THE KINGDOM OF SWAZILAND

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE TNA MITIGATION TECHNOLOGY ACTION PLANS REPORT FOR SWAZILAND

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UN environment

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Acronyms and Abbreviations

Acronym/abbreviation	Meaning
AfDB	African Development Bank
BAEF	Barrier and Enabling Framework
CHP	Combined Heat and Power
CO2e	Carbon Dioxide Equivalent
CTCN	Climate Technology Centre Network
DOF	Department of Forestry
DOM	Department of Meteorology
EMA	Environment Management Act
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Green House Gas
GoS	Government of Swaziland
Gt	Giga ton
GWH	Giga Watt-hour
kt	kilo ton
kW	kilo-Watt
LPA	Logical Problem Analysis
MCDA	Multi Criteria Decision Analysis
MEPD	Ministry of Economic Planning and Development
MHUD	Ministry of Housing and Urban Development
MNRE	Ministry of natural resources and Energy
MOF	Ministry of Finance
MOJ	Ministry of Justice
Mt	Mega ton
MTEA	Ministry of Tourism and Environmental Affairs
MW	Mega-Watt
NDS	National Development Strategy
PV	Photovoltaic
ROC-T	Republic of China on Taiwan
SEA	Swaziland Environment Authority
SEDCO	Small Enterprise Development Corporation
SIPA	Swaziland Industrial Promotion Agency
T.B.D.	To Be Determined
TAP	Technology Action Plan
TNA	Technology Needs Assessment
UNDP	United nations Development Programme
UNEP	United nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USL	Ubombo Sugar Limited

Executive Summary

Executive Summary

This Report is the third one for the Technology Needs Assessment (TNA) exercise for Swaziland which began in 2015. The first was on extensive stakeholder consultation for the identification and prioritisation of mitigation technologies in the energy, waste and land use and land use change and forestry (LULUCF) economic sectors. The technologies were prioritised using multi-criteria decision analysis (MCDA). The second was the Barrier and Enabling Framework which identified barriers and means to overcome them. This report is on the Technology Action Plans (TAPs) for the selected Technologies. There were three technologies prioritised for the energy sector and two each for the waste and LULUCF sectors and are listed in the table below.

Sector	Subsector	Technology
Energy	Energy efficiency	Building insulation
Energy	Power generation	Combined heat and power
Energy	Electricity production	Solar PV
Waste	Waste management	Waste sorting
Waste	Waste treatment	Composting
LULUCF	Forestry	Agroforestry
LULUCF	Forestry	Urban Forestry

To produce the TAPs the following process was followed:

- The ambition of the TAP is stated
- Actions and activities
- Identification of stakeholders and determination timelines
- Capacity needs and costs estimates
- Technological Action Plans for Mitigation Technologies
- Management planning including risk management and contingency measures
- Project idea notes

Crosscutting Actions

During the development of the report, it was noted that two actions were common for all the TAPs. The first was accessing finance. It was noted that Swaziland lacked personnel to write bankable proposals for accessing international funding and that in most cases the funding received came through assistance by international partners, and usually not though local efforts to solicit funds. Accessing finance was considered once as a crosscutting action for all TAPs. Selected people will be trained in writing bankable projects proposal in order to increase access to finance for all the TAPs.

The second common issue was raising awareness. Al the TAPS needed some form of awareness-raising. Different technologies have different stakeholders that can be reached through a variety of platforms such as print media, traditional electronic media, social media meetings, workshops, road shows, community meetings etc. The budget is expected to vary across the technologies.

Energy Sector

Installation of building envelope insulation: Installation of building insulation is expected to be financed by residents and commercial property owners as part of mortgage. What is critical is to demonstrate to property financiers that building insulation adds value to ta building. That can reduce the financing costs. Climate change and energy efficiency funding can assist to initiate the process at inception and maybe the building insulation itself if there are enough financial resources. It is expected that wealthier households and commercial property developers will be the first to invest in this technology. This will result in the development of skills and access to insulation materials leading to lower overall prices that can increase the adoption of the technology by the less wealthy.

Combined heat and power plant using biomass fuel: This technology can succeed the country can develop a Renewable Energy Feed-in-tariff programme and standard power purchase agreements. This can ease the selling of renewable energy power to the national grid. There is also a need to complete the integrated power resource plan in the form of the Energy Master Plan currently under development. Such can provide for the necessary allocation for renewable power and also in view of the country's target to have 50% of power generation to be from renewables by 2030. The companies that are ready to invest in power generation through combined heat and power systems are Montigny Investments and the Royal Swaziland Sugar Corporation. There are also other companies that are interested in CHP generation using biomass resources, such as peak Timbers and Suxe International. All these companies have their own finance but could use the benefit of climate change and renewable energy funding to subsidise their equipment purchase.

Solar PV: The solar PV technology is not widely used even though Swaziland has favourable insolation for its deployment. There are three large solar PV systems that are under development and are at an advanced stage. These include a 22 MW by Wundersight Investments, 10 MW w=by Swaziland Water Services Corporation and another by the national electricity utility Swaziland Electricity Company. The TAP therefore does not cover large scale solar PV systems but considers home and institutional solar PV systems. The main barrier for the uptake of solar PV systems is the lack of a net metering programme. With net metering individual households and institutions can invest in solar PV leading to increased availability of skills and lower equipment prices. The availability of skills and reduced prices can facilitate the deployment of off-grid solar PV solutions. Also of importance is the development of solar pV standards covering equipment, installation and maintenance. For net metered system it is expected that the investment can be done by the users without the need for subsidies, while for off-grid solutions there will be a need for donations and subsidies for equipment. The Tap is expected to make the coditions for solar PV deployment in the country more conducive.

Waste Sector

Waste sorting: For the waste sorting technology the key activity for success is the development of the downstream uses of the separated waste products. The waste sorting facility can sustain itself by selling the waste to the downstream users of separated waste. It can also be paid for reducing waste

quantities that eventually go to the landfill. The waste sorting facility will need funding to subsidies the purchase of equipment and land.

Composting: The most important activity for the composting technology is promotion of the use of the end product and doing a proper comparison with commercial fertilisers. Another key activity is the setting up of laboratories to certify the compost fertiliser produced. This technology will need a lot of financial support in the form of grants and subsidies at the initial phase.

LULUCF

Agroforestry: The keys activity for the success of the agroforestry technology is the development the entire value chain. There will be a need to set up a monitoring and reporting system to provide the status of each stage of the value chain so that goods can move seamlessly from one stage to another. The development of the value chain will need donor funding. The training of farmers will also be another crucial activity.

Urban forestry: The key activity for this technology is to satisfy residents that urban forestry has tangible benefits for them. That way a budget line for agroforestry can be created and the municipality bylaws can be amended to incorporate urban forestry.

1 Introduction

This Report is the third one for the Technology Needs Assessment (TNA) exercise for Swaziland which began in 2015. The first was on extensive stakeholder consultation for the identification and prioritisation of mitigation technologies in the energy, waste and land use and land use change and forestry (LULUCF) economic sectors. The technologies were prioritised using multi-criteria decision analysis (MCDA). The capacitation to do this work was through a workshop held at Ngudorto, Tanzania in June 2016 conducted by UNEP-DTU and the use of the book entitled "Handbook for Conducting Technology Needs Assessment for Climate Change."[1] The technologies prioritised had to be in line with national development priorities so that they would get political support by policy makers. The national development priorities are found in the Swaziland National Development Strategy (NDS) include sound economic management; economic empowerment; human resource development; agricultural development; industrialisation; promote research for development; and environmental management.[2] This strategy advocates for the mainstreaming of environmental issues in development policies in order to achieve sustainable development.

Following the prioritisation of the technologies was the barrier and enabling framework (BAEF) development phase, which also was based on stakeholder consultation. This exercise sought to identify the barriers to the deployment and diffusion of the identified technologies, analyse them and develop an enabling framework to overcome them. Capacitation to carry out the BAEF was through a workshop conducted by UNEP-DTU in Cape Town, South Africa in March 2017 and the guidebook titled "Overcoming Barriers to the Transfer and Diffusion of Climate Technologies."[3] The barriers were analysed using the logical problem analysis (LPA). The measures to overcome the barriers were used to develop activities for the TAPs to promote the transfer and diffusion of the prioritised climate change mitigation technologies. The TAPs are summarised plans for the acceptance, transfer and diffusion prioritized technologies that will contribute to the country's priorities outlined above. The TAP lists specific actions that are of key importance to implement the measures identified in the BAEF.

Three sectors were prioritised for the Tap development. As mentioned above, these include energy, waste and LULUCF. The technologies included in the TAPS are shown in Table 1-1.

Table 1-1: Technologies selected for TAP development

Sector	Subsector	Technology
Energy	Energy efficiency	Building insulation
Energy	Power generation	Combined heat and power
Energy	Electricity production	Solar PV
Waste	Waste management	Waste sorting
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The technology action plans for each technology were developed following the guidelines in the document "Technology Needs Assessments: Preparing a Technology Action Plan."[4] Each TAP includes the descriptions of respective sector and sub-sector, the ambition related to implementation of the technology, the list of actions, as well as the activities to be implemented under each action. For each

activity, there are indications on the sources of funding of its implementation, responsible bodies, the implementation timeframe and relevant risks.

