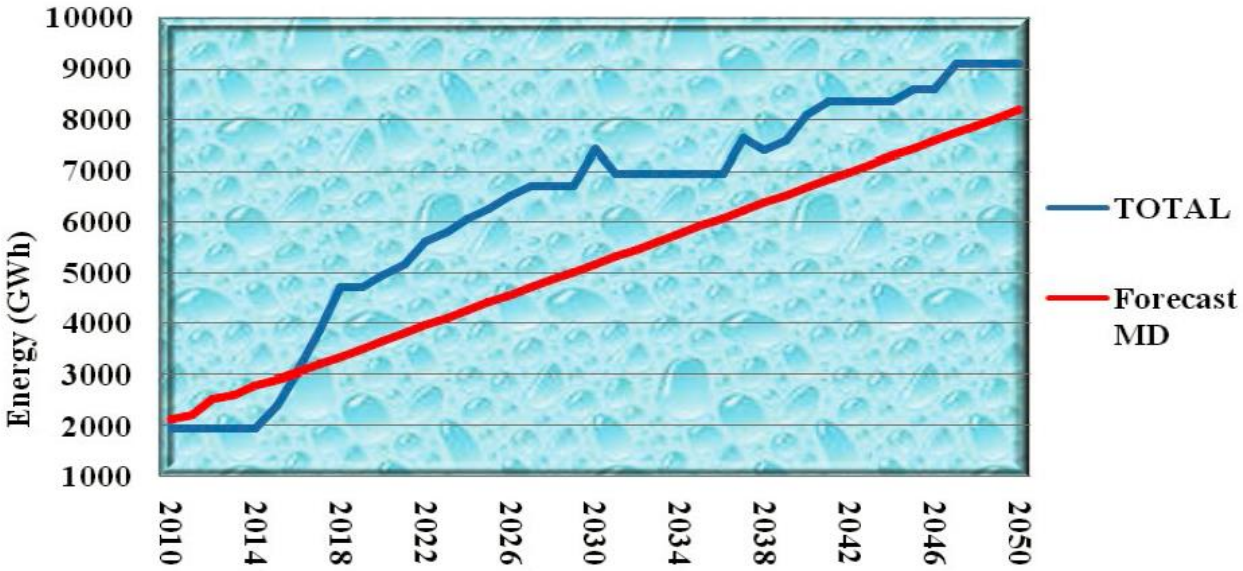

Figure 2: Supply/Demand Projections (Source: ZPC)

Renewable Energy Programmes in SADC

1. Angola

The government is strongly engaged with renewable energies and with the goal of keeping the renewable energies as a support of the electric system of Angola, in specific through a strong investment in the hydroelectric potential of the country. The Development Plan for the Energy and Water Sector for the period of 2013-2017 foresees the installation of 5,000 MW mainly of hydroelectric energy. This investment not only enhances the competitiveness of the system but also represents the commitment with future generations.

The main goal of the present strategy is to diversify the investment in renewable energies through a growing role of the new renewable energies, including small hydropower plants. It is expected that by 2025 energy consumption may reach 39 TWh meaning that it is necessary to go further than 9 GW of installed energy capacity to meet the hydrological variability and also to guarantee the safety of energy supply.

Strategic Goals for the New Renewable Energies

Three strategic goals are set forth for the new renewable energies in order to meet the main challenges identified:

1. Improving the access to energy services in rural areas based on renewable sources: The goal for off-grid situation is to ease the accomplishment of several activities that support the rural development and that relieve them from poverty, as well as to guarantee that communities living in non-electrified areas may access to safer and better quality energy sources.
2. Develop the use of the new renewable technologies connected to the grid, enhancing the establishment of new markets and reduction of regional asymmetries: The goal for grid-connected renewable energies is to develop the national renewable resources for generating electric energy, taking advantage of opportunities for replacing fossil fuels, avoiding investments in grids or enhancing new sectors that will generate wealth and employment.
3. Promote and accelerate the private and public investment in the new renewable energies: The goal is to generate effective conditions of investment in the new renewable energies that mitigate the distortion introduced by the subsidies to the fossil fuels, offering a suitable payback to the investment, an appropriate mitigation of risks and a regulation, procedures and communication that ease the implementation and commit investors.

Framework and Specific Goals

Energy is a development factor not only in urban areas but also in rural areas. Rural areas are defined by a low population density, high dispersion of population and low energy consumption.

The rural areas far from the grid may be divided in two areas: rural areas of influence – commune headquarters and others – and dispersed rural areas.

In the rural areas of influence, it is possible to guarantee the supply of electric energy through small local grids or systems of renewable energies, mainly solar and pico/micro hydro plants, associated with public or commune infra-structures. It is possible to foresee solutions of incentive to the installation of “Individual Solar Systems” (thermal or photovoltaic) or to the establishment of energy stores through private initiative.

The incentives to private initiative and the financing solutions are fundamental as the investments to be made are heavy and, most times, not much attractive in comparison with the alternative of diesel or gasoline generator with a subsidized price that represents a cost for the country.

In disperse rural areas the systems or single solutions based on solar energy are the most suitable solution for providing basic services of energy. The use of wood or charcoal will remain as the most used solution for cooking, giving priority to the spread of efficient or improved ovens. The higher dispersion and lower economic capacity may justify a higher level of subsidy associated with simpler energy services and of lower investment. The productive use of renewable energies in agricultural communities regarding water pumping, drying and milling may be defined as an area of high priority in these areas.

An integrated management of several interventions regarding rural electrification is important to optimize the allocation of resources and guarantee the quality, coherence and regional balance of on-going initiatives. Quality is one of the important issues because often the low purchasing power compels consumers to opt for solutions of low quality and with reduced duration, which will result in increased spending and a throwback to traditional solutions.

The specific goals, by 2025, in the area of energy services for offgrid rural areas are:

- Establishment of the National Institute for Rural Electrification;
- Broadening the program of “solar village” to every commune headquarters and populations with more than 2,000 inhabitants that are not connected to the national grid by 2025, with the target of connecting at least 500 sites, implementing more than 10 MW of solar photovoltaic energy and installing 50 systems based on pico and micro-hydro;
- Promote the private domestic market of at least 1 MW per year of individual solar systems produced in Angola;
- Distribute at least 100,000 improved stoves and 500,000 solar flashlights, to the most remote populations and with low purchasing power, and create distribution and training teams within the scope of the National Institute for Rural Electrification;
- Implement in more than 200 agricultural communities, systems for productive uses (irrigation, drying and milling) based on renewable energies;
- Promote the establishment of at least 200 new companies or businesses dedicated to manufacturing, maintenance and distribution or commercialization of renewable energetic solutions for rural areas.

To reach the goals the following measures were identified. This measures should be aligned with the economic development programs defined by the Government.

Measures within the scope of the communitarian and public services

- Establishment of the National Institute for the Rural Electrification (NIRE) which will be responsible for managing the National Fund for Electricity and, in the most rural areas, for managing every initiatives of the Ministry of Energy and Water, guaranteeing the engagement with Provincial Governments and drive the allocation of concessions for

distribution or production/distribution to private parties for extending the grid or for the establishment of new local grids;

- Establishing parameters to define when the energy services will beneficiate from a local grid, individual system or service, as well as communitarian or public energy services which may be available in each type of site. Based on those parameters a new map of the national territory will be developed that identifies the proposed areas for electrification by grid extension, by means of isolated systems, local grids or individual services by 2025, as well as the level of "energy" services on a public and communitarian level in each site;
- Launch public tenders, in articulation with the Provincial Governments, for the installation of local grids (known as "solar or renewable villages") based on systems of solar photovoltaic energy in the rural commune headquarters and populations with more than 2,000 inhabitants, with no access to the grid until 2025, benefiting social infra-structures, namely: public illumination, water pumping, health centers, schools, administrative buildings, police stations and communitarian centers;
- Promote the development of communitarian local grids also based on pico and micro-hydro ("renewable villages"), through mapping, identification and research on sites with potential on the territory, and through the launch of tenders for its deployment;
- Over-sizing "solar or renewable villages" in order to establish a concession of energy services in each site conceded to the private sector that carries out individual services to communities and that guarantees a maintenance of both communitarian and local individual systems;
- In addition to "solar or renewable villages", promote the installation of solar thermal systems in community buildings and, in more dispersed and less populous areas, to promote the installation of streetlights from photovoltaic systems.

Measures within the scope of domestic use:

Promote the installation of photovoltaic systems of illumination on houses located in off-grid areas and where there are no more economically favorable alternative through, among others:

- Programs and campaigns of divulgation and training;
- Credit lines with low-interest (subsidized) to be established through banks;
- Tax benefits to equipment manufactured in national territory and to commercial solutions of renting or payment per use.

Ease the access to solar photovoltaic energy systems, in particular in disperse areas, with low consumption and low purchasing power, through a program of incentives to the establishment of distribution and retail networks of these equipment.

Establishment of a system for certifying equipment traded in the area of renewable energies for rural electrification in order to guarantee the regularly specified quality standards.

Promote the construction of small bio digesters for individual use, in the agricultural areas, through an incentive and training program to be developed in coordination with the Ministry of Agriculture.

Promote, in articulation with the Provincial Governments, the distribution of efficient or improved stoves and solar flashlights, manufactured in Angola and also the training for final users.

Measures in the area of productive activities and stimulus to entrepreneurial initiative:

Promote close to agricultural communities, in articulation with the Ministry of Agriculture, a program of incentive to the productive use of renewable energies for agriculture, including the incentive to install it:

- Systems of water pumping for agricultural and cattle raising use;
- Bio digesters, with the ultimate purpose to produce electric energy;
- Electric mill systems based on renewable energies;
- Solar systems for drying food.

Launch a program of training, accreditation and distribution of raw materials for the manufacturing by local artisans of low cost solar dryers for food.

Support and ease the establishment of small private local grids based on renewable energies, energy stores and companies of installation and technical assistance in the area of the new renewable energies, through a program of training, incentives and a simplified licensing regime.

Enhance the establishment of factories for equipment oriented to the off-grid rural electrification associated with “solar or renewable villages”, with the individual solar systems, with the improved stoves and solar flashlights, as well as with the productive uses in order to provide knowledge, employment and decrease the cost of these solutions.

STRATEGIC GOAL 2: Develop the use of new renewable technologies connected to the grid, enhancing the establishment of new markets and reduction of the regional asymmetries

Framework and specific goals

It is important to develop with logical reasoning the grid connection of each of the priority new renewable energies: solar energy, small hydropower plants up to 10 MW, biomass energy and wind energy.

