SHORT-TERM GENERATION EXPANSION PLAN FOR ESWATINI

STUDY REPORT

26 MARCH 2018

PREPARED FOR

MINISTRY OF NATURAL RESOURCES AND ENERGY

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Preamble

This report (the “SGEP Report” or the “Report”) has been prepared in good faith by Energy System Planning (Pty) Ltd (“ESP” or the “Consultant”) based on the information provided by the Ministry of Natural Resources and Energy (“MNRE” or the “Client”). The data and assumptions contained in this Report have been compiled following consultation with the MNRE and other key stakeholders in the Eswatini Electricity Industry (“EEI”). The Client absolves ESP from any and all liabilities arising from the use of the data and assumptions in this Report for the purposes of developing the Short-term Generation Expansion Plan for Eswatini (“SGEP”).

The use of the contents and findings of this Report shall be at the user’s sole risk and shall constitute a release of ESP from any liability in connection with such use.

Glossary

Abbreviations	
ALSF	African Legal Support Facility
COD	Commercial Operation Date
EEC	Eswatini Electricity Company
EPC	Engineering, Procurement and Construction
ESERA	Eswatini Energy Regulatory Authority
ESP	Energy System Planning (Pty) Ltd
Eskom	Eskom Holdings SOC Ltd
FGD	Flue gas desulphurisation
IPP	Independent Power Producer
IPPP	Independent Power Producers' Policy
IRP	Integrated Resource Plan
IRR	Internal Rate of Return
MNRE	Ministry of Natural Resources and Energy
O&M	Operation and Maintenance
PPA	Power Purchase Agreement
PR	Performance Ratio
PV	Photovoltaic
RE	Renewable Energy
SGEP	Short-term Generation Expansion Plan
Currency	
E	Emalangeni
USD	United States Dollar
ZAR	South African Rand
Units of Measurement	
km	kilometres
kV	kilo volts
kW	kilowatt
kWh	Kilowatt hour
MVA	Mega Volt-ampere
MVAr	Mega Volt-ampere reactive
MW	Megawatt
MWh	Megawatt hour

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1 INTRODUCTION

1.1 Background

The Kingdom of Eswatini is a landlocked country located in Southern Africa with a population of just over 1.3 million. To supply its electricity demand, Eswatini relies heavily on electricity imports from mainly Eskom in South Africa despite the potential of natural resources that could be exploited to generate electricity locally. Due to the challenges faced by and the expected significant tariff increases from Eskom, the reliance on imports is no longer secure.

Eswatini has therefore embarked on plans to introduce local generation capacity to reduce its reliance on imported electricity. Moreover, an Independent Power Producers' Policy ("IPPP") has been established and is aimed at increasing the utilization of Eswatini's local renewable energy resources including biomass, solar photovoltaic, wind and geothermal resources to enhance energy security and self-sufficiency.

The Eswatini Government has requested the African Legal Support Facility ("ALSF") to aid with capacity building on the procurement of new generation in the country. The ALSF has subsequently appointed a team of consultants to prepare an independent power producer toolkit ("IPP Toolkit") which comprises a standardised set of tender documents including fully drafted project agreements that will assist the sector in the procurement of the new generation capacity.

When procuring new generation, a concrete plan to guide the relevant authorities on the amount of the various possible types of generation capacity that will need to be procured and the envisaged timeframes is required. This is typically undertaken by means of an integrated resource plan. The preparation of an integrated resource plan is a protracted process and due to the immediate need for Eswatini to procure new generation to meet the strategic objectives of the Government a decision was made that a plan which focuses only on the short-term generation plans for Eswatini should be prepared.

As a consequence, ESP was appointed by the MNRE, in conjunction with ALSF, to provide consultancy services for the preparation of the SGEP.

1.2 Structure of the Report

ESP has prepared this report (the "SGEP Report" or the "Report") outlining the background to the Study, scope and methodology, key assumptions, results of the Study and recommendations. The structure of the Report is as follows:

Section 1 is this Introduction;

Section 2 provides an overview of the Eswatini Electricity Supply Industry;

Section 3 outlines the scope of work and describes the approach and methodology for the Study;

Section 4 outlines the key assumptions employed in the Study;

Section 5 presents and discusses the results of the Study; and

Section 6 provides the conclusion and recommendations of the Study.

2 ESWATINI ELECTRICTY SUPPLY INDUSTRY

2.1 Situational analysis

The energy sector in Eswatini has been undergoing rapid changes in the last few years. This has included the introduction of new policies, enactment of new laws, establishment of the energy regulator and introduction of electricity standards. The changes are driven by the country's desire to improve energy security, access to reliable, adequate and affordable electricity and the mitigation of the potential detrimental impacts on the environment because of the growing energy demand.

The recent amendments to legislations which were enacted into Acts of Parliament in 2007 to liberalise the electricity supply industry in Eswatini include:

- the Electricity Act of 2007;
- the Eswatini Electricity Company ("EEC") Act; and
- the Energy Regulatory Authority Act.

The Eswatini Electricity Company Act of 2007 establishes EEC as a company in terms of the Companies Act No.8 of 2009. EEC assumed all duties and powers previously conferred to Swaziland Electricity Board ("SEB"), as well as activities thereof, namely generation, transmission, distribution and supply of electricity.

The Energy Regulatory Authority Act of 2007 established the Eswatini Energy Regulatory Authority ("ESERA" or "Authority"). The Authority is tasked with enforcing compliance standards, approving tariffs, adjudicating concerns from consumers and promoting economic efficiency in the energy industry. ESERA is further empowered to launch tender processes for the procurement of the new generation capacity in Eswatini.

2.2 Prevailing energy policies

<u>National Energy Policy (2003)</u>

The National Energy Policy ("NEP") guides energy developments in the country by ensuring that Eswatini has a policy which clearly establishes priorities and plans for the short, medium and long term.

<u>Independent Power Producers Policy (2016)</u>

The Independent Power Producers Policy ("IPPP") is aimed at promoting the utilization of Eswatini's extensive local renewable energy resources including biomass, solar photovoltaic, wind and geothermal resources. This will be done by promoting the deployment of Independent Power Producers ("IPPs") projects to meet Eswatini's electricity needs and to enhance energy security and self-sufficiency by reduced reliance on imports.

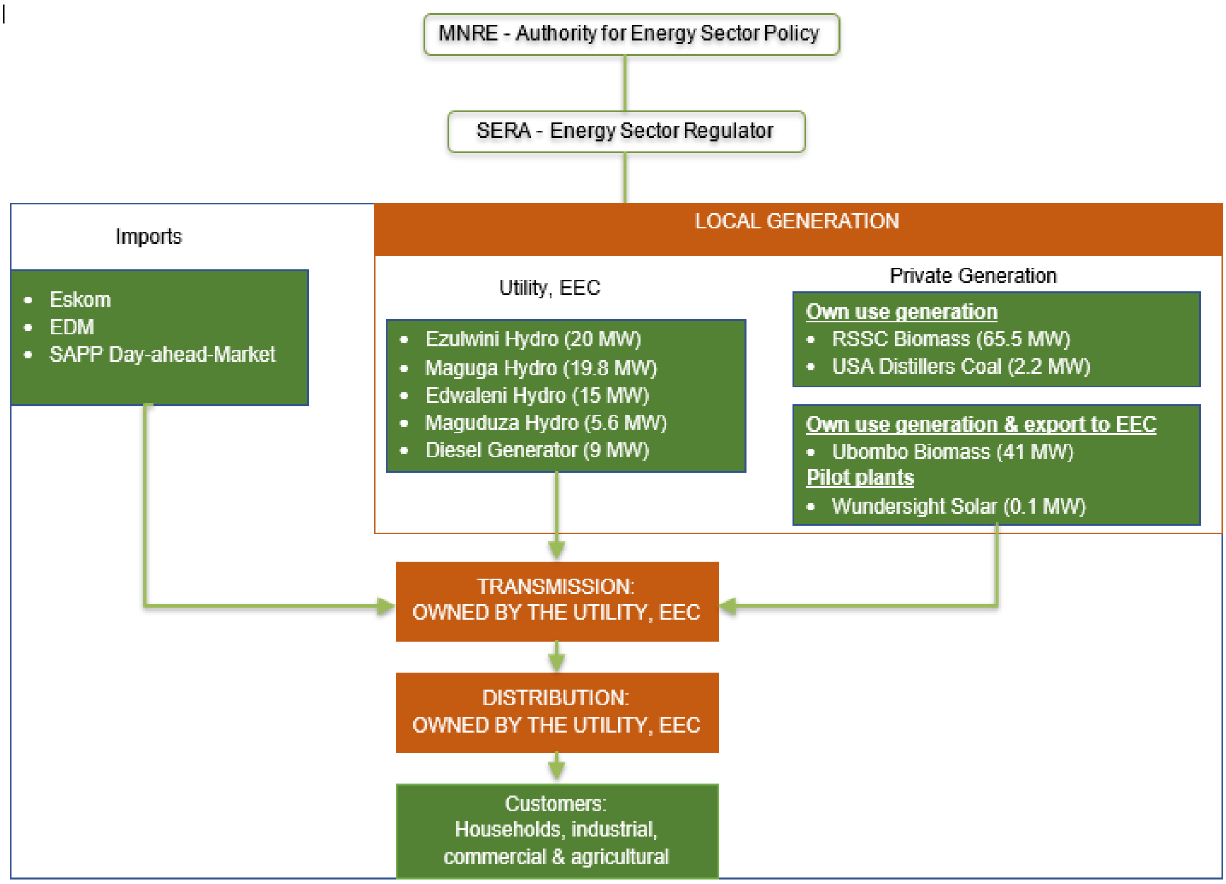
2.3 Overview of the Eswatini Electricity Supply Industry

Figure 2-1 below shows the key players in the Eswatini Electricity Supply Industry ("EESI"). The roles and responsibilities for each stakeholder are as follows:

- The Department of Energy ("DoE") is a branch of the **MNRE** that is responsible for making energy policies to create an environment for efficient operation and growth of the energy sector. It sets the strategic direction for the growth of the sector and provides a long-term vision for all sector players.