The budget and costs estimates were made based on previous experiences of implementation some local programmes and projects. For cases where the use of international consultants is recommended, the National Occupational Employment and Wage Estimates United States was used as a guide.[5]

2 Crosscutting actions

During the development of the report, it was noted that two actions were common for all the TAPs. The first was accessing climate change finance. It was noted that Swaziland lacked personnel to write bankable proposals for accessing international funding, and that in most cases the funding received came through assistance by international partners. Also, according to Vladimir Hecl[6], the move for TNAs to the implementation of technology actions on the ground was poor. It was therefore decide that accessing climate change finance be considered once as a crosscutting action for all TAPs. The issue of raising awareness of technologies was also seen to be crosscutting, and that it should be covered in detail only once. The stakeholders will be different for each TAP and the platform used will vary. The process of carrying it out will basically be the same. These two actions are covered in detail at the beginning separately and included as actions briefly in each TAP with the matching budget determined by the stakeholders and the platforms used to reach them. The crosscutting actions and their associate activities are outlined in Table 2-1.

Table 2-1: Crosscutting actions

Crosscutting Actions								
Cross-cutting activities								
Action	**Activities to be implemented**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Risk mitigation or contingency measure(s)**	**Sources of funding**	**Budget per activity (USD)**
Action 1: Reduce costs of technology deployment	**Activity 1.1:** MTEA meets with MEPD on the need to create a local team capacitated to develop bankable, waste, renewable energy, climate change and forestry projects in order to subsidise equipment purchases	MTEA	2018 2020	MEPD delays because of more pressing issues	MTEA and MEPD reach consensus	MTEA develops understanding between ministries	MTEA	5 000
	Activity 1.2: Solicit funding for training of personnel	MTEA	2018 - 2020	Difficulty obtaining funding	Funding obtained	MTEA has to be creative and learn from other regions	GEF, GCF, IRENA, AfDB, and other international partners	15 000
	Activity 1.3: Identify with	MTEA	2021	Inappropriate consultants	Identification of required	Develop a system for	GEF, GCF, IRENA, AfDB,	100 000

	the help of consultants the required skills and training options for personnel			may be identified	skills and training options	verifying skills needs and training options	and other international partners	
	Activity 1.4: Select suitable personnel for training	MTEA	2021	Nepotism and corruption leading to poor selection of people	Appropriate personnel selected	Develop method for verification of suitability of personnel	GEF, GCF, IRENA, AfDB, and other international partners	15 000
	Activity 1.5: Provide the necessary skills training	MTEA	2021 - 2021	Some selected people may not go for training or may not complete	Personnel complete training	Monitor selected people throughout the process once selected.	GEF, GCF, IRENA, AfDB, and other international partners	500 000
	Activity 1.5: Task trained personnel to find funds to subsidise the deployment of the technologies selected as TAPs		2020	Failure to attract adequate funds	Adequate funds obtained	Develop methodologies used to solicit for funds	GEF, GCF, IRENA, AfDB, and other international partners	30 0000
Action 2: Collect and disseminate information	**Activity 2.1:** Identify all stakeholder groups	MNRE and MTEA	2018 -2022	Poor disaggregation of stakeholder groups	Stakeholders properly identified for the purpose of	Verify stakeholder classification	MTEA and MNRE	10 000

					targeted promotion			
	Activity 2.2: Set up different teams to develop technology promotional material targeted to specific stakeholders on various platforms (radio, TV, print media, social media, brochures and community gatherings)	MNRE and MTEA	2018 - 2022	Poor selection of teams	Capable teams selected	Verify selection of teams	MTEA, MNRE and MEPD	10 000
	Activity 2.3: Production and dissemination of material to the various platforms for the different technologies	MNRE and MTEA	2018 - 2022	Poor material prepared	Desired response from targeted stakeholders	Production of quality promotional material	2019 – 2020	TAP dependent, given under each TAP

3 Technology Plan and Project Ideas for the Energy Sector

3.1 Technology Action Plan for Energy Sector

3.1.1 Energy sector overview

The energy sector in Swaziland is the driver of socioeconomic development like in any other country. Energy is used in transportation (petrol and diesel), manufacturing industry (electricity, coal, bagasse, wood chips, and paraffin), agricultural production (diesel and electricity), commercial and the domestic (electricity, wood fuel, liquefied petroleum gas and paraffin) sectors of the economy. There are greenhouse gas (GHG) emissions that emanates from the production, transformation, delivery and use of energy resources. The GHGs emitted from the energy sector can be calculated more accurately than for most other sectors. This offers more accurate determination of GHG reduction or avoided emissions through the implementation of mitigation measures. The Third National Communication indicates that the energy sector in Swaziland contributed 1.523 million tons of CO_2e in 2010. This shows an average increase of about 25% since 1990.[7]

There are a number of legal and regulatory instruments that directly address energy matters in the country. These form part of the enabling framework for climate change mitigation and are listed here.

Swaziland National Development Strategy

The NDS Vision 22 takes into consideration that energy is a key element in socio-economic development. It recognises the importance of research and development in energy, energy efficiency, energy accessibility, renewable energy technologies and climate change mitigation.[2]

Swaziland Draft National Energy Policy 2003 reviewed in 2017

The Swaziland National Energy Policy 2003 has as its mission: "Ensuring that the development goals of the country are met through the sustainable supply and use of energy for the benefit of all the citizens of the country." This policy is currently being updated to address outstanding issues from the previous one so as to better serve the nation on energy matters, and increasing the role of renewable energy technologies in the energy mix.[8]

National Energy Policy Implementation Strategy 2003 reviewed in 2017

This strategy was developed to implement the energy policy. It has had some successes but things have changed since its development and therefore draft policy has been developed. This new policy proposes a 50% power generation capacity by 2030. It supports net metering and also promotes the establishment of an energy efficiency policy.[9]

Swaziland Renewable Energy and Independent Power Producer Policy (SIPPP) 2016

This policy was developed to address the growth and development of the power sector in Swaziland through supporting independent power producers particularly the renewable independent power producers. It aims to addresses economic, technical and regulatory challenges faced by renewable energy independent power producers.[10]

Electricity Act 2007

The Electricity Act constitute laws that govern the electricity industry in Swaziland. It allows for licensing of other electricity producers in addition to the national power company that generate, import, transmit and distribute electrical power. This is a departure from the previous arrangement

where the national company had sole rights to generate and sell electricity, and therefore allows for the existence of independent power producers.[11]

Energy Regulatory Act 2007

This legislation was formulated to create the Swaziland Energy Regulatory Authority (SERA) whose mandate is to administer the Electricity Act. It is the body responsible for issuing energy licenses regulate and approve electricity tariffs, monitor conformance to licences and many other functions.[12]

Petroleum Bill 2009

This bill is still to be reviewed by the office of the Attorney General. It aims to cover all aspect of the petroleum industry including regulations, production, exploration and distribution and many other issues related to the petroleum industry.[13]

United Nations Framework Convention on Climate Change

Swaziland is Party to the UNFCCC, part of which requires that parties to the Convention do their part in a drive towards a low carbon development, through the mitigation of the emission of greenhouse gases.[14]

Three technologies were identified for TAP development in the energy sector. They included installation of building insulation to reduce heating and cooling energy consumption, power generation using biomass resources and up-scaling the use of solar PV systems both for grid-connected power generation and small scale installations with and without net metering. The selected technologies for the energy sector are briefly discussed in Table 3-1.

Table 3-1: Technologies selected for TAP development in the energy sector

Subsector	Technology	Description	Level of uptake	Targets
Energy efficiency	Building insulation	This technology involves the installation of building insulation materials in commercial and residential areas to reduce space heating and cooling costs.	There are two big establishments that have employed this technology in the country. They are the American Embassy, and the Motor Vehicle Accident Fund building. Stakeholders stressed the need to for the implementation of this technology to improve comfort in the work place and home for increased productivity and well being	Initially for wealthy households (15 000) and commercial spaces (44 million m^2)
Power generation	Combined heat and power	This technology is the burning of biomass (bagasse, wood chips etc.) in a	This technology has been used before in Swaziland in the sugar, pulp and timber industries. It is now only used in the sugar	The timber and sugar industry – 35 MW initially

		boiler to produce steam which is directed to a steam turbine to produce electricity.	industry as the pulp company closed and the timber company stopped producing power this way. The timber industry particularly Montigny and Peak Timbers are considering producing power from wood chips and feeding it to the national grid.	
Electricity generation	Solar Photovoltaic (PV)	Solar PV is the technology where sunlight is directly converted to electricity. Single solar panels can be is used to run small appliances and to charge small batteries. Solar PV panels can also be connected in series into strings that can in turn be connected in parallel and series to produce high power for micro- and mini-grids or to feed to the grid.	Solar PV uptake is low in Swaziland. The contribution of solar PV to the energy budget for the country is so small that it is not included. There are a number of installations in the country used for water pumping, lighting and running small appliances. There is also a 100 kW pilot system that feeds into the national grid.	Households (13 000) and institutions (15 000)

3.1.2 Action Plan for Technology A1: Building Insulation

3.1.2.1 Introduction

This technology is on the installation of building envelope insulation of built environment for residential and commercial activities. This is to reduce energy consumption for heating and cooling per unit area. The global heating and cooling energy use vary between 18% and 73%.[15] Biomass is still by far the most dominant fuel for space-heating. In Swaziland there is an increasing use of electricity for both space-heating and cooling. The technology will initially be targeted to the wealthy property owners and commercial properties to allow for skills can be development and increased access to materials. The prices can eventually come down because of ease of availability of skills and increased access to material sources.

