Assessing the GHG Impacts of the Eswatini Policy on Renewable Energy Resources for Electricity Generation

ICAT Initiative for Climate Action Transparency

Initiative for Climate Action Transparency – ICAT

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Deliverable #2

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ABBREVIATIONS

CSO	Central Statistics Office
CSER	Centre for Sustainable Energy Research
EEC	Eswatini Electricity Company
EEPPRA	Eswatini Public Procurement Regulatory Agency
ESERA	Eswatini Energy Regulatory Authority
ESWADE	Eswatini Water and Agricultural Development Enterprise
ETF	Enhanced Transparency Framework
GHG	Greenhouse Gas
GoE	Government of Eswatini
ICAT	Initiative for Climate Action Transparency
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
KoE	Kingdom of Eswatini
MNRE	Ministry of Natural Resources and Energy
MoU	Memorandum of Understanding
MTEA	Ministry of Tourism and Environmental Affairs
NC	National Communication
NDC	Nationally Determined Contributions
NEP	National Energy Policy
NIR	National Inventory Report
PP	Policy Position
RE	Renewable Energy
SD	Sustainable Development
SDGs	Sustainable Development Goals
SGEP	Short Generation Expansion Plan
UNESWA	University of Eswatini
UNFCCC	United Nations Framework Convention on Climate Change
UNOPS	United Nations Office for Project Services

EXECUTIVE SUMMARY

The Kingdom of Eswatini has a National Development Plan (NDP) 2023-2028 that commits to a low carbon economy. In 2022[1], the World Bank Report indicated that Eswatini has lower greenhouse gas (GHG) emissions per capita of 1.3 Mt CO2e, compared to 3.3 and 6.8 Mt CO2e for Africa and the world, respectively. This picture is likely to change significantly in the near future as the country seeks to cut close to 70% of its electricity imports from South Africa, Mozambique and the Southern Africa Power Pool to improve its energy security. A 200 MW coal-fired power plant is planned for 2029 to manage base load demand, currently supplied by the imported electricity.

The country is also planning to procure over 730 MW of renewable energy (RE) electricity mainly from Independent Power Producers (IPPs) through energy auctions. The country's policy on RE-generated electricity outlines the country's plan, "*To support the development of RE resources for a target of 50% of the energy mix in electricity generation*". Currently, the RE sources contribute about 30% of the grid electricity mix.

In this study, the Centre for Sustainable Energy Research (CSER) at the University of Eswatini (UNESWA) conducts an assessment of the RE policy impacts on GHG emissions using the Initiative for Climate Action Transparency (ICAT) Renewable Energy Methodology. To conduct the assessment, the team reviewed legal and policy documents, including the National Energy Policy 2018, the Energy Masterplan 2050 and its accompanying Short-Term Generation Expansion Plan. In addition to reviewing legal documents, the assessment also utilised interviews of national energy experts, including officers from the Energy Department, Eswatini Energy Regulatory Authority (ESERA), Eswatini Electricity Company (EEC) and IPPs. The report has been updated after three rounds of reviews by experts on the assessment of mitigation actions acquired through the ICAT office.

Taking into account existing regulatory and financial barriers, the assessment shows that out of the 730 MW proposed auctions (SGEP), only about 203-220 MW of RE electricity will be installed in addition to the 85.85 MW of existing installations. The emissions under a baseline scenario are 1,350 kt CO2e and the introduction of RE technologies could see these reduced to 778-692 kt CO2e. Moreover, the analysis indicates that the 50% energy mix target will be met by 2030, a view that is also held by seven out of eight polled energy experts.

A recent update from the Head of Government was that the country is considering constructing a 1000 MW coal power plant instead of the minimum required for base load capacity, 150 MW. In this regard, the Government's main goal is creating more jobs in the coal mining sector and associated value chains. However, the study has created a platform to evaluate the scenario of a bigger coal plant and meeting the 50% RE target. In light of these prospects, national energy experts are of the opinion that the 1000 MW power plant would not be possible in the near future due to severe technical barriers that include financing and upgrades that would be required on the national grid's capacity.

The study also reveals that the procurement of RE capacity through auctions and tendering is ideal for the country because it also enables IPPs to provide bankable proposals that have had to withstand a competitive bidding process. The tendering process also ensures that projects are delivered within the planned timeframes to provide a predictable deployment of generation technologies. The ICAT Renewable Energy Methodology therefore provides a good projection of RE capacity addition under the auction/tender procurement processes.

[1] https://ourworldindata.org/grapher/per-capita-ghg-emissions?tab=chart&country=SWZ~OWID_WRL~OWID_AFR

CHAPTER 1: GENERAL INFORMATION

1.1 Country Context

The Kingdom of Eswatini is classified as a lower-middle-income country with a GDP per capita of USD3,797 and an annual GDP growth rate of 4.8% in 2023[2]. It was ranked 121 of 190 economies according to the World Bank's Ease of Doing Business Index 2020, indicating that it has a regulatory framework that is relatively moderate in assisting business start-ups or supporting operating businesses[3].

Access to electricity as a percentage of population has been growing steadily over the past two decades from 20.4% in 2000 to 82.3% in 2023 as shown in Figure 1.1. Eswatini's greenhouse gas (GHG) emissions per capita were 1.3 Mt CO2e, compared to 3.3 and 6.8 Mt CO2e for Africa and the world, respectively, in 2022[4]. This means Eswatini has a relatively low carbon footprint; however, this is partly because the country imports close to 70% of its electricity from South Africa, Mozambique and the Southern Africa Power Pool (SAPP), with the 30 percent locally generated electricity coming from clean energy sources. It is noted that there are captive, low generation capacity fossil fueled power plants, which includes a 2MW coal fired power plant. The GHG emissions from Eswatini's electricity and heat generation (from fossil fuels) were estimated at 90,000 MtCO2e in the last GHG inventory, much lower than the leading sector agriculture (990,000 MtCO2e) and transport (730,000 MtCO2e). However, the low emissions from the electricity sector are most likely to change as the country begins to increase local generation for security of supply.

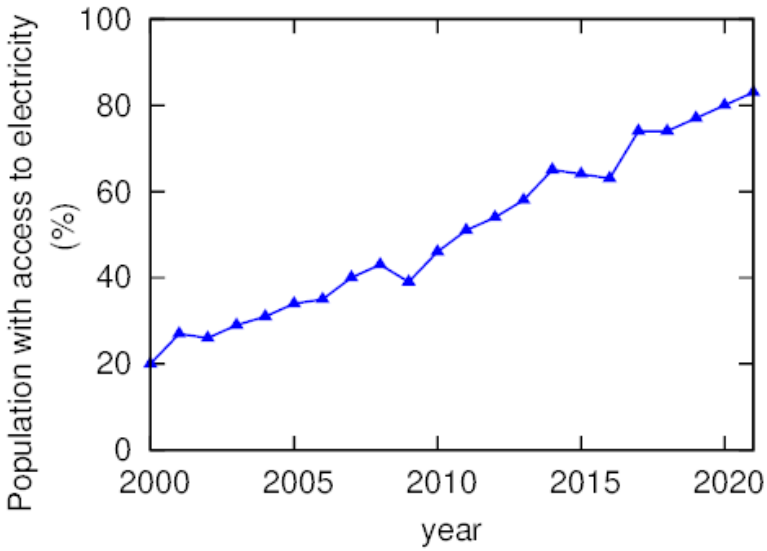

Figure 1: Share of the Eswatini population with access to electricity (source: World Bank data, 2023)

1.2 Assessing Eswatini's Policy Position on Renewable Electricity

This document presents an assessment of the Eswatini renewable energy electricity policy position as stated in the National Energy Policy (NEP) of 2018 using the Renewable Energy

[2] https://data.worldbank.org/country/eswatini?view=chart
[3] https://archive.doingbusiness.org/content/dam/doingBusiness/country/e/eswatini/SWZ.pdf
[4] https://ourworldindata.org/grapher/per-capita-ghg-emissions?tab=chart&country=SWZ~OWID_WRL~OWID_AFR

Methodology developed by the Initiative for Climate Action Transparency (ICAT). The NEP was adopted together with the National Energy Policy Implementation Strategy (NEPIS) of 2018 which sets goals for the energy sector and further provides implementation details, targets and implementing partners. The Eswatini Government has set a goal of eradicating energy poverty by 2030 as well as ensuring security of supply through local power generation. In relation to Renewable Energy (RE) to be added to the grid, the country set a RE target of at least 50% of the electricity generation mix.