- **ESERA** is a statutory Energy Regulatory Body established through the Energy Regulatory Act, 2007. ESERA has core responsibilities of exercising control over the EESI and regulation of generation, transmission, distribution, supply, use, import and export of electricity in Eswatini. ESERA, in consultation with the MNRE, also acts as the procuring authority of new generating capacity in the country.
- **EEC** is engaged in the business of generation, transmission and distribution of electricity in the country. The legislations that governs EEC include (i) the Eswatini Electricity Company Act, 2007, (ii) the Electricity Act, 2007, (iii) the Companies Act, 2009, (iv) the Energy Regulatory Act, 2007, as well as (v) the Public Enterprises Unit (Control and Monitoring) Act, 1989.
- **IPPs** are private companies that own generation facilities and produce electricity for their own consumption as well as exporting excess power to EEC through long term contractual arrangements. There are currently four existing IPPs in Eswatini with a total installed capacity of close to 110 WM made up of thermal, coal and solar photovoltaic plant technologies.
- **Eskom** is a South African utility that is a member of SAPP and has entered into a long-term agreement with EEC for the supply of electricity. EEC imports bulk of its electricity from Eskom to supply most of the Eswatini load demand.
- **Customers** purchase power from EEC at a tariff regulated by ESERA. The customer classes that exist in Eswatini are residential, industrial, commercial and agricultural.

Figure 2-1: Overview of Eswatini Energy Supply Industry



2.4 Eswatini generation capacity

Presented in Table 2-1 below are the existing generating plants in Eswatini.

Table 2-1: Eswatini generation capacity

Eswatini generation	Plant	Installed capacity (MW)	Available capacity (MW)	Technology
EEC generation	Maguga	19.8	19.8	Hydro
	Maguduza	5.6	5.6	Hydro
	Ezulwini	20	20	Hydro
	Edwaleni	15	15	Hydro
	Edwaleni Diesel Plant	9	9	Diesel
Private generation	Royal Swazi Sugar	65.5	37	Biomass
	Ubombo Sugar Limited	41.5	41.5	Biomass
	USA Distillers	2.2	2.2	Thermal
	Wundersight	0.1	0.1	Solar PV
Total (MW)		**178.7**	**150.2**	

2.5 Energy consumption and supply

Figure 2-2 below presents the energy consumption levels from EEC customers categorised per sector from 2012 – 2016.

Figure 2-2: Energy consumption by EEC customers

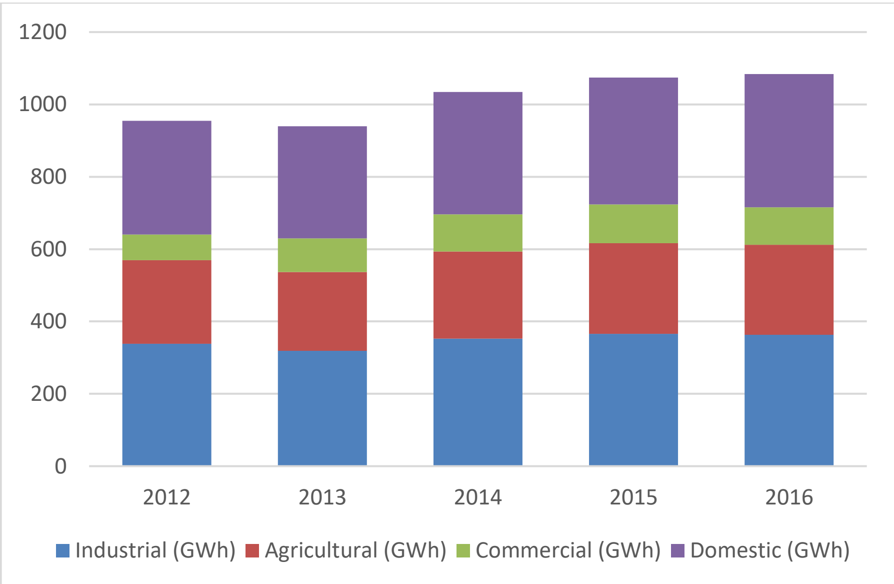
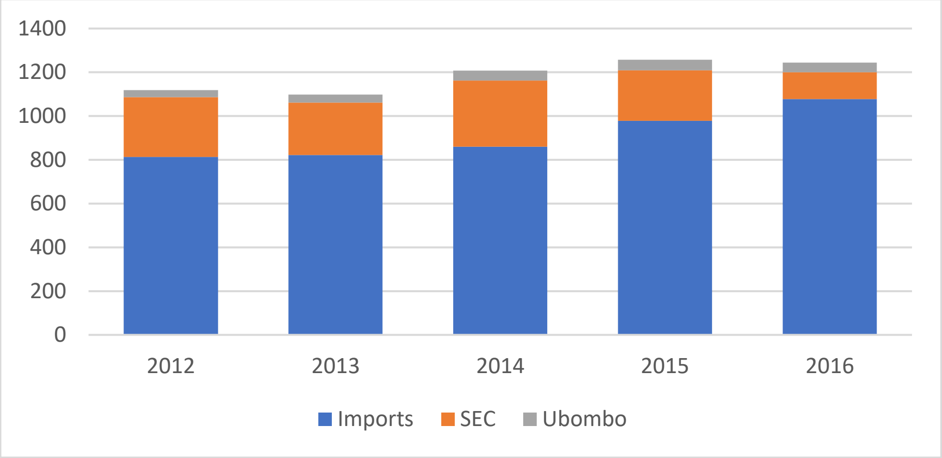


Figure 2-3 below presents the electricity supply sources to meet the energy consumption by EEC customers between 2012 - 2016. The supply sources have been dominated by imports.

The energy supply increased to 1,245 GWh in 2016 and with the energy demand of 1084 GWh, 161 GWh of losses were experienced and these were 12.9% of the total energy supply in that year.

Figure 2-3: Electricity supply sources



3 APPROACH AND METHODOLOGY

This section presents and discusses the methodology that was employed in executing the scope of work for the preparation of the SGEP. The scope of work for the Study comprises:

- Data collection and review;
- Review existing demand forecasts and prepare an updated demand forecast;
- Consultations with relevant Government stakeholders;
- Compiling generation supply options and costs;
- Conducting demand/supply balance analysis;
- Preparation of a least cost generation development plan; and
- Preparation of the Study Reports.

A kick-off meeting was held on 01 November 2017 with the Client where the above scope was discussed.

3.1 Data collection and review

Shortly following the kick-off meeting, ESP issued a data requirement list to the MNRE, EEC and ESERA for data required to conduct the Study. For information that was missing, assumptions were prepared. These are presented in Section 4 and have been discussed with the Client as the basis upon which the Study was executed.

3.2 Demand forecast data review

To derive the demand forecast for the Study, the demand forecasts that were reviewed are as follows:

- A 20-year (2017 – 2037) peak demand (MW) EEC demand forecast which was prepared in September 2017;
- A 20-year (2014 – 2034) peak demand (MW) and energy (excluding losses) forecast draft report which was done by Aurecon in March 2015;
- A demand forecast in the draft Energy Master Plan; and
- A demand forecast prepared for the MNRE for the Ngwempisi feasibility study.

The analysis for deriving the updated demand forecast for the Study is presented in Section 4.2.

3.3 Preparation of generation supply options

In Section 4.5, the possible plant technologies that have been considered for Eswatini are discussed. ESP gathered information on the capital development cost, operating cost, fuel costs, development timeframes, plant life, plant load factor, etc for the possible technologies. This information was used to compile a database for generation supply options.

3.4 Least cost generation plan

Electricity supply for Eswatini is primarily sourced from imports from Eskom in South Africa. New generation supply sources would likely be targeted at displacing this imported electricity. To evaluate the potential of new generation capacity that could be developed in Eswatini, the new generation supply sources were compared to the future cost of imports to determine the combination of sizes and technologies that are optimal for Eswatini. For this analysis, the following was conducted:

- Development of the generation dispatch model utilising daily and seasonal hourly load profiles derived from the demand forecast and historical hourly load profiles;
- The above model was used to match the generation supply against the demand profiles;
- The potential new generation options were evaluated against the potential future imports and the displaced imported energy to determine the economic value of the potential future generation options; and
- The imported energy costs displaced were evaluated against the estimated cost of generation options to be developed in order to determine which potential generation options are viable.