The Annual report of the Swaziland Electricity Company shows that the residential and commercial sectors consumed 44% of the total electricity supply. Most of the electricity (about 80%) consumed is imported from South Africa and mostly generated from coal power plants with an average emission factor of 1.05 tCO2e / MWh.[16]

How technology is expected to reduce GHG emissions

The technology is expected to reduce GHG emissions by reducing the heating and cooling electrical energy requirements through the reduction of heat transfer between the inside and outside of the building. Most of the electricity consumed in Swaziland is imported and is produced from coal thermal power stations that are high emitters of GHGs. Swaziland is also considering construction of a coal thermal power station that can also still have relatively high emissions even at the highest improvements. The reduction of electricity demand can therefore lead to the reduction of GHG emissions related to energy consumed in buildings.

Current status of technology at the country level

The technology is still not well adopted in Swaziland. There are only two large buildings that are known to have employed this technology. Products in the market for this technology are still limited and have to be mostly imported. Research and development is required to establish local production. There is also relative low awareness of the technology amongst the general public. The MNRE is in the process of developing and energy efficiency policy that will include energy efficiency in buildings. Some municipalities include building energy efficiency in their bylaws but are not enforceable without and updated building act. The current building act was enacted in 1968 well before concerns on climate change were common concerns. There are only two major building in Swaziland that installed this technology and they are the American Embassy and the Motor Vehicle Accident Fund.

Support for technology prioritisation

Several reasons were put forward by stakeholders for selecting this technology. The main ones are outlined here.

Increased productivity and better living: Stakeholders cited that in some cases homes and work areas are hot during the summer months and cold during the winter months leading to increase in the need to use more energy for heating and cooling. Where the discomfort is not addressed productivity is lowered as a result of lack of sleep at home due to temperature discomfort or working at uncomfortable temperatures at work.

Cost: Stakeholders also noted that the technology can be quickly promoted if the commercial sector and upscale homes can adopt it. Lower income consumers can access the technology when the prices have come down, and materials and skills easily available. Commercial entities can afford the costs while the domestic sector can benefit from low financing through mortgage loans in house improvements.

Mitigation and Adaptation: This technology combines both mitigation and adaptation. With warming climate cooling energy can be saved and even where cooling resources are limited the building insulation can help reduce the discomfort.

3.1.2.2 Ambition for the TAP

The technology implementation aims at reducing greenhouse gas emissions through the adoption of thermal building insulation. It shall target both existing and new buildings. It is assumed that the technology shall first be adopted by the commercial sector and wealthy families. At a later stage it is expected that the cost of the insulation materials and installation shall have come down low enough that they shall be generally afforded. In the commercial sector 44 million m^2 of space is targeted. In the residential sector 13 000 houses are targeted with an average of 150 m^2 per house. The energy savings is expected to be 14.5 GWh per year, which is equivalent to avoidance of 33.5 Mt CO2e emissions over 30 years.

3.1.2.3 Actions and Activities for inclusion in the TAP

Summary of barriers and measure to overcome them

The barriers in the deployment of the technology seem to be high cost of technology and low awareness. High cost is in general the major barrier that stops the deployment of technologies, and is equally applicable to that of the installation of building insulation. There is also low awareness of the building insulation technology even amongst some in the construction industry. There is also low awareness on the demand side. Households that can afford the technology and commercial property owners may not be aware of the technology and its benefits. The barriers and measures to overcome them are summarised in Table 3-2 below. Some of these measures were developed as actions and are listed following the table.

Table 3-2: Selected barriers and their measures for the building insulation technology

#	Barriers	Measures
1	High cost of building insulation technology deployment	Demonstrate to property financiers that the installation of building insulation increases the value of a building
2	Low awareness on the building insulation technology	Conduct awareness campaigns in all available platforms including brochures, traditional electronic media, print media, social media and community meetings
3	No regulatory framework to promote energy efficiency in buildings, particularly the building envelope insulation technology	Amend the National Building Act 2016, the Swaziland National Building Regulations 2016 and municipality bylaws to include energy efficiency in buildings
4	Limited skills for architects, builders and building material suppliers on the building insulation technology	Up-skill the entire value chain of the construction industry on the building insulation technology
5	Imported insulation materials may not be compatible with local humidity and temperature conditions	Develop building insulation standards for materials and installation
6	Building insulation material is not readily available	Investigate potential for local production of building insulation materials

Measure selected as actions for TAP

Action1: Assure property financiers that building insulation increases the value of a building, *through demonstrating that building insulation adds value to a house to enable financing as part of property development thus reducing financing interest.*

Action 2: Conduct awareness campaigns *through the preparation and dissemination of information in all available platforms including brochures, traditional electronic media, print media, social media and community meetings* - There is low knowledge of the benefits of building insulation by property owners and the entire value chain of the building industry in Swaziland. Hence it is important to raise the awareness of the technology and it benefits. It was mentioned earlier that there are only two major building in Swaziland that installed this technology.

Action 3: Update regulatory framework *through the amendment of the National Building Act 2016, the Swaziland National Building Regulations 2016 and municipality bylaws* - The Building Act and regulations do not incorporate building energy efficiency issues and need to be amended. Most municipal by laws address issues such as fire safety, electrical safety, structural integrity, aesthetic appeal and health impacts of buildings. There is need to update these bylaws to include climate resilience in them. The Mbabane Municipal Council Building Bye-Laws, 2015, stipulates that buildings in the city must be retrofitted with 70% energy savings technologies as means to mitigate climate change.

Action 4: Up-skill the construction industry on the building insulation technology*, through targeted short-term training for construction industry personnel in the entire value chain.* - The building insulation technology is not readily deployed because of low level of skills in the entire construction value chain. If that was not the case the wealthier property owners would have readily adopted this technology. This calls for the up-skilling of architects, engineers, construction workers and material suppliers.

Action 5: Develop building insulation standards for materials and installation *through the submission of standards proposals to the SWASA*. The technology needs standards for materials and installation. The building industry in general is now flooded with inferior products from all over the world, making it difficult to obtain those that meet desired specifications and quality. Standards can help separate the right products from the inferior products.

Action 6: Investigate potential for local production of building insulation materials *through the investigation of manufacturing needs; new materials research and development; and replication of existing products.* Some of the building insulation materials could be sourced locally. This could lead to job creation and lower prices which can further drive the deployment of the technology.

Action7: Install building insulation in residential and commercial spaces *through the identification of material suppliers; installers; and qualifying households and commercial offices; and followed by quantity surveying, procuring and installing*.

The actions and activities that can lead to the successful deployment of the building insulation technology are outlined in Table 3-3.

Table 3-3: Actions and activities for building insulation technology

TAP overview table								
Sector: Energy								
Sub-sector: Energy Efficiency in Buildings								
Technology: Building insulation								
Ambition: In the commercial sector 44 million m^2 of space is targeted. In the residential sector 13 000 houses are targeted with an average of 150 m2 per house. The energy savings is expected to be 14.5 GWh per year, which is equivalent to avoidance of 33.5 Mt CO2e emissions over 30 years. It is envisaged that this will lead to the development of the technology locally leading to availability of skills and lower building envelope insulation costs for increased affordability.								
Benefits:	**Social**	– Improved living conditions and creating new employment opportunities						
	Economic	– Cost savings from lower space heating and cooling energy costs. – Increased productivity at work due to more comfortable sleep at home and working conditions. – Country saves foreign exchange by reducing energy imports.						
	Environment	– Reduction in the use of unsustainable woodfuel for space heating therefore reducing GHG emissions and preserving the indigenous forest which is GHG sink. – Reduction in the use of imported coal generated electricity thus indirectly reducing GHG emissions. – Reducing the use of other heating fuels such as paraffin and LPG, avoiding GHG emissions.						
Action	**Activities to be implemented**		**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Risk mitigation or contingency measure(s)**	**Sources of funding**	**Budget per activity (USD)**
Action 1: Improve access to finance	**Activity 1.1:** MNRE and MTEA lead the process of increased access to funds		MNRE	2018 - 2019	One ministry not taking the other seriously	Meeting happens	MATEA develops mutual understanding between ministries	Mortgage financiers, GEF, GCF, IRENA, AfDB, and other international partners	Budgeted for in Chapter 2
Action 2: Collect and disseminate information	**Activity 1.1:** Collect and disseminate information		MTEA, MHUD, MNRE	2020 - 2022	Poor material developed and improper delivery	Quality material in the right format delivered to	Develop systems to monitor the quality of	GEF, GCF, IRENA, AfDB, and other	100 000

					stakeholders using the right platform(s)	prepared material and methods of delivery	international partners	
Action 3: Develop and update regulatory framework	**Activity 3.1:** Complete the Energy Efficiency Policy	MNRE	2018	Delayed approval by Parliament	Approved Policy	MTEA approach MNRE on finalising the policy for approval	MNRE	5 000
	Activity 3.2.a: MTEA organise inter-ministerial meeting with MNRE, MHUD, MOW and MOJ on amending the building act and review municipal bylaws	MTEA	2018 - 2019	Disagreements between ministries	Consensus reached	MTEA facilitates agreement to amend act and review bylaws	MTEA, MHUD and MNRE	5 000
	Activity 3.2.b. Amend the National Building Act 2016, the Swaziland National Building Regulations 2016	MTEA	218 - 2019	Delay in amending Act and regulations	Amendment of Act and regulations	Amending of Act	GEF, GCF, IRENA, AfDB, and other international partners	100 000
	Activity 3.3: Review municipal bylaws and ensure that they are in line with the amended Building Act	MHUD	2018 - 2019	Opposition by residents to the review of bylaws	Reviewed bylaws	Reviewing of bylaws	GEF, GCF, IRENA, AfDB, and other international partners	100 000
Action 4: Up-skill	**Activity 4.1:** MTEA organise meeting with MNRE, MHUD,	MTEA	2019	Disagreements in team selection	Consensus reached and team selected	Fruitful meeting	MTEA and MNRE	10 000

construction industry	MOW, tertiary institutions and construction industry stakeholders to set-up team to assess skills requirements for technology							
	Activity 4.2: Team identifies required skills	MTEA	2019	Poor team selection	Proper team selected	Proper criteria for team selection in place	GEF, GCF, IRENA, AfDB, and other international partners	15 000
	Activity 4.3: Develop training programmes for professionals in the construction sector	MTEA	2020	Improper programmes developed	Appropriate programmes developed	Follow international best practices in developing programmes in the local context	GEF, GCF, IRENA, AfDB, and other international partners	50 000
	Activity 4.4: Engage international consultants to train trainers in local tertiary institutions	MTEA	2020 - 2021	Failure to find appropriate consultants to deliver training locally and inability to capacitate tertiary institutions	Appropriate consultants identified and engaged	Properly check the credibility of international consultants and determine the preparedness of local tertiary institutions to be capacitated	GEF, GCF, IRENA, AfDB, and other international partners	300 000

