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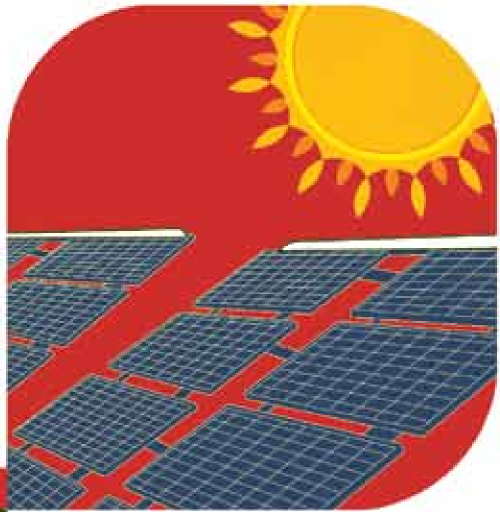
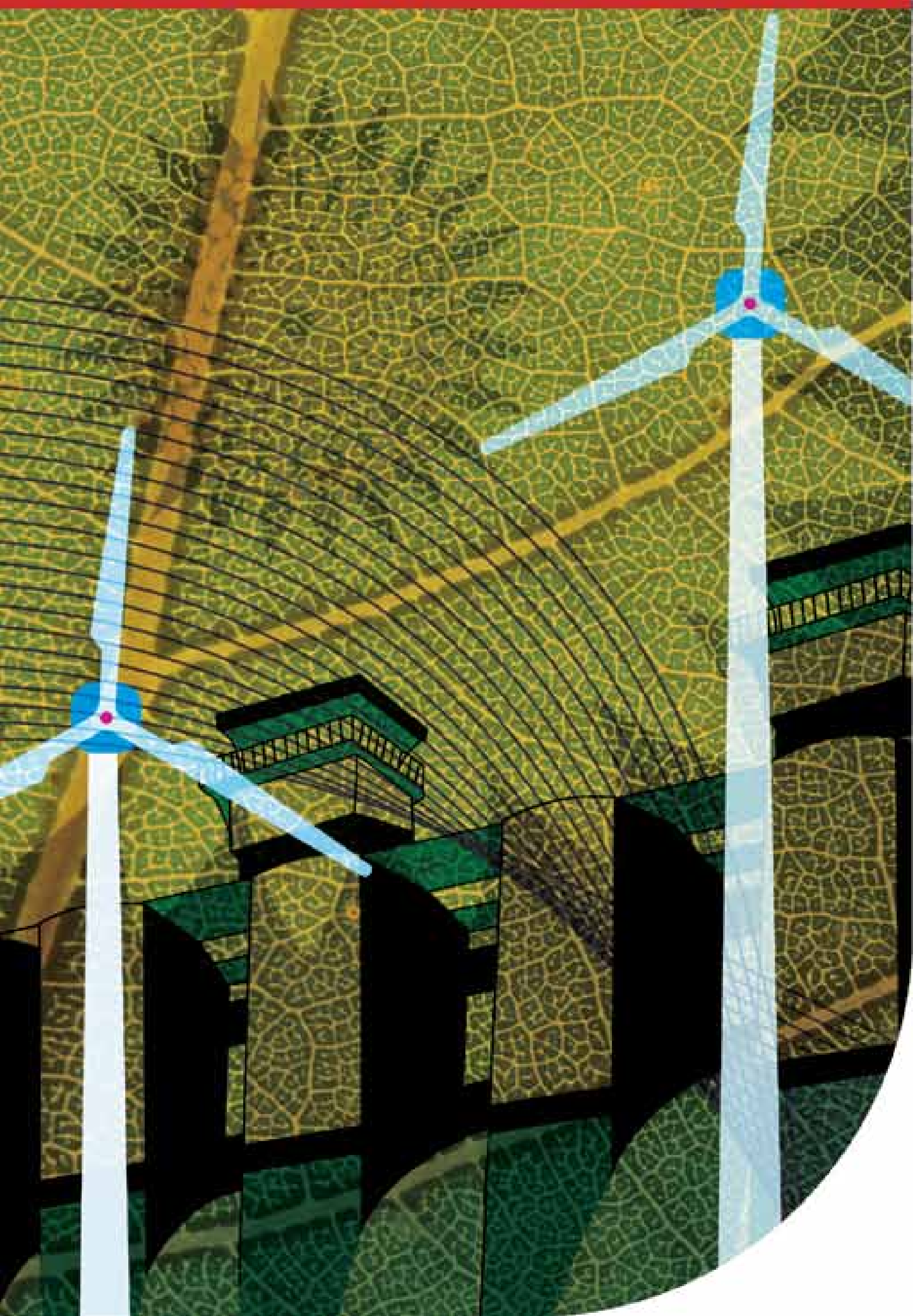


SWAZILAND
RENEWABLES READINESS ASSESSMENT



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About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

About RRA

A Renewables Readiness Assessment (RRA) is a holistic evaluation of a country's conditions and identifies the actions needed to overcome barriers to renewable energy deployment. This is a country-led process, with IRENA primarily providing technical support and expertise to facilitate consultations among different national stakeholders. While the RRA helps to shape appropriate policy and regulatory choices, each country determines which renewable energy sources and technologies are relevant and consistent with national priorities. The RRA is a dynamic process that can be adapted to each country's circumstances and needs. Experience in a growing range of countries and regions, meanwhile, has allowed IRENA to continue refining the basic RRA methodology.

In June 2013, IRENA published a guide for countries seeking to conduct the process in order to accelerate their renewable energy deployment.
For more information visit www.irena.org/rra

Acknowledgement

IRENA prepared this report in close collaboration with Francis Yamba (Centre for Energy, Environment and Engineering— CEEEZ— Zambia), Peter Zhou (Energy, Environment, Computer and Geophysical Applications Group— EECG— Botswana), Boaventura Cuamba (Eduardo Mondlane University of Mozambique), Mduduzi Mathunja (University of Swaziland) and Ecofys. The report benefited from review and consultations with the Southern African Development Community (SADC). IRENA wishes to thank the following experts for their insights and constructive guidance during the peer review process: Peterson Dlamini (Ministry of Natural Resources and Energy), Alexander Filippov (USAID Southern Africa Trade Hub), Veli-Pekka Heiskanen (VTT—Finland), Mzwandile Ndzinisa (Ministry of Natural Resources and Energy), Henri Shongwe (Ministry of Natural Resources and Energy), Elijah C. Sichone (Regional Electricity Regulators Association of Southern Africa—RERA), Mandla Vilakati (Ministry of Natural Resources and Energy) and Frank Wouters (IRENA).

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SWAZILAND

RENEWABLES READINESS
ASSESSMENT

FOREWORD

Minister for Natural Resources and Energy

Swaziland supports, and welcomes the backing of, the International Renewable Energy Agency (IRENA) in the challenge to scale up renewable energy. We have been promoting energy access throughout the country by extending the grid and utilising off-grid systems. Solar lighting was introduced in primary schools, and solar water pumping programmes were also run in rural areas in the early 1990s, as Swaziland worked tirelessly to make use of renewable energy resources. However, the lack of assessment and over-reliance on imports of renewable energy equipment were major setbacks.

In 2003, Swaziland adopted a National Energy Policy (NEP), which highlighted the need to develop the renewable energy sector. In 2007, the government carried out reforms in the electricity supply industry. We now have new Electricity and Regulatory Authority legislation that covers both on-grid and off-grid power systems. Swaziland has also run biofuels initiatives and anticipates the future rollout of ethanol-blended fuel throughout the country. Reconnaissance and pre-feasibility studies on mini and micro-hydro have been completed, and potential has been found at some sites.

IRENA's report on the country's Renewables Readiness Assessment (RRA) has come at the right time. This report will go a long way in helping Swaziland chart a more systematic approach to renewable energy deployment. Several important issues need to be resolved for the country to be ready for renewables. Clear business and financial models are requested, along with a renewable-specific energy policy, strategies and action plans. A regulatory framework specifically aimed at renewable energy and a comprehensive resource assessment for different renewable energy resources are also needed, along with appropriate technical and human resource capacity within and outside government. We must also create a resource assessment map, build information resources on renewable energy technologies, and set standards and sustainability criteria for biofuels production.

The outputs of this exercise outline strategies and actions that I trust will serve to increase renewable energy deployment in Swaziland. I therefore look forward enthusiastically to continued assistance from and collaboration with IRENA, in the pursuit of investments to deploy appropriate renewable energy technologies.

Honourable Jabulile Mashwama
Minister for Natural Resources and Energy,
Swaziland

FOREWORD

from the IRENA Director-General

The Africa High-level Consultative Forum held by the International Renewable Energy Agency (IRENA) in July 2011 highlighted the need for technical support for African countries and regions to identify their renewable-energy readiness. The Renewables Readiness Assessment (RRA) process stemming from this involves a holistic evaluation of a country's conditions and identifies the actions needed to overcome barriers to renewable energy deployment. This is a country-led process, with IRENA primarily providing technical support and expertise to facilitate consultations among different national stakeholders.

Since 2011, more than 20 countries in Africa, the Middle East, Latin America and the Caribbean, Asia and the Pacific Islands have undertaken the RRA process, which generates knowledge of good practices and supports international cooperation to enable the accelerated deployment of renewable technologies. Swaziland, in keeping with its strong and consistent support of IRENA's mission, is one of those pioneering countries.

As RRA consultations highlighted, the involvement of private operators in the renewable energy sector remains limited due to the absence of an enabling framework for independent power producers. However, the Ministry of Energy and Natural Resources is developing a comprehensive set of system codes, including a grid code, with a view to enhancing private sector interest. The Swaziland grid code, once finalised, can serve as a model for other IRENA member states.

Renewable energy resources can help reduce Swaziland's dependence on imported electricity. Bagasse co-generation, for instance, a by-product of the sugar industry, could meet about half of electricity demand in a sustainable way, while solar power also offers enormous potential for development. At the same time, Swaziland forms a key link in the Africa Clean Energy Corridor, IRENA's initiative to meet East and Southern Africa's growing power needs sustainably and with a high share of renewables.

IRENA wishes to thank Minister Mashwama and her team for their impressive contribution and warm welcome in hosting this study. We are grateful for their positive engagement and valuable input, which has given us additional insights for undertaking further RRAs in 2015 and beyond. Additionally, this report will feed into other IRENA regional work, increasing the share of renewables through the Africa Clean Energy Corridor.

We sincerely hope that the outcomes of these RRA consultations will assist Swaziland in fulfilling its aim to scale up renewable energy. IRENA stands ready to provide continuing support to Swaziland in implementing the actions identified.

Adnan Z. Amin
Director General, IRENA

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DAM	Day-Ahead-Market
GDP	Gross Domestic Product
GWh	Gigawatt-hour
ha	Hectare
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
km	Kilometre
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt-hour
m/s	Metres per second
MNRE	Ministry of Natural Resources and Energy
t	tonnes (metric)
MW	Megawatt
MWh	Megawatt-hour
NDS	National Development Strategy
NEP	National Energy Policy
NGO	Non-governmental organisation
PPA	Power Purchase Agreement
PV	Photovoltaic
RRA	Renewables Readiness Assessment
SADC	Southern Africa Development Community
SAP	Day-Ahead Market
SAPP	Southern African Power Pool
SEC	Swaziland Electricity Company
SERA	Swaziland Energy Regulatory Authority
SHS	Solar Home System
SIPA	Swaziland Investment Promotion Authority
SWASA	Swaziland Standards Authority
TOU	Time-of-Use
TPES	Total Primary Energy Supply
USD	United States Dollars
Wp	Watt-peak

EXECUTIVE SUMMARY

The Kingdom of Swaziland is a landlocked country in the Southern African region with an estimated population of 1 080 337 (2012) and an annual growth rate of 1.2%. Swaziland is a lower-middle-income country and has a gross domestic product (GDP) per capita of United States Dollars (USD) 3 186. Its economy is mostly sourced from within the Southern African Customs Union and therefore very closely linked to that of South Africa, which accounts for 94% of Swaziland imports. Biomass (firewood, charcoal and agricultural waste) accounting for 66% of the country's energy supply (in 2010, see Figure 2) was used mainly for household cooking and heating, as well as cogeneration in the sugar industry. Oil products accounted for 23% of the energy supply. Petroleum was mostly used for transport, whereas kerosene and liquid petroleum gas, were used for cooking and heating, and coal accounted for 8% of the energy supply. Over 76% of the electricity supply comes from imports, predominantly from South Africa, while the national rate of access to electricity is 55% (65% urban and 45% rural).

Electricity is generated in Swaziland through hydro and diesel power plants owned and operated by the national utility, Swaziland Electricity Company (SEC), and although the generation sector has been opened to Independent Power Producers (IPP) only one sugar mill (Ubombo Sugar) sells power to SEC under a Power Purchase Agreement (PPA). In the past five years, considerable investments have been made by SEC including constructing new grid infrastructure in rural areas and maintaining existing infrastructure to ensure continuous and reliable power supply and this has extended national grid coverage to 70%. Moreover, demand side management measures were also introduced, including the massive installation of prepaid meters and efficient lighting, coupled with Time-of-Use (TOU) tariffs for the commercial and industrial sectors (including irrigation).

As South Africa is moving towards cost-reflective tariffs, South Africa's electricity public utility, Eskom, is applying for annual tariff increases over the next five years to stimulate more investment in its generation capacity and upgrade its transmission infrastructure. As power import costs from South Africa have risen, electricity tariffs have also gone up in Swaziland and there is a growing concern about the Swaziland electricity sector's dependence on external factors.

The country's available renewable energy resources, like biomass and solar, could complement hydropower generation and shift the current energy scenario. Increasing renewable energy share in the electricity supply mix would reduce dependence on imports from neighbouring countries.

Although the country's rural electrification approach focused on grid extension has been relatively successful, achieving access for all Swazi citizens through centralised solutions will prove to be a challenge due to the sparse population, low demand in certain areas and the prohibitive cost of grid extension. Given the country's ample solar resources and the falling cost of solar photovoltaic (PV), decentralised solar PV applications offer an opportunity to further increase access to decentralised electricity and complement the grid. The large-scale deployment of improved solar water heaters can also reduce electricity demand and improve energy efficiency.