Although the analysis above was conducted for a 15-year horizon, the focus for determining new generation plant options was limited to the next 5 years.

3.4.1 Generation planning process

The objective of a generation expansion plan analysis is to meet the demand for electricity at:

- An acceptable level of reliability; and
- At the least overall discounted cost in economic terms.

Any demand/supply balance model typically consists of two steps in the optimisation process:

- The existing and committed generation system is simulated to meet the energy demand over the study period.
- Depending on the defined planning criteria and plant costs, a candidate plant is selected to satisfy the planning criteria at the lowest cost.

The two steps above are repeated iteratively until the lowest cost solution that satisfies the planning criteria is achieved.

3.5 Consultations with relevant stakeholders

Due to the nature of the Study we conducted extensive engagements with the key players of the Eswatini energy sector. These include the MNRE, EEC and ESERA as well as IPPs such as Royal Eswatini Sugar Corporation (“RSSC”) and Ubombo Sugar Limited (“USL”).

4 KEY ASSUMPTIONS

This section presents the key assumptions that were employed in the Study. These assumptions have been discussed and agreed with the Client and formed the basis upon which the Study was conducted.

4.1 Study horizon and base date

Although the demand forecast analysis was conducted over a period of 15 years (2017-2032), the determination of the least cost plan was limited to the next 5 years. The base year of the Study was assumed to be 2017.

4.2 Demand forecasts

The objective of the SGEP is to provide a development plan to facilitate the procurement of new generation capacity in the short-term. The new generation is targeted at supplying the electricity demand of Eswatini by displacing imports from Eskom. The demand forecast should therefore be inclusive of the expected future demand of the entire country and not just the demand supplied by the EEC.

As indicated in Section 3.2, four demand forecasts were reviewed in order to prepare an updated demand forecast for the Study. The review outcome is summarized below.

4.2.1 EEC demand forecast (and Aurecon demand forecast)

The EEC peak demand (MW) forecast which was prepared in September 2017 is an update to the demand forecast done by Aurecon in 2015. These forecasts (Aurecon and EEC forecasts) use distributed geographically based demand estimates which are then built up to derive demands at substation and system level.

These two demand forecasts were prepared for EEC purposes and excluded the energy consumed by the sugar industry.

4.2.2 Ngwempisi demand forecast

The demand forecast was prepared for assessing the feasibility of the proposed Ngwempisi hydro power project and, similarly to the EEC demand forecast, this also excluded the energy consumed by the sugar industry.

4.2.3 Master plan energy forecast

In the draft Energy Master Plan ("EMP"), a detailed energy demand assessment for the period between 2015 and 2035 was performed using a software package called the Long-range Energy Alternatives Planning System ("LEAP"). An energy demand accounting model for Eswatini was created and three demand projections were formulated. The LEAP software is a tool to generate a detailed accounting model to develop energy demand projections in a bottom-up manner, by taking into account energy consumers useful energy needs and their choice of technologies and appliances. The EMP energy forecast is an analysis of all the sectors in the economy and their total energy consumption irrespective of the supply source.

4.2.4 Demand forecast conclusion

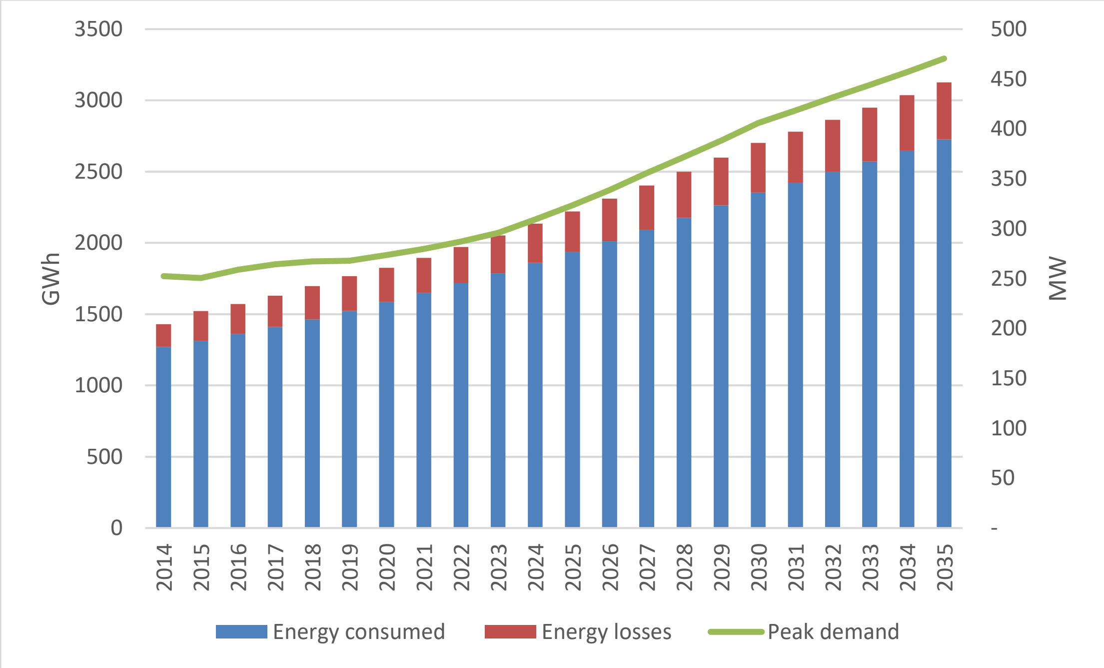
ESP was satisfied with the validity of the EMP forecast hence considered this for use in the Study but with advances as provided below:

- Energy purchases for the EMP forecast were derived by adding the percentage network losses extracted from the Ngwempisi forecast; and

- The peak demand forecast for the EMP were derived by applying load factors (%) derived for the Aurecon forecast to the energy purchased.

Figure 4-1 shows the forecast that was derived for the Study. Provided in the figure is the electricity consumed, derived network losses and peak demand forecast.

Figure 4-1: Forecast for electricity consumed, losses and peak demand



Furthermore the base, low and high energy and demand forecast scenarios were derived, these are shown in Figure 4-2 and Figure 4-3 below respectively.

Figure 4-2: Base, low and high energy forecasts

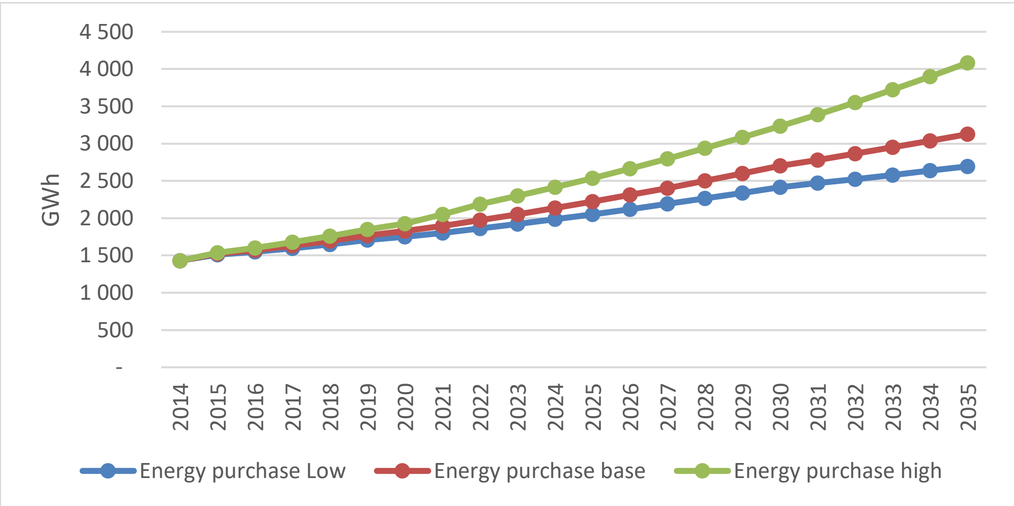
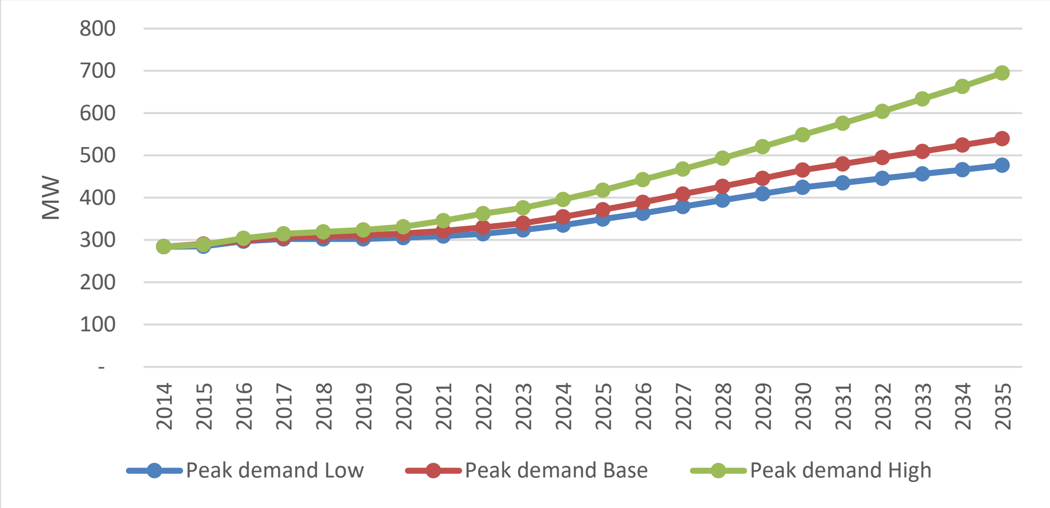