The Short Term Generation Expansion Plan (SGEP) developed for the Eswatini Energy Masterplan 2050 has a schedule for procurement and addition of the following generation capacity to the national grid: 40 MW solar PV (increased to 75 MW during the procurement process), 40 MW biomass (increased by an additional 80MW), 80 MW hydro, among other technologies. The assessment was conducted by a team of experts from academia and government: three from the Centre for Sustainable Energy Research (CSER) at the University of Eswatini (UNESWA) and an Energy Climate Specialist under the Ministry of Natural Resources and Energy (MNRE), with support from ICAT.

In addition to the team of experts from the CSER, national energy experts from The Energy Department, Eswatini Energy Regulatory Authority (ESERA), Eswatini Electricity Company (EEC) and an IPP were invited to a meeting to discuss barriers to RE capacity addition after they had initially responded to a survey.

1.3 Motivation

The Government of the Kingdom of Eswatini has committed itself to a low-carbon economy, reducing GHG emissions by 14% compared to the baseline scenario by year 2030 through a number of mitigation measures, including adding 40 MW solar PV and 40 MW biomass electricity capacity[5]. Of the 13 mitigation measures identified in the 2021 review of Nationally Determined Contributions (NDC), 10 are from the energy sector, with the NEP and supporting instruments being key inputs in the NDC projections.

The Government faces the challenge of ensuring energy security, by reducing electricity imports, while maintaining the stability of the national grid. In light of the challenge, the Government is planning to maintain a balance between variable RE technologies and dispatchable technologies such as fossil fueled thermal power stations, raising the need to assess the impact of the 50% RE mix on GHG emissions. The current project is also the first assessment that has been carried-out to evaluate the effectiveness of the NEP policy. Hence, this work could serve as a reference for future assessments and can also serve as a demonstration of the usefulness of the ICAT RE methodology.

1.4 Organisation of the Report

The rest of the report is organised as follows: Chapter 2, provides the objectives of the study. Chapter 3 provides a brief description of the Eswatini Energy Policy and related documents. Chapter 4 unpacks the GHG impacts of the policy, whilst Chapter 5 provides the potential of RE technologies and the landscape of RE energy auctions in the country. Chapter 6, provides the LEAP results on the projected GHG emissions, whilst Chapter 7 gives the conclusions of the study. Chapter 8, provides conclusions to the study and recommendations for improvements to the ICAT RE Methodology.

[5] Note the NDC has modest projection compared to the Masterplan 2050

CHAPTER 2: OBJECTIVES OF THE ASSESSMENT

2.1 Objectives

The goal of the assessment is to identify the *ex-ante and ex-post* GHG impacts of the Eswatini RE policy position on grid electricity and related frameworks, that include the following:

- To estimate the GHG impacts of the NEP to determine whether they are on track to help meet the NDC targets**.** Eswatini revised its NDCs and pledged to the United Nations Framework Convention on Climate Change (UNFCCC) to reduce GHG emissions, contributing to climate action (SDG 13) by 14% compared to baseline projections, provided sufficient support from external partners is secured. Of the thirteen mitigation measures identified by the NDC, ten are energy sector actions sourced from the NEP policy statements and supporting documents. In this regard, the success of the revised NDC relies on the implementation of the NEP policy action statements.
- To maximize the positive impacts of the NEP in relation to RE grid electricity**.** The NEP seeks to ensure that the country has access to affordable and clean energy (SDG 7), while safeguarding the environment.
- To assess policy effectiveness by determining whether the NEP is delivering the intended results on RE electricity generation, eradicating energy poverty and ensuring access to the entire population. Eswatini's electrification rate improved from 20% in 2000 to 82.3% in 2023. However, the expansion of access has not been accompanied by expansion of generation capacity, with growing demand provided for by securing import contracts. The Government has identified the reliance on imports as a risk and has embarked on improving security of supply. The effectiveness of the NEP requires a balancing act between improving access and expansion of sustainable electricity generation.
- To improve policy implementation by determining whether RE electricity policy statements are being implemented as planned.

2.2 Intended Audience

The main beneficiaries of the project are policy analysts and policy developers with the Ministries responsible for energy and the environment, in particular the Department of Meteorological Services (responsible for the Climate Change Unit) in MTEA and the Department of Energy in MNRE. The Department of Meteorological Services has already indicated strong interest in the assessment results and MTEA provided a letter of support to UNOPS in this regard. The report will assist the Climate Change Unit to;

- Track progress towards national goals and targets such as NDC's, the SDG's of the 2030 Agenda for Sustainable Development and national RE targets.
- Inform future reformulation of NDC's towards enhanced ambition, decide whether to continue current actions, enhance current actions or implement additional actions.
- Attract and facilitate financial support for the NEP based on the assessment of mitigation potential or GHG reduction achieved.

The results from the report will also assist the Energy Department to:

- Measure the implementation status of the RE policy position related to grid electricity as contained in the NEP.
- Meet funding requirements on RE capacity addition or RE electricity generation.
- Prepare for the review of the NEP by ensuring its effectiveness in mitigating the impacts of GHG emissions, particularly in the energy sector.

Overall, the assessment report will benefit national policy developers, implementers, evaluators and beneficiaries, including the following entities:

- Department of Energy in the MNRE
- Department of Meteorological Services in the MTEA
- Eswatini Electricity Company (EEC)
- Eswatini Energy Regulatory Authority (ESERA)
- Renewable Energy Association of Eswatini (REAESWA)
- Independent Power Producers (IPPs)
- Public Policy Coordination Unit (PPCU)

2.3 Level of Ownership of the Report by Key Stakeholders

The following steps were carried out as part of the project planning process:

- The National Designated Authority for Climate Action, the Department of Meteorological Services in the MTEA, was engaged to discuss the study and its outcome. The Director of the department expressed interest in the results of the study. The study also comes at a time when the MTEA is compiling National GHG inventories and revision of the NDCs.
- The Department of Energy in MNRE, which has primary responsibility over the NEP implementation, was engaged. A brief concept note was prepared and discussions were held with the Director of the Department. The Department endorsed the study, which was important due to the role of the MNRE in overseeing energy issues in the country through policy direction.

CHAPTER 3: METHODOLOGY

3.1 The Assessment Process

The steps followed in the assessment process include:

Step 1: Seek support from key stakeholders. As discussed in section 2.3, the CSER engaged the MTEA through the Department of Meteorological Services, which is the focal point for climate action in Eswatini. The CSER also engaged the MNRE through the Energy Department.

Step 2: Identify energy policy documents. The team worked on collecting policy and supporting documents from the MNRE. Having an officer from the Energy Department in the team helped the team get documents efficiently and facilitated the literature review as some of the documents are not available online.

Step 3: Review of the National Energy Policy. The team identified the RE policy for Eswatini in the NEP as one of the 23 policy statements. The RE policy provides guidance on the procurement of RE technology capacities for the national grid. The procurement of RE-generated electricity is led by a state-owned entity, ESERA, and the procurement policy is through the auction and/or tender system.