Regarding solar energy, there were identified several opportunities for connecting to the grid, in particular in the South System and Eastern System that is important to carry out together with the establishment of at least one modern factory that enhances a real market of solar solutions also for the rural areas. The thermal solar, despite not producing electricity, may decrease its consumption, with particular interest in the sites where the production of electric energy is based on diesel.

Regarding hydropower, it is fundamental to implement the projects assigned, prepare the launch of tenders for the remaining identified potential and carry out a detailed mapping in order to identify additional opportunities, for the electrification of isolated urban areas and also for the small hydroelectric projects for connecting to the grid.

Regarding biomass energy, it is important to implement the opportunities identified with potential for enhancing agricultural and forestry initiatives, in particular in the North, Center and East. The cogeneration or the energy use of waste from agricultural and/or livestock activities may help enhancing new entrepreneurial realities in the agro-livestock that is important to support through the acquisition of exceeding energy, always that its prices are suitable. Finally, it is important to establish incentives, in cooperation with the Ministry of the Environment, for the construction of 1 or 2 incineration units based on waste fuels (up to 50 MW) and in order to the landfills be prepared for using the gas that will generate to produce energy.

Regarding wind energy, the confirmed resources in Tombwa together with the heavy investments required in terms of the grid suggest a phased project – meaning that it is possible to reach the target of 100 MW by 2025 with a first phase of 20 MW in Tombwa and several other projects across the territory. It is also important to take advantage of the first 100 MW to obtain knowledge, train people with the needed skills to maintain the equipment and create competencies in the area of renewable energies, promoting the link to the universities and the launch of training offers in this area.

Regarding other sources of energy and investigation and development, it is important to follow technological evolution, trying to understand its consequences and application in the Angolan context.

The specific goals for grid connection of renewable energy technologies by 2025 are:

- Regarding solar generation, to reach 100 MW of installed capacity, including 10 MW off-grid, establishing a factory unit of solar photovoltaic panels and the associated cluster;
- Regarding generation based on small hydropower plants, to reach 100 MW with at least 60 MW oriented to the electrification of municipalities headquarters based on isolated systems;
- Regarding generation based on biomass, to reach 500 MW of installed capacity, supporting the establishment and development of new livestock and agriculture ranks, with a particular interest for sugarcane, of new forestry businesses in the eastern and center of the country, and of the establishment of incineration units of waste fuels;
- Regarding wind power, to reach 100 MW of installed capacity, with a specific focus on a broader regional diversity and a taking better advantage of the current infra-structures;
- Regarding other sources of renewable energies and research and development, to establish a center of research and development for the new renewable energies in Angola.

To implement the mentioned goals the following measures were identified:

Measures in the area of solar energy

Launch tender to concede licenses for the construction of photovoltaic power plants connected to the grid, under the regime of Independent Power Producer, with a total capacity of 100 MW - 10 MW per year over 10 years - associated with the installation of a modern factory unit and of distribution networks and trade of individual systems at competitive prices for rural areas.

Study and dimensioning of solar systems to replace diesel fuel in thermal power plants of isolated system to be included in the tender to be launched.

Promote the establishment of a market for solar photovoltaic and solar thermal energy disseminating information to the general public by means of great impact, such as on television and radio. Moreover, technical, commercial, economic and legal information should be disseminated for the private sector through official websites.

Launch a pioneer program to encourage the use of solar collectors for heating water in the interior Provinces headquarters supplied with electricity generated from diesel, in order to launching a national program.

Measures in the area of small hydropower plants

Promote the study of projects and launch tenders for the construction of at least 60 MW of projects for competitive small hydroelectric power plants oriented for the electrification of municipalities' headquarters away from the network.

Establish a system of concession of production/distribution and remuneration of isolated systems based on small hydropower plants that limit the risks and create the appropriate incentives to the optimization of projects, namely through power purchase agreement of the type that "receive or pay" and independent remuneration by type of asset. A system of certification/inspection of the energy produced and distributed to safeguard any subsidies to be awarded will be created.

Conduct a thorough mapping of the hydroelectric potential and national projects to boost the private sector or promote new tenders.

Promote the allocation of concessions and construction of small hydroelectric power projects connected to the grid at competitive costs.

Measures in the area of biomass energy

Promote and encourage the interconnection to the National Grid and sale of energy surplus from units of electricity cogeneration, from sugarcane bagasse and agro-livestock waste, providing for the installation of at least 110 MW by 2025.

Promote the implementation of hydro-thermal phased projects in the central region and associated with the establishment of a forestry industry in the region, providing for the installation of 300 MW of biomass power plants and equivalent additional capacity of medium and large-size hydro by 2025 (power capacity greater than 10 MW).

Promote the construction of at least 2 forestry biomass power plants close to large cities in the east of the country with a total power capacity of 40 MW, associated to the development of the forestry industry.

Promote, in close cooperation with the Ministry of Environment, the construction of 1 or 2 incineration units based on waste fuels in the main urban centers of the country, totaling 50 MW, and the establishment of incentives for preparing landfills to collect and value biogas energy.

Measures in the area of wind energy

Promote the construction of the Tombwa Wind Farm with an initial capacity of 20 MW and a 60kV connection to Namibe, taking advantage of existing and planned grid infrastructures to meet the consumption needs of the Southern System.

Complete the wind resource measurements at the 12 identified sites with potential for the construction of wind farms.

Promote the construction and operation of new wind farms across the territory with a total power capacity of 80 MW by 2025, giving preference to the link with universities and the launch of training courses in the area of renewable energies.

Ease the establishment of wind turbine maintenance systems and their respective spare equipment, to feed the domestic market.

Measures in the area of the remaining sources of energy and research and development

Promote the establishment of a Research Centre for Renewable Energies in close cooperation with the Ministry of Science and Technology.

Promote the establishment of protocols with national leading universities for research and development in the area of renewable energies, as well as for equipment certification.

STRATEGIC GOAL 3: Promote and accelerate public and private investments in new renewable energies

Framework and specific goals

In order to accelerate the investment in new renewable energies it is important to set clear rules in terms of regulation, incentives and favorable tax regimes for investment and also develop human skills regarding qualification and information.

Regarding regulation, it is important to establish appropriate procedures to private initiatives in the allocation of concessions, clear rules and deadlines defined in the access to the grid and in the licensing of projects, as well as clear and simple rules to entities acting at the level of rural electrification.

Regarding financing and incentive mechanisms, the establishment of subsidized tariffs for new renewable energies connected to the grid ("Feed in tariffs") are an important component, therefore the establishment of tariffs should take into consideration the applicable tax system, the type of financing and respective interest rates and maturities, and the CDM - variables that must be optimized to the RE. In addition to the tariff, the developers should obtain a payment guarantee from the Ministry of Finance.

The National Electricity Fund (FUNEL) plays an important role in this strategy, particularly in supporting rural areas and in raising/channeling concessional financing and assistance. FUNEL, through INEL, will also keep cooperation with the Sovereign Fund that may be a minor shareholder of the projects to be developed.

Regarding skills training and communication, it is important to promote conditions for staff and skills training and increasing knowledge regarding the potential and benefits of renewable energies, particularly in rural areas.

SPECIFIC OBJECTIVES TO PROMOTE NEW RENEWABLE ENERGIES

The specific goals to promote investment in renewable energies by 2025 are:

- Approve specific laws for new renewable energies;
- Approve pre-defined subsidized tariffs (FiT) for renewable projects to be grid-connected of up to 10 MW and review the tax system;
- Allocate an amount of at least 1,000 million Kz per year to the National Electricity Fund (FUNEL) by 2025 to support rural electrification programs based on renewable energies and to the establishment of subsidized credit lines for the purchase of individual systems or launch of productive activities;
- Ensure the establishment of at least one training center for renewable energies;

– Launch a media campaign about renewable energies and its advantages, particularly as a means of bringing basic energy services to rural areas and boost solar thermal.

In order to implement the goals the following measures have been identified:

Measures in the area of regulation

Approve and publish specific legislation for attribution of concessions and licensing of RE projects, including procedures for the private sector, the allocation of power blocks - regardless of locations - for promotion of tenders with industrial counterparts, and a simplified and integrated regime for the attribution of joint concession for production and use of water resources for small hydropower plants of up to 10 MW.

Define, in the laws to be approved relative to RE, the principles and rules for grid connection and supply from the new renewable energies. Given its specificity, among other aspects, the rules should establish the principle of "receive or pay" and provide total priority in the hierarchy of dispatch to energy generated by RE.

Review of the environmental impact assessment legislation in order to establish a simplified procedure based on Environmental Incident Studies whenever renewable energy projects are developed outside protected natural areas and exemption of license and environmental impact assessment in the case of solar PV projects and mini-hydro of up to 10 MW. Adopt specific laws and regulations for the exercise of off-grid generation activity, considering the particularities of the technologies associated with the new renewable energies, as well as for the licensing of off-grid operators, either for generation and trade, or for the provision of energy and/or maintenance services, ensuring that technical standards are met, that the service quality is also met, that the licensing and monitoring of the activities are simple and eased, and that the activity is profitable, in terms of the licenses provided.

Measures in the area of financing and incentive mechanisms

Establish and promulgate subsidized tariffs for the supply of electrical energy to the grid based on new renewables of up to 10 MW. Accommodate, whenever possible, the regime of decreasing tariffs to ensure the sustainability and competitiveness of renewable energies in the future. For more than 10 MW, provide for a negotiated tariff regime based on Power Purchase Agreement ("PPA").

Establish specific calculation rules or standards for specific situations in case of concessions for the supply of electricity in isolated systems based on renewable energies. For local grids prioritize subsidy investment and initial installation through pre-determined amounts per client connected and installed kW.

Establish the concession of sovereign guarantees during the initial 15 years of operation for all new renewable energy projects over 1 MW and ensure, through the Ministry of Finance, concessional financing for investments in approved renewable energy projects, which management and retrocession of their responsibilities will be guaranteed by the National Energy Fund.

Review fiscal policy applicable to new renewable energies, namely at the consumption tax level applicable to investments in renewable energies, to the purchase of individual solutions and systems and to power purchase in local grids, as well as at the level of the exemptions to be applied to the custom levels and industrial tax in the early years.