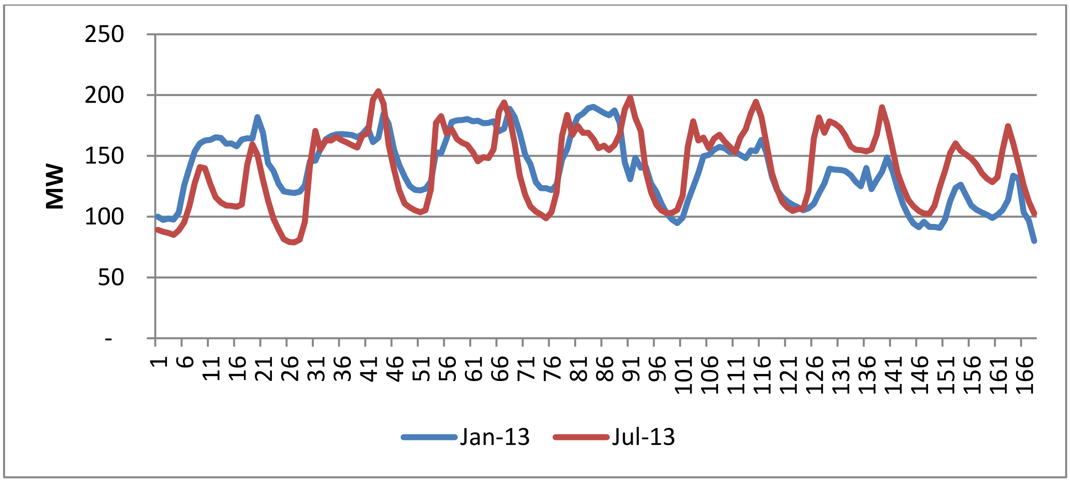
Figure 4-3: Base, low and high peak demand forecasts



4.3 Hourly load data

To model the future generation expansion, representative hourly load curves are required which are typically converted to representative load duration curves. Figure 4-4 below presents a sample historical hourly load curve data for two weeks in 2013 in Eswatini. This 2013 data was adjusted for each year to present the forecast energy and peak demand.

Figure 4-4: Hourly load curves for 2 weeks in 2013



4.4 Existing generation supply

4.4.1 The EEC generation

The EEC owns and operates four hydro power plants with a total capacity of 60.4 MW. Table 4-1 provides a list of the existing hydroelectric power plant in the EEC system together with the key plant characteristics used for purposes of the Study.

It should be noted that EEC also owns a 9 MW diesel generator which, due to high operating cost, is only operated during emergency conditions.

It is not anticipated that the EEC hydro plants and diesel plant will stop operation within the SGEP time horizon hence these were assumed to be operational during this period.

4.4.2 Committed projects

The Lower Maguduza Hydro Power Scheme ("LMHPS"). LMHPS is a committed project in Eswatini and is a run-off river 13.6 MW hydro power plant to be located along the Lusutfu river. LMHPS will be built and operated by an IPP with the electricity generated sold to EEC over a PPA term of 25 years. After the expiry of the PPA, the plant will be transferred to the ownership of EEC at no cost. The EEC may choose to operate the plant for the remainder of its economic life which is expected to be a further 20-25 years.

The key plant characteristics of the LMHPS that were used in the Study are also shown in Table 4-1.

Table 4-1: Existing and committed plant characteristics

	Operating Parameters										
Plant Name	Installed Capacity (MW)	FOR* (%)	POR** (Days)	Availability (%)	Commission date	Plant life (Years)	Fixed O&M*** Cost (E/kW/Yr)	Firm Energy (GWh)	Average Energy (GWh)	Firm energy Capacity Factor (%)	Variable O&M (c/kWh)
EXISTING HYDRO	60.4							175	253		
Maguga	19.8	2	21	92.4	2005	50	110	60	85	35.1%	13.10
Ezulwini	20	2	21	92.4	1985	50	110	35	50	20.0%	13.10
Edwaleni	15	2	21	92.4	1963	50	110	40	70	30.4%	13.10
Maguduza	5.6	2	21	92.4	1969	50	110	18	28	36.7%	13.10
COMITTED PROJECTS	13.6							54	71		
LMHPS	13.6	2	21	92.4	2020	50	108	54	71	45.3%	12.83

*FOR – Forced outage rate i.e. the percentage of time one would expect the plant not to be available due to unplanned outages.

**POR – Planned outage rate i.e. the number of days the plant will be on planned outages every year

***O&M – Operating and maintenance

4.4.3 Private generation

Table 4-2 below presents the existing privately-owned generating plants in Eswatini. These privately-owned generating plants are mainly used as co-generation plants to supply own consumption. However, USL has surplus power that it sells to the EEC over a long-term power purchase agreement.

Table 4-2: Eswatini existing privately-owned generation

Plant	Installed capacity (MW)	Available capacity (MW)	Technology
Royal Swazi Sugar (RSSC)	65.5	37	Biomass
Ubombo Sugar Limited (USL)	41.5	41.5	Biomass
USA Distillers	2.2	2.2	Thermal
Wundersight	0.1	0.1	Solar PV
Total (MW)	**109.3**	**80.8**	

4.4.4 Imports

The EEC imports bulk of its electricity needs from Eskom and has entered into a long-term power purchase agreement with Eskom. In the financial year 2015/16 the EEC's imports from Eskom were 1,077 GWh which account for 85% of the EEC's electricity supply to its customers.

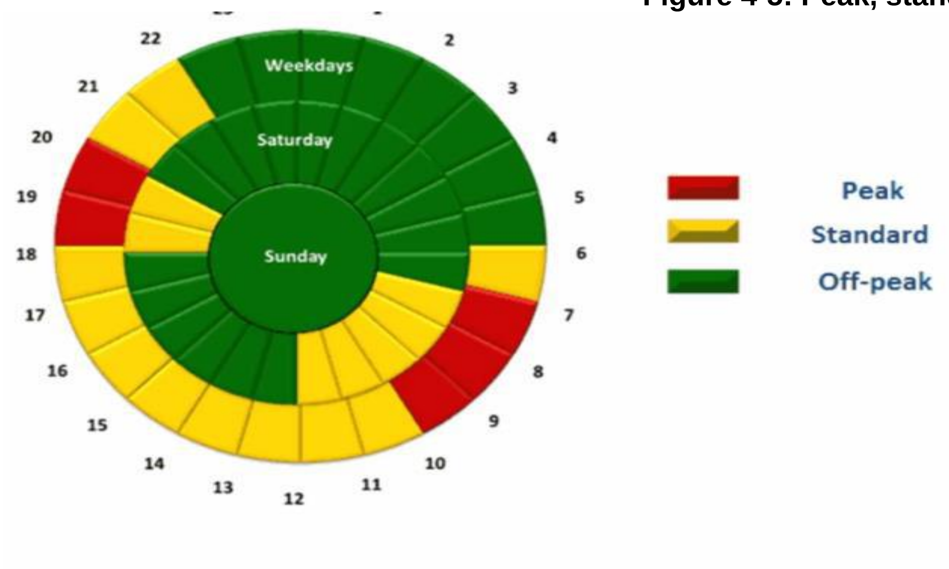
For the purposes of determining the cost of imports and deriving the imported energy values displaced it was assumed that the import tariff charged to the EEC is the Eskom MegaFlex tariff. The tariff for the 2017/18 financial year is presented in Table 4-3 and the hours (peak, standard and off-peak) in every week to which the time of use applies are presented in Figure 4-5.