Swaziland relies on fuel imports from South Africa, mostly to meet its transport sector needs. The growing demand for petrol affecting the total import bill, triggered the government interest in promoting locally-produced biofuels, especially fuel grade ethanol.

Renewables are considered key to achieve socio-economic development and the government is pushing for setting necessary policy and appropriate legal and regulatory frameworks for their promotion. Through bagasse cogeneration, the sugar industry has the potential to meet about half the country's electricity demand in a sustainable way, while the unexploited solar potential presents interesting prospects for greening both the centralised and decentralised energy infrastructure

However, although the costs of renewable energy technologies are declining, they still require high capital expenditure. Local financial institutions still perceive them as high-risk, which limits domestic appetite for renewable energy investments. Despite their ability to structure renewable energy projects and attract funding, new (mainly foreign) potential investors face obstacles to securing bankable PPAs.

Despite the high grid coverage enjoyed by the country, an important section of the population is still too poor to afford to be connected. The inhabitants could benefit from decentralised renewable energy solutions, however local financial institutions are still averse to provide financing for the uptake of these systems for rural inhabitants due to a lack of awareness of the solar business and mistaken beliefs that the rural population would not be able to repay its debt. In addition, there is a lack of technical capacity in installing, operating and maintaining these systems.

Moreover, the most comprehensive household energy study in the country dates as far back as 1997. This was when the Energy Sector Management Assistance Programme carried out a study to help the government develop a strategy for the household energy sector. Since then, no comprehensive household energy survey has been carried out. This means there is no precise data on overall domestic energy consumption. This is a major constraint for the government if it is to make good plans for the energy sector.

Recommendations

Swaziland is now developing a Renewable Energy and Independent Power Producers Policy (REIPPP) that will allow the country to fully realise its untapped renewable energy potential. Bagasse cogeneration and solar Photovoltaic (PV) can play an important role in reducing electricity imports. This will increase domestic power generation, so long as clear policy signals and regulatory stimuli are put in place to attract investment to the sector.

Bagasse cogeneration can provide base load power and thus does not affect grid stability. It increases its reliability. The amendment of the 2007 Electricity Act, including specific provisions for bagasse cogeneration, should be used. There is a need for new measures specifically geared towards encouraging the sugar industry to invest in energy-efficient machinery and equipment to boost bagasse-based electricity production. A first step could be to extend existing tax credits and allowances to the sugar industry to incentivise investment in more efficient equipment for bagasse-based power generation. These are already included in the current investment code for the renewable energy sector. A generation-based incentive should also be developed, and for example, any costs saved by the utility from electricity imports could be from fossil-based generation. It should be complemented by a model PPA for bagasse cogeneration to ensure project bankability and facilitate financing.

A detailed assessment of the economic potential of bagasse and solar resources needs to be conducted. This is required to comprehensively promote utility-scale renewable energy projects and private sector investment in the sector. A detailed assessment can be conducted using the renewable energy zoning methodology that is outlined in the Africa Clean Energy Corridor framework, and in which Swaziland is taking part. This methodology aims to identify cost-effective, high-potential and high-density renewable energy zones for the development of utility-scale power plants. It uses a multi-criteria geospatial and economic analysis. Renewable energy zoning will allow the government to strategically allocate and promote identified zones for the commercial development of utility-scale solar PV power plants. This activity would fit with the Public Private Partnership policy vision to promote the use of state-owned land to provide private investment opportunities.

Creating an enabling environment for renewable energy IPPs is crucial if Swaziland is to significantly increase renewables in its electricity mix. This is because the renewable energy provisions in the Electricity Act and the Energy Policy are not sufficient to attract private sector investment. The enabling environment can be further developed through the design and adoption of tailor-made policies and measures in the framework of a renewable energy IPP policy. These are outlined below.

The country has yet to develop a grid code and therefore there are no clear guidelines to facilitate third party access to the grid. A comprehensive grid code should therefore be developed including enabling conditions and clear market rules for integrating renewable energy to the grid, while setting appropriate standards for the quality of supply and services.

A consultation on the development of a standardised PPA to increase the bankability of renewable energy power projects is needed. This would attract scalable investment, limit elaborate and tedious negotiations and give potential investors clear expectations on their investment. Finally, key business sectors that include mining, tourism, manufacturing and agro-business enjoy a range of additional investment and fiscal incentives provided by Swaziland Investment Promotion Authority (SIPA). There is no specific mention of the renewable energy sector. It would be a good idea if these incentives were extended to renewable energy (especially bagasse cogeneration and large-scale solar PV). This would reduce capital costs.

Solar systems present a clear opportunity for Swaziland to increase electricity access and improve energy efficiency in an economically and financially viable way. However, a number of crucial measures will need to be taken to stimulate market transformation that can lead to the sustainable deployment of decentralised solar systems. To decrease costs, the removal of all import duties and taxes on renewable energy equipment, especially solar systems, should be actively pursued. Also, local financial institutions should be made aware of the commercial viability of decentralised solar systems. Given their overall risk aversion towards these technologies, they should be informed and supported through dedicated credit lines or guarantees. This will help with the design and the financial products on offer, at favourable rates and with sound loan tenure, to end-users. Finally, Ministry of Natural Resources and Energy (MNRE) should actively engage with Swaziland Standards Authority (SWASA) and the University of Swaziland to develop a solar PV Quality Assurance scheme. This would cover solar technology standards development and certification programmes for installers and technicians to raise the confidence of stakeholders.

In light of the successful blending trials and the large availability of molasses for ethanol production, the E10 blending mandate should be enacted. This mandate requires petrol to include 10% ethanol and diesel fuel to include 5% biodiesel. The introduction of the B5 mandate should be further investigated, as oil-producing crops compete with food crops in Swaziland. The creation of a legislative and regulatory framework for ethanol blending should be accompanied by guidelines for establishing fuel quality assurance and standards. Guidelines are also needed for price-setting and control mechanisms, as well as fiscal and financial incentives that allow distilleries to increase fuel grade ethanol production in a sound and coordinated manner.

A 32 kW solar array supplies power to the Border Post in Mhlumeni

I. INTRODUCTION

1.1 COUNTRY BACKGROUND

The kingdom of Swaziland is a landlocked country in the Southern African region and covers an area of 17 364 square kilometres (km^2). It shares about three-quarters of its boundary with South Africa to the South, West and North, and Mozambique to the East. The current population estimate is at 1 080 337, with an annual growth rate of 1.2% (Central Statistics Office, 2012). Around 29% of inhabitants live below the poverty line, and the country has a gross domestic product (GDP) per capita of United States Dollars (USD) 3 186. This means it is classified as a lower-middle-income country (Central Bank of Swaziland, 2012).

Swaziland's economy is fairly diverse. Agriculture and forestry contribute about 7.5% of GDP. Manufacturing (mainly textiles and sugar-related processing, metal works and light industry) represents 44% and mining 0.5% of GDP. Services, particularly government services, constitute the remaining 48% of GDP. This is mostly sourced from Southern African Customs Union receipts (African Economic Outlook, 2013). The economy is therefore very closely linked to that of South Africa (which accounts for 94% of Swaziland imports). It is very export-oriented, primarily to South Africa and the European Union, which accounts for about 70% of the country's exports. Meanwhile, Swaziland has experienced some of the slowest growth in sub-Saharan Africa. The growth rate is estimated to have contracted by 0.3% in 2012 (African Economic Outlook, 2013). This subdued growth is due to a combination of effects. These include a poor agricultural season, which affected the primary and secondary sectors, the slow recovery of its major importers, structural bottlenecks and the delayed impact of the fiscal crisis. This economic situation has further exacerbated private sector performance, especially small and medium-sized enterprises, who for the most part rely on government contracts. However, the economic situation is expected to improve over the coming years as the global economy recovers from the financial crisis.

One of the key issues faced by the country's economy is job creation in high value-added sectors. Although the agricultural sector employs the vast majority of the population, its contribution to GDP has been declining in favour of sectors like manufacturing and services. However, workforce skills development has lagged behind the requirement of the productive sector, causing a divergence between existing skills and those required by businesses. As a result, about 52% of the country's youth is unemployed, one of the highest rates in Africa (African Economic Outlook, 2013). Investment in human capital and skills development is therefore required to improve the dynamism of the labour market.

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[1] The Southern African Customs Union is the world's oldest custom union and consists of Botswana, Lesotho, Namibia, South Africa and Swaziland. It applies a common set of external and excise tariffs, which are collected and shared among members according to a formula described in the agreement.

1.2 ENERGY FOR DEVELOPMENT

Through its Ministry of Economic Planning and Development, the government of Swaziland completed and launched the National Development Strategy (NDS) in 1999. This addressed development concerns for the 1998-2022. The NDS document states: "the purpose of the NDS is to formulate a vision and mission statement with appropriate strategies for socio-economic development for the next 25 years and provide a guide for the formulation of development plans and for the equitable allocation of resources" (Ministry of Economic Planning and Development, 1999). The NDS covers all development aspects including agriculture, forestry, environment management, energy, water and sanitation, land, rural development, health, and research and development. Energy in the NDS is considered a key sector for achieving socio-economic development through three central strategic objectives. These are research and development, energy efficiency and energy access. Achieving these objectives means, among other things, identifying future options for electricity sector development and increasing the spread of appropriate renewable energy technologies. It also means setting cost-reflective pricing policies for all types of consumers making energy affordable, while encouraging conservation and efficient resource use and assuring full participation in the Southern African Power Pool (SAPP). This ensures access to new regional market opportunities whilst improving the whole population's access to a range of energy services (Ministry of Economic Planning and Development, 1999).

Biomass dominates Swaziland's household energy consumption, as well as electricity generation in its sugar, pulp and saw mill industries. Wood fuel is the traditional biomass, accounting for about 90% of household energy usage. It is mainly sourced from local forests by both rural and urban householders. However, over the past ten years, population growth has put a severe burden on indigenous forest and woodlands, coupled with increased wood fuel consumption and rising demand for arable land. This deforestation is having a negative impact on the environment, further exacerbating soil erosion and desertification.

Swaziland's power sector depends heavily on imports from Mozambique and South Africa. This makes it vulnerable in the short- to medium-term to regional capacity shortages and rising costs, as outlined in the National Energy Policy (NEP) Implementation Strategy. Furthermore, just under half the population lacks access to electricity. Swaziland is thus looking to draw from its locally-available renewable energy resources to widen access to electricity, and achieve greater energy security.

1.3 RENEWABLES READINESS ASSESSMENT PROCESS

The International Renewable Energy Agency (IRENA) has a mandate to increase renewable energy deployment across the world. In pursuit of this mandate, one of the key activities of the IRENA's work programme is the Renewables Readiness Assessment (RRA). This is a holistic investigation into conditions for renewable energy deployment and the action necessary to further improve these conditions in a particular country. The RRA is intended to be a rapid assessment of how a country can improve its readiness and overcome the main barriers to technology deployment. It has three purposes. Firstly, it identifies where action is needed to improve readiness. Secondly, it identifies partners and organisations who can help deliver it. Finally, it facilitates focused discussions with donors and other partners aiming to secure agreement on the actions outlined.

Through the Ministry of Natural Resources and Energy (MNRE), the government conducted and took responsibility for the RRA process in Swaziland. As a first step, the Department of Energy and the national consultant familiarised themselves with the IRENA RRA methodology. The team also went on to identify key national experts and stakeholders in relevant institutions that could participate in the RRA process. This included policy makers, regulatory and promotion agencies, non-governmental organisations (NGOs), financial institutions, the private sector and academia. Resource-service pairs relevant to Swaziland were then identified. These comprised on-grid, off-grid and biofuels applications. The RRA templates were then completed and captured the current status, outlined relevant problems and capacity needs and proposed concrete action for each resource-service pair.

The RRA workshop took place on 14-15 December 2012. The national expert team, IRENA and the Southern Africa Development Community (SADC) took part. They reviewed the templates, provided further inputs and a consensus was built on recommended action.

II. ENERGY CONTEXT

2.1 REGIONAL ENERGY

Swaziland is a member state of the SADC that was formed in 1992 and currently comprises of 15 countries. The SADC population is about 280 million. In 2008, the SADC primary energy supply was estimated at 9 552 petajoules (PJ) (International Energy Agency, 2011). Coal dominated the primary energy mix at 44%, followed by renewable energy (39%), oil (14%), gas (2%), and nuclear (1%). The renewable energy is made up of traditional biomass (36.66%), predominantly firewood used for cooking and heating, hydropower (1.95%) and modern biomass in the form of bagasse and wood chips (0.39%). Other renewable energy sources such as solar, geothermal, wind and biofuels are negligible (*ibid*). In 2010, SADC's combined GDP was USD 575.5 billion and growing at 5.14%.

The SADC has a strategic goal for its member states to access adequate and reliable energy services. It has been recognised that in the long term this can have a pivotal role in reducing poverty and forecasts show a regional growth rate of 7% could be achieved. Subsequently, the SADC established an operational goal to halve the number of SADC inhabitants with no access to energy services by 2020. The aim is then to continue halving the number of those members remaining without access every five years, until the strategic goal of full access is achieved. The initial ten-year plan to halve the number of people lacking energy access demonstrates a political will in the region to eliminate the problem. Efforts to increase energy access focus on the expansion of distribution networks, often carried out by the national utilities. Another focus is the use of small-scale distributed generation, often driven by rural electrification agencies or funds.

The SADC community is setting up a new agency, the Southern Africa Centre for Renewable Energy and Energy Efficiency. This comes in response to a consultation between ministries of energy and other regional stakeholders in SADC member countries. Once established, the Southern Africa Centre for Renewable Energy and Energy Efficiency will concentrate on creating an enabling environment for the uptake of renewable energy and energy efficiency. Energy planning and policies, business models and technical innovation, finance and risk management, capacity building and knowledge management will all make this possible.