Establish appropriations, rules and management of the National Energy Fund (FUNEL) by the National Institute for Rural Electrification. The Fund should make provision for, among others:

- Obtaining and channeling concessional financing, guaranteed by the Angolan State, in favor of new renewable energy projects connected to the grid, assuming the retrocession of their responsibilities and channeling capital gains to financing rural electrification;
- A suitable engagement with the Angolan Sovereign Fund, which will seek to take minority share in large projects (greater than 10 MW) to support its financing and feasibility;
- The subsidy for the installation of “solar or renewable villages”;
- The support, through pre-established subsidies per customer and installed kW, to an initial investment in local networks, allocated by a tendering procedure;
- Support the distribution of improved stoves and solar flashlights, manufactured in Angola, or “renewable vouchers” for rural and dispersed areas in Angola;
- The promotion, along with local banks, of credit lines to purchase individual solar systems and to support entrepreneurship and the creation of businesses for distribution of solutions and energy stores;
- International cooperation in order to maximize the raising of non-refundable financing for rural electrification projects in Angola;
- The realization of the CDM procedures reverting its benefits for the financing of rural electrification.

Capacity building and communication measures

Promote, in conjunction with the Ministry of Education and the university system, the creation of RE training centers that contribute to the technical development of the country in the RE.

Promote and disseminate this strategy of RE development together with the financing institutions, at various levels in the country (through lectures, seminars and workshops) and internationally in active countries in renewable energy matters.

Promote and stimulate the RE market, through the diffusion of information related to the economic, environmental, social and commercial benefits of renewable energy technologies and its

applications, in particular in rural areas. Launch the communication campaign and spread the knowledge of the technologies use and conversion of renewable resources, in particular through:

- Regular information and education programs in communities and schools;
- Bilingual brochures (in official and local languages) with the divulgation of RE;
- Information about RE on the website of the Ministry of Energy and Water.

Promote the communication and interaction between national, provincial and local governmental institutions in the RE policies. Empowering provincial institutions to serve as a link between communities and the central strategy and ensure that both are continuously aligned.[vii]

2. Botswana

Botswana's abundant renewable energy potential, particularly in solar and biomass remains largely untapped. The government acknowledges the need to create a regulatory framework to provide incentives for renewable energy development, and is working to develop a standalone renewable energy strategy.

Solar Potential

The country has over 3,200 hours of sunshine per year, and an average global irradiation of 21 MJ per m2/day throughout the country, one of the highest levels of solar irradiation in the world. The government has made initial efforts to exploit this solar potential. In July 2015, Botswana called for Expressions of Interest for a 100 MW solar PV plant, and the electricity supply outlook from the Department of Energy Affairs contains 100MW of solar capacity from 2017 onwards. The African Development Bank and the World Bank have worked with the Government of Botswana on the development of a Bankable Feasibility Study for a 100 MW Concentrated Solar Thermal Plant (CSTP).

Wind Potential

The relatively low average wind speeds range from 2.0 to 3.5 m/s are not considered attractive for large-scale wind power development.

Hydro Potential

Botswana is not suitable for a significant hydropower development due to low and uneven rainfall that has caused severe water restrictions and supply interruptions. Ongoing hydro power projects are subject to international discussions of water use.

Bioenergy Potential

Biomass, mainly charcoal and firewood, continues to be a major source of energy for rural and low-income urban communities. The increase of trade in fuel-wood has resulted in deforestation and fuel-wood is now scarce in all areas of the country except in the North. The cattle population, estimated at 2.2 million head (exceeding the human population), indicates promising biogas potential, however few domestic and institutional biogas digesters have been installed in the country. The biofuel sector remains stagnant due to policy constraints, with a continued debate over a biofuels blending mandate primarily hampering growth in the sector.

3. Democratic Republic of Congo

The Democratic Republic of Congo is in the process of implementing the UNFCCC. Within the framework of its National Communication, it has undertaken studies on the country's vulnerability and adaptation strategy in priority areas such as water resources, agriculture and coastline.4

In its first National Communication, DRC recognised the need for the country to have improved access to clean energy for domestic, residential or transport needs and industrial activities and aimed achieve this by reducing its dependence on fuels and derivatives, improving electricity generation and distribution, substituting fossil fuel energy for renewable energy sources and incorporating policies of using clean technologies in the transport section and of promoting the exploitation of biogas reserves.

The period covered by the second National Communication from the Democratic Republic of Congo coincided with a period of conflict that has caused significant loss of life and damage to infrastructure. Notable environmental degradation was recorded. Further, the impacts of climate change are already being recorded throughout the country5.

The second National Communication touches upon DRC's energy and resource use:

Biomass

The DRC has around 125 million hectares of forest. The wood potential is assessed at 12.5 billion m3 i.e., 100 m3 of wood per hectare, and annual production is 2 m3/ha. Firewood and charcoal account for the majority of primary energy consumption. DRC's domestic energy demands result in the net loss of around 400,000 hectares of forest each year6. Reforestation is therefore a priority.

Biogas

The potential to produce biogas from plant and animal wastes is immense. The total estimated methane reserves at Lake Kivu are 50 billion m3.

Electricity

Hydropower resources are abundant. The DRC has a huge hydropower potential of 100,000 MW, the equivalent of 13 % of the world's hydropower potential. Yet the domestic rate of electrification remains low, and is currently estimated at no more than 9 %, while less than 3 % of the DRC's hydropower potential is exploited. Hydroelectricity provides more than 96% of electricity generated in DRC. The main sources of hydroelectricity are the two Inga dams, 140 miles south-west of Kinshasa. Current aggregate power for all of Congo's power stations stands at an estimated 650-750 MW.

Solar

The DRC is in a very high level sun belt that makes the installation of photovoltaic systems and the use of thermal solar systems viable throughout the country. Currently there are 836 solar power systems, with a total power of 83 kW, located in Equateur (167), Katanga (159), Nord-Kivu (170), the two Kasaï provinces (170), and Bas-Congo (170). There is also the 148 Caritas network system, with a total power of 6.31 kW7. The potential for further solar development is high.

CDM projects

There are currently two CDM projects registered in Democratic Republic of Congo.8 As the Democratic Republic of Congo is a Least Developed Country, the CERs issued from CDM projects registered in DRC after 31 December 2012 will be eligible for compliance under the EU's Emissions Trading Scheme.

ICTs for climate change mitigation

One of the UN Millennium Development Goals is to make the benefits of new technologies - especially information and communications technologies (ICTs) – available to both industrialised nations and developing regions. With these goals in mind, many projects have been founded by the International Telecommunication Union (ITU), Organisation for Economic Co-operation and Development (OECD), World Wide Fund for Nature (WWF) and other organisations with the aim of looking into ICTs and climate change.

Climate Change Legislation

DRC has no National Climate Change Policy and Strategy that presents DRC's current and future efforts to address climate change vulnerability and adaptation. It currently relies on environment-related policies and action plans to implement climate change initiatives and activities. Nevertheless, several NGOs and donor agencies have been active in the DRC to develop an

administrative structure to address the needs of environmental protection and natural resources management.

Semi-Urban and Rural Electrification Project

DRC has the 4th highest hydro-electric power potential in the world, with 600 billion KWH and about thirty power stations mainly located in Katanga and in the Bas-Congo. Almost 2.5 percent of this potential is currently tapped.

Hydroelectricity provides more than 96 percent of electricity generated in DRC. More than half of the exploitable capacity is at the Hyd'Inga facility. The long distance between this site and users has had a negative impact on electrification of villages and towns across the country as due to DRC's size (four times that of France), it requires thousands of kilometres of electricity lines to reach users. As a result, the electrification rate is just 6 percent.10

In line with its strategy to boost energy infrastructure to accelerate Africa's development, the African Development Bank (AfDB) Group approved in December 2010, a grant of USD 106.6 million to the DRC, to finance the country's rural and semi-urban electrification projects. In 2002, the World Bank also approved USD 167 million in energy support for the DRC's electricity system. The aim was to rebuild Inga Dams I & II, strengthen or add power lines, and extend power distribution to 250,000 additional people in Kinshasa.

Real change on the ground has been slow however. To date, only two of Inga's turbines have been refurbished, and power output remains at barely 40 percent of the original capacity.[viii]

4. Lesotho

Physical Potential

Renewable power, in particular hydropower and biomass, makes up a large share of existing energy production in Lesotho. The country, however, has to import almost as much (66MW) as it produces domestically (72MW) to meet the basic needs of cooking and space heating by the majority of the population in the rural areas. Still Lesotho has got abundant potential for renewable energy resources. Opportunities lie in the generation of solar energy, wind energy and hydro power to generate electricity and meet the current supply gap.

Solar

Except for a few days in the rainy season, the sun appears all day for 10.2 to 13.8 hours, and most parts of the country get 300 days of sunshine a year with required radiation that can be used effectively to produce electricity. The theoretical solar power reception in Lesotho is about 60 x

1012 kWh per year. This is equivalent to 5159 million tons of oil equivalent (mtoe) per year. With 14% solar-to electricity conversion efficiency via PV modules, usable energy is 280 KWh/m2/yr. Solar PV is seen as having a very high potential especially in rural electrification for off-grid installations in households, schools, hospitals etc. Due to very mountainous terrain and sparse population, grid extension is not viable in the southern parts of the country. Solar energy is also seen as a means for water heating and the government has embarked on a project to equip public buildings with solar heaters. Solar cookers and solar dryers are also discussed for rural households. An analysis undertaken by the Department of Energy indicates that about 30 per cent of rural households could afford solar PV if there is a financing mechanism (whereby owners buy on credit) in place.

Wind

Lesotho offers the opportunity to build one of the highest windfarms in the world, with more than 80% of its territory lying at least 1,800m above sea level. Estimates have ranged that there is the potential to generate over 6,000 MW of wind power in the foreseeable future. Wind is a potentially significant source of energy for Lesotho not only for its own uses, but as well for export to its neighbours which present higher energy demands. Despite the potential to be one of the world's highest wind farms, Lesotho is susceptible to one of the highest rates of localised lightning strikes. Another concern is the ability of the aluminium composite blades to withstand the Mountain Kingdom's icy (down to -20°C) winters. Ice accumulation is a problem that can worsen in low-wind scenarios, which impacts economic viability.