Table 4-3: Eskom Megaflex tariff charges

Transmission zone	Voltage	Active energy charge [c/kWh]												Transmission network charges [R/kVA/m]	
		High demand season [Jun - Aug]						Low demand season [Sep - May]							
		Peak		Standard		Off Peak		Peak		Standard		Off Peak			
			VAT incl		*VAT incl*		*VAT incl*		*VAT incl*		*VAT incl*		*VAT incl*		*VAT incl*
≤ 300km	< 500V	**279.71**	*318.87*	**85.11**	*97.03*	**46.44**	*52.94*	**91.58**	*104.40*	**63.20**	*72.05*	**40.28**	*45.92*	**R 7.79**	*R 8.88*
	≥ 500V & < 66kV	**275.30**	*313.84*	**83.41**	*95.09*	**45.29**	*51.63*	**89.81**	*102.38*	**61.81**	*70.46*	**39.22**	*44.71*	**R 7.11**	*R 8.11*
	≥ 66kV & ≤ 132kV	**266.61**	*303.94*	**80.76**	*92.07*	**43.86**	*50.00*	**86.97**	*99.15*	**59.87**	*68.25*	**37.97**	*43.29*	**R 6.92**	*R 7.89*
	> 132kV*	**251.27**	*286.45*	**76.12**	*86.78*	**41.33**	*47.12*	**81.96**	*93.43*	**56.41**	*64.31*	**35.79**	*40.80*	**R 8.76**	*R 9.99*
> 300km and ≤ 600km	< 500V	**281.99**	*321.47*	**85.43**	*97.39*	**46.38**	*52.87*	**91.99**	*104.87*	**63.33**	*72.20*	**40.17**	*45.79*	**R 7.83**	*R 8.93*
	≥ 500V & < 66kV	**278.05**	*316.98*	**84.23**	*96.02*	**45.74**	*52.14*	**90.71**	*103.41*	**62.43**	*71.17*	**39.60**	*45.14*	**R 7.18**	*R 8.19*
	≥ 66kV & ≤ 132kV	**269.22**	*306.91*	**81.55**	*92.97*	**44.28**	*50.48*	**87.82**	*100.11*	**60.44**	*68.90*	**38.33**	*43.70*	**R 6.97**	*R 7.95*
	> 132kV*	**253.77**	*289.30*	**76.89**	*87.65*	**41.74**	*47.58*	**82.77**	*94.36*	**56.98**	*64.96*	**36.14**	*41.20*	**R 8.84**	*R 10.08*

Distribution network charges						
Voltage	Network capacity charge [R/kVA/m]		Network demand charge [R/kVA/m]		Urban low voltage subsidy charge [R/kVA/m]	
		VAT incl		*VAT incl*		*VAT incl*
< 500V	**R 15.54**	*R 17.72*	**R 29.45**	*R 33.57*	**R 0.00**	*R 0.00*
≥ 500V & < 66kV	**R 14.25**	*R 16.25*	**R 27.01**	*R 30.79*	**R 0.00**	*R 0.00*
≥ 66kV & ≤ 132kV	**R 5.10**	*R 5.81*	**R 9.42**	*R 10.74*	**R 12.48**	*R 14.23*
> 132kV / Transmission connected	**R 0.00**	*R 0.00*	**R 0.00**	*R 0.00*	**R 12.48**	*R 14.23*

Figure 4-5: Peak, standard and off-peak hours



4.5 Potential future supply options

Open cycle Gas Turbine plant

Open cycle Gas Turbine ("OCGT") and Combined Cycle Gas Turbine plant ("CCGT") typically operates on some form of distillate fuel or natural gas. There are no natural gas reserves known in Eswatini. The fuel assumed for the OCGT plants is distillate fuel which can be imported.

Coal fired thermal steam plant

Coal reserves are known to exist in Eswatini. Recent coal exploration work carried out suggests that there are significant bituminous coal resources in the Lubhuku area which would be suitable for a coal power plant using standard pulverizes coal fired boilers.

There is a great potential for new developments in coal mining. The country is considering development of a coal fired thermal power station that will result in the establishment of a new mine to provide feedstock to the power station.

Hydro power plant

Since 1970, numerous studies have been conducted to assess hydropower potential which has led to an estimated theoretical and technical potential of 440 MW and 110 MW respectively.

The country conducted a concept study for the Ngwempisi River to ascertain the hydro potential that may exist along the river. The study indicated that there is potential of about 120 - 140 MW, but further analysis in a form of a pre-feasibility study is currently being undertaken.

Furthermore, upon commissioning of the 20 MW Maguga Hydro Plant, it was indicated that there is a potential for another hydro power plant downstream and a recommendation was made that a feasibility study must be conducted.

Solar PV plant

According to the Eswatini Renewable Energy Readiness Assessment report (IRENA, 2014), Eswatini has relatively abundant solar potential throughout the country with an estimated Global Horizontal Irradiance of 4-6 kWh/m^2/day. The highest irradiation occurs during summer months (December-March); the lowest irradiation occurs during winter months (June-September), but is still adequate for both solar PV and water heating. This information is however based on satellite data and no ground measurements have yet been carried out to validate this.

Five zones for utility scale solar PV farms were identified for solar PV potential. The total capacity of these zones is about 600 MW.

Wind power plant

According to the draft EMP, the MNRE participated in the renewable zoning study under IRENA's Africa Clean Energy Corridor initiative (IRENA and LBNL, 2015), which resulted in inventories of possible wind and solar project zones.

The zoning study inventory identified a total of 17 potential zones for wind power generation, which collectively amount to 4,300 MW of generation capacity. The Eswatini working team in the study selected five priority zones from the 17 potential zones for further analysis. These 5 priority zones have a total capacity of 880 MW.

Biomass plants

Eswatini is well-endowed with conventional and renewable energy resources including biomass residues from the sugar and forestry industries. The use of wood chips in Eswatini is on the rise due to increased demand in cogeneration by the sugar companies. The timber and sugar industries have established an association, which amongst other activities include exploration of power generation opportunities using the available biomass resources.

Bagasse is one of the by-products of the sugar production process. Sugar millers use bagasse as fuel for steam boilers that produce process steam, but also used in power generation. The use of wood chips in Eswatini is on the rise due to increased demand in cogeneration by the sugar companies. Currently, the average annual demand for woodchips by the sugar industry is approximately 206 tons. The timber industry has potential to increase fuel supply to meet feedstock requirements for proposed biomass power generation.

4.6 Candidate power plant

Given the fuel resources that can be utilised within Eswatini, the potential new generation supply options were limited to the technologies assessed in this Section 4.6. While an integrated resource plan focuses on a longer planning horizon (30 years) the SGEP focuses on the short-term horizon of 5 years and therefore technologies that have a longer development timeframe were not considered in the Study. These will however be considered in the EMP which is being conducted by the MNRE.

4.6.1 Hydro power plants

Table 4-4 provides a list of the candidate hydroelectric power plants in Eswatini, together with the key plant characteristics for such plants that were used in the Study. It should be noted that since the time frame for developing the proposed Ngwempisi hydro power plant is at least 7 years this plant was not considered in the Study.

Several mini/micro hydro schemes are being promoted and have been identified as viable schemes and are intended to be developed. For the SGEP we have assumed that 1.9 MW of these schemes are to be implemented by 2022 and these include Lusushwana River (300 kW), Mpuluzi River (155 kW), Great Usuthu River (490 kW), Mbuluzi River (120 kW) and Lubovane Dam (850 kW).

4.6.2 Biomass generating plant

It is expected that sugar cane production will increase in the future thus providing an opportunity to increase cogeneration capacity which uses bagasse. Cogeneration also provides an opportunity for diversification in the sugar industry's revenue steam. Sugar companies have declared interest to increase power generation capacity to 160 MW. Furthermore, the timber industry has also shown interest in developing biomass plants using woodchips as fuel feedstock. Table 4-5 provides the key plant characteristics for the biomass plants that were used in the Study

For the purpose of the assessment we have assumed 40 MW biomass power plant and, notwithstanding that the industries believe they can develop more, a conservative approach of assuming 40 MW was used in the Study. New biomass plants can be developed within the timeframe of the SGEP.

The biomass plant should comprise woodchips, biofuel, municipal waste but exclude fossil fuels.

4.6.3 Coal power plants

The country is considering the development of a coal fired thermal power station that will result in the development of a new coal mine to provide feedstock to the power station. The production capacity of the mine is still yet to be determined.

There are ongoing discussions to resuscitate the Mpaka Coal Mine for power generation, as well as exporting coal products. Table 4-5 provides the key plant characteristics for the Mpaka Power Station that were used in the Study.

Even though there is evidence of substantial coal reserves in Eswatini for the development of coal-fired power plants, these plants have not been considered in the SGEP for the following reasons:

- Coal exploration studies have been done but no mining plan has been done to determine mining conditions and funding institutions will not consider funding a project without a mining plan;
- An extensive environmental impact study will be needed to obtain funding;
- There is great concern about the limited availability of water for the plant;
- The EEC have indicated that a bankable feasibility study will commence within the next few months; and
- The minimum timeframe to develop a coal fired power plants in Eswatini is in the order of 5 to 6 years, which is not within the time frame of the SGEP.

4.6.4 Wind plants

No site-specific ground level measurements of specific wind sites have been done in Eswatini to verify the desktop wind zoning studies conducted in Eswatini to identify potential wind zones. Therefore, no wind farm power plants were assumed in the Study.

4.6.5 Solar PV plants

Over the past 2 years the EEC has been approached by a number of private sector developers on an unsolicited basis proposing to develop solar PV projects. Furthermore, the EEC is in the process of developing a solar PV plant. This information suggests that there is potential in Eswatini for the development of solar PV plants.