In 1995, 12 continental SADC member countries signed an inter-governmental Memorandum of Understanding that led to the creation of the Southern African Power Pool (SAPP). Its aim was to create a common market for electricity that would provide economically reliable power to consumers in each SAPP member country. Another aim was to optimise the use of available energy resources in the region and support cooperation between countries during emergencies. The Regional Energy Protocol, signed in 1996, advanced this initiative. It acknowledges the need for a coordinated approach to energy strategy formulation and planning in the SADC.

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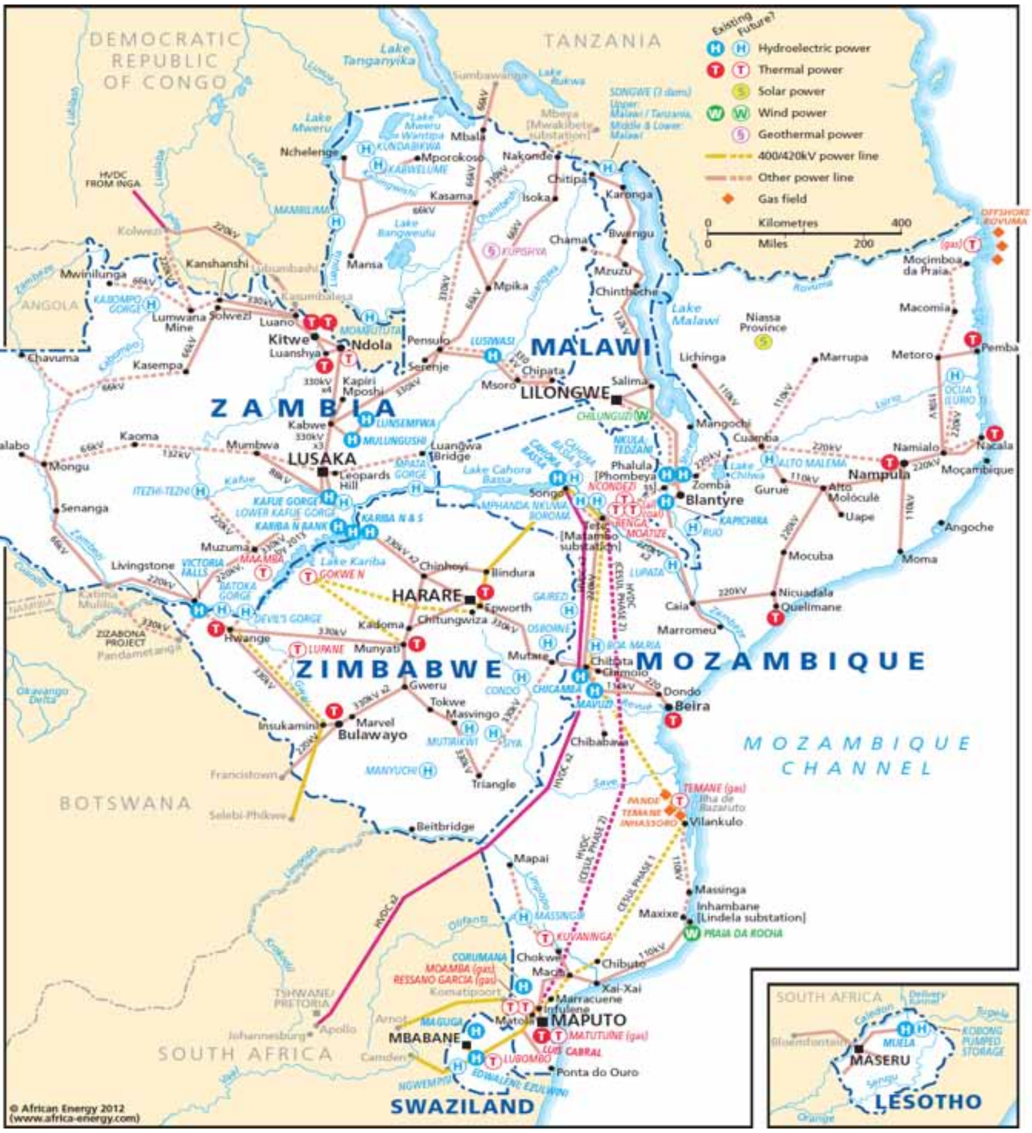
[2] SADC member countries on the African continent are Angola, Botswana, the Democratic Republic of Congo, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. The island member countries are Madagascar, Mauritius and the Seychelles.

Figure 1: Existing and proposed generation and transmission infrastructure around Zambezi River basin



Source: adapted from SAPP

The SAPP electricity mix is dominated by coal, which makes up 74% of the total mix, followed by hydropower at 20% (largely from the Congo and Zambezi basins), nuclear 4% and diesel 2% (SADC, 2012). In 2012, SAPP total installed capacity was 57 182 megawatts (MW) with an available capacity of 51 702 MW, against a peak demand of 53 833 MW (SAPP, 2013). The region is facing a critical power shortage. This is due to escalating demand growth and delays in capacity addition projects. In 2009 the first SAPP master plan was commissioned based on member countries' national plans. It envisaged an additional total capacity of 56 000 MW by 2025 composed of 23 883 MW of coal, 18 045 MW of hydropower and 14 758 MW of gas. Non-hydro renewable energy was excluded. However, as various countries now aspire to a cleaner electricity mix, this is reflected in their national plans. It is also reflected in the 2012 SAPP plans. This envisages additional capacity of 55.5 gigawatts (GW) comprising 9 650 MW of coal, 14 646 MW of hydropower, 9 600 MW of nuclear and 7 600 MW of gas. Finally, 14 000 MW of non-hydro renewable energy (wind and solar) are included.

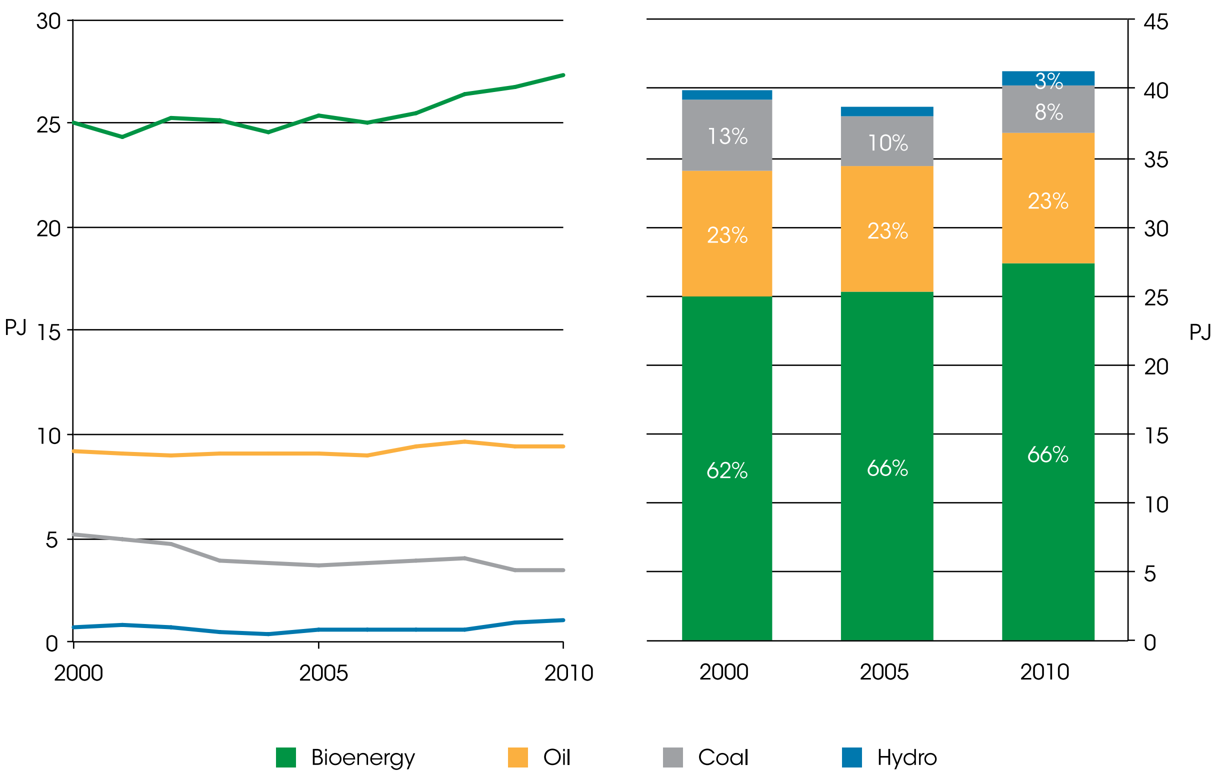
Electricity generation, transmission and distribution in SAPP are mainly provided by publicly-owned, vertically-integrated national utilities. Independent Power Producers (IPPs) and independent transmission companies have now been introduced by different SADC countries, albeit with varying degrees of success. Policies in most countries reflect an aspiration for greater private sector involvement in power generation. However, investor perception of risk holds back these efforts. This focuses on two concerns. The first relates to legal and regulatory frameworks unfavourable to private sector participation (namely worries about over competition between public and private generation assets). The second relates to difficulties in developing well-structured bankable projects (Development Bank of Southern Africa, 2010).

The interconnected grid is operated through three control areas. Eskom runs the first control area for Botswana, Lesotho, Southern Mozambique, Namibia, Swaziland and South Africa. Zimbabwe Electricity Supply Authority runs the second for Zimbabwe and Northern Mozambique and Zambia Electricity Supply Corporation runs the third for the Democratic Republic of Congo and Zambia. The three utilities, or system operators, are responsible for balancing electricity supply and demand, and power flows within their control areas. The Swaziland power grid is interconnected to Mozambique and South Africa through a 132 kilovolt (kV) direct current and a 400 kV alternating current line respectively. The latter is operated by MozambiqTue Transmission Company, a joint venture between the three public utilities of Mozambique, South Africa and Swaziland. These interconnectors enable Swaziland to participate in the SAPP Day-Ahead Market (DAM). This was previously known as the Short-Term Energy Market (figure 1). This offers a harness for Swaziland's renewable energy resources, allowing it to meet growing demand and offset coal-based electricity imports from South Africa. It also offers the possibility to share excess renewable power with the rest of the SAPP region.

2.2 ENERGY SUPPLY AND DEMAND

The total primary energy supply (TPES) of Swaziland is mainly composed of biomass, oil, coal and hydropower. In 2010, biomass (firewood, charcoal and agricultural waste) accounted for 66% of TPES, mainly for household cooking and heating as well as cogeneration in the sugar industry. Oil products accounted for 23% of TPES. This was mainly composed of petroleum for transport, paraffin (kerosene) and liquid petroleum gas for cooking and heating. Coal accounted for 8% of TPES and is mainly used in the sugar industry for cogeneration, while hydropower accounted for the remaining 3% (figure 2).

Figure 2: Swaziland Total Primary Energy Supply by fuel



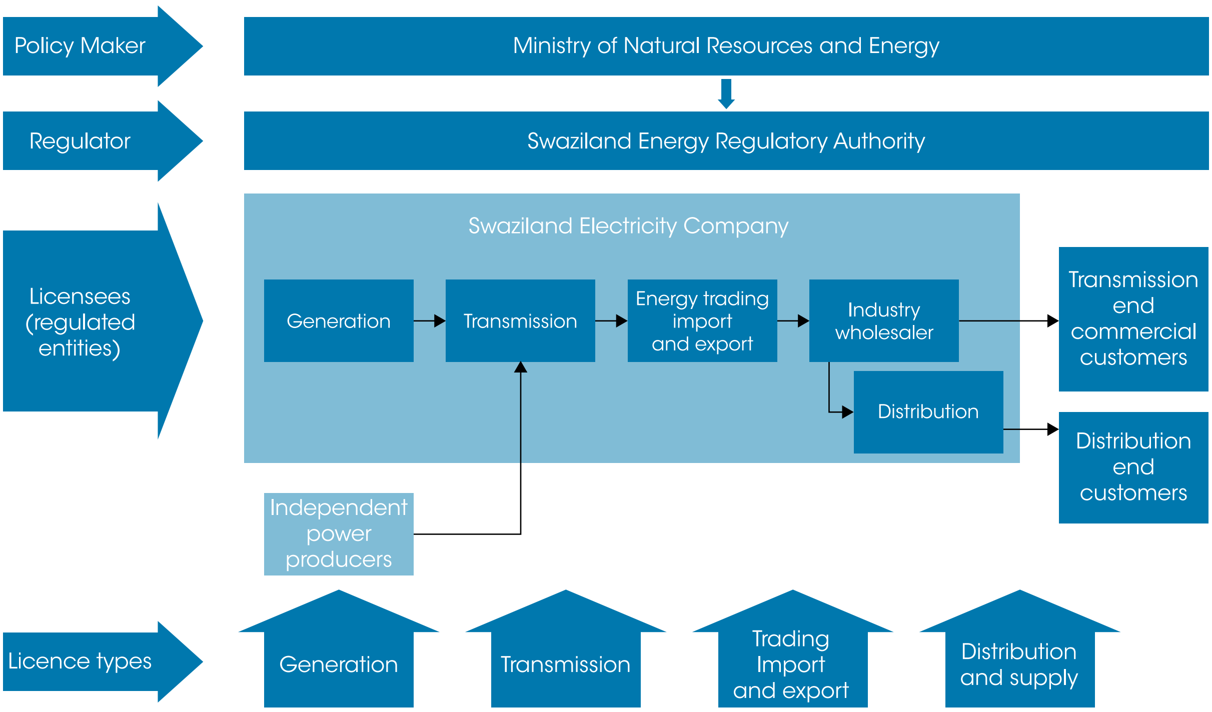
Source: IRENA, based on data from United Nations Statistics Division (excludes electricity trade)

2.3 ELECTRICITY SYSTEM

The creation of the Swaziland electricity sector dates back to the early 1920s when a 52.5 kV amp hydro-turbine was installed on the Mbabane River. Government involvement in the electricity sector led to the foundation of the Swaziland Electricity Board in 1963. In 2007, following the adoption of the Swaziland Electricity Company Act, the Swaziland Electricity Board was converted into the Swaziland Electricity Company (SEC). This is a vertically-integrated public utility that generates, transmits and distributes power through the national power grid under the supervision of the Swaziland Energy Regulatory Authority (SERA). Although the generation sector has been open to IPPs, only Ubombo Sugar sells power to SEC under a Power Purchase Agreement (PPA). Royal Swaziland Sugar Corporation at present only produces electricity for its own consumption (figure 3).