Hydro

The Lesotho Highlands Water project offers opportunities for mid to large scale hydropower development and several studies have been conducted on possible pumped-storage plants as well. In most cases, the units are not operating at their full capacity because of drought and siltation. However, it is estimated that the large-scale hydropower generation potential for Lesotho is approximately 450 MW. As to small scale hydro, there are currently four mini hydro-power stations in the mountains at Semonkong, Tlokoeng, Tsoelike and Mants'onyane. It is estimated that there are roughly other 20-40 sites available for exploitation with a combined potential of more than 20 MW. The situation in Lesotho is conducive to developing small hydropower systems due to adequate existing hydropower resources and a settlement pattern in rural areas that favours decentralised energy systems. The current legislation that allows independent power producers to generate electricity for the national grid and the creation of a National Rural Electrification Fund by the government is seen as facilitating the uptake of small hydropower technology.

Biomass

Lesotho's energy balance is dominated by biomass energy, which contributes 66% to the energy mix. The overwhelming reliance of rural households on biomass fuels places tremendous pressure

on this forest resource. The percentage of households in Lesotho with access to energy efficient stoves in Lesotho is growing and an estimated 2900 stoves are in operation in the country, however this reliance on biomass is not sustainable. Fuelwood scarcity is already evident through the Lesotho's reliance on imports for fuelwood and coal to complement its domestic supply. In addition, there is no institutional support for promoting alternative energy fuels such as LPG and the efficient use of biomass. Biogas is considered a difficult technology for a rural population, and the subsequent water needs for bio-digesters are difficult to meet in many rural areas. Hence, the rural population finds it much easier to burn dung directly than going through complicated digester systems to produce gas for cooking. A common problem with digesters in Lesotho is that the gas production can drop sharply in winter due to low temperatures and frost. Another major problem is a sharp decline in livestock population due to stock theft in most rural locations.

5. Madagascar

A majority of Madagascar's renewable energy potential remains unharnessed. The country has high hydro, solar, and wind potential and considerable biomass resources. In its New Energy Policy (NEP), the government identified an ambition to produce 85% of the country's power from renewable sources by 2030.

Solar Potential

Madagascar has a large solar energy potential. Almost all regions of Madagascar receive over 2,800 hours of sunshine per year, with the daily solar radiation ranging from 1,500 to 2,100 kWh/m2. PV systems are currently utilised for powering public buildings such as health clinics, as well as off-grid community electrification solutions. A few foreign companies are assisting with various electrification projects on a small-scale (i.e. solar-powered pumps for clean water).

Hydroelectric Potential

Hydroelectric potential has been estimated at around 7.8 GW, although the economically exploitable potential has not been specified. Only 2% of this technical potential is currently utilised. More than 800 untapped high potential hydro sites have been reported throughout the country, ranging from 10 kW to 600 MW. The World Bank (through ESMAP) is providing technical assistance to the sector, including the mapping of potential for small hydropower projects (<20 MW). A resulting study has identified 2,045 small hydro sites and prioritized 30 promising sites from 1 to 20 MW.

Biomass Potential

High potential for biomass energy production from sugar production is located in the South, where bagasse co-generation is already common. Madagascar has several decades of experience in

jatropha production, and is recognized as one of the largest producers of jatropha-based biodiesel in Africa.

Wind Potential

The northern part of the country, around Antsiranana, and the southern part of the country, around Taolagnaro, have wind speeds of 3 to 8 m/s, with a potential capacity of about 2,000 MW for electricity production.

Geothermal Potential

Madagascar is believed to have geothermal potential estimated in excess of 350 MW – exploration is at an early stage.

6. Malawi

Malawi is endowed with significant renewable energy resources, but so far only the larger hydropower resources have been exploited. This is mainly due to lack of funding for research institutions, inadequate policy provisions and implementation, previously high technology costs, and the lack of experience with technologies such as solar and wind power. The resource potential is also particularly misunderstood.[ix]

Malawi's installed electricity capacity is a mere 351 megawatts (MW), not nearly enough to meet current demand, let alone to plan for the future. As in many countries across sub-Saharan Africa, Malawi's abundant renewable energy resources—such as solar, wind, and hydropower—are the most likely source of rapid new generation capacity. Turning these resources into reliable, distributable electricity can be achieved most efficiently through investment in renewable energy power plants by independent power producers (IPPs).[x]

7. Mauritius

Mauritius has no known oil, natural gas or coal reserves, and therefore depends on imported petroleum products to meet most of its energy requirements. Local and renewable energy sources are biomass, hydro, solar and wind energy. Biomass energy consists mainly of bagasse, a by-product of the sugar industry, and contributes about 22 % of the primary energy supply. Fuel wood and charcoal are minimally used. Hydropower plants, with a combined installed capacity of 59 MW, is virtually the entire hydro potential. Furthermore, Mauritius has a good solar regime with a potential average annual solar radiation value of some 6 kWh/m2/day. The wind regime in Mauritius is very good in some areas, with an annual average speed of 8.1 m/s at 30 m above ground level.[xi]

Overview

The Government of Mauritius' energy policy encourages the use of renewable and clean energy to reduce the country's dependence on fossil fuels and decrease greenhouse gas emissions; it aims to increase the use of renewable sources from 20% in 2016 to 35% by 2025. The Central Electricity Board (CEB) is the sole agency for transmission, distribution, and sale of electricity in Mauritius. CEB currently generates 40% of the country's total power requirement from four thermal power stations and eight hydroelectric plants; the remaining 60% is purchased from Independent Power Producers, mainly private generators from the sugarcane industry using bagasse and imported coal. The government has indicated that renewable energy will be an important aspect of the next budget, and it is currently developing a variety of plans in this field. In 2014, a total volume of 2,937 GWh was generated, with only 20% from renewable sources, including bagasse (sugarcane waste). While bagasse remains the key source of renewable energy (16%), Mauritius derived the remaining 4% of renewable electricity generation from hydro, wind, landfill gas and solar. In 2015, the CEB invited Expressions of Interest for the installation of renewable energy plants to include wind, solar photovoltaic, sustainable biomass, hydro, ocean, and waste-to-energy. The government seeks international competitive bidding for all its power projects and favors joint ventures between the local private sector and international firms. The existing grid can accommodate up to 70 MW of renewable energy.

The GOM is also undertaking legal and institutional reforms in the energy sector and plans to establish an independent utility regulatory body. The Energy Efficiency Act of 2011 provides the framework for product labeling and importation of energy-efficient equipment. The GOM also passed a Building Control Act in 2011 to improve energy efficiency in building design.

In the 2015-2016 budget the Minister of Finance announced the creation of 8 "smart cities." According to the GOM, these cities will generate their own energy and water and will provide connectivity and modern transportation.

Sub-Sector Best Prospects

- Photovoltaic cells and technology
- Solar energy technology for solar water heaters
- Waste-to-energy plant for burning solid waste
- Pumping of cold sea water for air conditioning
- Wind turbines
- Liquefied Natural Gas Projects
- Green building design services and equipment
- Energy efficiency projects and energy audits

Opportunities

Solar Technology/Waste-to-Energy: Much of Mauritius receives almost year-round intensive sunlight that makes solar photovoltaic (PV) energy a feasible energy option. In 2014, local firm Sarako Ltd, with the technical assistance of a German partner, completed a 15 MW solar PV farm that is now supplying electricity to the national grid. Moreover, CEB negotiated power purchase agreements with a number of selected bidders, including one U.S. firm, for several PV projects of 1 to 2 MW for a total of 10 MW. These projects are currently being implemented. In the third quarter of 2016, CEB plans to issue a Request for Proposal for more solar energy projects ranging between 10MW and 15 MW as well as an 18MW waste-to-energy project.

Wind and Wave Energy: The CEB has thus far signed two Energy Supply and Purchase Agreements with two foreign firms for wind farm projects. French company Quadran completed the first project for 9MW in 2016 in a joint venture with a local partner. The CEB granted a second project for 29MW to Indian firm Suzlon, also in a joint venture with a local partner, but litigation has delayed that project. Preliminary research carried out by the Mauritius Research Council (MRC) show potential for developing offshore wind farms as well as wave energy in the waters of both Mauritius and Rodrigues. In November 2015, Australian company Carnegie Wave Energy Ltd. signed a Collaboration Agreement with MRC to explore opportunities for commercial wave energy plants.

Energy Efficiency/Green Building: As part of a general move away from fossil fuel-generated energy, opportunities exist for energy efficiency, audit, management, and advisory projects targeting large energy consumers. The Building Control Act 2011 provides opportunities for consultancy services in the design of “green” buildings and the supply of related equipment and materials. Energy efficiency is now one of the main criteria in the design of public buildings and in rental of private buildings.

Deep Ocean Water Applications (DOWA): The GOM’s Board of Investment is actively promoting Deep Ocean Water Application (DOWA) projects, often known in the U.S. as “O-tech” or Sea Water Air Conditioning (SWAC). Local company Sotravic through its subsidiary Urban Cooling Ltd, is implementing a project to pump cold sea water from a deep ocean current into downtown Port Louis for the air conditioning of buildings and other applications. Sotravic has partnered with U.S. company Makai Ocean Engineering to carry out the feasibility study and the conceptual design of the project. By the end of 2016, Sotravic plans to solicit bids for the detailed design and engineering study for the project. Following this study, Sotravic will seek a partner with experience laying undersea pipes and constructing pumping stations.

In addition to air conditioning, Sotravic is considering the next phase of the project which will involve using cold ocean water for bottling, aquaculture, seaweed cultivation, pharmaceutical and cosmetic products.

Liquefied Natural Gas (LNG): In June 2016, the Cabinet of Ministers approved a full feasibility study on the implementation of an LNG project for electricity production. The GOM authorities assert that natural gas plants are ideal backup option for renewable energy as they are less polluting than coal, diesel and heavy fuel oil. The feasibility study will include the technical, economic and financial feasibility of LNG, as well as an assessment of environmental and social impact, and assistance in the appointment of transaction advisers.

Partnering with Mauritian Firms in Africa: Several Mauritian firms are currently involved in or investigating renewable energy projects, particularly hydropower and PV solar farms, in Kenya, Rwanda, Burundi, Madagascar, and Ghana.