	Activity 4.5: Provide training to construction professionals in the entire value chain	MTEA	2021 - 2023	Consultants fail to pitch up	Training at the right level conducted	Have internationally enforceable contracts for engaged consultants	GEF, GCF, IRENA, AfDB, and other international partners	500 000
Action 5: Develop standards	**Activity 5.1:** Develop a standard for insulation material	MTEA with SWASA	2019 - 2023	SWASA overwhelmed with requests for standards leading to delays	Standard developed	Involvement in standards technical committee	SWASA	50 000
	Activity 5.2: Develop standards for insulation material installation	MTEA with SWASA	2019 - 2023	SWASA overwhelmed with requests for standards leading to delays	Standard developed	Involvement in standards technical committee	SWASA	50 000
Action 6: Investigate potential for local production of building insulation materials	**Activity 6.1:** Engage manufacturing stakeholders to determine production capacity needs	MTEA	2019 - 2020	Poor response from quality manufacturers	Enthusiasm from the manufacturing sector and capacity requirements determined	Level of participation by manufacturers	GEF, GCF, IRENA, AfDB, and other international partners	50 000
	Activity 6.2: Conduct research and development of new building insulation products using easily available able materials	MTEA	2019 - 2024	Low capacity for research and development	Active research groups developed	Level of capacity to do research in the area	GEF, GCF, IRENA, AfDB, and other international partners	500 000

	Activity 6.3: Carry out a feasibility study on developing a local building insulation company	MTEA	2023 - 2024	Improperly done and overly optimistic results obtained	Accurate feasibility study results obtained	Methods of collecting and analysing collected data	GEF, GCF, IRENA, AfDB, and other international partners	500 000
Action 7: Install building envelope insulation in domestic and commercial spaces	**Activity 7.1:** Identify houses and commercial buildings where the insulation will initially be installed	MTEA, MHUD and MNRE	2024	Some buildings with low possible impact identified	Buildings to gain highest benefit identified	Develop a system to predict gains from installing insulation	GEF, GCF, IRENA, AfDB, and other international partners	50 000
	Activity 7.2: Negotiate with selected stakeholders	MTEA, MHUD and MNRE	2024	Some stakeholders do not agree delaying the process	Stakeholders agree to have insulation installed	Provide extensive information prior to negotiating	GEF, GCF, IRENA, AfDB, and other international partners	50 000
	Activity 7.3: Acquire and install installation	MTEA, MHUD and MNRE	2024 - 2025	Problems getting all required materials	All required materials obtained timeously	Identify multiple compatible sources prior to starting procurement	Mortgage fanciers, GEF, GCF, IRENA, AfDB, and other international partners	1.1 million
	Activity 7.3: Monitor impact of intervention	MTEA, MHUD and MNRE	2024 on-going	Unstable monitoring institution	Reliable monitoring institution providing timely informative reports	Asses to quality of institution prior to awarding responsibility	GEF, GCF, IRENA, AfDB, and other international partners	100 000 per year

3.1.2.4 Stakeholders and Timeline for Implementation of TAP

Overview of stakeholders for the implementation of the TAP

There are several key stakeholders whose full cooperation will be needed for the implementation of the TAP. Since the TNA project is under the UNFCCC and the Focal Point is in MTEA, this Ministry is therefore its proponent. The technology itself on the ground shall address energy efficiency in buildings which will require partnership with the MNRE and MHUD. Table 3-4 summarises the list of the broader key stakeholders and their roles.

Table 3-4: Stakeholders and their roles in implementing the building insulation technology

#	Stakeholder	Action	Role
1	Ministry of Tourism and Environmental Affairs	1, 2, 3, 4, 5 and 6	Proponent
2	Ministry of Housing and Urban Development	2, 3 and 4	Amend Building act and liaise with municipalities
3	Ministry of Natural Resources and Energy	1, 2, 3 and 4	Complete and promulgate Energy Efficiency Policy
4	Ministry of Works	3 and 4	Amendment of Building Act and implement technology
5	Ministry of Justice	3	Amendment of Building Act
6	Swaziland Standards Authority	5	Developing building insulation standards
7	Construction Industry Council	2, 3 and 7	Monitor technology implementation
8	Property Financiers	1	Financing technology
9	Municipalities	3, 4 and 7	Sensitising residents, amending bylaws and monitor technology implementation
10	Construction industry	3, 4 and 7	Up-skilling personnel
11	Residents	3 and 7	Amendment of bylaws and implementing technology

3.1.2.5 Stakeholders and Timeline for Implementation of TAP

Estimation of capacity building needs

There is need for training people on the entire construction value chain.

3.1.2.6 Management Planning

Risks and contingency planning

The technology has several risks to its implementation, particularly being a new technology in Swaziland. The risks and their mitigation are outlined in Table 3-3. Under each activity. Other general risks and associated contingency actions are outlined in Table 3-5.

Table 3-5: General risks and their associated contingency actions

Risk item	Description	Contingency action
Cost Risks	An activity costs more than originally planned	In the calculations for demonstrating the benefits of the technology there are high cost risks due to the fluctuation of the local currency, price increases and that local production may not take –off as envisaged. Local production may also be not cost effective. The cost risks in the calculations can be taken to be as high as 30%.
Scheduling Risks	An activity takes longer to complete than originally planned	There could be delays in the development of appropriate regulatory framework. This requires the Ministry of Justice and Parliament both of which have to attend to different priority issues. For delays in developing capacity for local production insulation materials can always be imported.
Performance Risks	A technology or human resource does not perform as planned or environmental and social benefits not being delivered	Only tested and proven insulation materials must be used to ensure success.

Next steps

The immediate requirements to deploy the technology are outlined here as follows:

1. **Demonstrate to property financiers that the technology is beneficial and adds value to property.** This technology is expected to be financed by local property financiers. Property financiers in Swaziland are very conservative. They have to be thoroughly convinced of the benefits of building insulation.
2. **Information dissemination.** There is need to inform targeted stakeholders of the benefits of building insulation so that they can adopt the technology. The stakeholders should feel that they need this technology for it to be universally adopted.

3. **Training of construction industry personnel.** Selection of personnel at targeted levels in the construction industry must be selected for training. There is currently a low level of skill in the building insulation technology installation.
4. **Development of standards.** For the technology deployment to succeed there is need for material and installation standards of the building insulation. Poor quality products and workmanship can result in detrimental impact on the technology.
5. **Support legislation and updated bylaws have to be in place.** The amendment of the Building Act 1968 and updating of municipality bylaws can lead to better enforcement of the installation of building insulation, particularly in the commercial sector.

3.1.3 Action Plan for Technology A2: Combined Heat and Power – Biomass Fuel

3.1.3.1 Introduction

A combined heat and power (CHP) plant produce electrical power by a turbine driven by steam produced from burning a fuel. Once the steam passes through the turbine it is harnessed for other uses such as for example process heat in industry. Various primary fuels can be used but of interest in this TAP are CHP systems that use biomass fuel. Swaziland is endowed with large quantities of renewable biomass resources that include bagasse from the sugar cane industry and wood chips from the plantation forest. Swaziland has experience in using these fuels for CHP from the pulp, timber and sugar industry, although the pulp company has since been closed. Bagasse is currently the highest renewable energy contributor to the national energy budget accounting for 23% of total energy consumption.[8] It was mentioned before that one sugar company, Ubombo Sugar Limited, sell power to the national grid through a power purchase agreement. The total installed capacity in the sugar industry in Swaziland is 106 MW[17] while the national utility has a capacity 60.4 MW in hydropower.[8]

The companies involved in this technology are mainly the sugar and timber industries. These companies can secure funding to implement these technologies, and they are already implementing them to some extent. They are not expanding the implementation of this technology because of uncertainties of the market for the electricity produced. There are also local plans to construct a thermal coal power plant. Cheap imports from Eskom (South Africa) are also threat to local power industry. The local CHP companies can have market confidence if there could be government guarantees that locally produce power at a reasonable price could be purchased locally. Also, the companies could be helped to obtain carbon credits that can reduce the overall cost of their electricity so that they can be price competitive.

How technology is expected to reduce GHG emissions

The technology is expected to reduce GHG emissions by reducing the consumption of electricity produced from coal fired power stations.

Current status of technology at the country level

The technology has been used in the country in the sugar, timber and pulp industry. The two sugar companies, Ubombo Sugar Limited (USL) and Royal Swaziland Sugar Corporation, have indicated their interest in increasing their power production through co-generation if the market can be conducive. USL already has a power purchase agreement with the Swaziland Electricity Company (SEC) to supply them with their excess power. In 2016, SEC purchased 55.6 GWh from USL.[18]

Support for technology prioritisation

There were a number of reasons put forward by stakeholders for selecting this technology. The main ones are outlined here.