Step 4: Identify energy auction timelines. The Energy Masterplan and SGEP list the action plan for energy procurement up to the year 2034. The team used the available information to construct a business-as-usual scenario and alternative scenarios.

Step 5: Determine the potential. The RE addition due to the policy was determined using the steps in the ICAT RE Methodology.

Step 6: Determine GHG impacts. A causal chain for the RE policy was developed to identify linkages in the actions emanating from the policy and the GHG impacts. The expert reviewer of the assessment provided valuable suggestions and guidance for this process.

Step 7: Report preparation. The report was prepared following the ICAT RE Methodology. Feedback was provided by the ICAT team in terms of the document structure and general comments.

Step 8: Stakeholder Engagement. After feedback from the ICAT team, the revised version was submitted to the officials at MNRE (custodian of the NEP) and at MTEA (national focal point for climate action). As part of stakeholder engagement, a survey questionnaire was distributed to key stakeholders of the electricity supply industry. Furthermore, stakeholders were engaged through a half-day working meeting that was attended by 10 participants from MNRE, and representatives of the two State-Owned Enterprises, ESERA and EEC, responsible for implementing the Auction process and maintaining the national grid, respectively. Thereafter, the feedback from the stakeholders was incorporated into the document.

3.2 ICAT Renewable Energy Methodology

This study applied the ICAT RE Methodology for assessing greenhouse gas impacts of RE policies. The methodology is applicable to the following policy types: -

- Feed-in tariff and feed-in premium policies;
- Auction/tender policies; and
- Tax incentive policies.

Given the prescription of the Electricity Act of 2007, the assessment focuses on the auctions and tender aspects of the guide. The function of power procurement currently rests with

ESERA whilst the MNRE gives direction. ESERA prepares Requests for Qualifications (RfQ) and subsequently Requests for Proposals (RfP) for capacity to be procured. The Act prescribes that the calls for tender should sufficiently detail the following:

- Capacity;
- In-put fuel where appropriate; and
- Any other information as necessary.

The Act further states that the award of contracts (Power Purchase Agreements) shall be carried out according to regulations set by the Authority. In the language of the ICAT Methodology, in this report, “auction policies” refers to the ESERA auction and tender processes as ESERA is an agent in the implementation of RE electricity policy.

The MNRE set a RE target of 50% in the national electricity mix through the NEP and the timelines for auctions are reflected in the national Energy Masterplan 2050 and its associated SGEP. Intermediate targets include the procurement of 75 MW for solar PV, 80 MW for biomass, and 20MW for geothermal, among others.

The ICAT Methodology provides a process to estimate the GHG levels of the RE added through Auctions ex-ante and ex-post. The Methodology, as applied in the assessment, included the following steps:

(i) Determining the RE Auction policy potential.
(ii) Developing a causal chain that links policy implementation activities to GHG impacts.
(iii) Estimating GHG impacts of the RE added through the related policies using existing data and projections of the future energy mix using inputs from experts and other stakeholders.
(iv) Analysing how each trajectory meets or misses the RE targets or shifts from the baseline.

CHAPTER 4: POLICY DESCRIPTION

4.1 Current RE Policy and Regulatory Framework

MNRE launched Eswatini's NEP and the NEPIS in 2018. The NEP is still being implemented and has not yet been reviewed (no end date has been set). The NEP includes a policy position (PP) on the generation of RE electricity for addition to the national grid. The RE policy position is indicated under PP 3 in the policy statements:

- **PP3: To support the development of RE resources for a target of 50% of the energy mix in electricity generation.**

The NEP also includes four policy positions that support the implementation of PP3, which outline the government's commitment:

- PP4: To plan and support a comprehensive development of national capacities in renewable energy projects.
- PP7: To ascertain options and ensure the establishment of a National Electricity Fund in support of renewable energy and accelerating access to modern energy throughout the country.
- PP9: To facilitate the further liberalisation of the electricity market.
- PP10: To facilitate the access of IPPs in the electricity market through an effective regulatory framework.

The pressing energy issues at political level are elimination of electricity imports and achieving 100% access to modern energy sources. This is also stated in the NEP as detailed below:

- PP1: To ensure adequate security of electricity supply.
- PP5: To strive to provide all households with access to modern energy by 2022.
- PP6: To strive to ensure eradication of energy poverty at all levels by 2030.

The country seeks to eliminate the need for electricity imports through building a thermal power station, a dispatchable technology. The RE policy is thus critical in reducing GHG emissions in the electricity sector. While the electrification rate stands at around 83%, implying that PP5 has not been achieved, it remains a policy position of the Government to achieve universal access to modern energy.

The country also has several legislations, strategies, policies, plans and regulations in the energy sector that support or/and enable the implementation of the national RE policy position and these include:

- **Electricity Act of 2007** for the regulation of the Electricity Supply Industry (ESI). This Act specifies that new capacity in the areas of power generation, transmission and distribution shall be procured through tendering or auction.
- **The Energy Regulatory Act of 2007** for establishing the, Eswatini Energy Regulatory Authority (ESERA) which is responsible for approving tariffs and conditions of services provided by the licensed energy entities.
- **The Eswatini Electricity Company Act of 2007** for establishing the state owned power utility, EEC. The Act prescribes that EEC shall meet the objectives of the Government in the generation, transmission, distribution and supply of electricity.
- **Revised Nationally Determined Contributions of 2021.**This report highlights the Government's commitment to a low carbon economy. The target is to reduce GHG

emissions by 14% compared to the baseline scenario by year 2030 through a number of mitigation measures that are dependent on the successful implementation of the NEP.

- **Masterplan 2034; updated Masterplan 2050**. These are documents exploring the national development pathways of the energy sector.
- **Independent Power Producer policy.** This policy liberalises the electricity supply industry.
- **Short-Term Generation Expansion Plan for Eswatini,** 2024 draft**.** This plan provides a ten-year generation expansion plan (2024 to 2034) for the country, analysing various scenarios to optimise generation and transmission strategies. The SGEP reports that 108.5 MW is committed and 648 MW is proposed RE addition over the next decade.
- **Energy Efficiency and Energy Conservation Policy of 2018.** This policy promotes energy efficiency and energy conservation solutions to reduce grid electricity demand. These include; energy audits of public buildings, phasing out inefficient lighting, and development of mandatory minimum energy performance standards for electric appliances, as well as the adoption of cost-reflective electricity tariffs.
- **Eswatini Bioenergy Policy (draft).** A policy providing a framework for increased exploitation of available bioenergy resources in Eswatini for electricity generation, biofuels productions, as well as to increase access to clean cooking technologies to reduce traditional biomass use.

4.2 Type of Policy

The RE policy position sets the target for RE energy sources for local electricity generation mix. The procurement mechanism for the RE into the national grid is prescribed by the Electricity Act of 2007. The Act prescribes that procurement of new generation capacity shall be done through tendering/auction processes. Following the ICAT RE Methodology the RE policy action is therefore Auction and Tendering. Tenders for RE electricity (solar PV and biomass) have been issued since the declaration of the RE policy position in the NEP.

4.3 RE Electricity Auction Process

The energy regulator, ESERA, issues Auctions based on instructions from MNRE. Section 25 of the Electricity Act 2007 prescribes that the auctions shall specify the in-put fuel (technology) and the capacity required. As stated in the previous section, the SGEP indicates that there is 108.5 MW committed and 648 MW proposed RE procurement over the next decade. Committed Auctions include a 75 MW solar PV plant, 13.5 MW hydro, and 20 MW Biomass (woodchip feedstock) that are planned to be operational in 2026, 2026, and 2028, respectively.