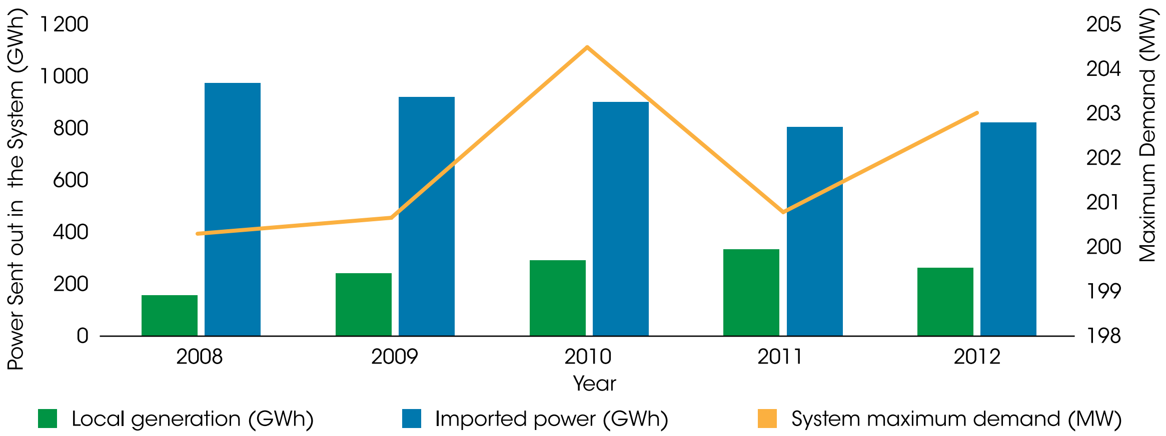
Electricity demand in Swaziland grew by an average of 1% per year in 2007-2010. Peak demand rose from 196 MW to 204 MW and fell back to 200 MW in 2011 (figure 4). Demand declined in 2011 for a number of reasons. Two companies in the pulp and paper industry (SAPPI and Usuthu Paper Mills) closed, and on-site generation by sugar mills intensified. Meanwhile, demand side management measures were introduced including the massive installation of prepaid meters and efficient lighting coupled with Time-of-Use (TOU) tariffs in the industrial sector. In the same year, 805 gigawatt-hours (GWh) of electricity was imported and about 333 GWh generated locally. However, it is worth noting that electricity imports have been falling by about 15% while local generation has almost doubled over the last five years. That said, relatively dry seasons in recent years have affected domestic hydropower generation (SEC, 2012).

Figure 3: Swaziland power sector



Source: IRENA, based on SERA

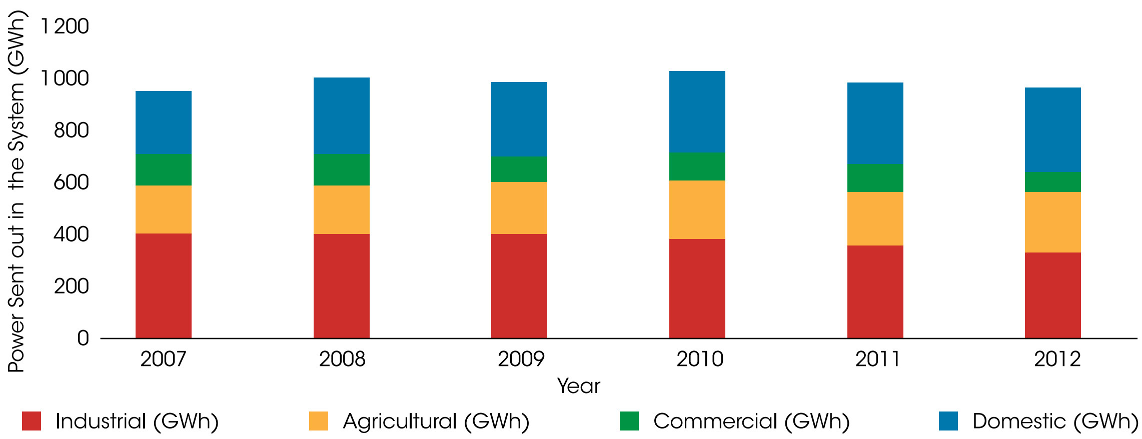
Figure 4: Electricity supply and demand in Swaziland



Source: IRENA, based on SEC

The major power demand sectors are industrial, domestic, agriculture and commerce with a share of 37%, 31%, 22% and 10% respectively (figure 5). Demand hit a record 203 MW in 2012 (SEC, 2012). SEC experienced an increase in its domestic customer base from 63 000 in 2007 to 110 000 by the end of 2012. This was due to the implementation of the rural electrification project in partnership with MNRE. The national electricity access rate in Swaziland is therefore estimated at 55%: 65% for urban households and 45% for rural households. However this rise in the number of domestic customers does not translate to an increase in sales volumes. This is because they only account for a small proportion of total sales volumes when compared to the industrial and agricultural sectors.

Figure 5: Swaziland historical electricity consumption by sector



Source: IRENA, based on SEC

Generation capacity

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.

Table 1: Swaziland installed capacity

SEC power stations and IPPs	Installed capacity (MW)
Ezulwini hydropower station	20
Edwaleni hydropower station	15
Edwaleni diesel power station	9.5
Maguduza hydropower station	5.6
Maguga hydropower station	19.5
Ubombo Sugar	41
Royal Swaziland Sugar Corporation	64.5
Total	**175.1**

Source: SEC, 2013

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.

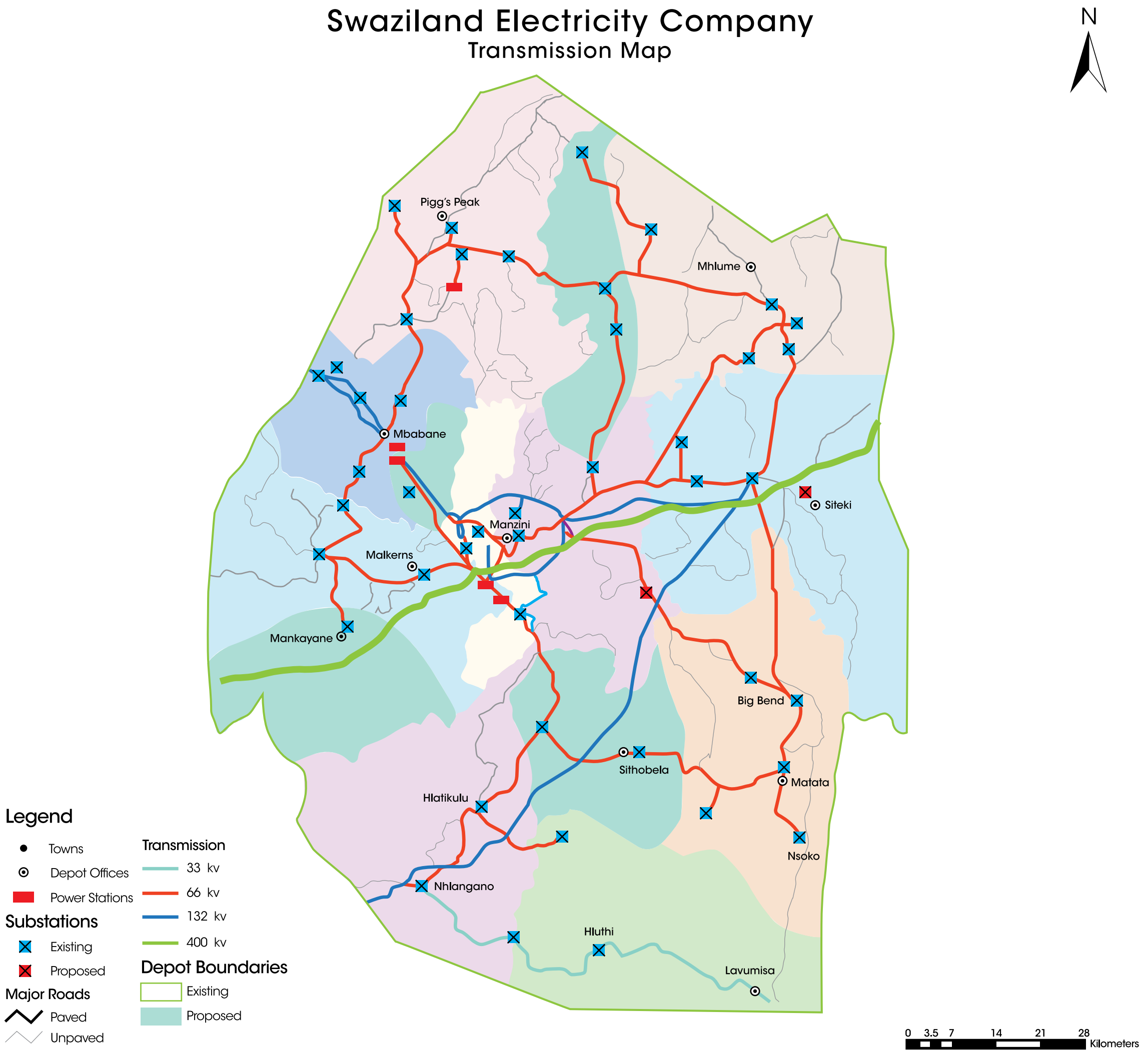
Grid infrastructure

The Swaziland grid infrastructure consists of a 400 kV alternating current interconnector operated by Mozambique Transmission Company and 296 km of 132 kV direct current transmission lines connecting the country to South Africa. In addition, SEC operates 930 km of 66 kV and 9 093 km of 11 kV lines for internal transmission and distribution (see figure 6). System losses were estimated at 15.5% in 2012 (SEC, 2012).

In the past five years, SEC has been the main source of considerable investment in the electricity sector. This has contributed to an increase in the performance of the electricity supply industry. Through its distribution department, SEC has embarked on an extensive maintenance programme to ensure continuous power supply and reliability. Several new outgoing 11 kV feeders were constructed to improve the reliability of the network and extend the grid to rural areas. This extended national grid coverage to 70% in 2012 (SEC, 2012).

[3] Mozambique Transmission Company is a special purpose vehicle principal set up between Electricidade de Mozambique (EDM), Swaziland Electricity Company (SEC) and Eskom South Africa. It supplies energy to Mozal Aluminium Smelters in Mozambique and wheels electricity between the utilities. Each utility has a 33% equity share in the company.

Figure 6: Swaziland national grid network and regional interconnectors



Source: SEC, 2013

In the grid infrastructure sector, feasibility studies have also been completed for a range of grid extension and quality improvement projects. These include 66 kV transmission lines in Nhlangano and Pine Valley and the upgrade and construction of substations in Hlathikhulu, Mayiwane, Lawuba, and Nkhaba. In addition, the SEC Supervisory Control and Data Acquisition system has been upgraded, while an automated and prepayment metering project system has been set up.

Costs and tariffs

Electricity costs in Swaziland depend on supply. As previously noted, power imports account for 76% of SEC supply with bulk purchase tariffs at 0.03-0.29 USD per kilowatt hour (USD/kWh) from Eskom, EDM and SAPP DAM. This depends on the source and season (table 2). The remaining 24% is supplied by SEC own generation through four small hydropower plants with production cost averaging at 0.01 USD/kWh. Electricity was imported in 2012 at an average wholesale price of 0.05 USD/kWh and has increased at an average annual rate of 25% over the last five years. Electricity tariffs are at 0.048-0.12 USD/kWh depending on customer category. Domestic customers are subjected to a standard and a lifeline rate, known as the 'poverty tariff'. These are at 0.09 USD/kWh and 0.08 USD/kWh respectively. Small commercial customers are charged 0.12 USD/kWh (table 3).

Table 2: SEC bulk purchase tariffs from Eskom, EDM and DAM, 2010-2012

Source	Season	2010 (USD/kWh)	2011 (USD/kWh)	2012 (USD/kWh)
Eskom	High – peak	0.20	0.25	0.29
	High – standard	0.05	0.06	0.07
	High – off Peak	0.03	0.03	0.04
	Low – peak	0.06	0.07	0.08
	Low – standard	0.04	0.05	0.05
	Low – off peak	0.02	0.03	0.04
EDM	High – peak	0.04	0.05	0.06
	High – standard	0.04	0.05	0.05
	High – off Peak	0.03	0.04	0.04
DAM			0.03	0.05

Source: SEC, 2012

Table 3: Swaziland electricity tariffs[4]

Customer category	Facility charge USD/month	Energy charge USD/kWh
Lifeline	–	0.08
Domestic	–	0.09
General purpose	15.3	0.12
Small commercial – prepayment	14.7	0.12
Small commercial – credit meter	29.4	0.12

Source: SEC, 2012

As part of the demand side management programme it started in 2008, SEC has introduced TOU tariffs for the commercial and industrial sectors (including irrigation). Tariffs are further differentiated according to seasonal demand (high demand in June-August and low demand in September-May) (table 2 and figure 7). Electricity tariffs have also gone up over the last five years with an annual average increase of 16%. However, this increase is occurring at a slower rate than import costs and thus starting to affect the SEC balance sheet. Indeed, Eskom was granted an annual tariff increase of 10.1% for 2013–2018 (SEC, 2013). As a result, SEC applied for a 36.5 % average tariff increase, but was only allowed to increase it by an average of 9.3% for the financial year 2013/2014. This was later scaled down to 5% for subsequent years (SERA, 2013b).