Maturity of technology: The technology has been used in Swaziland for decades in the sugar and timber industries and was therefore mature.

Cost: It was noted that even though the investment cost of the technology is high the sugar and timber industries are familiar with this technology. They know the investment costs, operation and maintenance costs, risks and other aspect of this technology and therefore prepared for its deployment. Access to climate change and renewable energy funds can help enable this technology compete with Eskom and the proposed local thermal power plant.

Mitigation: This technology can reduce the importation of coal generated electricity thus reducing GHG emissions. The biomass (wood chips and bagasse) resources used are sustainable.

Job creation: The technology was seen as a good job creator particularly in the production of the feed stock.

3.1.3.2 Ambition for the TAP

The initial implementation capacity of the technology is 65 MW. This technology has the capability to be scaled up to higher levels. Other than USL and RSSC, there are also Montigny and Peak Timbers that can operate CHP systems to feed into the national grid, and Suxe International who are interested in providing the national electricity base load using the same technology with bamboo as the feedstock. At 65 MW the technology could save 11 390 GWh of electrical energy at result in 8 090 Gt CO_2e of avoided GHG emissions over 30 years. If the conditions are right a greater capacity installed than the 65 MW where more electricity can be produced and further reduction of GHG emissions.

3.1.3.3 Actions and Activities for inclusion in the TAP

Summary of barriers and measure to overcome them

The main barrier in implementing the technologies is the uncertainty in the electricity market. The initial investment cost of the technology is high and can pose risks in an uncertain market. There is no legislation that would guarantee the market for biomass CHP power. There is overreliance in external high level skills for construction and maintenance. The main barriers and measures to overcome them are summarised in Table 3-6 below. A brief discussion of why these measures were selected as actions follows.

Table 3-6: Selected barriers and their measures for the CHP technology

#	Barriers	Measures
1	High initial investment cost	Gain access to climate change and renewable energy funds to subsidise deployment to enable RE power to compete with coal power.
2	Market uncertainty	Develop market for CHP power in the Southern Africa Power pool. Countries are supposed to declare their future power production potential in order to secure a market in SAPP.

3	No regulatory framework to guarantee market for reasonable priced RE power or a transparent power purchase agreement method	Develop regulatory framework to guarantee reasonably priced locally generated biomass power for energy security and establish a transparent power purchase agreement methodology.
4	Inadequate skills for the operation and maintenance of power generation equipment	Up-skill artisans and engineers to install and maintain power generation equipment

Action 1: Gain access to climate change and renewable energy funds *through setting up a team to be trained in writing bankable proposals for accessing the various renewable and energy efficiency and climate change funds* - Even though high initial investment cost is a concern, it was noted that on their own the sugar and timber industries were capable of mobilising resources to implement the technology. However, with the competition from Eskom and the proposed local thermal power plant they could benefit from accessing climate change funds to subsidise their equipment costs in order to improve their competitiveness.

Action 2: Develop market for CHP power *through the establishment of a Renewable Energy Feed-in-Tariff programme to support the 50% RE power generation by 2030; developing transparent purchase model and negotiating access to the SAPP market for local RE power* **producers** - There is a proposed thermal coal power plant in Swaziland. Its impact on prices and local market share is still unknown. This is preventing the sugar and timber industry from further investing in the power section of CHP plants. The current agreement between SEC and Eskom ends in 2025 and what the new agreement will be will include is unknown to the CHP companies. There is also no transparent power purchase agreement methodology. The Swaziland Energy Master Plan needs to accommodate CHP power in the energy mix. Already the Draft NEP 2017 has a target of 50% power generation from renewables by 2030.[9] This has to be taken from paper to action. The country could also declare the CHP plants to supply the SAPP.

Action 3: Develop regulatory framework *through MNRE engagement with SEC, SERA, IPPs and others stakeholders* **-** The Government having set the target for 50% RE power generation by 2030 and therefore needs to develop a regulatory framework to make this a reality. This has to be developed taking cognisance of the planned thermal power plant and the negotiations with Eskom.

Action 4: Up-skill the artisans and engineers *through training and attaching artisans and engineers in the power production component of CHP.* There are still high level skills where the installation, operation and maintenance of the power generation units of CHP plants are performed by expatriate personnel. Swaziland needs to develop the skills level of the locals to match their expatriate counterparts so that the level of skills to install, operate and maintain the power generation units are readily available in the country to enhance the deployment of the technology.

The actions and activities that can lead to the successful deployment of the CHP technology are outlined in Table 3-7.

Table 3-7: Actions and activities for the CHP technology

TAP overview table								
Sector: Energy								
Sub-sector: Power generation								
Technology: Combined Heat and Power Biomass Fuels								
Ambition: The initial implementation capacity of the technology is 65 MW. This technology has the capability to be scaled up to higher levels. Other than USL and RSSC, there is also Suxe International that is interested in providing the national electricity base load using the same technology with bamboo as the feedstock. The technology could save 14.2 GWh of electrical energy at result in 10.9 Gt CO2e of avoided GHG emissions over 30 years								
Benefits:	**Social**	– Job creation in growing and harvesting biomass resources						
	Economic	– Country saves foreign exchange by reducing electricity imports						
	Environment	– Reduction in the use of imported coal generated electricity thus indirectly reducing GHG emissions						
Action	**Activities to be implemented**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Risk mitigation or contingency measure(s)**	**Sources of funding**	**Budget per activity (USD)**
Action 1: Improve access to finance to reduce equipment costs	**Activity 1.1:** MTEA and MNRE lead process to access climate funds	MTEA and MNRE	2019 - 2020	MEPD delays because of more pressing issues	MTEA and MEPD reach consensus	Develop mutual understanding between ministries	GEF, GCF, IRENA, AfDB, and other international partners	Budgeted for in Chapter 2
Action 2: Adopt energy security position by maximising the use of local resources	**Activity 2.1:** Complete the Swaziland Energy Master Plan	MNRE	2018	Interest groups may oppose the Master Plan leading to its delay	Energy Master Plan approved by Parliament	Make sure all scenarios are addressed including promising technologies for the future	MNRE	15 000
Action 3: Guarantee	**Activity 3.1:** Develop a Renewable	MNRE and SERA	2018 - 2022	Transparent power purchase	Transparent power purchase	Identify self-interests and deal with them	GEF, GCF, IRENA, AfDB, and other	1 000 000

markets for CHP power	Energy Feed-in-tariff programme and standard power purchase agreements			agreement may meet resistance	agreements in place		international partners	
	Activity 3.2: Commit the country to supply power to the Southern Africa Power Pool (countries that guarantee future power availability have preference to supply the SAPP)	MNRE	2018 - 2023	Uncertainty on the future availability of promised power	Swaziland gets a quota of future power supply to SAPP	Monitor negotiations and readiness of local RE power producers	GEF, GCF, IRENA, AfDB, and other international partners	1 000 000
Action 4: Capacitate engineers and artisans with necessary skills	**Activity 4.1:** Conduct a manpower demand analysis in the power sector	MNRE	2020	Manpower analysis not done properly	Proper manpower demand analysis done	Systems in place for quality control	GEF, GCF, IRENA, AfDB, and other international partners	200 000
	Activity 4.2: Select personnel suitable for up-skilling	MNRE	2020	Inappropriate personnel may not be selected due	Suitable personnel selected	Selection process verified by independent means	GEF, GCF, IRENA, AfDB, and other international partners	100 000

				to corruption and nepotism				
	Activity 4.3: Place selected people for training for selected people through attachment at appropriate organisations around the world	MNRE	2021 - 2024	Selected people may not go for up-skilling or may drop out	Placement of selected people in suitable organisations	Process monitoring from selection of individuals through training	GEF, GCF, IRENA, AfDB, and other international partners	5 000 000
Action 5: Purchase and install CHP equipment	**Activity 5.1:** Acquire, install and operate CHP equipment	IPPs	2023 - 2024	Delays in equipment delivery	Equipment installed and commissioned timeously	Place orders well in advance and continuously monitor progress and take corrective action immediately where necessary	IPPs, GEF, GCF, IRENA, AfDB, and other international partners	150 million
	Action 5.3: Monitor performance of installed systems	MTEA contracted institution	2034 and on-going	Unstable institution selected	Proper institution selected and reporting useful information annually	Proper select monitoring and reporting institution	IPPs, GEF, GCF, IRENA, AfDB, and other international partners	50 000

3.1.3.4 Stakeholders and Timeline for Implementation of TAP

Overview of stakeholders for the implementation of the TAP

The key government stakeholder for the CHP technology is the MNRE but in view of that the TNA is under the UNFCCC the MTEA is an equal partner. There are other stakeholders that will be instrumental in the implementation of the CHP technology. Table 678788%%^^* summarises the list of key stakeholders and their roles.