8. Mozambique

The Government of Mozambique and FUNAE conducted a study on solar, hydro, biomass, wind, geothermal, and maritime resources in the country between 2011 and 2013. This led to the publication of the Renewable Energy Atlas of Mozambique, currently the key reference document for technical potentials of renewable energy in the country. The Atlas (website not functioning at the time of writing) may be accessed at: http://www.atlasrenovaveis.co.mz/en

Physical Potential

Mozambique has a total renewable potential of ~23,000 GW. Solar potential is the most abundant resource at 23,000 GW, followed by hydro (19 GW), wind (5 GW), biomass (2 GW), and geothermal (0.1 GW). Of this total resource, approximately 7.5 GW of priority projects have been identified in the Atlas, comprising 5.6 GW of hydro, 1.1 GW of Wind, 0.6 GW of solar, 0.13 GW of biomass, and 20 MW of geothermal.

Solar Potential

Mozambique has significant and virtually unexploited solar potential. Global horizontal irradiation varies between 1,785 and 2,206 kWh/m2/year. In total, Mozambique has a potential of more than 2.7 GW that could be easily developed. This potential offers many possibilities for grid-connected and rural electrification projects. The Renewable Energy Atlas identified 189 locations for grid-connected power plants, close to existing substations, with a total capacity of 599 MW. The provinces of Maputo and Tete have the highest potential for grid-connected solar projects, essentially due to the favourable grid infrastructure. There is approximately 1.3 MW of solar PV-based mini-grids installed in Niassa funded by the Government of South Korea, approximately 200 kW (50x 4 kW each) of solar PV-based mini-grids funded through the Portuguese Carbon Fund, and a handful of multi- and bi-lateral programmes (e.g. World Bank, Belgian Development Agency (BTC), UNIDO, Energising Development) focused on the installation of solar home systems on rural

institutions, micro-enterprises, and households. Current installed capacity in the country is estimated to be 2.2 MW.

Since the rural population is highly dispersed, the majority of these projects are off-grid, stand-alone systems and decentralised mini-grids. When selecting locations for PV systems, priority is given to government institutions including schools, hospitals, and government administrative functions. In the absence of an incentive system, active commercial markets have not yet developed and there is relatively little private participation. A factor for that may also be that consumers may prefer to wait for arrival of FUNAE funded projects compared to private projects, given their cost disadvantage.

The Government's renewable strategy also includes targets for the installation of 100,000 solar water heaters and 5,000 solar refrigerators up to 2025.

Measurements of wind power potential are conducted throughout the country. Mozambique has limited wind resources. Average wind speeds reach over 7 m/s in Maputo and Gaza. The Renewable Energy Atlas identified a total wind potential of 4.5 GW, of which 1,100 MW may have potential for grid connection. Out of these, about 230 MW are considered high potential.

Hydro Potential

Mozambique is one of Africa's largest hydroelectricity producers. Its hydropower generation potential is estimated at roughly 19,000 MW, of which only 2,100 MW have so far been exploited. Two large scale projects are planned for the short to medium term: the expansion of the Cahora Bassa Dam (1,245 MW) and the development of the Mphanda Nkuwa Dam (1,500 MW).

The Renewable Energy Atlas identified a total of 1,446 potential hydro projects with an accumulated potential of 19 GW. 351 priority projects totaling 5.6 GW were identified, the majority being in Tete, Manica, Niassa, Zambezi and Nampula provinces. According to the Atlas, about 100 sites could be developed in the near term.

Bioenergy Potential

According to the Renewable Energy Atlas, Mozambique has potential to generate over 2 GW of electricity from biomass. Of this, a 128 MW pipeline of priority biomass projects would be viable for development in the short term. The following sectors and market segments offer potential for biogas or biomass technologies:

- Forestry: residues from conventional logging or dedicated plantations (1,006 MW)
- Industry and agriculture: agro-industrial waste from farms, wood and plant waste from manufacturing industries (N/A)
- Pulp industry: "black liquor" from wood-firing processes for use in cogeneration plants (280 MW)

- Sugar industry: residual bagasse from the sugarcane crushing process for use in cogeneration plants; sugar cane foliage (831 MW)
- Municipal solid waste: incineration or deposition in landfills for the production of biogas (63 MW)
- Other: small and medium-sized livestock holdings, vegetable oils extracted for coconut or jatropha

9. Namibia

Namibian national electricity utility, NamPower, has approved the Renewable Energy Policy Paper which states that the company's target for the renewable is 10% of the total installed capacity and the first target is 40 MW by 2011. Namibia has undertaken several energy savings measures such as special tariffs for big customers, introduced directive to install solar water heaters to all government buildings and introducing independent power producer concept and supporting development of the energy from the bush encroachment, introducing solar/diesel hybrid mini-grid system and the options for wind power generation.

About 80% of all rural households in Namibia rely on wood fuel as their main source of energy (FAO). The population in Namibia is small and dispersed with the more densely populated areas in the north and, on the other hand, with vast and thinly populated areas in the south. Consequently grid extension is very costly. Considering the situation of deforestation in Namibia and limited possibilities for grid extension, energy efficiency improvement and alternative rural energy solutions are needed. Some piloting activities have already been carried out with government support.

Namibia is very dependent on imported electricity from non-renewable energy sources. In 2008 the imported energy counted 52% of the remaining local generation 48% about 88% was produced by hydropower. The peak load in 2008 was about 430 MW. In 2008, the Namibian cabinet decided to aim for self-sufficiency in electricity generation and to reduce the dependency on ESKOM in South Africa. Namibia is already cooperating with Zambia, Zimbabwe and DRC on alternative supply options. The country has some natural gas resources and exploration for gas and oil resources on the coast is ongoing. Hydro power has significant potential for further exploitation but large scale plans for hydropower scheme establishment have raised political arguments with Angola, South Africa and Botswana over the decades.

Through the Energy White Paper of 1998, the Government has committed itself to introducing renewable energy sources: The Government will promote the use of economically viable renewable energy technologies to improve energy access in rural areas, as a complementary supply option to grid electrification. However, under current pricing the cost of using renewable energy is initially still higher than alternatives for rural customers. The Ministry of Mines and Energy of Namibia has

introduced a revolving fund to support solar energy usage for off-grid purposes to lower the threshold for RE investments. Furthermore, all imports of solar equipment has been relieved from import duties.

It is reported that the final draft contains four main scenarios that have been developed: the Reference Scenario; a Pro-Wind/Solar Scenario with Kudu; a Pro-Hydro Scenario without Kudu; and a 70% Renewable Energy (RE) in 2030 Scenario.

These scenarios express different possible paths that Namibia can take, with varying levels of installed capacity of renewable energies.

While the first three scenarios are developed for information and comparison purposes, the 70% RE in 2030 scenario will enable Namibia to reach the target of 70% renewable energy in terms of annual generated electricity in 2030.

Key goals of the policy

- Namibia must address the problem of inadequate access to electricity (especially in rural areas), the challenge of extending affordable energy services to underserved populations and the need for self-sufficiency and energy independence.
- The country must also ensure that the energy sector development is climate-resilient and able to secure energy access even in a non-stationary natural environment.
- Renewable energy, if developed strategically and with foresight, holds the solution to all these challenges.

10. Seychelles

Despite the market for RE, Seychelles is small and still far from reaching maturity, RE is and will play an increasingly important role in Seychelles economy thanks to its contribution in not only mitigating climate change but also in strengthening energy security. It is an area which will drive local industries, investment as well as create job opportunities. As such, there are opportunities in the solar and wind energy sector. However, given their small size and limited land, RE projects especially of utility-scale will be implemented through a competitive process. As and when and RE opportunity becomes available, Seychelles Investment Board will publish respective tenders on its website and Facebook page. Additionally, one can register their interest with the SIB and they will keep prospective bidders updated of upcoming tenders. Other than large RE projects, companies can also explore the possibility of setting up in Seychelles to supply the local market with RETs or set up an assembly plant for RETs and use Seychelles as a gateway to the larger market in the region (Indian Ocean and African Continent).

Other RE sources

- Biomass: Government is currently reviewing the waste management policy of the country and there is a possibility for Waste-to-Energy Facility. This will also be tendered out.
- Marine Renewable: Surrounded by almost 1.3million km^2 of ocean, there is a potential to harness marine RE sources. The government recognises that such technologies are not yet fully commercialised but are prepared to work with interested parties to use Seychelles as a test bed for their marine RETs. They would facilitate non-financially in the setting up and should the technology be proven economically and technically feasible, Government will explore adoption of such.

Energy Efficiency (EE)

This involves the provision of EE services especially to the commercial and industrial sector, for example, the tourism sector.[xii]

11. South Africa

Physical Potential

South Africa is endowed with multiple renewable energy resources, in particular solar and wind, which were also the most prominent technologies in the recent renewables procurement windows. The coastline of approximately 3,000 km provides favorable conditions for wind power throughout the country and large areas of flat terrain with high irradiation make an ideal ground for solar power. The east coast is tropical with large wood and sugar plantations creating promising bioenergy opportunities. Although South Africa is a water scarce country, opportunities for small-scale hydropower exist and have been exploited over the years. Tidal/wave power may become an important technology in South Africa in the future, given technical potential observed along the southwest coast.

Solar Potential

South Africa has an average of more than 2,500 hours of sunshine per year and average direct solar radiation levels range between 4.5 and 6.5 kWh/m2 per day. South Africa's Northern Cape is one of the most attractive solar resource areas in the world.

Grid-connected Solar PV and CSP

The Solar Energy Technology Roadmap (SETRM) is a joint initiative of the Department of Energy (DoE) and the Department of Science and Technology (DST) supported by CSIR, SANEDI, the International Energy Agency (IEA) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). SETRM estimated that 40 GW of Solar PV and 30GW of CSP can be

developed in South Africa by 2050. Currently contracted capacity, anticipated to be installed by 2021, amounts to 2,321 MW for solar PV and 600 MW for CSP. The IRP 2016 envisions 17,600 MW of CSP and solar PV generation by 2050, in addition to the already contracted capacity.

Solar PV rooftop

The solar PV rooftop market has been steadily growing without much Government support. A voluntary database of small-scale rooftop Solar PV installations suggests that by May 2015, these installations had reached a total of about 43.8MW. A majority of these Solar PV installations are in the commercial, agriculture, industrial and mining sectors. This is an area that still requires policy refinement at a national level. The combined commercial, industrial and residential installations of rooftop PV in the country is estimated to be between 3.5GW and 11.6GW by 2035.

Wind Potential

The Department of Energy (DoE), with international support, developed the Wind Atlas for South Africa (WASA I), which shows fair potential for wind energy in the coastal areas and inland. WASA II currently ongoing covers the remaining areas of the Eastern Cape, KwaZulu-Natal and Free State provinces.