[4] The tariffs were converted to USD based on the 2013 exchange rate 1 USD = 10.384 Emalangeni

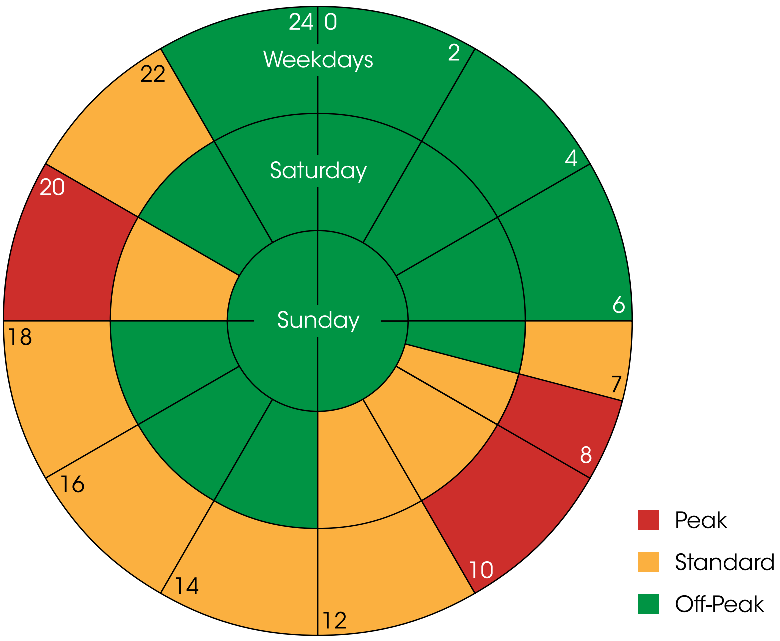
Table 4: Swaziland Time-of-Use tariffs (TOU)

TOU tariffs	TOU at MV* at HV network	TOU at MV*	TOU at LV*	TOU small irrigation <100 kVA*
Facility charge USD/month	355.6	171.1	128.7	109.4
Demand charge USD/KVA	8.7	9.1	9.6	8.1
Access charge USD/KVA	4.3	4.3	4.0	4.0
Energy – low demand peak USD/kWh	0.089	0.091	0.93	0.080
Energy – low demand standard USD/kWh	0.063	0.065	0.066	0.057
Energy – low demand off-peak USD/kWh	0.051	0.052	0.053	0.046
Energy – high demand peak USD/kWh	0.252	0.260	0.265	0.225
Energy – high demand standard USD/kWh	0.077	0.080	0.081	0.069
Energy – high demand off-peak USD/kWh	0.051	0.052	0.053	0.046

*MV: Medium Voltage: LV: Low Voltage; kVA: kilovolt-amp

Source: IRENA based on SERA, 2013a

Figure 7: Swaziland Time-of-Use periods



Source: based on SERA, 2013a

2.4 RENEWABLE ENERGY POTENTIAL

Swaziland is well endowed with solar and sugar cane residue. These sources have great potential for electricity production and use in many sectors, but data on renewable energy resources are not readily available.

Table 5: Availability and utilisation of renewable sources in Swaziland

Renewable energy	Opportunities/use	Resource availability
Solar	Electricity and water heating	Global Horizontal Irradiance of 4-6 $kWh/m^2/day$*
Wind	Electricity, motive power	Average 3 metres per second (m/s) at 10 m height
Hydropower	Electricity generation to the grid and for decentralised grid	Limited and highly variable
Biomass (cogeneration)	Electricity generation to the grid	Agricultural wastes - mainly bagasse from sugar cane and saw mill waste
Biomass (biofuels)	Ethanol for transport	Molasses from sugar cane

* per metre squared per day

Hydropower

Swaziland has a good experience with small hydropower generation. Since 1970, numerous studies have been conducted to assess its hydropower potential, leading to an estimated theoretical and technical potential of 440 MW and 110 MW respectively. Of this, 60.4 MW is under operation at present (Klunne, 2013). As part of its objective to expand the hydropower sector, MNRE has built a database of potential sites. This initially identified 35 candidates, ranging from 32 kW to 1.5 MW. This was further reduced to 26, based on their potential for electricity generation. Four have been identified as viable schemes and are being promoted by MNRE. These are Lusushwana River (300 kW), Mpuluzi River (155 kW), Usutu River (490 kW) and Mbuluzi River (120 kW minimum). T-Colle Investments, an IPP, filed for a generation licence with SERA. It plans to construct a 360 kW hydropower plant at Dwaleni's Ferreira Canal in the Manzini region for an estimated capital cost of USD 476 500.

Biomass

Biomass accounts for 66% of Swaziland TPES and comprises mainly traditional biomass and agro-industrial waste for cogeneration. Wood fuel production in Swaziland has increased by 25% in the last decade, reaching 1 093 333 cubic metres in 2012. Charcoal production increased by 50% over the same period, reaching 44 933 tonnes (t).[5] Traditional biomass is widely used in Swaziland for household heating and cooking especially in rural areas where it meets about 90% of energy needs. MNRE recognises the need to improve the efficient use of biomass in rural areas, where most of the firewood is used in open fires and three-legged pots. It therefore partnered with German development organisation, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), in 2008 to implement the Programme for Basic Energy and Conservation. This focused on the promotion of efficient cookstoves in rural areas with the objective of creating a viable and self-sustaining market.

[5] Food and Agricultural Organization statistics platform (FAOSTAT), 2013

Table 6: Swaziland main crop production

Crop/year	2010	2011	2012
Maize (t)	68 000	85 000	76 000
Roots and tubers (t)	55 000	57 428.00	57 428
Sugar cane (t)	4 908 152	4 862 302	5 460 409

Source: FAOSTAT, 2013; Swaziland Sugar Association, 2013

This objective was to be achieved by building the capacity of local producers to manufacture efficient cookstoves, while stimulating demand through an end-user awareness-raising and demonstration campaign.

Apart from woody biomass, three types of crops could play a role in the energy supply chain. These are sugar cane, maize, roots and tubers. Sugar cane is the main crop produced in Swaziland with an annual production of 5.4 million t in 2012. This is followed by maize with 76 000 t and roots and tubers with 57 428 t (table 6). However, the local production of maize and roots and tubers is entirely use for domestic consumption. In the case of maize, the country has to rely on imports to satisfy local demand.

Areas under sugar cane production increased by 30% from 40 000 hectares (ha) in 2010 to 52 000 ha in 2013. This is expected to reach 65 000 ha by 2017 (Swaziland Sugar Annual, 2013). According to the Food and Agricultural Organization Statistic Platform (2013), the country has a total agricultural area of 1 222 000 ha, out of which only 190 000 ha is arable land and permanent crops. This, combined with the fact that government and donors have made significant investments in expanding access to irrigation, means sugar production will rise over the next decade. The development of the Nsoko Msele Integrated Sugar Mill project, expected to be fully operational by 2017, is further evidence of the expanding the sugar industry.

Molasses are another by-product of the sugar industry with a total of 247 225 t produced in 2013 (Table 7). They are predominantly used for ethanol production for the beverage and pharmaceutical industry, but are being also considered for biofuels production.

Royal Swaziland Sugar Corporation and USA Distillers are the two major ethanol producers in Swaziland, making 134 000 litres/day and 120 000 litres/day respectively. The total is 60 million litres per year. Fuel grade bioethanol production in Swaziland at present is limited to a pilot bioethanol project run by Royal Swaziland Sugar Corporation with support from the government. This has been producing 2 444 litres per day since the project began in February 2008. Blending trials of 10% fuel grade ethanol and 90% petrol have been successfully conducted as part of this project. A programme scale-up to produce 10 000 litres of anhydrous ethanol per day is now under consideration.

Table 7: Sugar industry molasses production

Producer	2008/09	2009/10	2010/11	2011/12	2012/13
RSSC (Simunye mill) (t)	57 190	60 738	65 710	69 876	72 700
RSCC (Mhlume mill) (t)	51 794	55 756	53 982	60 814	63 299
USL (Ubombo mill) (t)	71 669	76 514	80 443	104 351	111 267
Total Industry (t)	180 653	193 008	200 134	235 041	247 267

Source: Swaziland Sugar Association, 2013

Solar energy

Swaziland has relatively abundant solar potential throughout the country with an estimated Global Horizontal Irradiance of 4-6 kWh/m^2/day (figure 8). The highest irradiation occurs during summer (December-March). The lowest occurs during winter (June-September), but is still adequate for both solar PV and water heating. No ground measurements have yet been carried out to validate satellite data.

The main solar applications developed in Swaziland include Solar Home Systems (SHS) of various sizes and solar water heaters. Through its rural electrification programme, MNRE has installed SHS and solar water heaters in various schools and public institutions across the country. It has been promoting the use of solar PV systems as far back as the early 1990s through an awareness-raising PV demonstration project. This ran from 1992-1995 in cooperation with the United Nations Educational, Scientific and Cultural Organization. The objective was to meet the basic electricity needs of people living in the countryside. This initial experience prompted a private sector project in 1997 to scale up the deployment of SHS in rural Swaziland. It was supported by Triodos Bank, a Dutch social bank and the Energy Research Centre (ECN) of the Netherlands with assistance from the World Bank for market development. MNRE has also facilitated the installation of slightly larger solar PV systems of 25 kW in the village of Bulembu, 32 kW at the Mbabane Blood Bank and 60 kW at the University of Swaziland (Luyengo campus). It is currently working on installing another 32 kW at the Mhlumeni border post.

Figure 8: Swaziland Global Horizontal Irradiance

Africa existing transmission lines by AICD

- 77.9574 W / m^2
- 124.892 W / m^2
- 145.328 W / m^2
- 160.063 W / m^2
- 172.654 W / m^2

3 TIER'S Global solar dataset 3km with units in W / m^2

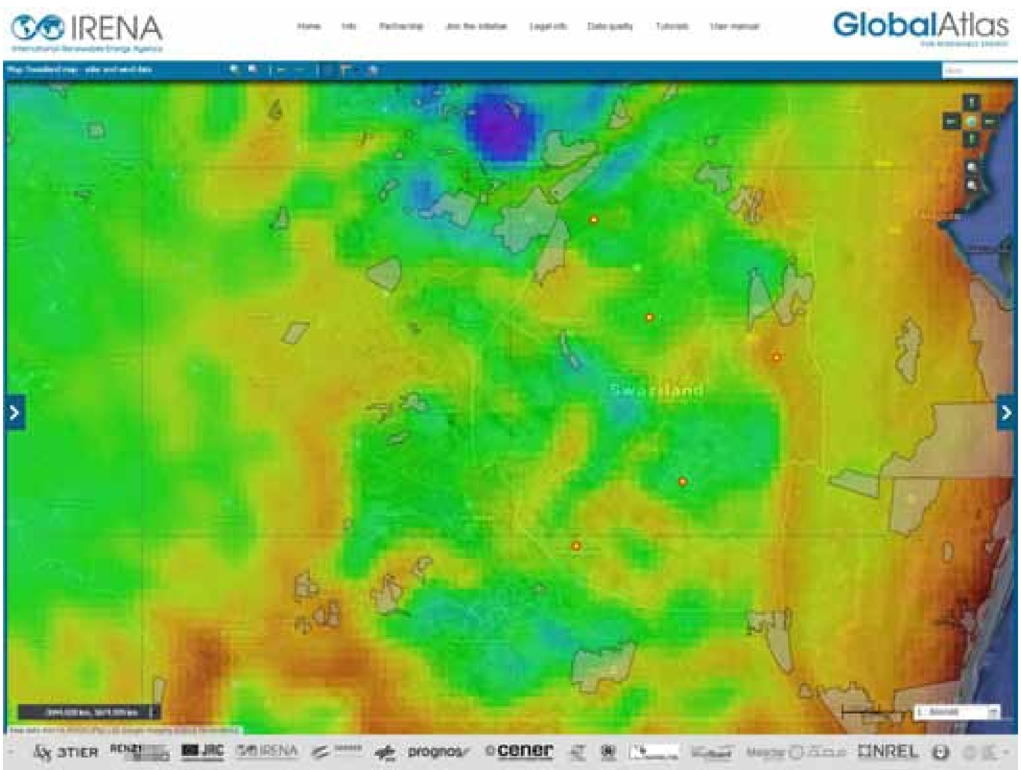
- 77.9574 W / m^2
- 124.892 W / m^2
- 145.328 W / m^2
- 160.063 W / m^2
- 172.654 W / m^2
- 184.423 W / m^2
- 206.783 W / m^2
- 236.519 W / m^2
- 283.954 W / m^2
- 365.164 W / m^2

Source: IRENA, 2012

Wind energy

A wind measurement campaign and data analysis was conducted in 2001 as part of the Swaziland NEP project supported by the Danish Cooperation for Environment and Development. Wind measurements were conducted over a year (2001-2002) on five sites across the country at 10 m, 20 m and 30 m above ground level (table 8). Mean annual wind speed at 30 m was 3.3-5.7 m/s. Extrapolation to 50 m yielded wind speed of 4.1-6.6 m/s. The highest measurements were recorded at Siteki in the Lubombo Plateau where further measurement at 50 m and above should be undertaken to ascertain wind power potential. Average energy production there was estimated for 600 kW standard and low wind turbines yielding 800 megawatt hours (MWh) and 1000 MWh per year respectively. A standard 1 MW wind turbine yielded an annual energy production of 1400 MWh per year. Although the overall wind potential is favourable for water pumping applications, wind water pumping is not feasible in most parts of the country due to the low permeability of the aquifers.