Table 4-6 provides the candidate solar PV power plant assumptions with the key plant characteristics used for the purposes of the Study. For the assessment we have assumed 40 MW solar PV plants. It is understood that at the time of the Study, the EEC was having discussions regarding the development of a 10 MW solar PV plant at Lavumisa. The 40 MW capacity of solar assumed in the Study does not include the EEC proposed Lavumisa solar PV plant.

Table 4-4: Candidate hydro plant

					Operating Parameters					Fixed Costs				Variable Costs					
Plant Name	No of Units	Unit Capacity (MW)	Fuel Type	Construction Period (Years)	Installed Capacity (MW)	FOR (%)	POR (Days)	Availability (%)	Plant Life (Years)	Capital Cost (E/kW)	Annuitised Capital Cost (E/kW/Yr)	Fixed O&M Cost (E/kW/Yr)	Total Fixed Cost (E/kW/Yr)	Firm Energy (GWh)	Average Energy (GWh)	Plant Capacity Factor (%)	Firm Energy cost (c/kWh)	Variable O & M (c/kWh)	Total Cost at Firm Energy (c/kWh)
HYDRO																			
Ngwempisi	4	20	Hydro	5	80	2	21	92.4	50	48243	5,809	108	5,917	299.6	392	42.7%	158.03	12.83	170.85

Table 4-5: Candidate thermal plant

				Operating Parameters					Fixed Costs				Variable Costs				
Plant Name	Unit Type	Fuel Type	Construction Period (Years)	Nominal Capacity (MW)	FOR (%)	POR (Days)	Availability (%)	Plant Life (Years)	Capital Cost (E/kW)	Annuitised Capital Cost (E/kW/Yr)	O&M Cost (E/kW/Yr)	Total Fixed Cost (E/kW/Yr)	Fuel Cost (E/ton)	Efficiency (%)	Fuel Cost (c/kWh)	Variable O & M (c/kWh)	Total Cost (80% CF) (c/kWh)
THERMAL COAL																	
Mpaka Coal	Steam	Coal	4	30	4	21	90.5	30	50,000	6,207	580	6,787	550.00	33.4	29.67	16.00	134.25
THERMAL BIOMASS																	
RSSC Mhlume	Steam	Bagasse	3	20	4	15	92.1	30	32,000	3,973	360	4,333	30.00	18.6	6.44	2.50	69.41
Usuthu Saw Mill	Steam	Woodchips	3	20	4	22	90.2	30	47,000	5,835	1510	7,345	15.00	25.3	1.82	2.50	87.58

Table 4-6: Candidate solar PV plant

Plant Name	Unit Capacity (MW)	Fuel Type	Construction Period (Years)	Installed Capacity (MW)	FOR (%)	POR (Days)	Availability (%)	Plant Life (Years)	Capital Cost (E/kW)	Annuitised Capital Cost (E/kW/Yr)	Fixed O&M Cost (E/kW/Yr)	Total Fixed Cost (E/kW/Yr)	Firm Energy (GWh)	Plant Capacity Factor (%)	Firm Energy cost (c/kWh)	Variable O & M (c/kWh)	Total Cost at Firm Energy (c/kWh)
Renewable																	
Solar PV - Tracking	PV	Sun	2	40	0	14	96.2	25	15900	2,027	290	2,317	77.09	22%	120.24	0.00	120.24
Solar PV - Fixed Tilt	PV	Sun	1	40	0	14	96.2	25	15000	1,912	310	2,222	63.07	18%	140.95	0.00	140.95

5 RESULTS OF THE GENERATION PLANNING STUDY

In this section we present the results of the generation planning study. We begin by presenting the screening curve analysis to provide an indication of the generation options that are likely to be selected to supply the demand in the SGEP. This is followed by the results of the development plan based on the potential replacement of imports with local generation resources.

5.1 Screening Curve Analysis

As a first step to evaluate potential future supply options, a relatively simple screening curve analysis was carried out to compare the costs of supply of the generation supply options considered.

The screening curve analysis provides an accessible and readily-understood method of pre-selecting generating plant options for the expansion planning. The screening curves gives an indication of the operating duties that different types of generating plant will likely perform in meeting system demand (i.e. how the generating plant are expected to be dispatched) and the lifetime unit cost. The screening curves however do not show when the system requires new generating plant, what type of generating plant is required and how much capacity is required. Screening curves can however be used to pre-select the generating plant options that are intended for the same operating duty (e.g. peaking plant).

Figure 5-1 presents the screening curves in E/kW/year for all the candidate thermal and the renewable plant options. The cost and operating data are plotted as cost curves across an operating range with the fixed costs annualised at a discount rate of 12%. Note that the screening curve for the hydro station is presented for the firm to average energy range of the plant.

In the comparison of the thermal plant which could be potential baseload supplies, the following should be noted:

- Across almost the entire range of utilisation, the biomass plants have a lower cost than the coal fired power plant;
- The coal fired plant has a steeper gradient of increase since there is a significant cost of coal supply compared to the biomass plants where the cost of fuel is not significant; and
- For capacity factors of 80% the biomass projects have significantly lower costs than the coal fired power plant.

The screening curve for the Ngwempisi hydro plant is only presented for illustrative purposes. A pre-feasibility study is currently in progress for this project and the development time frame for this project is outside the SGEP timeframe.

The screening curves are also presented in E/kWh cost of electricity basis as shown in Figure 5-2. The range of capacity factors that are achievable for each technology were considered.

Screening curves can be used to eliminate competing technologies. For this SGEP, only the coal fired plant will not be considered for the Study since:

- The biomass plant has significantly lower costs than the coal fired plant; and

- EEC is about to embark on a feasibility study for a coal fired plant in Eswatini and it is highly unlikely that the required studies and development will be completed within the timeframe of the SGEP.

The biomass and solar PV plants can potentially compete with import costs and are therefore retained for further analysis.

Figure 5-1: Life time costs per technology expressed in E/kW/year

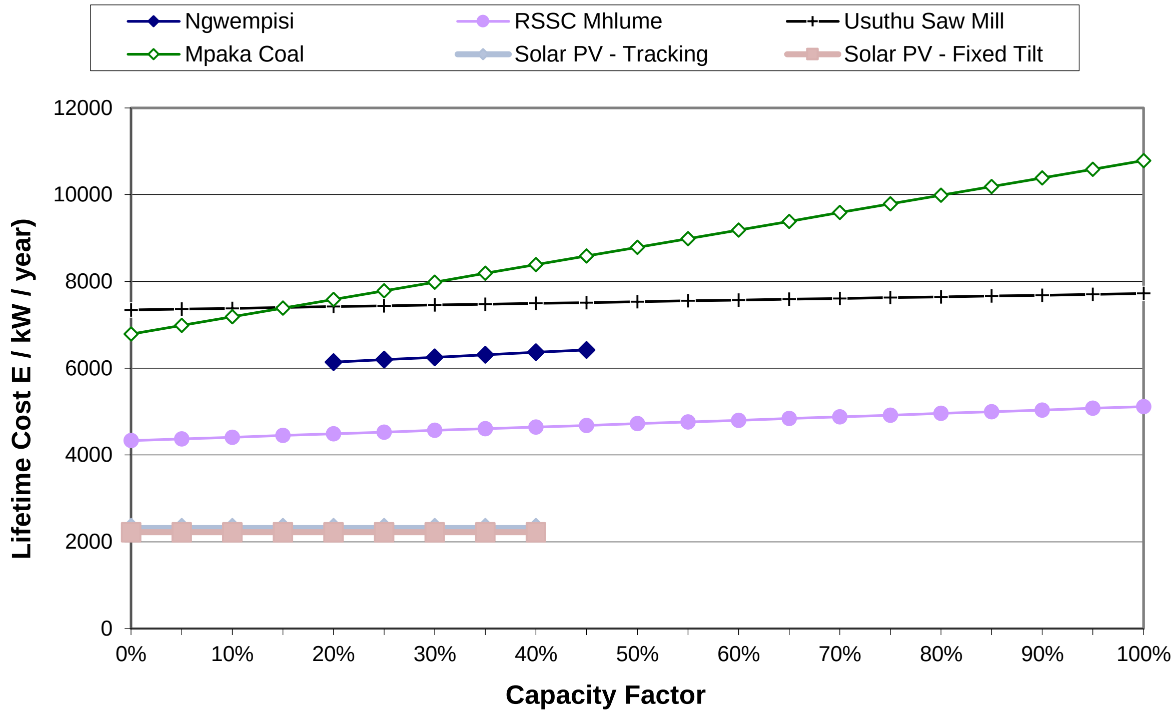
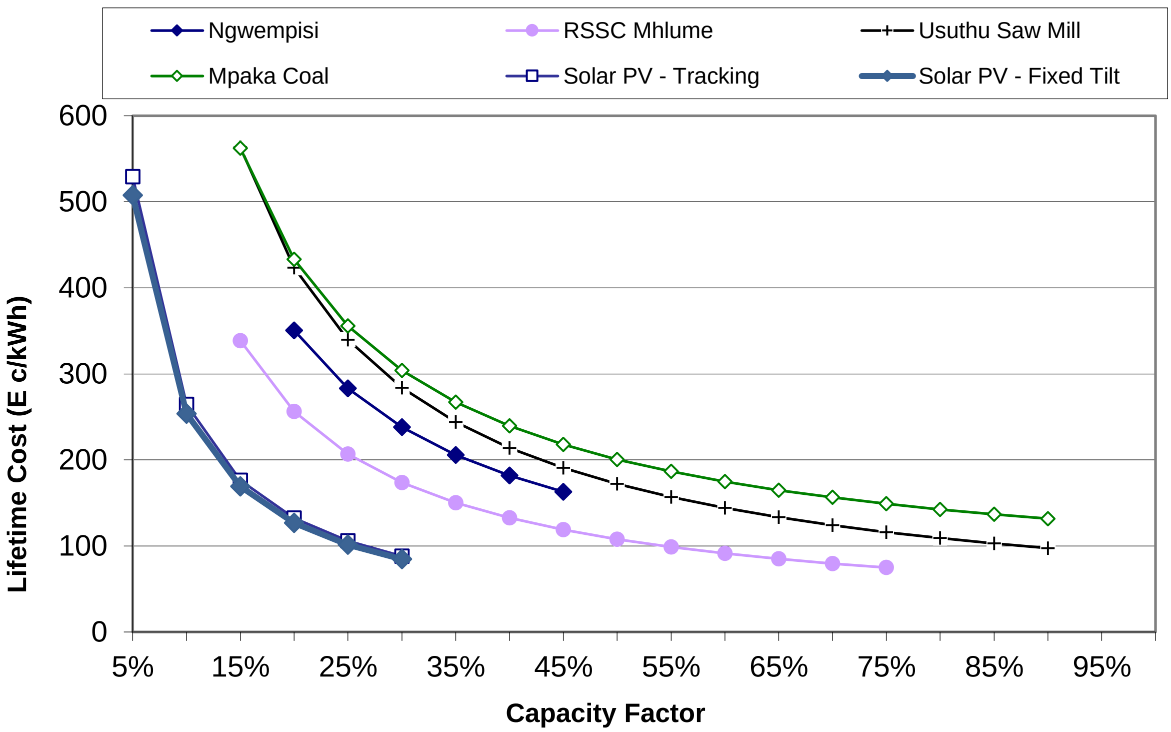