The national utility, EEC is vertically integrated and is responsible for power generation, transmission, and distribution to customers. ESERA facilitates Power Purchase Agreements between the IPPs and EEC. ESERA also guarantees access to the grid for IPPs who have contestable customers through a recently concluded Wheeling Framework. Section 10 of the Act prescribes that licenses may not be issued for a period exceeding 40 years; 30 years, and 25 years for generation, transmission and distribution, respectively.

4.4 Implementing Entities

The policy is implemented by MNRE, with the power procurement responsibility resting with ESERA through issuing of tenders. ESERA is also responsible for the verification of periodic plans of energy consumption, production, transmission and distribution, in order to ensure their adequacy and timely allocation. Public tenders and auctions are administered by the Eswatini Public Procurement Regulatory Agency (ESPPRA). It provides secretariat services

to the Independent Tender Review Board and also monitors compliance. The EEC is responsible for purchasing, wheeling and distributing the electricity from the IPP.

4.5 Objectives and Intended Impacts or Benefits of the Policy

The RE electricity policy position addresses the following objectives:

- To ensure low carbon economic development that benefits from climate change mitigation resulting in a more sustainable future.
- To increase access to clean modern energy technologies.

4.6 Monitoring and Evaluation of the Policy

The monitoring and evaluation (M&E) of the policy is supposed to be carried out by a team from the MNRE. It was anticipated to have been developed by 2019 and in operation by 2023, however the M&E plan is yet to be developed.

CHAPTER 5: POLICY IMPACT ON GHG EMISSIONS

5.1 Business as Usual (Baseline Scenario)

In the Business as Usual scenario (BAU), the GHG emissions of Eswatini are expected to increase to 1339.30 ktCO2e by the year 2029 with the addition of a 200 MW power plant. The BAU scenario has strong political support given that the thermal power plant will increase job opportunities within the coal mining sector and also allow the country to eliminate electricity imports. The BAU is also driven by the NEP policy statement, "To ensure adequate security of electricity supply." While the BAU scenario is also viable economically, it challenges the country's commitment to a low-carbon economy. Therefore, the RE policy position is critical to the achievement of the NDC. It is noted that the BAU in the assessment is the BAU against which NDC commitments were measured.

5.2 GHG Impact Casual Chain

This section identifies GHG impacts of the RE policy. The causal chain in Figure 2 traces the process by which the policy (dark blue box) leads to GHG impacts (light blue boxes) through a series of interlinked and sequential stages of cause-and-effect (white boxes) relationships. The assumption made in the study is that if more RE technologies are not installed then fossil fuels (coal) plants will come in. The causal chain diagram for the RE policy indicates that most actions will lead to a net reduction of GHG emissions.

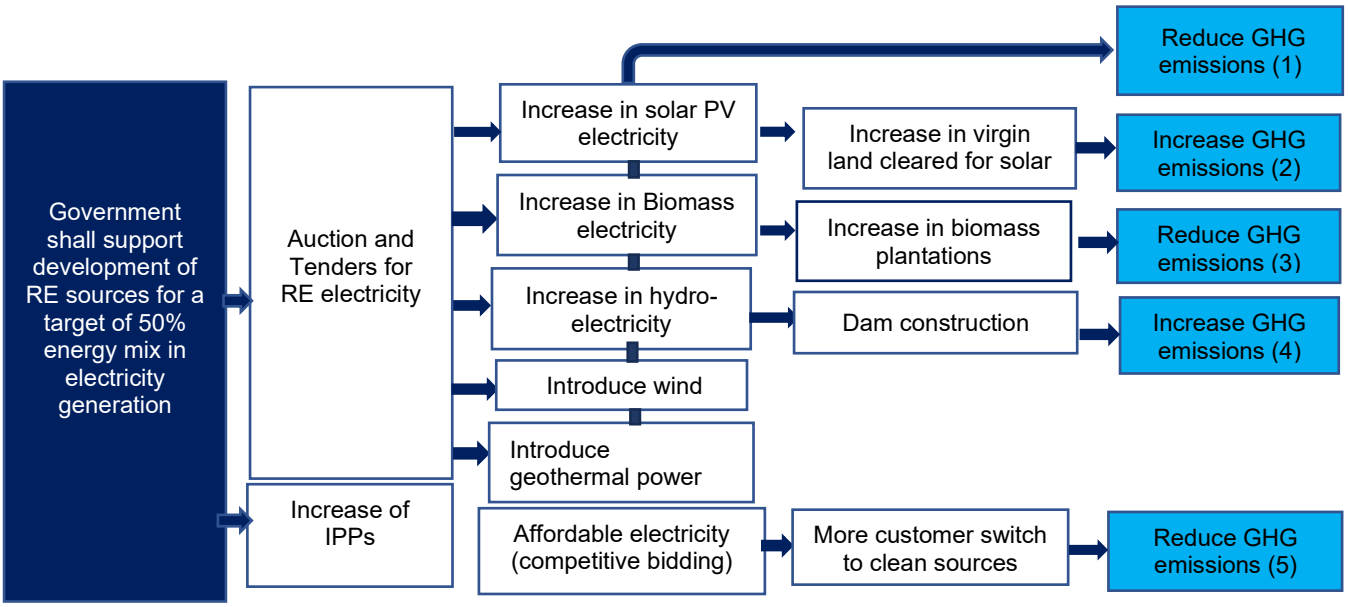

Figure 2: Causal chain diagram in the context of Eswatini RE policy application grid electricity generation.

The development of the causal chain is guided by the ICAT RE Methodology, and helps in determining the likelihood and relative magnitude of GHG impacts as given in Table 1. From the rating, impacts that are minor in magnitude or less likely are excluded from the quantitative assessment. Two GHG impacts that are included in the calculations are:

- Reduced GHG emissions (CO_2) for the accelerated uptake of RE sources into the national grid to satisfy the 50% RE target in the generation mix through RE electricity (biomass, solar, hydro, wind and geothermal energy),
- Increased GHG emissions (CO_2 and CH_4) from RE construction projects (dam construction for hydropower).

#	GHG Impact & GHG Type	Likelihood & Relative Magnitude of Impact	Included or Excluded	Explanation
1.	Reduction of GHG emissions (CO_2e) due to the accelerated procurement of RE electricity options (solar, hydro, wind and geothermal energy)	Very likely - Major	Included	Eswatini's NDC baseline emissions for locally generated electricity includes a 200MW coal-fired plant that is planned by the Government as a way of improving energy security and providing the baseload power. The RE policy position sets a 50% of RE target in the energy sources for the national grid to reduce GHG emissions in the electricity sector.
2.	For biomass power plants, increase in emissions associated with stored bio-energy feedstock, agriculture and land-use change CO_2 , CH_4 , N_2O	Very likely - Minor	Excluded	Biomass feedstock used in electricity generation are by-products of already existing industries, i.e. bagasse from sugar industries and woodchips from the timber industry.
3.	Increase in GHG emissions (CO_2) from decreasing carbon stock when solar plants are installed in virgin land	Very likely - Minor	Excluded	The land to be cleared is insignificant, land use change for solar plants from 0 to 50kgCO2e/MW[6]. Thus emissions for 150 MW planned Solar PV procurements are negligible.
4.	Increase in GHG emissions (CO_2 and CH_4) from Dam construction for hydropower	Possible-Moderate	Included	Significant for RE policies involving hydropower plants with reservoirs
5.	Reduction in emissions [CO_2 , CH_4 , N_2O] from lower energy consumption due to increased cost	Possible-Minor	Excluded	Considered insignificant for most RE policies

Table 1: GHG impacts and source categories included/excluded in the GHG assessment boundary

5.3 Sustainable Development Impacts of the RE policy

The renewable energy policy position in the NEP will have multifaceted impacts, encompassing environmental, social, and economic dimensions.