Wind power potential is generally good along the entire coast, with certain areas, such as the coastal promontories, showing strong potential. Inland areas noted with moderate potential, include the Eastern Highveld Plateau, the Drakensberg foothills in the Eastern Cape and KwaZulu-Natal. So far 3,366 MW of wind power has been contracted to be implemented by 2022. The IRP 2016 envisions 37,400 MW of additional capacity to be installed by 2050.

Hydro Potential

An estimated 247 MW potential for new small-scale Hydro development is believed to exist in the rural areas of the Eastern Cape, Free State, KwaZulu-Natal and Mpumalanga. South Africa only has an installed capacity of 38 MW. Apart from Eskom's installed hydropower capacity and number of privately and community-owned systems, it is estimated that around 60 systems have been installed in underground mining areas. No recent study has been conducted on the full potential of hydropower in South Africa.

Bioenergy Potential

Bagasse, bulk from logs and black liquor: Being a semi-arid country, the availability of bioenergy feedstock in South Africa is limited. However, the main sources of potential biomass utilization are wood waste (generated in the commercial forestry industry) and bagasse (generated in the sugar industry). Biomass is used commercially in the pulp and paper mills, and in sugar refineries where bulk from logs, black liquor (residue from paper production) and bagasse are burned to produce process heat and generate electricity.

The forestry sector produces a substantial amount of wood waste that is a potentially large resource for sustainable charcoal, gasification, or direct generation of power.

There is high potential for the production of biofuels from energy crops such as sugarcane, sugar beet, sunflowers and canola. However, the low energy density of these food crops makes it uneconomical to transport over long distances and hence they need to be used either close to where they are produced, or condensed for more economical transport.

South Africa disposes of almost all of its refuse in landfill sites. It has been estimated that the total domestic and industrial refuse has an energy content of about 11.000 GWh per annum. This could be directly incinerated or converted into biogas and methane to produce electricity. There have been proposals for such schemes, and several landfill sites already produce electricity, including: the Durban Landfill-Gas-to-Electricity Project, Mariannhill and La Mercy Landfills, Ekurhuleni Landfill Gas Recovery Project, New England Landfill Gas to Energy Project, Alton Landfill Gas to Electricity Project, Nelson Mandela Bay Metropolitan Landfill, and the EnviroServ Chloorkop Landfill Gas Recovery Project.

A national Biomass Atlas is currently being prepared and should provide more detailed information on biomass potential. 51.5 MW of biomass power plants have been contracted so far and will be implemented by 2022.

Wave Energy Potential

Detailed assessment of the spatial distribution of wave power off the southwest coast has been recently conducted. It was found that the average deep-sea resource ranges from 33 kW/m to 41 kW/m.

12. Swaziland

The concern on climate change and diminishing power capacity can be addressed through renewable energies. Renewable energy offers nearly unlimited supply of energy if one considers the energy needs of mankind compared to the energy we receive from the sun. Renewable energy resources include traditional biomass e.g. firewood, wood-waste from the forest industries, bagasse from the sugar industries; hydropower from water and new renewables such as solar and wind. There is a significant scope for increased renewable energy use in Swaziland. Renewable energy will play an important role in the world's energy supply in the near future mainly because of environmental concerns associated with conventional energy use. The Ministry will therefore continue to initiate, implement and support renewable energy projects and initiatives.

The Ministry formulated a strategic framework and action plan with regards to renewable energy development in the country to address access to energy.

The Ministry therefore seeks to:

- Develop a renewable energy information programme and will establish and maintain an appropriate renewable energy information system.
- Establish a centre for demonstration and education on renewable energy and sustainable energy
- Encourage and enhance, where applicable, topics on renewable energy and energy in general in educational and training curricula.
- Maximise the use of renewable energy technologies wherever they are viable
- Promote greater understanding and awareness of renewable energy resources and the associated technologies;
- Develop and maintain accurate renewable energy resource data and make it available to all, so as to make informed policy decisions regarding sustainable energy use and supply.
- Develop woodlots in areas where there is an acute fuel wood shortage.

Solar Energy

Solar Energy has great potential for widespread use in Swaziland. Experience through pilot projects has demonstrated that careful planning and consultation when developing rural solar installations are very important. In particular, community participation and ownership are key ingredients to success and sustainability. Investigations are underway with a view to developing a large-scale grid-connected demonstration PV plant in Swaziland.

Preliminary investigations have shown that there is a large potential for the use of solar water heaters in residential and commercial buildings. Presently, water heating in residential and commercial buildings is carried out through electric water heaters, which in turn creates a large electricity demand that could otherwise be reduced. Government will encourage a wider use of solar water heaters in residential and commercial buildings through promotional means for private sector initiatives.

The Ministry is currently undertaking a feasibility study and Action Plan for a solar energy programme for the country. The study will look at the sustainable use of solar technologies in the country. Funding is being sought for a solar schools programme to develop and implement a programme for electrification of ten schools in rural areas using solar technologies.

Pre-Electrification Using PV Systems

This programme involves the electrification of remote areas where it is still too costly to bring in grid electricity. It will involve the evaluation of private sector participation and identify possible areas for co-operation in the marketing and distribution of solar home power systems. This programme will

also be undertaken with SEC to test the technical, financial and operational feasibility of offering solar home systems in lieu of the main electrical connections as well as enlightening the public on how the two technologies complement each other. It is anticipated that the cost of solar photovoltaic systems will continue to fall; yet even at present prices it still makes economic sense to use solar electricity for small applications such as lighting. An important aspect of the project would be to investigate ways in which the private sector can assist in the project perhaps by operating as sub-contractors.

Government and SEC will work together on technical requirements for PV systems to ensure that electricity and solar systems are able to coexist and complement each other.

Wind and Solar Resource Assessment

For maximum, cost-effective use to be made of renewable energy resources, a comprehensive knowledge of the resources is required. In Swaziland, there is a considerable lack of such resource data. This makes it difficult to design cost effective renewable energy systems and to plan for the integration of renewable energy into the national energy balance. To assist in system sizing, economic viability assessment and evaluations, a solar and wind resource monitoring programme should be initiated. The Ministry is working in close collaboration with the National Meteorological Service, on this programme, to determine whether there is any realistic potential for effective utilisation of solar and wind energy in the country.

A wind and solar resource monitoring programme has been initiated to focus on the Lubombo Plateau plus one other moveable station for identifying areas that are particularly windy to make an accurate assessment of the wind power generation potential. Local funding will be required to monitor the project and to obtain external assistance when preliminary data is being analysed during the plan period.

There is an ongoing project that will install wind measuring equipment at strategic points along the Lubombo Plateau for data collection regarding wind power generation.

Biomass Energy

There is a need to develop detailed policies and measures for the production and distribution of commercial cooking fuel. Detailed feasibility studies are proposed that will investigate and define in sufficient detail a series of measures that might prove beneficial for the future utilisation of commercial firewood (or fuels derived from agro-forestry residues).

Following these investigations the proposed measures can be tested as a pilot project, limited to certain regions initially. The specific activities include:

- Developing commercial cooking fuel distribution
- Woodstove performance enhancement
- More efficient use of biomass.

GTZ ProBEC (Programme for Basic Energy and Conservation) is a SADC regional programme implemented by the German Technical Co-operation (GTZ) in the SADC region funded by the German and Norwegian Governments. In Swaziland, GTZ has partnered with the Ministry of Natural Resources and Energy to implement the programme. ProBEC manages projects based on basic energy conservation (charcoal, firewood, etc.) in 8 member states of SADC. Currently ProBEC is actively involved in Botswana, Lesotho, Malawi, Mozambique, South Africa, Swaziland, Tanzania and Zambia.

The Programme for Basic Energy and Conservation (ProBEC) concentrates on low-income biomass energy users. ProBEC's first component consists of the promotion of efficient energy devices, primarily associated with cooking, such as, wood-fired and charcoal stoves, solar cookers and heat retention devices. In order to do this, ProBEC adopts a commercial approach. In order to develop a market, ProBEC builds capacity by training producers to manufacture energy saving cooking devices and in parallel, ProBEC stimulates the demand for these devices through raising awareness to potential users. The programme is planned to run for two and a half years until December 2010.

Measures to counter the deforestation in the country through investigations in the wood fuel market chain in the country, the possibility of licensing wood fuel sellers, alternative cooking fuel options and wood lots pilot projects in areas of acute wood fuel shortages, are under development.

Biofuels

Biofuels are plants that can be grown specifically for oil extraction to use as a fuel, e.g. maize, rape seed, sunflower seed, and Jatropha curcas. Some of the oils can directly substitute petroleum fuels like paraffin and diesel, although blending with other fuels is the predominant method of using bio-fuels. Ethanol can be produced from molasses, a by-product of sugar manufacturing and from maize. There are presently two companies in the country producing ethanol from molasses; Royal Swaziland Sugar Corporation (RSSC) and USA Distillers.

Ethanol can be used as a supplement for petroleum; but it must be ensured that the blended fuel meets the required specifications for the country's vehicles. The use of ethanol will have positive environmental effects and also benefit the balance of payments and economic development in the industries concerned. Ethanol blending with petroleum takes place in some countries and many of the technological problems have been resolved. The commercial introduction of this option at a 10% blend of ethanol with unleaded petrol (E10) in the local market is therefore the main issue.

In the short term Government will conduct further investigations on blending ethanol with petrol with a focus on introducing products in the local markets

A “Farming for Energy” study was conducted by the Ministry. The aim of this study was to identify suitable crops for a Biofuels market in the country with our current land availability, rain patterns and soil conditions. The study recommended the following crops as suitable for the production of bio fuels in the country: sunflower, safflower, Soya beans, sesame seeds and Jatropha curcas for bio diesel and sugar cane, sweet sorghum, maize and cassava for the production of ethanol. The study further recommended that the blending ratios be 5% bio diesel with 95% mineral based diesel and 10% ethanol with 90% unleaded petrol. The production of Biofuels will provide the country with a chance to diversify its agriculture.

A Biofuels Task Force was approved by Cabinet. The Task Force is responsible for the development of the Biofuels Industry in Swaziland. It will also advise Government on the legislation that is required to ensure sustainability of the Industry.