Table 3-8: Stakeholders and their roles in implementing the CHP technology

#	Stakeholder	Action	Role
1	Ministry of Tourism and Environmental Affairs	1 and 4	Proponent
2	Ministry of Natural Resources and Energy	1, 2, 3 and 4	Proponent and implementing ministry
3	Swaziland Energy Regulatory Authority	3	Develop regulatory framework for transparent power purchase agreements
4	Swaziland Electricity Company	4 and 5	Develop capacity to accommodate RE power
5	Swaziland Sugar Association	4 and 5	Representative of implementers in the sugar industry
6	Ubombo Sugar Limited	4 and 5	Technology implementer
7	Royal Swaziland Sugar Association	4 and 5	Technology implementer
8	Montigny Investments	4 and 5	Technology implementer
9	Peak Timbers Limited	4 and 5	Technology implementer
10	Suxe International	4 and 5	Technology implementer

3.1.3.5 Stakeholders and Timeline for Implementation of TAP

Estimation of capacity building needs

Estimation of costs of actions and activities

3.1.3.6 Management Planning

Risks and contingency planning

The potential implementers of the technology are expected to be the RSSC, Montingy, and possibly in addition Peak Timbers and Suxe International. These companies are expected to implement the technologies using their own funding. According to Seluleko Fakudze of the SEC who has been involved in similar projects, these companies also undertake extensive feasibility analysis before they implement projects. The purpose of the TAP for this technology is to create an environment conducive for these companies to implement the technologies, which is a pre-requisite for implementing and reducing project risk. The IPPs are expected to conduct their own risk analysis and mitigation as part of their extensive feasibility studies. Other general risks are outlined in Table 3-9.

Table 3-9: General risk for the CHP technology and their contingency actions

Risk item	Description	Contingency action

Cost Risks	An activity costs more than originally planned	Biomass power of around 30 MW cost around $150 million including delivery and installation.[19] The feasibility studies by the implementing company can reveal the cost risks and develop means to mitigate it. The companies could also mitigate higher cost by accessing climate change funds.
Scheduling Risks	An activity takes longer to complete than originally planned	The scheduling risk for CHP plants is rather low. It is a mature technology and there are many suppliers of such plants all over the world. There could be scheduling problems if defective equipment is supplied. The contract should clearly specify clearly the penalties to be incurred by the supplier in the event of delivering defective equipment.
Performance Risks	A technology or human resource does not perform as planned or environmental and social benefits not being delivered	The technology is mature with standard biomass fuel such as bagasse, wood chips and bamboo. The problems could arise if there are shortages in the fuel supply. There is need to plant extra stock of biomass in the form bamboo and trees like wattle to cater for times when there is not enough bagasse.

Next steps

The immediate requirements to deploy the technology are outlined here as follows:

1. **Develop capacity to access renewable energy and climate change funds.** It is important that Swaziland develops the capacity to source renewable energy and climate change funds. These funds could help subsidise the deployment of CHP power to enable these companies to be price competitive with Eskom and local coal power.

2. **Develop a Renewable Energy Feed-in-Tariff programme.** Potential investment by IPPs is hindered by the lack of transparency in power purchase agreements. A Renewable Energy Feed-in-Tariff programme can bring

3. **Complete the Swaziland Energy Master Plan.** The Swaziland Energy Master Plan will enable the country to develop domestic energy supply capacity and diversify its national energy mix. It will identify all the energy sources needed to meet the demand, including untapped potential for domestic energy supply from renewable sources

4. **Train identified artisans and engineers.** Up-skill targeted identified personnel in CHP power generation to reduce installation, maintenance and operation costs.

3.1.4 Action Plan for Technology A3: Solar PV

3.1.4.1 Introduction

Solar photovoltaic is a process where when sunlight strikes a device called a solar panel it produces electricity. The solar panel absorbs light energy and converts it directly to electricity. The first generation solar panels are made from a material called silicone an element found in sand. The general public already know about solar PV. The reason for its low adoption is that it is of limited use as compare to grid electricity. It is produced during only the day and not available at night unless there is storage. Powering high energy appliances require huge investments in equipment. Storage solutions are still too expensive at this stage except for low power systems such as lighting. Solar PV can take off rapidly if net metering can be introduced. Net metering can allow installers to feed their excess power to the grid during low demand and use it during the periods of high demand.

How technology is expected to reduce GHG emissions

The technology is expected to reduce GHG emissions by reducing the consumption of electricity produced from coal fired power stations.

Current status of technology at the country level

The technology is available in Swaziland but not well adopted. The reason for the low adoption is the limited usability of solar PV electricity. People want to use the electricity produced from solar PV in a similar way that they use electricity from the Grid. This can be best achieved with net metering. Large scale solar PV plants are being planned by Wundersight Investments (21.6 MW) and separately the Swaziland Electricity Company.

Support for technology prioritisation

Several reasons were put forward by stakeholders for selecting this technology. The main ones are outlined here.

Technology maturity: The technology was seen to be mature and that it was sustainable.

Potential for job creation: The technology could be used for income generating purposes where there is no electricity, thus creating jobs.

Cost: Prices for solar PV had come down, were still reducing and can be afforded by domestic users and institutions even without subsidies.

Mitigation and Adaptation: This technology combines both mitigation and adaptation. The technology can reduce the importation of coal generated electricity thus reducing GHG emissions. With the frequency of drought, investment on Solar PV can reduce the dependence of hydropower.

3.1.4.2 Ambition for the TAP

The initial target is to install 14 000 1.5 kW solar home systems and 14 000 20 kW institutional solar PV systems. It is expected that other lower and larger solar PV systems shall also be adopted by individual households and institutions. The increased adoption of solar PV technology could lead to lower prices hence the affordability of the technology for a number of different applications that could lead to increased socio-economic development and consumption of coal generated electricity and the use of other fossil fuels. The targeted installation is expected to generate 12 950 GWh electrical energy resulting in avoided GHG emissions of 9 971 Gt CO_2e over 25 years.

3.1.4.3 Actions and Activities for inclusion in the TAP

Summary of barriers and measure to overcome them

The barriers and measures to overcome them are summarised in Table 3-10 below. Some of these measures were considered important to be made into actions listed following the table.

Table 3-10: Selected barriers and their measures for the solar PV technology

Barriers	Measures
High cost of solar PV equipment	– Demonstrate to property financers that solar PV technology increases the value of a house for eligibility for financing as part of the mortgage – Provide support for local or regional production of components to take advantage of bulk purchasing and lower regional labour costs – Harmonization solar PV standards and training to enable overall lower regional prices. – Subsidise the cost of solar PV equipment through renewable energy and climate change funding
Potential low price of import electricity	– This could be a perceived barrier in the sense that in neighbouring South Africa companies have been bidding to ESKOM, the state owned enterprise mandated to produce and distribute power, at $0.07 per kWh.[20] The prices of solar PV power are already low and coming down – Swaziland must prioritise energy security over price, and then address generation cost reduction once secured.
Low price of domestic electricity	Continue the change towards cost reflective tariff for the higher power users and still maintain the lifeline tariff for the low power users
High cost of land for large scale solar PV installation	– Develop a land-use policy that would ensure that land is used efficiently to provide space for large solar PV systems – Find creative sites for solar PV installations, such as, parking lot roof tops, building walls, recreation areas, space between runways at airports etc.

Limited research and development on solar PV systems	Stimulate solar PV research and development at tertiary institutions to promote participation in the South-South Cooperation on issues related to climate change, renewable energy and energy efficiency and rural energy access
Solar PV capabilities not properly understood	Conduct awareness campaigns in all available platforms including brochures, traditional electronic media, print media, social media and community meetings
Non uniform quality of solar PV equipment	Develop solar PV standards and an accreditation system for solar PV installers
No regulatory framework for net metering	Develop regulatory framework to allow net metering
No consistency in solar PV installation due to limited local technical skill for installation, operation and maintenance	Provide training, testing and accreditation of solar PV installers
Inadequate facilities to test solar PV equipment and installed systems	Upgrade available facilities for testing solar PV systems

Actions selected for inclusion in TAP

The actions selected for inclusion in the TAP are listed here. There are eight actions included. Details of sourcing funds and awareness-raising are taken as crosscutting activities and were discussed in Chapter 2. Standards development requires only the submission of standards proposals to SWASA and they do the rest with their own budget. The actions and their activities are presented in Table 2-11.

Action 1: Reduce cost of solar PV equipment *through demonstration to property financers that solar PV technology increases the value of a house for eligibility for financing as part of the mortgage; provision of support for local or regional production of components to take advantage of bulk purchasing and lower regional labour costs; harmonisation solar PV standards and training to enable overall lower regional prices; and subsidising the cost of solar PV equipment through access to renewable energy and climate change funding.*

Action 2: Increase awareness and knowledge on solar PV *through collecting and disseminating information in appropriate packages suitable for different stakeholders in available platforms such as electronic and print media, brochures, social media, community gatherings, etc.*

Action 3: Increase solar PV research and development at tertiary institutions *through capacitating tertiary institutions to collect and analyse insolation data, monitor the performance and degradation of solar PV equipment, and to participate in the South-South Cooperation on issues related to renewable energy and energy efficiency, climate change and rural energy access*.

Action 4: Develop standards for solar PV equipment and installation *through the submission of standards proposals to SWASA.*

Action 5: Develop enabling environment for net metering *through negotiations with SEC and the development of a regulatory framework for net metering.*

Action 6: Develop training testing and accreditation programmes for solar PV installers *through capacitating tertiary institutions to carry out such.*

Action 7: Upgrade facilities to test and monitor solar PV installations *through strengthening the existing capacity at testing laboratories and developing new ones if necessary.*

Action 8: Provide solar PV systems to households and institutions *through setting up teams to size and select quality systems suitable for targeted domestic segments and institutions*.