Figure 5-2: Life time levelized cost of electricity expressed in c/kWh



5.2 Short term Generation Expansion Plan

To start the process, we assumed the status quo as a baseline and introducing candidate plants as an alternative.

5.2.1 Energy supply plan and imports costs (status quo)

Table 5-1and Table 5-2 presents the capacities and energy produced from the generation supply sources under the status quo plan respectively. LMHPS capacity and energy production is introduced in 2021 and some of the energy previously imported is replaced by the energy produced by LMHPS.

Table 5-1: Generation capacities (MW) for status quo

Generation source	2018	2019	2020	2021	2022	2023
SEC Hydro	60.5	60.5	60.5	60.5	60.5	60.5
LMHPS	0	0	0	13.6	13.6	13.6
Ubombo Sugar Limited	41.5	41.5	41.5	41.5	41.5	41.5
Royal Swazi Sugar	37	37	37	37	37	37
Diesel Generation	9	9	9	9	9	9
Total (Eswatini sources)	**148**	**148**	**148**	**161.6**	**161.6**	**161.6**
Eskom Import	250	250	250	250	250	250

Table 5-2: Energy supplied (GWh) for status quo

Generation source	2018	2019	2020	2021	2022	2023
EEC Hydro	162	187	210	196	210	220
LMHPS	0	0	0	54	54	62
Royal Swazi Sugar	146	156	164	189	197	211
Ubombo Sugar Limited	161	173	182	210	219	233
Diesel Generation	1	1	2	1	1	2
Eskom Import	1,234	1,257	1,276	1,251	1,295	1,329
Total (GWh)	**1,704**	**1,774**	**1,834**	**1,902**	**1,978**	**2,057**
EUE	**1**	**2**	**2**	**1**	**2**	**3**

Table 5-3 below presents the monthly simulation results and costs for 2018 under the Status quo scenario. The expected average imported energy costs (including energy and demand charges) for 2018 is 89.1 c/kWh.

Table 5-3: Capacity and energy supply plan for 2018 and derived import costs

	Peak demand	Energy	Total SEC	Total Bagasse	Imported	Imported Energy cost	Max Imported demand	Demand charge	Total Import energy costs	Average energy cost
	MW	GWh	GWh	GWh	GWh	E million	MW	E million	E million	E c/kWh
Jan-18	267	135	8.39	22.42	104.12	70.30	170	4.18	74.49	71.54
Feb-18	302	135	13.22	23.92	97.91	67.95	198	4.87	72.82	74.38
Mar-18	291	158	18.04	28.33	111.08	75.19	188	4.63	79.82	71.86
Apr-18	284	138	11.56	23.23	102.63	69.97	182	4.48	74.45	72.54
May-18	270	131	9.55	20.95	100.60	118.76	172	4.22	122.98	122.26
Jun-18	310	141	12.66	24.22	103.94	126.30	203	5.00	131.30	126.32
Jul-18	288	147	14.12	25.45	107.67	127.44	185	4.57	132.00	122.60
Aug-18	273	147	13.79	25.88	107.61	120.98	173	4.26	125.24	116.38
Sep-18	274	143	13.55	25.28	104.39	70.77	174	4.27	75.04	71.88
Oct-18	277	148	14.20	26.25	107.53	71.97	176	4.32	76.30	70.95
Nov-18	274	143	23.39	37.36	81.86	56.39	157	3.86	60.26	73.62
Dec-18	265	138	9.57	23.43	104.74	70.57	169	4.16	74.73	71.34
Total	310	1,705	162	307	1,234	1,047	203	53	1,099	89.09

Simulation results for 2019 up to 2023 were also derived. The average import costs are expected to increase from 90.0 to 98.1 c/kWh based on the expected imported energy as simulated, the assumed tariff regime and expected real increases of the tariffs.

The expected status quo energy plan derived in this section sets the basis and costs that the candidate plants in Eswatini are expected to compete with to enter the supply market in the country. In the next section we introduce candidate plants as supply sources and derive the energy and costs displaced by these plants and determine if these plants will compete with imported costs.

5.2.1.1 Nominal costs of imports

As indicated above the average import costs are expected to increase from 90.0 to 98.1 c/kWh based on the expected imported energy as simulated, the assumed tariff regime and expected real increases of 2% on import tariffs. A request was made to present the expected future import tariffs in nominal terms (i.e. including the effect of inflation). We have assumed a producer price index ("PPI") of 5%. The average import costs in nominal terms inclusive of PPI are presented in Table 5-4. The average import costs in nominal terms are expected to increase from 91.7 to 128.2 c/kWh based on the expected imported energy as simulated.

Table 5-4: Average Import costs in nominal terms

Item	Year					
	2018	2019	2020	2021	2022	2023
Average Import costs in nominal terms (c/kWh)	91.7	97.1	104.7	111.2	119.4	128.2

5.2.2 Generation Development Plan candidate plant results

For the introduction of the candidate plants, the Eswatini supply system was simulated utilising the dispatch model developed for the purpose of this study for the years when these plants could potentially be introduced. Table 5-5 below presents the capacity plan with the candidate plant capacities introduced.

Table 5-5: Generation capacities (MW) for the short term

Generation source	2018	2019	2020	2021	2022	2023
EEC Hydro	60.5	60.5	60.5	60.5	60.5	60.5
LMHPS	0	0	0	13.6	13.6	13.6
Mini/Micro hydro	0	0	0	0	1.9	1.9
Ubombo Sugar Limited	41.5	41.5	41.5	41.5	41.5	41.5
Royal Swazi Sugar	37	37	37	37	37	37
Diesel Generation	9	9	9	9	9	9
Solar PV plants	0	0	40	40	40	40
Biomass plants	0	0	0	40	40	40
Total (Eswatini sources)	**148**	**148**	**188**	**241.6**	**243.5**	**243.5**
Eskom Import	250	250	250	250	250	250

5.2.2.1 Candidate solar PV plants

The candidate solar PV plants presented in Table 5-5 were considered to have been introduced into the Eswatini supply system in 2020 to evaluate the import costs that could be displaced by these plants. Table 5-6 presents the energy produced from the generation supply sources with the introduction of solar PV plants in the generation plan. The solar PV plants displaced the energy previously imported.

Table 5-6: Energy supplied (GWh) with the introduction of solar PV plants

Generation source	2018	2019	2020	2021	2022	2023
EEC Hydro	162	187	210	195	195	219
LMHPS	0	0	0	54	54	54
Royal Swazi Sugar	146	156	164	189	205	221
Ubombo Sugar Limited	161	173	182	210	228	245
Diesel Generation	1	1	2	1	1	2
Solar PV plants	0	0	77	77	77	77
Biomass plant	0	0	0	0	0	0
Eskom Import	1,234	1,257	1,199	1,176	1,218	1,239
Total (GWh)	**1,704**	**1,774**	**1,834**	**1,902**	**1,978**	**2,057**
EUE	**1**	**2**	**2**	**1**	**2**	**3**

The average imported costs displaced by solar PV plants is E 85.4 c/kWh in 2020. Comparing the displaced imported energy costs with the economic costs derived for solar PV plants in Section 5.1, the solar PV plants have a higher economic cost of E 120.2 c/kWh. The displaced average energy costs are E 86.9 c/kWh, 88.7 c/kWh and 90.7 c/kWh for 2021, 2022 and 2023 respectively.