Figure 9: Swaziland wind hotspots



Source: IRENA, 2012

Table 8: Mean annual wind speed in Swaziland

Area	Nhlangano	Siteki	Piggs Peak	Luve	Sithobela
Administrative region	Shiselweni	Lubombo	Hhohho	Manzini	Lubombo
Mean annual speed at 20 m (m/s)	3.9	5.1	3.5	3.7	2.8
Mean annual wind speed at 30 m (m/s)	4.2	5.7	3.8	4.1	3.3
Mean annual wind speed at 50 m (m/s) (extrapolated)	4.6	6.6	4.2	4.7	4.1

Source: FAOSTAT, 2013; Swaziland Sugar Association, 2013

The Maguga 20MW Hydropower Station

III. ENABLING ENVIRONMENT FOR RENEWABLE ENERGY

3.1 KEY ENERGY STAKEHOLDERS

This chapter gives a brief overview of the main stakeholders in the energy sector in Swaziland. This is mainly governed by the state through different ministry and government-owned agencies. In addition, important stakeholders such as development partners, industry associations, research and educational institutes, as well as non-governmental organisations, are very active. It is therefore important that a sound collaborative framework is developed including all relevant institutions. This ensures the effective deployment of renewable energy technologies for the benefit of Swaziland. The following list introduces the institutions and the role they play.

Ministry of Natural Resources and Energy (MNRE)
The mission of the energy department of the Ministry of Natural Resources and Energy is to effectively manage national energy resources. It is also to work towards affordable and sustainable energy provision for all inhabitants while ensuring the international competitiveness of the energy sector.

Swaziland Energy Regulating Authority (SERA)
SERA was established to put in place the regulatory framework on electricity matters, issue electricity production licences and regulate electricity tariffs in the local market. Electricity industry deregulation is another of its tasks.

Swaziland Electricity Company (SEC)
SEC is engaged in electricity generation, transmission and distribution in the Kingdom of Swaziland.

Ministry of Tourism and Environmental Affairs
This Ministry takes the lead in maintaining a coherent and up-to-date forest policy and legal framework, as well as a national forest inventory and management. It is also in charge of collecting weather and climate data through its meteorological department.

Swaziland Environment Authority
SEA mandate is to coordinate the activities of all organisations working on environmental matters in Swaziland. It is the focal point for liaising with international organisations on environmental concerns.


Ubombo sugar cogeneration plant

Ministry of Agriculture and Cooperatives

The Ministry of Agriculture is one of the key ministries in renewable energy production, as it is responsible for renewable energy resources such as bagasse, bioethanol and biogas.

Ministry of Finance and Ministry of Economic Planning

These two ministries are very important to national development, and are responsible for development priorities, financial planning and budget allocations. The development of a green economy depends on these ministries.

Swaziland Standards Authority (SWASA)

SWASA in charge of all activities related to product and service standards in Swaziland. Renewable energy deployment, being technology driven, stands to benefit from SWASA.

Swaziland Sugar Association

The Swaziland Sugar Association is an umbrella organisation bringing together all growers and millers of sugarcane. It is committed to consistently meeting the requirements and expectations of sugar industry principals, customers and other stakeholders by providing quality products and services in an efficient, cost-effective and sustainable manner.

University of Swaziland and technical colleges

The university contributes to policy and strategy development, and also assists in the implementation of projects on the ground. Technical colleges produce technicians in a variety of fields including plumbing, electrical works, surveying and construction.

Renewable Energy Association of Swaziland (REASWA)

This is an NGO, whose mission is to promote sustainable energy through energy efficiency and the cost-effective use of renewable energy in an environmentally sustainable and socially acceptable manner. Renewable Energy Association of Swaziland consists of a cross-section of stakeholders from government, the private sector, NGOs and tertiary institutions.

Bulembu Ministries Swaziland

This is an NGO restoring the town of Bulembu to a self-sustaining community through the provision of quality education, health services and employment, while also promoting renewable energy use.

International cooperation partner organisations

These include, among others, United Nations Development Programme, United Nations Industrial Development Organization, USAID, the US Trade and Development Agency, the World Bank, Deutsche Gesellschaft für Internationale Zusammenarbeit and Scandinavian organisations.

3.2 POLICY, STRATEGIES, LEGAL AND REGULATORY FRAMEWORK

Policies and strategies

Through the NDS, the government of Swaziland framed an overarching development master plan to deal with the country's social, economic, political and environmental issues. All policies in the energy sector are therefore formulated with the aim of contributing to reaching NDS objectives. The country's energy policy environment is governed by the NEP, the National Forestry Policy, the National Energy Policy Implementation Strategy (NEPIS) and the National Biofuels Development Strategy.

The National Energy Policy:

The NEP was shaped using stakeholder consultation and participation and approved in 2003. It aims to overcome the challenges of the energy sector transformation and development. To do so, it sets objectives to stimulate economic growth and development by ensuring energy security and energy access, while encouraging job creation and preserving long-term sustainability and health (MNRE, 2003). The policy also recognises that all locally available renewable energy resource could play a greater role in achieving NEP aims if a conducive framework was in place. This means setting up appropriate financing mechanisms, developing a quality assurance scheme for renewable energy technologies and facilitating conditions for self-generators to provide electricity to the grid as IPPs. Building the capacities of various stakeholders and developing a strong information and awareness-raising campaign would support these steps.

The NEP Implementation Strategy:

After NEP was created, MNRE developed NEPIS in 2009. Its focus was to develop and implement short-term measures and activities that will help reach the NEP objectives within three years. The renewable energy component of NEPIS identified the need to develop a renewable energy action plan and targets, including the establishment of fiscal incentives to promote renewables. It also proposed to incorporate renewable energy information and communication programme and standardisation in the sector. MNRE has since embarked upon a specific Renewable Energy and Independent Power Producers Policy that is being finalised.

The National Biofuels Development Strategy: in 2008, MNRE set to work on a National Biofuels Development Strategy and Action Plan. This was part of the effort to promote renewable energy. It primarily considered the use of biofuels to replace fossil fuels. In addition, it raised "the creation of stakeholder awareness and involvement, establishment of national biofuels institutional and regulatory structures and the creation of policies and strategies for the production, processing and marketing of biofuels". (MNRE, 2008). The Biofuels Strategy and Action Plan was completed and approved by cabinet in 2011.

Public Private Partnership policy:
The Ministry of Finance established the Public Private Partnership policy in 2013 to engage private sector resources to improve and develop infrastructure and service delivery. This policy applies to all ministries and government departments, state-owned and state-controlled enterprises and local authorities. It provides them with a means of cooperation with the private sector. The specific aim is to speed up efficient and cost-effective implementation, and management and better services to customers, while allowing the public sector to concentrate on its core function.

Legal and regulatory framework

The Swaziland legal and regulatory energy framework is made up of the following laws.

Energy Regulatory Act and Electricity Act of 2007:
This allowed SERA to be established, and opened electricity generation, transmission and distribution to third parties. SERA is mandated to oversee the electricity sector by, among other things, issuing electricity production licences and regulating national electricity tariffs. As far as renewable energy is concerned, the Electricity Act has a special provision for hydropower generation plant. This requires any licensee operating a hydropower plant with over 10 MW capacity to transfer all existing installations, property and rights to the government after 40 years of operation. The act stipulates that the ministry must develop a rural electrification strategy and plan. This includes several points. The first is the expansion of the grid. The second is the installation of solar PV systems for isolated settlements that cannot be economically connected to the grid. The third is the supply of renewable energy power to the grid and to mini-grids. Furthermore, the act provides a tariff option based on the avoided cost to the system from the sale of renewable power to the grid for a plant up to 20 MW. Although this provision has significant implications for the development of renewable energy IPPs and small power producers, only one of these has supplied electricity to the grid so far. This is Ubombo Sugar, and it is based on bagasse cogeneration.

The 2002 Environment Management Act:
This transformed the Swaziland Environment Authority, established by the 1992 Environment Act, into a corporate body. It has the mandate to establish a framework for environmental protection and integrate natural resource management, including the promotion of renewable energy. In addition, Swaziland Environment Authority is to establish and administer the Swaziland Environment Fund in accordance with the policies and directions of the Environment Fund's Board.

3.3 FINANCING AND INVESTMENT FRAMEWORK

Around USD 50 million has been invested in the energy sector in Swaziland over the past five years. Of this, 79% is attributed to SEC and 21% to the government and development partners. The bulk of these investments have been geared towards grid intensification and demand side management projects funded and implemented by SEC. Grid extension projects were funded by the government and development partners, but implemented by SEC. The last clean energy greenfield investment was realised in 2004 for the Maguga hydropower plant. It amounted to USD 22 million.

The Swaziland Investment Promotion Authority (SIPA) was founded in 1998 through the promulgation of the Swaziland Investment Promotion Act. It role is to promote, facilitate and coordinate domestic and foreign direct investments and trade in Swaziland. SIPA is therefore the one-stop shop for both domestic and foreign investors to source information related to doing business in Swaziland. This includes the provision of, or recommendation for, investment incentives.

Incentives to invest in Swaziland are quite comprehensive and resolves almost all concerns related to the investment process. However, the energy sector has not been considered in the investment framework. Most importantly, taxation issues are given due consideration. All companies are subject to the corporate tax rate of 30%. There is also a provision for loss cover. This unlimited facility allows a company to carry forward its loss (given that it incurs a loss in the year of assessment), and set it off against future assessable income.

Investment incentives

- *Duty-free access on capital goods and raw materials:*
  Capital goods imported into the country for productive investments are exempt from import duties. Raw materials imported into the country to manufacture products to be exported outside the Southern African Customs Union area are exempt from import duties.

- *Export credit guarantee scheme:*
  Investors who manufacture/process for export can obtain funds from local banks to process their orders. Through the Central Bank of Swaziland, the government of Swaziland guarantees loans raised for this purpose.

- *Repatriation of profits and legal protection of investments:*
  The liberalised foreign exchange mechanisms also allow full repatriation of profits and dividends of enterprises operating in Swaziland. Repatriation is also allowed for salaries of expatriate and capital repayments. Investments in Swaziland are protected from undue expropriation under the Swaziland Investment Promotion Act of 1998. In addition, Swaziland is a member of the World Bank's Multilateral Investment Guarantee Agency, which provides for added legal protection of investments.

- *Human resources training rebate:*
  The Commissioner of Taxes approves a tax rebate of 150% on the cost of training schemes.

- *Development approval order:*
  The government of Swaziland has identified specific areas to bolster local and foreign direct investment. A special corporate tax incentive exists for these areas. The Minister of Finance has the prerogative to nominate a certain investment company as critical to the development of Swaziland, and thus, with cabinet approval, provide it with a minimum tax rate of 10% for ten years on withholding taxes. This relates to investments such as manufacturing, mining, agribusiness, tourism and international financial services. Investment incentives are provided for additional productive capacity. Special deductions are allowed on new industrial buildings and new plant and machinery brought into use as part of a manufacturing or similar process. This also covers the hotel industry. These special deductions also apply to second-hand machinery not previously used in Swaziland and also to leased plant and machinery. These are outlined below.

Table 9: Cost deductions on plants, machinery and industrial buildings

Object	Deduction
Initial allowance on new plant and machinery in use	50% of cost
Initial allowance on used machinery housed in a building qualifying for the initial allowance, used in Swaziland for the first time and not replacing other machinery	50% of depreciated value
Initial allowance on new industrial buildings in service that house machinery qualifying for the initial allowance	50% of cost
Annual wear and tear on cost of industrial buildings	4% p.a.*
Annual wear and tear on improvements to industrial buildings	4% p.a.

*per annum
Source: Swaziland Investment Promotion Authority (SIPA), 2013

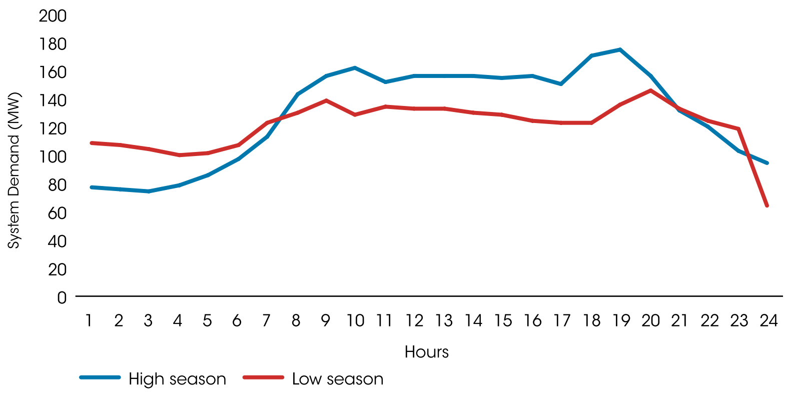
Wind and solar hybrid security light at a military checkpoint along the road between Siteki and Mhkumeni

IV. RENEWABLE ENERGY DEPLOYMENT- Emerging Concerns

4.1 ON-GRID ELECTRICITY

The Swaziland electricity grid currently covers 70% of the national territory and provides access to about 55% of the population. The country's daily load profile is closely correlated to the seasons with a high demand in winter and a lower demand in summer (figure 10). During both seasons the maximum daily demand occurs in the evening at around 8:00 p.m. while daytime peak demand is observed at around 10:00 a.m. Demand remains quite constant for most of the day, with an increase of about 25% in daytime demand in winter compared to summer.

Figure 10: Hourly load profile in high and low seasons



Source: IRENA adapted from SEC data

The grid electricity mix is heavily dominated by imports from South Africa and Mozambique, coming to around 80% of total electricity supplied. As South Africa is moving towards cost-reflective tariffs, Eskom is applying for annual tariff increases of 16% over the next five years. The purpose is to prompt more investment in its generation capacity and upgrade its transmission infrastructure. However, it was only granted a 10.1% increase. Swaziland is already feeling the impact of these changes, as power import costs from South Africa have risen. Thus there is growing concern about the Swaziland electricity sector's dependence on external factors. The country's available renewable energy resources, like biomass and solar, could complement hydropower generation and shift the current scenario. The higher share of the electricity supply mix would reduce dependence on imports from neighbouring countries.