Environmentally**,** the policy action will contribute to improved air quality and reduced GHG emissions, particularly when renewable energy sources are prioritised over fossil fuels. It can also lead to a cleaner cooking environment, when renewable energy is used instead of traditional fuels like wood for cooking and heating, benefiting human health (SGD 3) and reducing deforestation. This is a trend in rural areas in Eswatini, where there is a shift from

[6] D. Van de Ven et al, Scientific Reports **11**, 2907 (2021)

cooking with traditional fuels to a mix of electricity and wood-fuel[7]. This will also reduce the time spent on traditional household chores like collecting firewood and cooking, particularly for young girls and women (SDG 5 and 10). More free time allows girls to focus on their studies, improving quality of life (SDG 4). With more time, women can get involved in more productive economic activities like pursuing careers or starting small businesses, contributing to their financial independence and the overall economic growth of their communities. Socially**,** the policy can enhance access to clean, reliable, and affordable energy (SDG 7), particularly in rural areas. It can also create jobs and stimulate economic growth (SDG 8), especially in the agricultural sector. However, it is crucial to ensure that renewable energy projects are socially inclusive and do not displace communities or harm livelihoods.

Economically, renewable energy can lead to the growth of new industries (SDG 8), such as renewable energy power plants. This can attract investment, generate revenue, and boost economic growth. However, the economic viability of renewable energy projects depends on various factors, including feedstock availability, technology costs, and government policies. The indicators include the following:

- Proportion of people working within the renewable energy sector;
- Contribution to GDP by RE sector; and
- Energy tariff.

[7] Center for Sustainable Energy Research, National Survey on use of electric lighting technologies (unpublished), 2020.

CHAPTER 6: RENEWABLE ENERGY ELECTRICITY POTENTIAL

6.1 Technical Potential

The renewable energy resources available to Eswatini are: hydro, biomass, solar, wind and geothermal energy. The theoretical potential which is 5,460 MW (excludes geothermal power) as shown in Table 2.

Resource	Potential (MW)	Remarks
Solar	600	5 zones identified in IRENA's Africa Clean Energy Corridor initiative.
Wind	4300	17 zones identified in IRENA's Africa Clean Energy Corridor initiative. No ground measurements used
Hydro	110	Sourced from the Masterplan 2050
Biomass	120	The power producers using biomass stock are the sugar and forestry companies, themselves they are large energy users. Thus of the 200 MW installed capacity 80 MW would be for local consumption
Geothermal	---	No determination of potential except that there are a number of warm to hot springs around Eswatini.

Table 2: Technical Potential of RE Technologies

In the medium term the SGEP indicates that the country will procure 731.5 MW of RE electricity from IPPs through Auctions over the next ten years (a combination of committed auctions and proposed auctions). A significant portion (15 %) of the planned generation expansion has been committed, and includes

- 75 MW solar PV plant – to be operational in 2026,
- 13.5 MW hydro – to be operational in 2026
- 20 MW Biomass (woodchip feedstock) to be operational in 2028.

While in other jurisdictions the procurement is energy based, in the country, the call for tenders and auctions are power-based. Section 25 (3) of the Electricity Act states that "the call for tender shall specify in sufficient detail the size of the project, its input fuel where appropriate, environmental specifications as needed, as well as any other information necessary." The national energy regulator, ESERA, then ensures that the tariff for the energy supplied is competitive.

The timeline for proposed Auctions up to 2030 is specified in the SGEP as follows

- 75 MW of solar PV without storage in 2026,
- 50 MW solar PV with 100MWh of storage in 2028,
- 50 MW solar PV with 100 WMh of battery storage in 2029,
- 100 MW Wind power in 2028,
- 100 MW of Wind power in 2030,
- 10 MW of hydropower expansion at Maguga dam in 2026,
- 80-135 MW of hydropower at Ngwempisi dam in 2030,
- 60 MW of Biomass (wood-chip and baggase) in 2029 (RfP revised to 80 MW) and
- 20 MW Geothermal power plant in 2030.

The 2026 timeline for the solar PV and the hydro is not realistic at this point (as construction is yet to begin) and the timeline has been adjusted to 2027.

6.2 Adjustment of the Auctions

MNRE and ESERA after consultation with stakeholders adjusted the previously issued tenders to increase the total capacity being procured (solar PV) and the capacity that was being sought from an individual bidder (biomass). This is meant to grow the number of companies that have sufficient financial and technical capacity to implement the projects. The consequence of the consultations are as follows:

- **The predefined qualification requirements.** These qualification requirements were introduced to ensure the successful implementation of the auctioned capacity. In this regard, the MNRE has decided to increase the capacity for solar from 40 MW to 75 MW and has started negotiations with a successful bidder for biomass to increase the capacity from the initially set target of 20 MW for an individual bidder.

- **The sellers' liability requirements**. These are likely to reduce the expected RE Auctions as a number of potential power producers cannot provide the required guarantee at the signature of the PPA. These liability requirements were introduced to ensure the successful implementation of the auctioned capacity.

- **The longevity of the PPA.** This was set at 20 years.

Consultations with key stakeholders indicate that the technical potential of RE electricity procurement may be downgraded to 696.5 MW instead of the planned 731.5 MW by 2030. This is due to the competitive prices of biomass feedstock, in which some feedstock producers may prefer to continue selling wood chips to international markets instead of the domestic market. Anticipated bidders for biomass electricity generation are agricultural-based industrial companies. In the consultation, stakeholders expressed doubt over one of the major players being willing to develop generation beyond their own consumption. The breakdown of the planned procurement according of technologies is given in Table 3 below.

RE Source	Power Capacity (MW)
Hydro	181.5
Solar PV	175
Wind	200
Biomass (Woodchips and bagasse)	120
Geothermal	20
Total	**696.5**

Table 3: Adjusted capacity of planned RE procurement based on opinions of local energy experts

6.3 Financial Feasibility

To determine the financial feasibility of the different technologies, we explored the Levelised Cost of Electricity (LCOE) in the local context using the numbers from the SGEP. LCOE represents the per MWh cost of building and operating a generating plant over an assumed financial life and duty cycle. Key inputs to calculating LCOE include capital costs, fuel costs, fixed and variable operations and maintenance (O&M) costs, financing costs, and an assumed utilisation rate for each plant type.

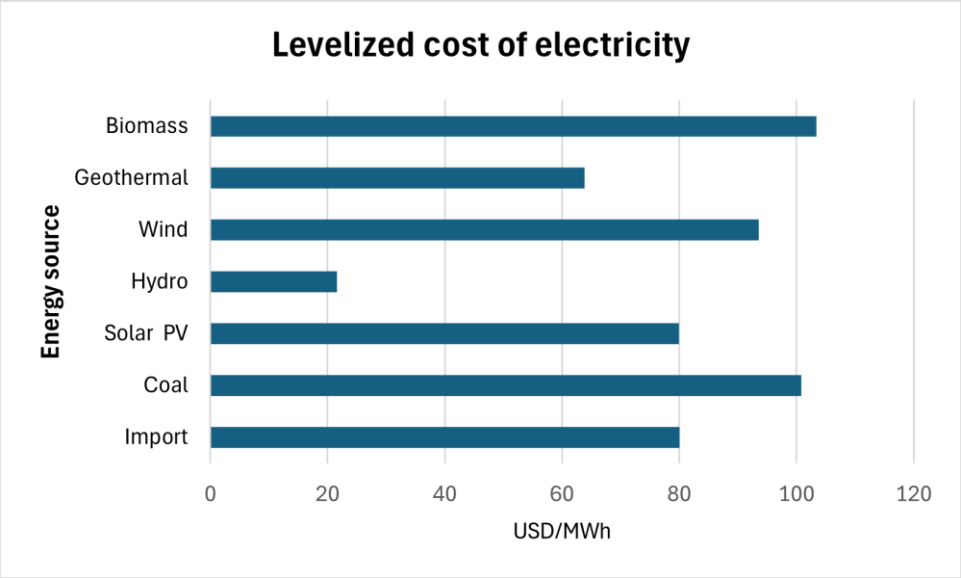

Figure 3: *Levelized cost of electricity generation for the different technologies for Eswatini adapted from the SGEP document.*

Figure 3 shows that hydropower has the lowest LCOE of USD21.6/MWh, compared to the other technologies. This is followed by geothermal (USD63.8/MWh), solar PV (USD79.9/MWh) and imports (USD/MWh), wind (USD94.0/MWh), coal (USD96.7/MWh) and biomass (USD103.2/MWh). While hydroelectricity may be the cheapest clean technology, the potential is insufficient to satisfy the needs of the country as most of the capacity to be added is for peaking. Technologies with higher LCOE were considered less competitive and likely to face more stringent conditions from financiers as their tariff would be higher leading to difficult PPA negotiations. The financial barrier impact for installing each technology was determined as the percentage difference of its LCOE relative to the LCOE of hydropower as shown in Table 4.