Table 3-11: Actions and activities for the solar PV technology

TAP overview table								
Sector: Energy								
Sub-sector: Electricity production								
Technology: Solar PV								
Ambition: The initial target is to install 14 000 1.5 kW solar home systems and 14 000 20 kW institutional solar PV systems. It is expected that other lower and larger solar PV systems shall also be adopted by individual households and institutions. The increased adoption of solar PV technology could lead to lower prices hence the affordability of the technology for a number of different applications that could lead to increased socio-economic development and consumption of coal generated electricity and the use of other fossil fuels. The targeted installation is expected to generate 12 950 GWh electrical energy resulting in avoided GHG emissions of 9 971 Gt CO2e over 25 years.								
Benefits:	**Social**	– Saved income to be used for other needs – Some job creation through availability of electricity						
	Economic	– Electricity bill savings – Income generating opportunities with availability of electricity						
	Environment	– Greenhouse gas avoided emissions						
Action	**Activities to be implemented**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Risk mitigation or contingency measure(s)**	**Sources of funding**	**Budget per activity**
Action 1: Reduce cost of equipment	**Activity 1.1:** MTEA and MNRE leads process to solicit funds for solar PV equipment	MTEA and MNRE	2018 - 2020	-	-	-	GEF, GCF, IRENA, AfDB, and other international partners	Budgeted for in Chapter 2
Action 2: Increase awareness and knowledge on solar PV	**Activity 2.1:** Collect and disseminate information	MNRE and MTEA	2020 - 2022	-	-	-	GEF, GCF, IRENA, AfDB, and other international partners	200,000

Action 3: Increase solar PV research and development	**Activity 2.1:** Assess level of research required and capacitate tertiary and research institutions to conduct research on solar PV systems performance and degradation over time		2019 - 2024	Inadequate facilities	Sufficient facilities	Access level and type of research required and ensure that the right equipment is purchased	MNRE, IRENA, ROC, local industry and international partners	3,000,000
	Action 3.2: Participate in South-South Cooperation to exchange information	Tertiary and research institutions	2019 - 2024	Inadequate staffing	Enough staff	Facilitate measures to enable tertiary institutions to participation in South-South Cooperation	UNDP and other International partners	500,000
Action 4: Develop solar PV standards	**Activity 4.1:** Submit to SWASA standards proposal for: • Imported solar PV systems • Secondary batteries for SPS	MNRE	2019 - 2022	SWASA overwhelmed with requests for standards leading to delays	Standards developed	Provide funding for standards development committees to increase the number of standards SWASA can develop per year	SWASA and MTEA	15,000

	• Electrical Wiring Rules • Lightning Protection • Wind Loads							
Action 5: Develop enabling environment for net metering Collect and disseminate information	**Activity 5.1:** MNRE organise meeting with MTEA, SERA and SEC on net metering	MNRE	2018	SEC reservations on net metering	Net metering approved	Progress in meetings	MNRE, MTEA, SERA and SEC	20,000
	Activity 5.2: Amend Electricity Act to include net metering	MNRE, MTEA, SERA, SEC and MOJ	2018 - 2022	Delays due to other priorities for Attorney General's office	Amended Electricity Act to allow net metering	Progress in act amendment	MNRE, MTEA, SERA, SEC and MOJ	10,000
	Activity 4.3: Develop net metering regulatory framework	SERA and MNRE	2018 - 2022	Delays due to other priorities for Attorney General's office	Net metering regulations developed	Selection if capable teams	MNRE, MTEA, SERA, SEC and MOJ	20,000
Action 6: capacitate solar PV installers	**Activity 6.1:** Develop programmes for training, testing and accreditation of solar PV installers	MNRE and tertiary institutions	2019 - 2024	Some institutions may be slow to play their assigned roles	Programmes developed	Monitor the whole process	MNRE, MTEA, IRENA and international partners	500,000
Action 7: Develop facilities to test and monitor	**Activity 7.1:** Set-up team that identifies	MTEA	2019	Poor team selection	Proper team selected	Proper criteria for team selection in place	MNRE and MTEA	5,000

solar PV installations	required equipment							
	Activity 7.2: Develop facilities and capacity for testing, inspection and troubleshooting solar PV systems	MNRE, tertiary and research institutions	2019 - 2022	Funding inadequate	Capacity developed and facilities in place	Testing equipment and inspection procedures should be in line with best international practices	UNDP, GEF, GCF and international partners	2,000,000
Action 8: Provide solar PV systems to households and institutions	**Activity 8.1:** Develop criteria for household and institutions solar PV subsidy beneficiaries	MNRE, MTEA, tertiary and research institutions	2022 - 2024	Inadequate funding	Funding in place	Monitor funds access prior to project implementation to ensure there is adequate support.	Households, institutions, plus subsidies from renewable energy and climate change funds	637,000,000
	Activity 8.2: Identify solar PV suppliers and installers	MNRE, MTEA, tertiary and research institutions	2022 - 2024	Poor identification of all suppliers	Quality suppliers identified	Make sure that credible suppliers are recommended		
	Activity 8.3: Purchase and sell subsidised solar PV systems		2022 - 2024	Poor or broken merchandise arrive and with delays	Right merchandise arrive timeously	Take insurance for all purchases made		
	Activity 8.4: Monitor impact of intervention		2022 - 2024	Unstable institution chosen for monitoring	Institution reporting correct information	Assess the monitoring institution prior to		

					annually selected	awarding contract		

3.1.4.4 Stakeholders and Timeline for Implementation of TAP

Overview of stakeholders for the implementation of the TAP

There are several key stakeholders that their full cooperation will be needed for the implementation of the TAP. Since the TNA project is under the UNFCCC and the Focal Point is in MTEA, this Ministry is therefore its proponent. The technology itself on the ground be implemented by MNRE. There will be other stakeholders involved. Table 3-12 summarises the list of key stakeholders and their roles.

Table 3-12: Stakeholders and their roles in implementing the solar PV technology

#	Stakeholder	Action	Role
1	Ministry of Tourism and Environmental Affairs	1, 2, 3, 4, 5, 7 and 8	Proponent
2	Ministry of Natural Resources and Energy	1, 2, 3, 4, 5, 7 and 8	Promotes renewable energy technologies
3	Ministry of Justice	3	
	Swaziland Energy Regulatory Authority	3	Set-up net metering policy and regulations
4	Swaziland Electricity Company	4 and 5	Set-up systems to accept net metering
6	Swaziland Standards Authority	4	Developing solar PV standards
7	Property Financiers	1	Finance solar PV technology
8	Tertiary institutions	2, 4, 6, 7 and 8	Collect and disseminate solar PV information; training and accrediting solar PV installers; set-up laboratory for inspecting and analysing solar PV equipment and installations

3.1.4.5 Stakeholders and Timeline for Implementation of TAP

Estimation of capacity building needs

There is need to build capacity to

- source available international funds
- train and accredit personnel on installation, operation and maintenance of solar PV systems
- participate in South-South Cooperation and knowledge management

3.1.4.6 Management Planning

Risks and contingency planning

The main risk for the technology is varied quality of imported products, lack of compatibility and poor installation. There is a wide variety of suppliers of solar PV equipment from all over the world. The development of the solar PV standards will play a major role in mitigating the risk of the importation of poor quality products. Poor installation can be mitigated by the accreditation of installers. SWASA may also not have an adequate budget to develop all the standards. Extra funds may have to be organised for SWASA to be able to develop a higher number than their usual 40 standards per year. Other general risks are outlined in Table 3-13.

Table 3-13: General risks for the solar PV technology and their contingencies

Risk item	Description	Contingency action
Cost Risks	An activity costs more than originally planned	Solar PV installations are targeted to households with adequate financial resources and institutions. The chosen systems are expected to cost under $3 000 (1.5 kW) for the households and $10 000 (50 kW) for institutions. There will therefore be no need for external funding requirements. The risk factors shall be in the quality and installation which this TAP is expected to address. The risk posed by the fluctuation of the local currency could be addressed by the capability to access carbon funds to subsidise the equipment as a result of the TAP. The cost for solar PV equipment is stable and also coming down. Transportation costs are also unlikely to escalate due to the stabilisation of oil prices.
Scheduling Risks	An activity takes longer to complete than originally planned	Scheduling risks could arise if there is inadequate manpower to install the systems. Action #6 is meant to mitigate the shortage of installing personnel.
Performance Risks	A technology or human resource does not perform as planned or environmental and social benefits not being delivered	The systems should be designed to perform above the required capacity. Most systems are designed to perform at 20% above the required capacity. If the installation is done in a cloudy area this percentage could be increased.

Next steps

The immediate requirements to deploy the technology are outlined here as follows:

1. **Build capacity to access renewable energy and climate change funding.** There is need to build capacity to access international funding for renewable energy and climate change to subsidise the cost of solar PV.

2. **Conduct research and disseminate solar PV information.** Tertiary and research institutions must conduct research on pro-poor energy access. They should incorporate knowledge management through South-South Cooperation on renewable energy and energy efficiency, climate change and energy access for all.
3. **Development of standards.** Standards need to be developed for solar PV equipment and installation, operation and maintenance.
4. **Allow net metering.** Net metering could be the essential driver for the deployment of solar PV systems. The benefit of the reduction of the electricity bill can boost the installation of solar PV systems even if there are no subsidies.
5. **Capacity must be developed to train, test and accredit solar PV installers.** The success of solar PV deployment will not only depend on the quality of the equipment but also on the quality of installation, operation and maintenance. There has to be properly trained people to do this.
6. **Develop facilities for testing and monitoring the performance of solar PV equipment.** It will be important to have equipment in place to test imported products and monitor the operation of solar PV equipment systems.

3.2 Project Ideas for the Energy Sector

Project ideas for the energy sector are discussed here. They are for (i) the installation of building envelope insulation in residencies and commercial spaces, (ii) CHP biomass plant and (iii) domestic and institutional solar PV installation.