The Ethanol Blending pilot project is a joint venture between Swaziland Government and Royal Swaziland Sugar Corporation (RSSC). The project entails testing a fuel blend consisting of 10% ethanol (without water) with 90% unleaded petrol on a selection of Government and RSSC vehicles. To make it suitable for use in vehicles, it goes through a water removal process in an anhydrous plant, before the anhydrous (water free) ethanol is blended with unleaded petrol. Ethanol produced in Swaziland is a by-product of the sugar production process therefore does not compete with food security.

Aim of project:

- To introduce a locally produced and environmentally friendly component into the fuel pool
- To reduce reliance on fuel imported from South Africa as well as to reduce fossil fuel emissions
- To serve as a public awareness campaign for bioethanol

The project began in 2007. Government, along with RSSC, have also are using a selection of its vehicles to be used in this pilot project. These cars will only run on the E10 blend and will be monitored at various service intervals. The vehicles being used in the project are normal vehicles and no modifications have been made to them. The National Association of Automobile Manufacturers in South Africa (NAAMSA) also gave Government a go ahead to blend with 10% ethanol. This blend ratio is suitable for vehicles and does not require cars to make modifications to their engines.

Various parameters will be tested during this project which includes fuel consumption, engine wear and tear, power output and emissions. The ultimate aim of this project is to introduce a locally

produced and environmentally friendly component into the fuel pool, to reduce reliance on fuel imported as well as to reduce fossil fuel emissions.

The Ministry is also developing a National Biofuels Strategy and Action Plan, with the assistance of UNDP, which will ensure that a sustainable (social, economic and environmental) biofuels industry is developed in the country.

Bagasse-Fired Thermal Power Station

Swaziland has abundant sources of waste from agro-industries that could be used for power production. These industrial wastes include bagasse from processing sugar-cane and wood-waste from the timber processing industries. A pre-feasibility study for a 100 MW bagasse-fired power plant concluded that a 54 MW plant could be built at Simunye sugar factory, an 85 MW plant at Mhlume sugar factory and a 30 MW plant at Ubombo Sugar Plant. A recent study (2007) conducted by AFREPREN/FWD, supported by the Global Environment Facility through the United Nations Environmental Programme (UNEP) and the African Development Bank (AfDB) under the Cogen for Africa project, indicated that the potential for cogeneration in Swaziland can be as high as 185 MW. Indications show that the bagasse and wood-waste may have to be supplemented by other forms of fuel such as coal and Natural Gas.

Natural Gas

A feasibility study into the construction of a natural gas pipeline from Mozambique to Swaziland and a gas study market was undertaken to assess the amount of gas required in the country. Natural gas can replace the imported coal in the industry generating power and paraffin in the industrial site at Matsapha. A cross border agreement between the two countries will be entered into once a company is identified that will invest in the pipeline. Government has to invest in a public – private sector partnership on this project.

Hydro-Power Generation- Mini- Micro Schemes

The goal for the Ministry is that access to electricity is made available to all citizens of the country by 2022. The Ministry established a database on the potential of developing mini-micro hydropower electricity schemes. The target was to pin point specific sites around the country where the river basin that exist can be used to generate electricity and further quantify the cost related to establishing the respective electricity schemes. A report was produced from the study and 35 sites were identified. The capacity of the schemes identified ranged between 0.032MW to 1.525MW.

A desktop approach was used to identify these sites hence there was a need to further investigate the sites and quantify the capacities practically. The Ministry in 2006 engaged the consultants to investigate two sites that were seen to be having a high capacity at a reasonable cost. The sites were along the Ngwempisi River. The objective of the Ministry was to develop one these sites into a pilot project. Unfortunately, before the study was completed the consultants noted that the

environmental conditions would not permit that either of these sites could be developed into the pilot project. The river was found to be one of the rivers that is protected as it still has its habitat intact and undisturbed.

The Ministry then changed the scope of the consultants to now determine from the remaining sites the feasibility of developing them into the electricity schemes. The study will cover the environmental investigations, and the actual cost that would be required to develop each of these sites. With that information, it would be then possible to identify the right project to be used as a pilot. The report will further rank the sites according to their capacity, cost and impact to the community should the site be approved as the pilot project.

The three sites identified were Mbuluzi, Lusushwana and Mnjoli Dam. In the feasibility study all these sites were investigated and ranked accordingly. Mnjoli was cheaper to develop compared to the other sites as a result Mnjoli has picked as the pilot project site. The developments are ongoing to build a 0.5 MW mini hydro scheme at Mnjoli Dam.

13. United Republic of Tanzania

Physical Potential

Tanzania has a high and mostly untapped potential for renewable energy sources. The only resource significantly in use is hydropower at a large scale. Additionally, small hydropower has good potential and is particularly feasible in rural areas. Biomass resources are mostly exploited in traditional, but unsustainable ways though there remains great potential due to large amounts of organic waste generated from the agricultural sector. Solar energy is abundant with initial efforts being undertaken to exploit this resource through both off-grid and grid-connected solutions. Wind resources have been assessed with results showing promise with plans for developments underway. The World Bank is mapping renewable energy resources within their ESMAP Programme.

Solar Potential

Tanzania has promising levels of solar energy, ranging between 2,800 and 3,500 hours of sunshine per year and a global horizontal radiation of 4–7 kWh per m2 per day. Solar radiation is particularly high in the central region of the country.

To date, about 6 MW of solar off-grid PV has been installed countrywide. PV installations are generally used at villages, schools, hospitals, health centers, police stations, small telecommunications enterprises and households, as well as for lighting, street lighting and basic electricity needs. The government, through the REA and various donors, has supported a number

of solar PV expansion programs. One grid-connected PV plant has been commissioned to date. The 1 MW-plant produces about 1,800 MWh/year. The potential for grid-connected solar PV is estimated to amount to 800 MW.

In the short-term, the Power System Master Plan (PSPM) 2007-2031 envisages the construction of 120 MW of PV capacity by 2018. Several private companies have expressed interest in developing 50–100 MW solar plants.

Wind Potential

Initial assessments have shown Tanzania to have promising wind resources, with Kititimo (9.9 m/s average wind speed at 30m) and Makambako (8.9 m/s) having been identified as having adequate wind speeds for grid-scale electricity generation. The Ministry, in collaboration with TANESCO, is conducting wind resource assessments on eight further sites throughout the country. In addition REA supports wind measurements on Mafia Island. To date, four private companies have expressed interest in investing in wind energy, considering construction of farms in the 50–100 MW range.

Hydro Potential

Traditionally hydropower has been the main source for electricity in Tanzania, however intermittent river flows have decreased its reliability. Another key challenge facing hydropower is the regional mismatch between hydro sites and major demand centers with a strengthening transmission system a requirement for further development. Tanzania does intend to further develop its large-hydro capacity with estimated potential calculated as high as 4,000 MW. The Power System Master Plan (PSMP) includes 16 projects with a combined capacity of 3,000 MW to be finalized by 2031, if developed large hydropower would still exceed 30% of generation capacity after 2025.

Of the presented installed grid connected capacity, two small-scale hydro power plants are owned by TANESCO (Nyumba ya Mungu 8MW, Uwemba 4MW), and a further two by private developers (Mwenga 4MW, Yovi 1MW). Beyond these existing developments Tanzania has significant small hydropower potential (installed capacity <10 MW) estimated at 315 MW. Further site level assessments undertaken by TANESCO and financed by Ministry of Energy and Minerals (MEM) have identified 131 specific small hydro sites across the country. Complimentary economic analysis has concluded that a number of sites are commercially viable for generating electricity for the national or mini-grids.

Bioenergy Potential

Currently, there is only one grid-connected biogas plant (18 MW) in place. However, several agro-industrial companies have constructed captive power systems based on biomass to generate electricity for their operations. The potential for modern biomass uses is high, considering that the raw material available is abundant and includes sugar bagasse (1.5 million tons per year), sisal

(0.2 MT/year), coffee husk (0.1 MTPY), rice husk (0.2 MT/year), municipal solid waste (4.7 MT/year) and forest residue (1.1 MT/year).

Geothermal Potential

Tanzania has significant geothermal potential that has not yet been fully quantified. Estimates based on analogue methods indicate a potential exceeding 650 MW across 50 identified sites in three main prospect zones located in the East African Rift Valley.

14. Zambia

Renewable energy sources are abundant in Zambia. Small and large hydropower is the major contributor to the country's electricity supply and will be further developed over the next decades, given its high technical potential. Furthermore, high solar irradiation values promise strong potential for the development of solar PV-based generation. With declining technology costs, there is potential for expansion of solar PV, recently evidenced by the IFC's Scaling Solar program and SIDA's Beyond the Grid Fund.

Solar Potential

The country has an average 2,000-3,000 hours of sunshine per year. Average irradiation is 5.5 kWh/m2/day, with northern areas recording the highest global solar irradiation, of 2,300 kWh/m2/year.

Wind Potential

Wind energy potential in Zambia is relatively limited. Wind data collected at 10 meters above the ground indicate speeds of between 0.1 to 3.5 meters per second with an annual average of 2.5 m/s. These wind speeds are not particularly suitable for electricity generation, but may be suited for water pumping for household use and irrigation purposes. There are specific areas in the Western Province where wind regimes are estimated to be as high as 6 m/s.

Hydro Potential

The country's electricity production is heavily dependent on hydroelectric generation, which currently comprises 95% of its energy generation mix. Zambia's hydro generation potential is estimated at more than 6,000 MW. Several existing large hydro facilities are currently being upgraded by ZESCO with support of several donors, while a substantial pipeline of projects in planning stages has been elaborated, including the 2,400 MW Batoka Gorge Dam power project and the 850 – 1,200 MW Luapula hydro scheme. A large and untapped potential remains for small scale hydropower, especially for rural electrification.

Bioenergy Potential

Zambia has a total biomass resource and economic bioenergy potential of approximately 2.15 million tons and 498 MW, respectively. The largest feedstock contributions are from agricultural and forest waste. The government sees bioenergy as a viable option for electricity production, which is hence considered in public energy expansion plans. With regard to household cooking energy, nearly 60% of the country's households rely on fuelwood for cooking. SNV has developed a feasibility study for biogas applications on the basis of animal waste, identifying strong technical potential in the livestock and dairy sectors, and ERB has developed a draft Code of Practice for biogas installations.