RE Source	Planned Procurement Technical Capacity	Financial barrier Impact	Adjusted Capacity
Hydro	181.5 MW	0%	181.5 MW
Solar PV	175 MW	14.9	148.9 MW
Wind	200 MW	18.4 %	163.2 MW
Biomass (residues)	120 MW	20.9 %	94.92 MW
Geothermal	20 MW	10.8 %	17.84 MW
Totals	**696.5 MW**		**606.36 MW**

Table 4: Adjusted capacity of planned RE procurement after discounting for financial barriers

6.4 Accounting for Other Barriers

The main barriers for the auction policy in the country include:

1. **Lack of resource availability assessments.** For example, in the IRENA (Africa Clean Energy Corridor) study[8] that identified the wind energy potential to be 4300 MW, satellite data was used due to lack of ground data. In addition, Eswatini has a number of geothermal active hot-springs with surface temperatures up to 43^{0}C, but no assessments

[8] IRENA and LBNL (2015). Renewable Energy Zones for the Africa Clean Energy Corridor — Multi-Criteria Analysis for Planning Renewable Energy. International Renewable Energy Agency and Lawrence Berkeley National Laboratory, Abu Dhabi, United Arab Emirates

of the potential have been done, and only recent developments point to a proposal for feasibility studies.

2. **Regulatory and policy uncertainty**. Robust standards for solar technology equipment have only just been developed and dissemination of these standards is still ongoing. Low cost-low quality solar PV panels are also common in the local market due to lack of regulations on imports. There is a likelihood that poor solar equipment was used in the now non-functional 100kW solar PV pilot project from a decade ago.

3. **Low cost of imported electricity.** Eswatini currently imports about 70% of electricity from South Africa, Mozambique and the SAPP. While the NEP calls for self-sufficiency in the electricity sector, any new initiative or auctions indirectly compete with the price from neighboring markets. The auctions or call for tenders are price competitive, whilst the winning bid may be under pressure to be as close as possible to import prices, there is no direct competition with the import price due to fluctuations in the availability of power in the regional market.

4. **Difficulty in obtaining sovereign guarantees**. RE investments require high capital investment and state owned companies often require sovereign guarantees to access capital abroad. The Government is sensitive to sovereign guarantees as they effectively increase government debt.

5. **Lack of awareness in RE and skilled personnel for RE**. Installation and maintenance of RE technologies require the upskilling of the local labour market. The Government, working with international partners such as the Africa Mini-grids Program, is trying to close this gap.

The severity of each barrier is evaluated using polls/statistics of 8 national energy experts drawn from ESERA, EEC, IPPs, and the Energy Department. The rankings by the experts were combined to determine the severity of each barrier to the different RE sources. The poll rating for each barrier was from level 1 (low impact) to level 5 (severe impact). The average score from the poll is given in Table 5.

Technology	Barrier 1 Score	Barrier 2 Score	Barrier 3 Score	Barrier 4 Score	Barrier 5 Score	Weighted Barrier Impact
Hydro	3.7	2.1	3.25	3.375	2.625	**63.9%**
Solar PV	1.75	2.375	3.25	3.375	2.875	**46%**
Wind	4.75	2.75	3.125	3.25	3.125	**77.5%**
Biomass	3.375	2.5	3.25	3.75	3.125	**64%**
Geothermal	4.625	3.125	3.375	3.375	3.375	**79%**

Table 5: Average rating of the other barrier by a team of eight top experts in RE energy sector: lack of resource availability (barrier 1), regulatory policy uncertainty (barrier 2), low-cost of imported electricity (barrier 3), difficulty in obtaining sovereign guarantees (barrier 4), lack of awareness in RE and skilled personnel (barrier 5).

The expert poll indicates that other barriers are severe for Geothermal and Wind, this is mainly due to lack of detailed resource assessments. The weighted barrier impact percentage was used to adjust the capacity of the RE technology to determine the power output that is most likely to be installed and operational by 2030.These values are given in Table 6 as the “ICAT Methodology forecast” since they were derived by applying the procedure from the ICAT Methodology. . National energy experts were also asked to predict capacity of RE technologies that is most likely to be added in the grid by 2030, based on their experience in the field. The average expert opinion forecast was that 203.5 MW will be installed by 2030, slightly less than from the ICAT Methodology forecast of 220.58 MW as shown in Table 6. When the values from the average expert opinion are utilized as the gold standard, the ICAT Methodology

forecast leads to the Murphy Skill Score of 0.33. A positive score supports the view that the ICAT Methodology provides a good forecast[9]

RE Source	Financial Barrier Adjusted Capacity	Other Barrier Impact	ICAT Methodology Forecast:RE1 (MW)	Average Expert Opinion:RE2 (MW)
Hydro	181.5	63.9%	65.52	68.5
Solar PV	148.9	46%	80.42	75
Wind	163.2	77.5 %	36.72	0
Biomass (residues)	94.92	64 %	34.17	60
Geothermal	17.84	79 %	3.75	0
Total	**606.36 MW**		**220.58 MW**	**203.5**

Table 6: Forecast of the capacity of RE technologies that will be added to the Eswatini national grid by the year 2030. The ICAT Methodology forecast is obtained by deducting Other Barrier Impact from the Financial Barrier Adjusted Capacity. Average Expert Opinion forecast corresponds to the collective wisdom of leading national energy expert.

[9] A. H. Murphy, 1993: What is a Good Forecast?: An Essay on the Nature of Goodness in Weather Forecasting . Amer. Meteor. Soc. 8, 281-293

CHAPTER 7: POLICY IMPACTS ON GHG EMISSIONS: EX-ANTE ANALYSIS

7.1 Scenarios for Electricity Generation

Eswatini's existing power system's installed capacity is 180.55 MW as shown in Table 7, and consists of hydro and biomass sources, supplemented by10 MW (utility owned) and 0.85 MW solar PV plants. However, out of the 106 MW biomass capacity only 14 MW is supplied to the grid and the remainder is either unavailable capacity (37 MW) or capacity for own consumption by the sugar industry. The 61.4 MW hydro power plants owned by the utility are for peaking in the system.

Technology	Installed Capacity (MW)	Maximum Availability to the national grid	Efficiency
Hydro	61.4	33.5 %	100
Biomass-USL	40.5*	45.64 %	21
Biomass-RES	65.5**	0	Not provided
Solar	10.85	20 %	100
Coal	2.2***	0 %	Not provided
Total	**180.45**		

Table 7: Existing Power Plants connected to the grid

**14 MW is available to the main grid, 26MW is consumed in-house.*
***37 MW is not available and the remainder is for own consumption.*
****2MW thermal power station for own consumption by industry.*

In 2022, the total electricity consumption was 1277.5 GWh, of which 67 % was imported, 28% was supplied by the national utility (EEC) and 5% was supplied by IPPs. On a daily basis the demand varies from the minimum demand of about 100 MW to a peak of about 240 MW. The power demand pattern also varies monthly with highest demand occurring during the hotter months (mostly due to increased demand for crop irrigation and air conditioning) as shown in Figure 4 for the year 2023.