Table 10: Potential electricity output from sugar cane cogeneration in Swaziland

	44 bar – 90 kWh/tC*		65 bar – 115 kWh/tC		82 bar - 140 kWh/tC	
Cane crushed (t)	GWh	MW	GWh	MW	GWh	MW
5 219 851	469	85.3	607	110.2	782	142.2

*tC= tonne of cane processed

Bagasse cogeneration

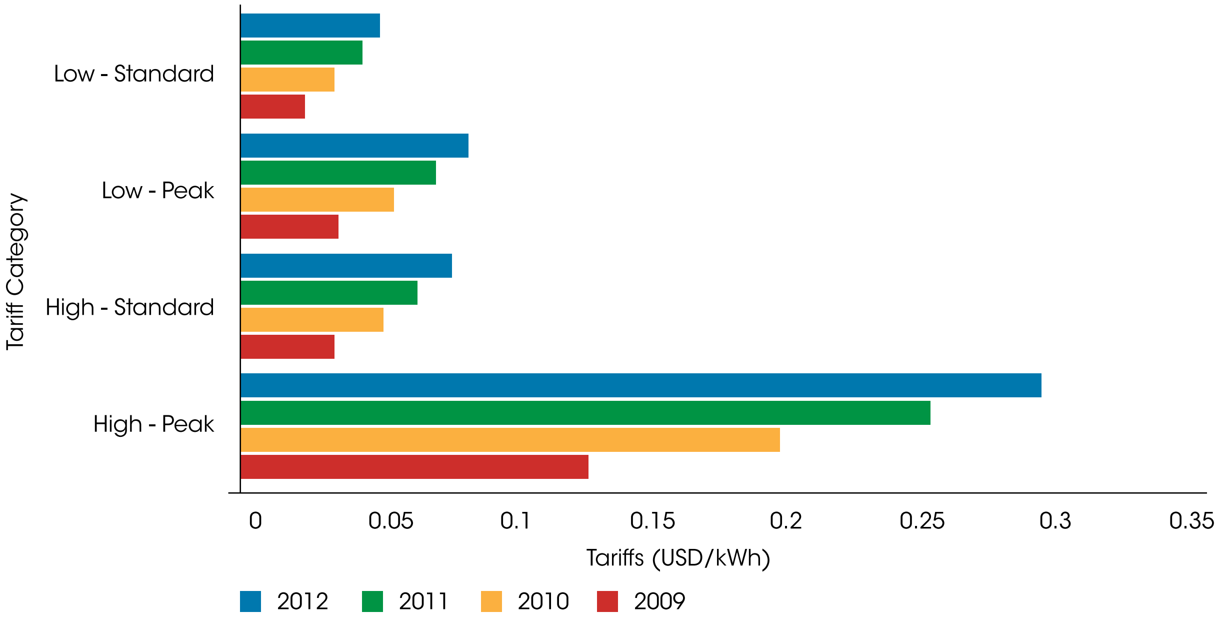
Across the world, the sugar industry generally meets its energy requirements for cane-to-sugar production by using bagasse as its main or sole fuel. In Swaziland the sugar industry has an installed capacity of 105.5 MW. It generated 259 GWh in 2012 and 285 GWh in 2013 from both bagasse and coal. Out of this, 33 GWh and 37.2 GWh respectively were fed into the SEC grid from Ubombo Sugar. Despite producing more than half of domestic electricity, the sugar industry still purchases power from the grid. This came to 131.4 GWh and 127 GWh respectively in 2012 and 2013. However, the sugar industry could produce much more electricity, become fully self-sufficient and provide surplus power to the grid during the milling season. Assuming a bagasse-to-cane ratio of 35% with a moisture content of 50%, bagasse cogeneration in Swaziland could produce between 469 GWh and 782 GWh each year. This depends on boiler pressure and efficiency (table 9). This would mean adding 64% to power generation, which would bring the present total up to 170%.

The boilers currently used by the sugar mills have a pressure of 31 bar and do not allow for efficient and increased power generation. This is because most mills in Swaziland have been deliberately designed to be inefficient at burning bagasse for power generation. Until recently the sugarcane industry has had no incentive to sell excess power to the grid, because electricity imports have been historically cheaper than cogenerated power from bagasse boilers. However, growing electricity import costs, load shedding from Eskom and highly variable domestic hydropower generation present an opportunity for Swaziland. It could draw further on its bagasse cogeneration potential and reduce its dependence on electricity imports by building an enabling environment for the sugar industry to play an increasing role in supply. A clear strategy for the development of bagasse cogeneration needs to be articulated in the country's energy policy. It needs to include the appropriate policy measures and incentives to encourage further investment in bagasse cogeneration by the sugar industry.

A 32 kW solar PV powering the blood bank in the Mbabane Government Hospital

[6] Boiler pressure assumptions are based on the Mauritius experience with 35% bagasse-to-cane ratio and 50% moisture content. Conversion from electricity production to installed capacity assumes that plants will be operating for 270 days (with a nine month milling period) 24/7 with a capacity factor of 85%.

Figure 11: SEC bulk purchase tariffs from Eskon



Source: IRENA based on SERA, 2013a

Solar

The door is now open for IPPs in the generation sector. This, along with increasing electricity supply charges and falling solar PV technology costs, provides an opportunity for deploying both large and small-scale grid-connected solar systems in Swaziland. Solar PV presents a viable option for the country to reduce the reliance on imports to meet daytime peak demand. This was the case, for instance, when bulk purchase tariffs rose to as much as 0.30 USD/kWh in 2012.

As far as utility-scale solar PV development is concerned, SEC has concluded a memorandum of understanding with several private operators who expressed interest in this. They include Vuselela Energy & Solon Energy Consortium (10 MW), Wunder Energy Ltd (3 x 50 MW) and SGL Power (100 MW). The latter is at the most advanced stage, as it is currently negotiating a 25 year PPA with SEC for the establishment of a 100 MWp (megawatt-peak) solar PV plant. This uses a back-end loaded tariff methodology. The proposed Feed-in Tariffs would progressively increase from 0.12 USD/kWh to 0.175 USD/kWh from year one to year seven. They would be capped at that amount for the remaining period of the PPA. These tariffs are competitive with the weighted average generation costs of large-scale solar PV plants in Africa. These are around 0.20 USD/kWh (IRENA, 2013). They are also competitive with the high season peak tariffs (June to September) applied by Eskom to SEC at approximately 0.29 USD/kWh (figure 11).

PPAs are to be drawn up on a case by case basis. So far, only one is concluded, and that is for Ubombo Sugar bagasse cogeneration. Important factors that would strengthen PPA bankability need to be considered in order to attract investment for medium to large-scale grid-connected solar power plants. These include mitigating dispatch risks by including clauses that set the tariff based on the energy delivered. This is done by embedding a fixed charge independent of dispatch. Alternatively, a capacity charge is set along with charges for energy actually delivered. This would improve PPA bankability by providing improved revenue stream predictability for the plant. This would increase investor confidence.

However Swaziland still faces major potential challenges to PV deployment. These are due to its relatively small size, its mountainous topography and a complex land tenure system. The land use requirement for large PV power plants and the capability of the grid to accommodate intermittent renewable energy are other challenges. As electricity demand is rising sharply in South Africa, Eskom is urged to fill the gap created by years of underinvestment in power generation and to diversify power supply. It can do this by drawing on its renewable energy resources. This has had a significant impact on SEC, which has experienced electricity import tariffs doubling in 2009-2012 (figure 11). This trend is likely to continue over the coming years. End-user tariffs in Swaziland have already risen as a result. It can therefore be assumed that solar PV grid parity may be achieved in Swaziland over the next decade.

The Electricity Act allows for the supply of distributed renewable energy to the grid. Nevertheless, there are currently no small-scale grid-connected PV systems in the country. This is because of the absence of clear regulations and by-laws to guide and incentivise third party involvement in distributed PV. The government could send a clear policy signal that would kick start the small-scale grid-connected solar PV market by adopting a net metering policy. This would be based on increasing avoided costs to the system as outlined in the Electricity Act. Net metering is generally defined as a light touch policy/regulation that allows electricity consumers to generate or store surplus electricity from small-scale variable energy sources into the grid. If adopted, a policy of this kind could spark the interest of the industrial and commercial sector. These consume 47% of the electricity supplied by SEC and are subject to TOU tariffs (peak tariffs were up to 0.26 USD/kWh in 2012).

Recommendations

Swaziland is now developing a Renewable Energy and Independent Power Producers Policy (REIPPP) that would allow the country to fully realise its untapped renewable energy potential. Bagasse cogeneration and solar PV can play an important role in reducing electricity imports. This will increase domestic power generation, so long as clear policy signals and regulatory stimuli are put in place to attract investment to the sector.

Strategy for the development of bagasse cogeneration

Bagasse cogeneration can provide baseload power and thus does not impair grid stability. Rather, it increases its reliability. The amendment of the 2007 Electricity Act including specific provisions for bagasse cogeneration should be made use of. There is a need for new measures specifically geared towards encouraging the sugar industry to invest in energy-efficient machinery and equipment to boost bagasse-based electricity production. A first step could be to extend existing tax credits and allowances to the sugar industry to incentivise investment in more efficient equipment for bagasse- based power generation. These are already included in the current investment code for the renewable energy sector. A generation-based incentive should also be developed. It could be founded on the avoided costs of power generation to the utility. It should be complemented by a model PPA for bagasse cogeneration to ensure project bankability and facilitate financing.

Renewable energy zoning

A detailed assessment of the economic potential of bagasse and solar resources needs to be conducted. This is required to comprehensively promote utility-scale renewable energy projects and private sector investment in the sector. Swaziland is party to the renewable energy zoning methodology from the Africa Clean Energy Corridor framework. This methodology aims to identify cost-effective, high-potential and high-density renewable energy zones for the development of utility-scale power plants. It uses a multi-criteria geospatial and economic analysis. Renewable energy zoning would allow the government to strategically allocate and promote identified zones for the commercial development of utility-scale solar PV power plants. This activity would fit in with the Public Private Partnership policy vision to promote the use of state-owned land to provide private investment opportunities.

Enabling environment for IPPs

Creating an enabling environment for renewable energy IPPs is crucial if Swaziland is to significantly increase renewables in its electricity mix. This is because the renewable energy provisions in the Electricity Act and the Energy Policy are not sufficient to attract private sector investment. The enabling environment can be further developed through the design and adoption of tailor-made policies and measures in the framework of a renewable energy IPP policy. These are outlined below.

The country has yet to develop a grid code and therefore there are no clear guidelines to facilitate third party access to the grid. A comprehensive grid code should therefore be developed, including enabling conditions and clear market rules for integrating renewable energy to the grid, while setting appropriate standards for the quality of supply and services.

A consultation on the development of a standardised PPA to increase the bankability of renewable energy power projects is needed. This would attract scalable investment, limit elaborate and tedious negotiations and give potential investors clear expectations on their investment.

Finally, key business sectors that include mining, tourism, manufacturing and agro-business enjoy a range of additional investment and fiscal incentives provided by SIPA. There is no specific mention of the renewable energy sector. It would be a good idea if these incentives were extended to renewable energy (especially bagasse cogeneration and large-scale solar PV). This would reduce capital costs.

4.2 OFF-GRID RENEWABLE ENERGY OPTIONS

Despite covering 70% of the country, the Swaziland electricity grid only provides access to 55% of the population (65% urban and 45% rural). The country's rural electrification approach has primarily focused on grid extension. This approach has been relatively successful, but achieving access for all Swazi citizens through centralised solutions will prove to be a challenge. This is due to the sparse population, low demand in certain areas and the prohibitive cost of grid extension. Given the country's ample solar resources and the falling cost of solar PV, decentralised solar PV applications offer an opportunity to further increase access to electricity and complement the grid. The large-scale deployment of solar water heaters can also reduce electricity demand and improve energy efficiency. There were early pilot projects in wind and solar technologies for irrigation, but scaling up these applications seems unlikely. This is because groundwater aquifers are generally of low permeability. Even well-sited and designed boreholes produce only a small quantity of water and often dry out, making the system unviable for any form of irrigation.

Solar PV for decentralised electrification

The only well-documented private sector Solar Home System (SHS) deployment project in Swaziland was implemented in 1997-2000 (as explained in section 2.4). It aimed to develop a financially sustainable business model to sell or lease SHS of up to 50 Wp capacity costing up to USD 525 to rural customers. The leasing option was supported by a three-year loan made byTriodos Bank to the local company, Solar International Swaziland (a joint venture between ECN and Swazitronix, a local company). This was because local financial institutions were unwilling to provide end-user credit for SHS. Customers had to make a down payment of 25% of the capital cost and a repayment of the balance within 36 months. The interest rate was at 22% (2% below the commercial lending rate). After running it for three years, the company sold more than 600 SHS on credit and achieved a loan repayment rate of about 80% (ECN, 2001).

This credit scheme proved the financial sustainability of this model and showed that SHS could become widespread in rural areas in Swaziland without massive subsidies. However, once the SHS is installed, customers are responsible for the operation and maintenance of the system. This results in the underperformance of some of the SHS and the unwillingness of some customers to continue paying the debt, and is one of the shortfalls of the model. The Electricity Act provides a clear impetus for the deployment of solar PV systems and mini-grids for isolated settlements. Thus, lessons learnt from this initiative should enable MNRE to design and implement a sustainable business model for scaling up off-grid solar PV systems in Swaziland. It can do this in cooperation with the Ministry of Finance, local financial institutions and private enterprises in the energy sector.

Solar water heating

Water heating is widely used in Swaziland, especially in winter (April to September) when temperatures average 10 degrees Celsius and often drop below zero. In urban areas, households and hotels mainly use electric water heating systems. In rural areas, wood fuel is predominantly used. As mentioned in section 4.1, daily demand is about 25% higher in winter than in summer season. This growth in demand can be clearly attributed to increased heating needs, especially for hot water. The daily peak occurs at 8:00-11:00 a.m. and corresponds to the highest peak import tariffs applied to SEC by Eskom (up to 0.29 USD/kWh).