Geothermal Potential

Of 80 hot springs in Zambia, 35 were rated highly in terms of surface temperature, flow rate, and proximity to power lines, indicating ease of access and relative energy potential. These springs have not been tapped for industrial or energy provision purposes. At present there is one geothermal generation plant in the country. The plant was installed following an initiative of the Italian Government in the mid 1980's. Two 120-kW turbines were installed at Kapisya Hot Springs in 1987. Recent estimates indicate that the plant can be upgraded to produce 2 MW of electricity. Efforts are being now being made by ZESCO to revive the plant. At least one private developer, Kalahari Geo-Energy, is exploring geothermal resources in the country.

15. Zimbabwe

Zimbabwe has strong potential for electricity generation from hydro, solar and biomass resources. So far, only a fraction of the country's hydro energy potential has been exploited. Solar and biomass resources also remain largely untapped. Wind and geothermal energy are believed to have less potential in Zimbabwe than in other countries in the region and projects are thus less feasible.

Solar Potential

The average solar irradiation is 5.7 kWh/m2/day with the north and west regions of the country having the highest irradiation potential. Solar PV has a technical potential of over 300 MW. While installed solar power capacity is mainly situated in rural areas and particularly within social institutions, the private, individual home market is growing. A number of small and medium-sized companies that focus on the installation of PV and solar water heaters are emerging. The government will promote the use of solar water geysers that are intended to replace conventional ones. Solar-powered "base stations" for charging electrical appliances have also been installed, mainly through the national telecommunications company.

Wind Potential

Average wind speeds are estimated at 3.5 m/s. The Ministry sees potential in the exploitation of these slow wind speeds for water pumping. The NGO ZERO, a regional environmental initiative, has conducted feasibility studies and financed the production of 1 and 4 kW wind turbines for off-grid purposes, as well as providing power to municipal buildings such as clinics. Areas around Bulawayo and the Eastern Highlands could have potential for larger power generation, since the most prevalent wind speeds range from 4 to 6 m/s.

Hydro Potential

The gross theoretical hydropower potential is 18,500 GWh/year. The technically feasible potential is 17,500 GWh/year, of which 19% has been exploited. Rusitu Hydro, a mini hydro plant (750kW), is one plant constructed and operated by private entrepreneurs. Around eight other small-hydro plants, ranging from 3 kW to over 700 kW, have been installed in the country. Four plants with a total capacity of 21 MW have been commissioned between 2010 and 2014, operating as Independent Power Producers (IPPs). The total small-hydro potential is estimated at 120 MW with Gairezi in Nyange district being particularly promising.

Bioenergy Potential

Co-generation potential (bagasse) currently provides 633 GWh of electricity. The primary source of power generation is obtained from the waste materials of sugarcane production. Two sugarcane-crushing mills process more than 1.3 million tonnes of bagasse to generate electricity used by the sugar factories. The timber industry also has strong biomass potential, generating over 70,000 tonnes of waste for biomass annually. Long-term projections anticipate this figure to double. At the larger mills approximately 10% of the wood waste is consumed in process steam boilers for lumber drying kilns. The vast majority of the industry's waste is burned outdoors or discarded. An estimated 4 MW of additional energy could be created through enhancing equipment at these facilities.

More than 200 biogas plants have been installed around Zimbabwe, primarily by the Ministry of Energy. The vast livestock population offers high potential for biogas generation. The country's first utility-scale biogas power plant (800 kW) is currently at the planning stage.

Geothermal Potential

50 MW of geothermal potential were identified in 1985, but little has been done since to further catalogue the resource. It is reasonable to assume from the country's geographic location near to the geologically-active Rift Valley indicates that geothermal power may be a viable generation option.

History of Renewable Energy Projects Financed in the Last Four Years

It is anticipated that by 2050 the Sub-Saharan African population would have grown to two billion people; commensurate with this population growth is the growth in the gross domestic product (GDP) for Sub-Saharan Africa (SSA). Energy poverty is still a problem for many SSA countries – power cuts, rotational outages and weak regional interconnections and scarce supply have become synonymous with most SSA countries – average electrification is 34%. The Southern African Power Pool anticipates up to 24,062 MW in new generation being commissioned between 2015 and 2019; 45% of this being from South Africa's New Build Programme.

A noticeable trend however is the numerous small projects being built in the other countries as opposed to mega-projects; in addition the projects in the rest of SSA are being developed more by independent power producers than utilities

As at 31st March 2015, SAPP had an installed capacity of 52,598 MW against a demand of 49,563 MW that includes peak demand, suppressed demand and reserves. Available operating capacity stands at 46,910MW. This gives a regional capacity shortfall of 8,247 MW

No	Country	Commited Generation Capacity, MW					
		2015	2016	2017	2018	2019	Total
1	Angola	0	1280	2271	0	0	3,551
2	Botswana	-	-	-	300	-	300
3	DRC	430	-	150	-	-	580
4	Lesotho	-	-	-	-	-	-
5	Malawi	-	-	-	74	300	374
6	Mozambique	205	40	-	600	-	845
7	Namibia	-	15	-	-	800	815
8	RSA	1,828	3,462	3,032	1,476	1,476	11,274
9	Swaziland	-	-	-	-	12	12
10	Tanzania	150	-	500	1,140	300	2,090
11	Zambia	135	-	300	101	1,090	1,626
12	Zimbabwe	15	-	120	1,200	1,260	2,595
TOTAL		2,763	4,797	6,373	4,891	5,238	24,062

Figure 3: Committee Generation Projects Planned 2015 to 2019

This planned generation has however fallen short; it will not be achieved by 2019.

Of the 208 energy projects globally reaching financial close in 2016 – 107 were wind, 48 were solar PV and 15 were gas projects. The number of projects reaching financial close between 2013 and 2016 has remained constant with 211 and 208 projects respectively. Renewable content has increased since 2013; in 2013 renewable technologies accounted for 76% of total projects but in 2016 accounted for 85%. CSP has declined to just one project; however the future looks even bleaker. CSP relied on heavy subsidies and required immense R&D - this is what put CSP developers out of the market, players such as Abengoa had unsustainable R&D costs.

Africa has opted for gas (Ghana, Egypt x2), CSP (South Africa), Powership (Ghana), solar & battery storage (Tanzania), solar PV (Egypt, Senegal) and wind (Morocco) technology. Africa closed potential capacity of 7101.6MW whereas the global capacity was 46 734.24MW; SSA has 545MW of planned capacity. 68% of projects closed globally are less than 100MW; Africa's projects are between 25MW and 4800MW. Total transaction value was in excess of $86bn; Credit value is particularly skewed towards 4 countries - UAE, USA, UK and Japan – only $2.9bn went to Africa.

The only SADC project to reach financial close in 2016 was the CSP project in South Africa

Renewable Energy Project Pipeline

The following table represents specific projects emanating from the previous section; this zooms into opportunities per sector and what kind of assistance is required if any.

Country	Opportunities
Angola	
	Small hydro plants
	10MW off grid rural electrification
	100MW solar PV
	On grid renewable energy
	Localisation through development of solar home systems
	Distribution of energy efficient technologies
	Introduction of minigrids
	500MW of biomass
	100MW of wind
Botswana	
	100MW CSP plant (project prep underway)
Democratic Republic of Congo	
	Biogas from Lake Kivu – bank was approached, project has stalled
	Biogas from plant and animal waste
	PV solar
	Rural electrification

	Grand Inga – bank already involved
Lesotho	
	Solar PV
	Wind
	Large hydro
Madagascar	
	Solar
	Hydro (World Bank doing prep)
	Biomass
	2000MW wind
	350MW of geothermal
Malawi	
	Solar
	Wind
	Hydropower
Mauritius	
	Wind
	Solar
	Hydro
	Bagasse
Mozambique	
	5.6GW of hydro
	1.1GW of Wind
	0.6GW of solar
	0.13GW of biomass
	20MW of geothermal
Namibia	
	Hydro
	Policy aims for 70% renewables but this does not include solar (oversubscribed)
Seychelles	
	Waste to Energy - programmes are announced
	Solar - programmes are announced
	Wind - programmes are announced
	Marine Energy - programmes are announced
	Energy Efficiency - programmes are announced
South Africa	
	Renewable Energy IPP Programme - solar, wind, small hydro, bioenergy
Swaziland	
	Off-grid solar – in progress
	Solar PV – need prep funding
	Wind – need prep funding
	Biomass – working with other funders

	Biofuel – need prep funding
	Natural gas from Mozambique – in prefeasibility
	Mini hydro – in prefeasibility
United Republic of Tanzania	
	Solar - Initial reports done, need prep funding
	Wind - Initial reports done, need prep funding
	Hydro - Initial reports done, need prep funding
	Bioenergy - Initial reports done, need prep funding
	Geothermal - Initial reports done, need prep funding
Zambia	
	Hydro – currently in construction, others in prep
	Solar
	Wind – speeds too low, more suited to water pumping
	Biofuel
	Geothermal – developer is working on reviving an existing plant
Zimbabwe	
	Solar (small and rooftop PV)
	Wind – speeds too low, more suited to water pumping
	Hydro
	Bioenergy – need prep
	Geothermal – need prep

Increasingly projects are coming in for off-grid electrification; projects are in rural areas and have small quantums; lending is limited to balance sheet not project finance – a funding opportunity is being missed by the bank. There is also interest by state owned companies to invest in rooftop solar for their buildings, following on the heels of successful installations in commercial installations such as mall rooftops and parking lots.

Technologies are leaning heavily towards renewables, an opportunity lies to assist countries in developing their own IPP programmes in order to build the pipeline. Further to that, assisting countries in understanding their networks and facilitating dialogues inter-utility to gather lessons learnt relating to EPCs, technology mix and grid stability with the introduction of renewables

Gas is still a dominant technology, global gas players envisage increased gas requirements in Africa and in particular South Africa. An opportunity lies for South Africa and Mozambique to import gas to neighbouring countries through offshore facilities using pipelines

Numerous projects are in need of O&M funding; there is a great need for these services particularly on hydro plants. Most of these plants are more than 60 years old and are in need of a major refurbishment.

Conclusion

The bank needs a dedicated focus if it's to pursue renewable energy technologies; a policy statement with set targets and an implementation arm that focuses solely on renewable energy projects. It should be noted that most renewable projects are in early stage development and are in need of project preparation funding. Furthermore, most countries lack the capacity to run or even implement a renewable energy programme – project preparation could change its scope and be broader to include capacity building. SADC individual country grids are relatively small therefore the penetration of renewables may be limited due to grid instability caused by renewables. For a successful renewables arm, collaboration between utilities, regulators, IPPs and government is essential in ensuring programmes that are well structured ensuring a high probability of success when implemented.

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