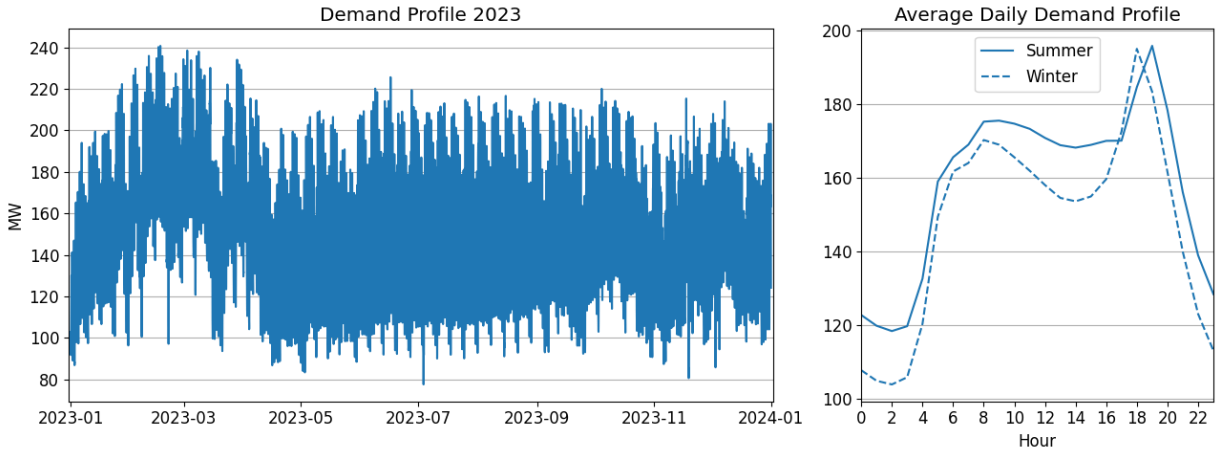

Figure 4: Annual power demand profile for 2023 (left). Average daily demand profile for the warmer season (Oct. – Mar.) and colder season (Apr. –Sept.). Figure adapted from the SGEP report.

The Government remains committed to ensuring energy security through a mix of RE and fossil fuel power plants. While the Government is also committed to a low carbon economy, it requires a supply of reliable dispatchable electricity to cater for the current national base load demand of about 960 GWh(110 MW). Under the BAU projections, this would be covered by a 200 MW coal plant. One of the drivers for the coal power plant is economic growth as Eswatini

has vast coal reserves.

If the coal power plant gets built and the RE technologies are deployed as per the current schedule, Eswatini will either continue producing from the plant at maximum plant availability, resulting in a surplus for the export market (when available), or Eswatini can use the RE resources to reduce production from the power plant, resulting in emissions savings. The goal of the assessment is to determine the potential for reducing emissions from reduced electricity generation from conventional sources, in our case the coal power plant.

In the Low Emissions Analysis Platform (LEAP) modelling results discussed in the next section, the existing grid connected power plants and the coal power plant are considered to be the baseline and two scenarios for RE addition are considered. The RE1 scenario corresponds to the capacities as projected using the ICAT RE Methodology and RE2 scenario corresponds to what national experts believe could be added to the national grid by the year 2030. The amount of the projected electric power that will be added to the national grid by 2030 is given in Table 9.

RE Source	Installed Generation (MW)	Planned Addition from RE sources (MW)	ICAT Methodology Forecast (MW) (RE1 -Scenario)	Energy Expert Forecast (MW) (RE2-Scenario)
Hydro	61.4	145	65.52	68.5
Solar PV	10.85	100	80.42	75
Wind	0	200	36.72	0
Biomass (residues)	106	60	34.17	60
Geothermal	0	20	3.75	0

Table 9: Existing Power Plants and projected additional generation from RE sources by 2030

7.2 Results of LEAP Modeling

The baseline scenario was modelled in LEAP for GHG emissions and other pollutants in conjunction with the ICAT Methodology. The LEAP model was selected to ensure consistency with previous results from an ICAT project focusing on the impact of biomass electricity and the mitigation assessment for the revision of the Eswatini's NDC, in which the CSER team was involved. The LEAP model results were validated against historical data up to 2022. Subsequently, the model was utilised to calculate GHG emissions for the scenarios for the period 2023-2030. In this study, the team used the same LEAP parameters and changed the supply side *(fixing the demand side)*, since the policy affects the supply side.

Because of the significant shift in timelines due to delays in procurement both for the coal power plant and the RE technologies, it is the year 2029 and 2030 where we can evaluate emissions reductions due to the RE additions.

The application of the ICAT RE Methodology and LEAP has been explored in a number of studies accessing the impact of several energy policies, such as in Mozambique[10]. The LEAP model has also been applied for energy planning and GHG mitigation assessments in Thailand[11], Sierra Leone[12], and Hunan province of China[13], among others. The key equation LEAP uses to estimate GHG emissions and other pollutants is the multiplication of an ***emission factor*** with an ***activity variable***. The activity variable quantifies the process in terms of feedstock fuel in the case of combustion power plants. On the other hand, emission factors quantify the amount of emissions per unit of Activity. In this analysis all emission factors are Tier 1.

[10] C. Zebra et al, Assessing the GHG Impact of Renewable Energy Feed-in Tariff Policy in Mozambique, Sustainability 13, 5376 (2021)

[11] L. Chhay and B. Limmeechokchai, Open Env. Res. J. **12**, 15-25 (2019)

[12] F. Conteh *et al*, Sustainability 15, 11838 (2023)

[13] R. Chen *et al*, Energy Procedia 160, 396-403 (2019)

In a nutshell, the LEAP model indicates that baseline or BAU projections results in GHG emissions of 1,350 ktCO2e in the year 2030, while the RE1 and RE2 scenarios result in 692 ktCO2e and 778 ktCO2e of GHG emissions, respectively. The RE1 scenario represents 49 percent emissions reductions in 2030 and the RE2 scenario represents 42 percent emissions reductions in 2030. The energy generated under the BAU and RE1 scenarios are compared in Figure 5. In the BAU scenario, the coal power plant generates about 1400 GWh while in the RE1 scenario it is only required to generate 778 GWh in order for the system to satisfy local demand. The emissions under each scenario are summarized in Table 10 below and the emission trajectories are summarized Figure 6.

Scenario	Emissions in 2030 (kt CO2e)	Avoided Emissions in 2030 (kt CO2e)	% Avoided Emissions in 2030
BAU	1,350	--	
RE1	692	658	49
RE2	778	572	42

Table 10: GHG impact of the RE policy. Results summarise emissions under the baseline scenario and two scenarios for RE addition in the year 2030.