Note that the input costs used for the solar PV plants are effectively typical estimates and the actual costs may be quite different if obtained through a competitive bidding process from IPPs.

Table 5-7: Displaced imported energy by candidate solar PV plants in 2020

	Imported	Solar PV	Imported Energy cost	Max Imported demand	Demand charge	Total Import energy costs	Import costs displaced	Average displaced energy cost	Average energy cost
	GWh	GWh	E million	MW	E million	E million	E million	E c/kWh	E c/kWh
Jan-20	101.90	6.78	69.00	164	4.20	73.20	5.21	76.79	73.27
Feb-20	93.91	6.94	65.31	183	4.68	69.99	5.33	76.79	75.94
Mar-20	106.15	7.01	71.80	176	4.50	76.30	5.38	76.79	73.27
Apr-20	100.51	6.09	68.77	173	4.42	73.19	4.68	76.79	74.21
May-20	99.95	6.42	121.35	166	4.24	125.60	6.65	103.62	126.30
Jun-20	101.36	5.94	123.63	189	4.85	128.48	6.15	103.62	127.46
Jul-20	105.13	5.94	124.98	175	4.47	129.46	6.15	103.62	123.95
Aug-20	104.94	6.02	121.10	167	4.29	125.38	6.24	103.62	120.42
Sep-20	100.87	6.75	69.26	168	4.30	73.56	5.18	76.79	74.32
Oct-20	104.40	6.66	71.18	169	4.33	75.52	5.11	76.79	73.71
Nov-20	76.93	6.62	53.23	148	3.80	57.03	5.25	79.32	76.06
Dec-20	102.85	6.24	69.65	163	4.17	73.82	4.79	76.79	73.18
Total	1,199	77.4	1,029	189	52	1,082	66	85.44	91.35

5.2.2.2 Candidate biomass plants

The candidate biomass plants were considered to have been introduced into the Eswatini supply system in 2021 to evaluate the import costs that could be displaced by these plants. Table 5-8 presents the energy produced from the generation supply sources for the introduction of solar PV and the biomass plants in the generation plan. Note the solar PV plants and biomass plants displace energy previously imported.

Table 5-8: Energy supplied (GWh) with the introduction of biomass plants

Generation source	2018	2019	2020	2021	2022	2023
EEC Hydro	162	187	210	195	218	228
LMHPS	0	0	0	54	54	62
Royal Swazi Sugar	146	156	164	189	198	211
Ubombo Sugar Limited	161	173	182	210	219	233
Diesel Generation	1	1	2	1	1	2
Solar PV plants	0	0	77	77	77	77
Biomass	0	0	0	298	298	298
Eskom Import	1,234	1,257	1,199	878	913	946
Total (GWh)	**1,704**	**1,774**	**1,834**	**1,902**	**1,978**	**2,057**
EUE	**1**	**2**	**2**	**1**	**2**	**3**

Table 5-9 below presents the monthly simulation results for 2021 for the introduction of the biomass candidate plants into the generation plan. Biomass plants have been assumed to be base load plants and dispatched across the entire load curve. The average imported costs displaced by the biomass plants are identical. This is E 90.4 c/kWh for all plants in 2021. The average imported costs displaced by the biomass plants increases to E 92.2 c/kWh and 94.1 c/kWh in 2022 and 2023 respectively.

Based on the analysis presented above it is expected that the biomass plants would be able to compete with base load import tariffs from Eskom. Note that the input costs used for the biomass plants are effectively typical estimates and the actual costs may differ depending on what the IPPs may offer in a competitive bidding process.

Table 5-9: Displaced imported energy by candidate biomass 2021

	Imported Energy	New bagasse energy	Woodchip energy	Max Imported demand	Total Import energy costs	Import costs displaced bagasse	Import costs displaced Woodchip	Average Bagasse cost	Average Woodchip cost
	GWh	GWh	GWh	MW	E million	E million	E million	E c/kWh	E c/kWh
Jan-21	74,7	12,64	12,64	136	62,40	9,30	9,30	73,54	73,54
Feb-21	69,6	11,41	11,41	159	61,14	8,63	8,63	75,63	75,63
Mar-21	79,8	12,65	12,65	150	67,04	9,31	9,31	73,64	73,64
Apr-21	73,5	12,24	12,24	145	62,69	9,11	9,11	74,42	74,42
May-21	73,4	12,46	12,46	138	106,56	15,50	15,50	124,44	124,44
Jun-21	74,3	12,24	12,24	165	109,39	15,29	15,29	124,88	124,88
Jul-21	77,3	12,65	12,65	148	110,36	15,50	15,50	122,58	122,58
Aug-21	77,1	12,65	12,65	139	106,54	15,13	15,13	119,63	119,63
Sep-21	74,5	12,24	12,24	140	63,23	9,11	9,11	74,42	74,42
Oct-21	77,3	12,64	12,64	141	63,87	9,19	9,19	72,67	72,67
Nov-21	51,8	12,24	12,24	123	47,27	9,05	9,05	73,90	73,90
Dec-21	75,1	12,64	12,64	135	62,91	9,34	9,34	73,85	73,85
Total	**878**	**149**	**149**	**165**	**923**	**134**	**134**	**90,42**	**90,42**

5.2.3 Longer term planning

The stakeholders that were consulted in the preparation of the SGEP raised concerns about the extent to which long-term planning was considered. It is important to note that even though longer-term projects were omitted in the Study, the opportunity for the development of these projects is not lost in the sense that committing to short term projects may lead to foregoing a project that could have been more favourable in displacing imports in the medium term to long term.

Table 5-8 presented the energy produced from the generation supply sources for the introduction of solar PV and the biomass plants in the generation plan. Even with the introduction of these plants, the energy sources are still dominated by imports (just under 50%). Furthermore, the expected maximum import demand is 174 MW. Demand and energy requirements are expected to increase beyond 2023. This leaves more than ample opportunity (more than 200 MW and 1,000 GWh) for medium- and longer-term local generation supply options. If it is decided to proceed with the development of solar PV and biomass plants, it would not restrict the development of other local generation supply options in the longer term.

6 CONCLUSION AND RECOMMENDATIONS

Table 6-1 below shows a summary of the least cost generation expansion plan in the short-term as identified in the Study. In the table, it can be seen (in green) that a total capacity of 40 MW from solar PV technology is recommended to be procured by the year 2020. It should be noted that this 40 MW of solar PV identified under the Study excludes any generation to be developed by the EEC, and in particular the Lavumisa Solar PV plant.

The procurement of solar PV technology shall be followed by 40 MW of biomass in 2021. As indicated in Section 4.6, biomass is considered as comprising woodchips, biofuel and municipal waste, but excluding any fossil fuels.

Table 6-1: Short-term Generation Expansion Plan Summary

Generation source	2018	2019	2020	2021	2022	2023
EEC Hydro	60.5	60.5	60.5	60.5	60.5	60.5
LMHPS	0	0	0	13.6	13.6	13.6
Mini/Micro hydro	0	0	0	0	1.9	1.9
Ubombo Sugar Limited	41.5	41.5	41.5	41.5	41.5	41.5
Royal Swazi Sugar	37	37	37	37	37	37
Diesel Generation	9	9	9	9	9	9
Solar PV plants	**0**	**0**	**40**	**40**	**40**	**40**
Biomass plants	**0**	**0**	**0**	**40**	**40**	**40**
Total (local sources)	**148**	**148**	**188**	**241.6**	**243.5**	**243.5**
Eskom Import	250	250	250	250	250	250

Furthermore, from the results of the Study, the following conclusions are drawn:

(1) If no new generation resources are developed in Eswatini, reliance on imported electricity will continue to grow and the costs are expected to increase substantially. Electricity price increases from Eskom are highly unpredictable and there are widely different opinions on forecasts of the electricity price increases required to sustain the South African utility.

(2) Based on the analysis conducted, it appears that there is scope for the development of biomass plants at competitive prices. It should however be noted that the opportunities to develop biomass plants in Eswatini are limited and competition would be vital to achieve competitive prices. Furthermore, the development of biomass plants in Eswatini will have significant additional economic benefits other than assisting in delivering new electricity generation capacity.

(3) The development of new generation capacity in Eswatini will bring benefits, to the advantage of Eswatini inhabitants, from the new foreign investment while, at the same time, the requirement to purchase electricity from neighbouring countries in foreign currency will reduce.

(4) Based on the cost assumptions for solar PV plants used in the Study, it is concluded that the solar PV plant costs in Eswatini are higher than the import costs from Eskom but the prices of solar PV plants have decreased dramatically over the last number of years and are expected to decrease even further, and procuring the solar PV plants through a competitive bidding process will ensure favourable costs are achieved.