SEC has, therefore, established TOU tariffs for industrial and large commercial and irrigation customers. At the same time, it has conducted an active energy efficiency and demand side management campaign to sensitise domestic customers to energy savings. As part of a demonstration programme, MNRE installed more than 100 solar water heaters in public institutions throughout the country. This showcased the practicality of the systems and raised the interest of various stakeholders. No data on the proportion of electricity usage for water heating in the domestic, commercial and industrial sectors are available. Nevertheless, it can be anticipated that introducing solar water heaters will further reduce electricity demand for this service. All solar water heaters deployed in the country at the moment are imported. A 200-litre system costs USD 1 300-3 300 (all duties, taxes and installation costs included) depending on model and origin. If properly installed and well maintained, this system may have a payback period of about five years (with a 10% discount rate) within a 20-year lifetime.

Recommendations

Solar systems present a clear opportunity for Swaziland to increase electricity access and improve energy efficiency in an economically and financially viable way. However, a number of crucial measures will need to be taken to stimulate market transformation leading to the sustainable deployment of decentralised solar systems. To decrease costs, the removal of all import duties and taxes on renewable energy equipment, especially solar systems, should be actively pursued. Also, local financial institutions should be made aware of the commercial viability of decentralised solar systems. Given their overall risk aversion towards these technologies, they should be informed and supported through dedicated credit lines or guarantees. This will help with the design and the financial products on offer, at favourable rates and with sound loan tenure, to end-users. Finally, MNRE should actively engage with SWASA and the University of Swaziland to develop a solar PV Quality Assurance scheme. This would cover solar technology standards development and certification programmes for installers and technicians to raise the confidence of stakeholders.

4.3 BIOFUELS

Swaziland relies on fuel imports from South Africa, mostly to meet transport sector needs. In 2007, petrol consumption was estimated at 115 million litres, diesel at 122 million litres and paraffin at 8 million litres respectively. The total import bill was USD 146 million (National Biofuels Development Action Plan, 2009). Demand for petrol is projected to reach 183 million litres by 2015. Meanwhile, the country has experienced a 75% increase in pump fuel prices from 0.8 USD/litre in 2006 to 1.3 USD/litre in 2012. Government interest in promoting locally produced biofuels, especially fuel grade ethanol, has grown. This led to the drafting of the National Biofuels Development Action Plan in 2009. The plan set a target to create an enabling legislative framework for biofuels and a national biofuels authority. It also sets goals for the phased development of biofuels and a blending mandate with the purpose of reaching a 10% ethanol and 5% biodiesel blend (E10 and B5).

The National Biofuels Development Action Plan identified a selected number of energy crops suited to the country's agri-ecological environment. These would help empower smallholder farmers as well as involving large-scale producers. However, concerns have been raised by different stakeholders, including the Ministry of Agriculture. These relate to land availability for biofuels production, especially biodiesel, and the potential competition between food and fuel crops. This is because the country is still not self-sufficient in food, and relies on food imports to meet its needs.

Swaziland is the third largest sugar cane producer in Africa, so it has a well-developed sugar industry, which produces significant by-products. These are mainly bagasse and molasses, and can be used as a feedstock for biofuels production. At the moment, the distilleries produce 60 million litres of ethanol per year and are considering expanding production. If an E10 blending policy is implemented, an estimated 18 million litres of ethanol would have to be produced. This is based on the forecast for demand of 183 million litres of petrol in 2015. The distillers will have to therefore be incentivised to significantly increase their fuel grade ethanol output by dedicating a share of current alcohol production capacity towards it. The economics of the blending policy needs to be carefully studied to set a price that will encourage the distilleries to provide the necessary quantity of ethanol fuel grade. It involves a close examination of the opportunity cost of alcohol sales.

Recommendations

In light of the successful blending trials and the large availability of molasses for ethanol production, the E10 blending mandate should be enacted. The introduction of the B5 mandate should be further investigated, as oil-producing crops compete with food crops in Swaziland. The creation of a legislative and regulatory framework for ethanol blending should be accompanied by guidelines for establishing fuel quality assurance and standards. Guidelines are also needed for price-setting and control mechanisms, as well as fiscal and financial incentives that allow distilleries to increase ethanol fuel grade production in a sound and coordinated manner.

4.4 OPPORTUNITIES AND CONSTRAINTS FOR SCALING UP RENEWABLE ENERGY DEPLOYMENT

Opportunities

Swaziland is a small country with an attractive investment framework supporting one of the most vibrant sugar industries in Africa. Through bagasse cogeneration, the sugar industry has the potential to meet about half the country's electricity demand in a sustainable way. It could also cut electricity imports while significantly increasing renewable power to the grid. The country has made some progress towards liberalising the electricity sector by allowing IPPs to generate power to the grid. This has prompted the first PPA between SEC and Ubombo Sugar.

[8] E10 is petrol/gasoline blended with 10% of ethanol fuel grade. B5 is diesel blended with 5% biodiesel.

Substation in Maguga

Swaziland's unexploited solar potential presents interesting prospects for greening both the centralised and decentralised energy infrastructure. This is especially true in light of the falling costs of solar PV technology and the maturity of solar water heaters worldwide. The government is also moving towards cost-reflective tariffs for electricity evidenced by the increasing tariffs. It is also constructing an IPP framework that should attract private sector investment in renewable as well as other types of energy generation.

At the regional level, there is a strong movement to increase the share of non-hydro based renewable energy. This is because countries in SAPP have started to assess their grid capacity to accommodate renewable energy and develop policies to import renewable power, as observed the South Africa. Power trade is rapidly developing in the region through SAPP DAM. Since Swaziland is interconnected to two of the SAPP member countries, it could greatly benefit from the African Clean Energy Corridor initiative. This is under development by IRENA. It aims to harness the renewable energy potential of countries in SAPP and the East Africa Power Pool, by speeding up the deployment of renewable energy through the promotion of cross-border electricity trade.

Constraints

A major constraint is still the limited incentives aimed at the renewable energy sector. Although, the costs of renewable energy technologies are declining, they still require high capital expenditure. Local financial institutions still perceive them as high-risk, which limits domestic appetite for renewable energy investments. Despite their ability to structure renewable energy projects and attract funding, new (mainly foreign) potential investors face obstacles to securing bankable PPAs. These need to include features to mitigate investment risks, such as dispatch, currency and interconnection risks. Innovative financing mechanisms and appropriate legislation to buy down cost of capital and risks are thus needed to enable the growth of renewable energy in Swaziland.

Although the country enjoys high grid coverage, an important section of the population is still too poor to afford to be connected. However, these inhabitants could benefit from decentralised renewable energy solutions such as SHS. There has been a proven business case in Swaziland from a private sector scheme. Nevertheless, local financial institutions are still averse to provide financing for the uptake of these systems for rural inhabitants. This is because they lack awareness of the solar business and have mistaken beliefs that the rural population would not be able to service its debt. In addition, there is a need for capacity building to reverse the lack of technical capacity in installing, operating and maintaining these PV systems. These support services are also important in the bid to engage financial institutions to provide the necessary investment.

The most comprehensive household energy study in the country dates as far back as 1997. This was when the Energy Sector Management Assistance Programme carried out a study to help the government develop a strategy for the household energy sector. Since then, no comprehensive household energy survey has been carried out and there is no precise data on overall domestic energy consumption. This is a major constraint for the government if it is to make good plans for the energy sector.

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Annex

Detailed description of recommended actions

ON-GRID

Action	Strategy for the development of bagasse cogeneration
Resource-service pair(s)	On-grid electricity (cogeneration)
Description	In Swaziland, the sugar industry generates more than half the domestic power. However, it is still purchasing power from the grid. Yet it could produce far more electricity than it currently does and be fully self-sufficient, providing surplus power to the grid during the milling season. This would reduce power import dependence. • The government should therefore amend the 2007 Electricity Act to include specific provisions for bagasse cogeneration. • Measures are needed that are specifically geared towards helping the sugar industry make use of more efficient machinery and equipment (*e.g.*, boilers) for electricity production. These could include raising the initial allowance for machinery or plant used for bagasse management, energy efficiency and electricity generation equipment tailored to the sugar industry. • Finally, the government should develop a price-setting mechanism based on the avoided costs to the utility. It should recommend the kWh price and develop a model PPA for bagasse cogeneration.
Actors	MNRE, Ministry of Finance, SERA, SEC, sugar and timber industries, any relevant stakeholders.
Timing	18 months
Keys to success	Engagement of all stakeholders and creation of platform for interaction among these institutions. Access to financial resources and skills to undertake the renewable energy and techno-economic assessments.

Action	Renewable energy zoning
Resource-service pair(s)	On-grid electricity (bagasse and solar)
Description	A detailed assessment of the economic potential of bagasse and solar resources is required. This will help comprehensively promote utility-scale renewable energy projects and attract private sector investments. One such detailed assessment can be conducted using the methodology developed within the Africa Clean Energy Corridor initiative to which Swaziland belongs. The renewable energy zoning methodology aims to identify cost-effective, high potential and high density renewable energy zones for utility-scale power plants, using multi-criteria geospatial and economic analyses. Renewable energy zoning would allow the government to strategically allocate and promote identified zones for the commercial development of utility-scale solar PV power plants. This activity would fit with the Public Private Partnership policy vision to promote state-owned land more efficiently and to provide the private sector with an investment opportunity.
Actors	MNRE, Ministry of Finance, SERA, SEC, sugar and timber industries, any relevant stakeholders.
Timing	18 months
Keys to success	Engagement of all stakeholders and creation of platform for interaction among these institutions. Access to financial resources and skills to undertake the renewable energy and techno-economic assessments.

Action	Enabling environment for IPPs
Resource-service pair(s)	On-grid electricity (bagasse and solar)
Description	Through MNRE, the government of Swaziland facilitated a PPA between Ubombo Sugar and SEC. Through this PPA, Ubombo Sugar sells its excess electrical power to SEC. Lessons are being learnt from this exercise that will lead to the proper formulation of a framework for IPPs to supply the national grid. This experience can be extended to other renewable energy such as solar. The current National Grid Code does not include any guidelines to facilitate third party access to the grid and does not grant priority access to renewable power. The renewable energy provisions in the Electricity Act and energy policy are not sufficient to attract private sector investment. If Swaziland is to significantly increase renewables in its electricity mix, the country should further improve the enabling environment for IPPs. It can do this by designing and adopting tailor-made policies and measures in the framework of a renewable energy IPP policy. • Through SERA, the government should develop a comprehensive grid code that would provide renewable energy IPP priority grid access. At the same time, it would set appropriate standards for the quality of supply and services to renewable energy technologies. • Investment and fiscal incentives already provided by SIPA for key business sectors should be extended to the renewable energy sector (especially bagasse cogeneration and large-scale solar PV). This would reduce capital costs. • The government should engage in a consultation to develop a standardised PPA to increase the bankability of renewable energy power projects. This would attract scalable investment, limit elaborate and tedious negotiations and give potential investors clear expectations on their investment.
Actors	MNRE, SERA, SEC, sugar cane and timber industries, any other relevant stakeholders.
Timing	Up to 18 months
Keys to success	Engagement of all stakeholders and creation of platform for interaction among these institutions ensuring participation and willingness of grid operators. Independence of the regulator to regulate the grid operator and enforce the grid code is also key.

OFF-GRID

Action	Stimulate market transformation leading to the long-term deployment of decentralised solar systems
Resource-service pair(s)	Off-grid solar
Description	• The electrification rate for Swaziland is relatively high compared to most SADC countries, except for South Africa and Botswana. In most of these rural areas, there is high solar irradiation. This can be used for off-grid electricity and heat generation. Solar systems present a clear opportunity for Swaziland to raise electricity access and improve energy efficiency in an economically-viable way. However, a number of critical measures are required to stimulate market transformation leading to the long-term deployment of decentralised solar systems in Swaziland. • The government needs to remove all import duties and taxes on renewable energy equipment, especially solar systems, to decrease the technology costs and make it even more affordable. • Local financial institutions should be made aware of the commercial viability and financial opportunity of decentralised solar systems. Given their general risk aversion to these technologies, they should be supported through dedicated credit lines or guarantees specifically for solar systems. This will help with the design and the financial products on offer, at favourable rates and with sound loan tenure, to end-users. • MNRE should actively work with SWASA and the University of Swaziland to develop a solar PV Quality Assurance scheme. This would include new solar technology standards and certification programmes for installers and technicians to raise the confidence of all stakeholders.
Actors	MNRE, Ministry of Finance, local financial institutions, SWASA, University of Swaziland, project developers and any other relevant stakeholders.
Timing	18 months
Keys to success	Engagement of all stakeholders in renewable energy regulatory and policy institutions to discuss feasible options to promote off-grid renewable energy systems.

Action	Assess the economics of bioethanol blending and enact E10 blending mandate
Resource-service pair(s)	Biofuels
Description	The sugarcane industry in Swaziland is mature and produces over 5 million t sugarcane per year. The industry has adequate feedstock from molasses, a by-product of sugarcane processing, which can be used for producing bioethanol. Two bioethanol producers - Royal Swaziland Sugar Corporation and USA Distillers - produce limited bioethanol quantities from sugarcane molasses. MNRE and Royal Swaziland Sugar Corporation carried out some trials for running vehicles on E10 fuel, a 10% ethanol and 90% gasoline blend. The trials were successful. Efforts have been made to commercialise bioethanol, but a number of problems need to be resolved to develop the bioethanol industry. For example, there is no policy for mandatory blends in petrol, no investor guide, no sustainability criteria to safeguard conflicts between energy and food and no pricing mechanism. Furthermore, the government has yet to investigate the infrastructure needs for storing, blending and distributing bioethanol blended fuel. An assessment of the benefits accruing to government and other stakeholders is equally necessary. • The government should undertake a comprehensive study into the economics of bioethanol use for transport from production to end-use. It should evaluate the costs to government and private sector. • Given the successful trials, the government should enact a fuel blending mandate of 10% ethanol. However, it should also be prudent on a biodiesel blend mandate as Swaziland has not had a very good experience in oil crop production for biodiesel.
Actors	MNRE, Ministry of Finance, Ministry of Agriculture, SERA, SEA, SWASA and Swaziland Sugar Association
Timing	18 months
Keys to success	Inputs to the study by all stakeholders listed above

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