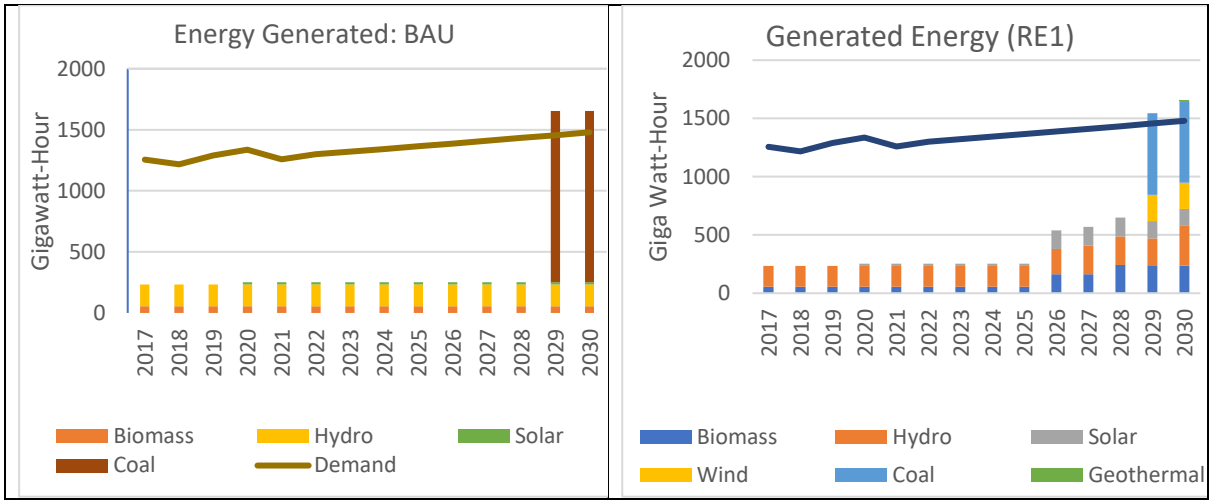

Figure 5: Energy generation by technology in the BAU scenario (left) and the RE1 scenario (right). The demand projection (solid line) is from the Energy Masterplan.

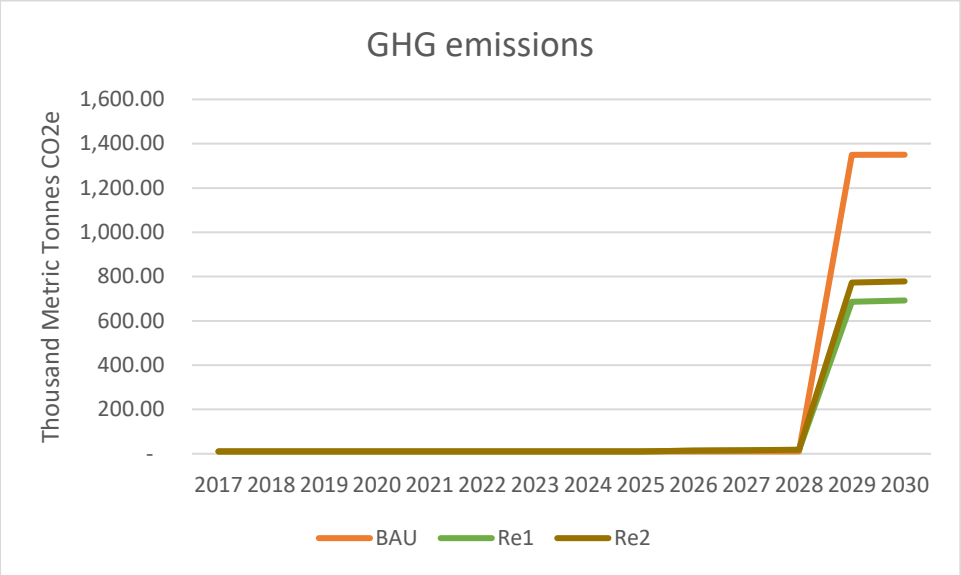

Figure 6: GHG emissions trajectory for the BAU, RE1 and RE2 Scenario.

CHAPTER 8: CONCLUSION AND FUTURE WORK

8.1 Project Outcomes

This report provides a detailed description of the application of the ICAT RE Methodology, to assess the impact of Eswatini's National Energy Policy on GHG emissions and on the Eswatini Government's commitment to a low carbon economy. The results of the application of the Methodology indicate that the country will meet its target of an energy mix of at least 50% of grid electricity generated from RE sources. The ICAT Methodology incorporates the discounting of planned generation from RE sources by factoring financial and other barriers obtained from consulting local energy experts. The outcomes of the analysis indicate that Eswatini is most likely to add 220.58 MW of RE power by 2030 in addition to the existing 85.85 MW RE electricity. The RE installation will drastically reduce imports to below 50% of the energy mix.

The country is also planning to eliminate imports by launching a 200 MW coal power plant by the year 2029 to improve energy security. The assessment indicates that these power plants will increase emissions for grid electricity to 1,350 kt CO2e. The addition of Renewables can help reduce these emissions by as much as 42% to 49%. These results indicate that Eswatini could build a smaller coal power plant (<150 MW) alongside the deployment of renewables and be able to achieve energy security while maintaining a low carbon footprint in the electricity generation sector. It is important to emphasize that national energy experts indicated in the poll that an RE only electricity mix will not be possible by 2030.

8.2 Usefulness of the ICAT RE Methodology

The study demonstrates that the ICAT Methodology is easy to use and important for systematically assessing the GHG impacts of RE policies. The methodology is robust and adaptable since it can be applied for both *ex-ante* and ex-*post* assessments. In the case of Eswatini, the RE policy was one of the mitigation measures considered in updating estimates for NDCs. Thus the ICAT Methodology provides another option for evaluating the performance of the country towards meeting its climate commitments.

8.3 Impact of the ICAT RE Methodology on Eswatini's Climate Action Activities

The Methodology has helped the team to project the amount of RE installation to the national grid by the year 2030 and to determine the associated GHG emissions from the electricity sector. The study also highlights the synergies and potential conflicts in the country's implementation of SDGs, in particular: SDG 8 (**Decent Work and Economic Growth**); SDG 7 (**Affordable and Clean Energy**); and SDG 13 (**Climate Action**).

Eswatini has significant progressed by improving the national electrification rate from 20% in 2000 to over 80% in 2023. The current focus of the country is to achieve 100% access by 2030 without relying on imports for base-load management. Energy experts indicate that this would be possible with the addition of a 150 MW coal power plant instead of the earlier plan to build a 200 MW power plant. However, it recently emerged (March 2025) that the Government is keen on a larger coal plant (capacity of 1000 MW) to boost the economy. This larger power plant, if eventually built, will serve the national grid's baseload but will primarily

serve the export market. The barriers for 1000 MW coal plant in the short term include the following:

- Grid infrastructure that will need a substantial upgrade in order to transmit the 1000 MW power. Upgrading the national grid would take some time and significant financial resources,
- Access to capital for the plant is a major barrier as the country has been struggling to secure investments for the smaller 200 MW power plant, and
- Political resistance. The 1000MW power plant will signal a major shift from the NDCs and thus, the country would face a backlash from the bilateral and multilateral partnerships.

The results from the study, therefore, will open a debate on the minimum required base load in addition to the more robust estimates of RE capacity by 2030, in particular if the country plans to meet its commitments in the revised NDC.

8.4 Usability and practicality of the ICAT RE Methodology

The Methodology is user friendly and self-explanatory. The team recommends that the ICAT programme should create an online archive of all published reports and links to research articles that utilised the Methodology in their studies. This could increase the community of users. The Methodology would benefit from direct and continual feedback from the users.

8.5 Recommendations for improvements

The ICAT Methodology includes a number of Tables making it a bit difficult for a first-time user to understand the overall goal of each step. A revised Methodology should include a flow chart that summarises the whole process of the methodology. A reporting template with fill-in boxes can standardise the reporting. The ICAT Methodology focuses on the impact of RE policies on GHG emission reductions and it does not factor effects of a sudden increase of RE electricity in the main grid such as intermittency and variability of power supply. There is a need to incorporate these effects in the Methodology so that the RE electricity impacts are sustainable.

8.6 Future Work

The impact of the sharp increase in RE generation in the local energy mix needs to be studied to understand the options for balancing the intermittency and variability of modern RE technologies. The impact of RE reliability will be a determining factor in the country's need for a thermal power station. In addition, the key national stakeholders have to balance between sufficient power and affordability, and continual revision of plans will be important.

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