3.2.1 Installation of building envelope insulation in residencies and commercial spaces

Introduction/Background

High summer temperatures and cold winters, coupled with the change in lifestyle that require comfort at work and in the home lead to increased use of energy for space cooling and heating. Cooling is mainly done with electricity through the use of air conditioners, while heating is done mainly using electric heaters, LPG heaters and wood in fire places. These energy sources lead to the emission of GHG gases directly and indirectly. Installation of building insulation materials in residential homes and commercial offices can reduce GHG emissions through the reduction of energy consumed for space heating and cooling.

Objectives

The objective is to install building envelope insulation to residential; hoses and commercial offices. In the commercial sector 44 million m^2 of space is targeted. In the residential sector 13 000 houses are targeted with an average of 150 m^2 per house. The energy savings is expected to be 14.5 GWh per year, which is equivalent to avoidance of 33.5 Mt CO2e emissions over 30 years.

Outputs

The main output of this project idea is to observe a reduction of electricity consumption for space heating and cooling where this technology is applied. This can be easily determined from the monthly energy expenditures compared to business as usual.

Relationship to the country's sustainable development priorities

Swaziland has a draft National Energy Efficiency Policy whose aim is to reduce national energy consumption through implementing energy efficiency and energy conservation measures. The policy also suggests some specific interventions in in energy in buildings including residential and commercial amongst others. The interventions include energy efficient building envelope, efficient lighting, more efficient heating, ventilation, and air conditioning (HVAC) systems, etc. The technology will lead to reduced consumption of coal generated electricity, firewood and petroleum products for space heating and cooling.

Project deliverables

Implementation of the TAP will lead to the reduction of energy consumption for heating and cooling in residential and commercial buildings.

Project scope and possible implementation

The initial target will be 13 000 residential buildings (wealthy households) and 44 million m^2 of commercial space. It is expected that the initial implementation will lead to the development of skills for the technology and access to materials. The availability of skills and access to materials can lead to lower prices and increase affordability thus raising the adoption of the technology.

Project activities

- MNRE and MTEA lead the process of increased access to funds
- Complete the Energy Efficiency Policy
- Amend the National Building Act 2016, the Swaziland National Building Regulations 2016 to include energy efficiency in buildings
- Review municipal bylaws and ensure that they are in line with the amended Building Act
- Identifies required skills
- Develop training programmes for professionals in the construction sector
-]Identify houses and commercial buildings where the insulation will initially be installed
- Negotiate with selected stakeholders
- Acquire and install installation
- Monitor impact of intervention

Project Timeline

The project time line is for 2023 to 2024

Budget/Resources requirements

Information dissemination: 150 000 USD
Budget for installation building envelope insulation: 1.1 million USD
Training of professionals in the construction value chain: 550 000 USD

Measurement/Evaluation

There will be data collection of energy consumption prior to installation of building insulation and after. For new buildings, the performance of identical buildings in the dame area will be evaluated for energy efficiency and compared.

3.2.2 CHP biomass plants in the timber and / or sugar industry

Introduction/Background

Swaziland is endowed with an abundance of solid biomass resources in the form of wood chips in the timber industry and bagasse, trash and sugar cane tops in the sugar industry. These resources are from sustainable plantations that are replanted annually. They have been used for decades in Swaziland provide feed stock for combined heat and power generation in the pulp, timber and sugar industries. It is currently used in the sugar industry and the timber industry is using the heat generation part and interested in returning to power generation too. The pulp company closed. One of the sugar company currently sells its excess CHP power to the national electricity utility SEC.

Objectives

The objective of this project idea note is to install a minimum of 35 MW CHP plant in the timber industry. This specification is motivated by that a timber company Montigny has publicly stated their intention of initially installing a 35 MW plant at their industry. The sugar industry could also do the same as they have the resources and the technology is identical.

Outputs

The main expected output will be the installation of a minimum of 35 MW CHP plant selling excess power to the national grid. It is expected that there will be reduction in imported electricity from coal powered plants. There will also be beneficiaries from the surrounding communities that wattle out growers as they will have a market for their product thus uplifting livelihoods in the area.

Relationship to the country's sustainable development priorities

This project idea is in line with the national target of generating 50% of electricity from renewables by 2030 as contribution for sustainable development in the energy sector.

Project deliverables

The project deliverables will include the installation of a 35 MW CHP plant in the timber industry and probably more including from the sugar industry. The aim is a reduction in the electricity imported coal generated electricity.

Project scope and possible implementation

Initially the target will be to assist Montigny Investments to install a 35 MW CHP power plant, and supplying the national grid through a Renewable Energy Feed-in-tariff programme. This could lead to increased grid connected power generation from the sugar industry and other timber industries such as Peak Timbers.

Project activities

- MTEA and MNRE lead process to access climate funds
- Complete the Swaziland Energy Master Plan
- Develop a Renewable Energy Feed-in-tariff programme and standard power purchase agreements
- Commit the country to supply power to the Southern Africa Power Pool (countries that guarantee future power availability have preference to supply the SAPP)
- Conduct a manpower demand analysis in the power sector
- Up-skill artisans and engineers
- Acquire, install and operate CHP equipment

- Monitor performance of installed systems

Project Timeline

The project is expected to be implemented from 2023 to 2024 when there will be more clarity on the type of agreement between Eskom and SEC. The position of the thermal power plant should also be clear at that time.

Budget/Resources requirements

The total cost of installing a 35 MW CHP plant was determined to be USD 150 million.

Measurement/Evaluation

The amount of electricity produced by the plant(s) can be determined and converted to avoided GHG emissions without the intervention.

3.2.3 Solar PV systems deployment for households and institutions

Introduction/Background

Solar PV converts sunlight directly into electricity. Solar PV has an emission factor (0.020-0.050 t CO2e per MWh equivalent),[21] and therefore its deployment reduces GHG emissions as compared to coal generated electricity. Solar PV is used in Swaziland but a low scale compared to the available sunshine throughout the year.

Objectives

The objective is to innstall solar PV systems with net metering to household and institutions.

Outputs

The output expected is to install 15 000 solar home systems of minimum 1.5 kW and 15 000 institutional systems minimum 50 kW.

Relationship to the country's sustainable development priorities

The Draft national Energy Policy 2017 promotes access to modern energy access for households. In addition it aims to eradicate energy poverty. Deployment of solar PV is one way of contributing towards meeting these national priorities. The policy considers that the eradication of energy poverty could be also contribute to the achievement of the goals of the Poverty Reduction Strategy and Action Plan since access to modern energy could lead to income generating activities and job creating thus improving the wellbeing of communities. Solar PV can provide energy without adversely affecting the environment, thus promoting sustainable development.

Project deliverables

Deliverable will include the installation 1.5 kW and 50 KW solar PV systems to 13 000 homes and 50 15 000 institutions, respectively. These will be the minimum size systems installed in each case.

Project scope and possible implementation

Of interest in the TAP are household and institutional installations with net metering. The reason for targeting this group is that there are currently two large grid-connected solar PV plants under development and they are at an advanced stage and do not need assistance from the TAP. Solar PV

systems with net metering are expected to take off rapidly thus providing for skills development and reduction of prices.

Project activities

- Submit proposals to SWASA for solar PV standards
- Develop programmes for training, testing and accreditation of solar PV installers
- Develop facilities and capacity for testing, inspection and troubleshooting solar PV systems
- Purchase and install solar PV systems
- Monitor impact of intervention

Project Timeline

Project timeline from inception to installation of systems: 2019 – 2024

Budget/Resources requirements

- Awareness raising
- Equipment
- Capacitating accreditation institutions
- Personnel training
- Capacitating testing facilities

Measurement/Evaluation

The systems will all be monitored for performance and annual reports produced.

4 Technology Action Plan for Waste Sector

4.1.1 Waste sector overview

In general waste disposal is one of the increasing problems faced by municipalities and peri-urban areas in Swaziland. Land is becoming more expensive and less available for waste disposal sites. Some municipalities and entities are now practicing waste management, where they try to minimise the waste that is destined for the landfill. They also construct engineered landfills instead of dumpsites. The common practice all along in Swaziland in dealing with waste has been waste dumping. This method of dealing with waste is still widely practiced in the country. The reason for this is that Swaziland has inadequate legislation on waste as listed below. Also, small municipalities and communities do not have the financial results for proper waste management.

The Environmental Management Act, 2002 (EMA 2002)

This Act made the Swaziland Environment Authority a body corporate. It established a regulatory framework for environmental protection. It also provides for the integrated management of natural resources on a sustainable basis. Section 7 of the Act directly addresses waste issues.[22]

The Waste Regulations 2000

These regulations are meant to ensure appropriate waste management in Swaziland. It prescribes stringent sanctions in cases of poor management of waste. These regulations were not nullified by the EMA 2002 as long as they were consistent with it.[23]

National Solid Waste Management Strategy

This strategy was developed to implement the Waste Regulations 2000 and the EMA 2002. Its aim was to align waste management practices in Swaziland with international accepted practices.[24]

Two technologies were identified for TAP development in the waste sector. They include the construction of waste sorting and composting and are briefly discussed in Table 4-1.

Table 4-1: Waste sector technologies selected for TAP development

Subsector	Technology	Description	Level of uptake	Targets
Waste management	Waste sorting	This technology is on the sorting of waste at a central landfill to be constructed in Mafutseni.	Currently full waste sorting is done in Thabankulu by the RSSC. Waste is sorted	Waste from Manzini City, Matsapha (including Ezulwini), Siteki and Sikhuphe shall initially be sorted. Waste sorting will extend in the future to all municipalities.
Waste management	Organic waste composting	This is a technology involving the decomposing of organic waste in an oxygen rich environment to produce a fertiliser.	There is no extensive use of this technology in Swaziland. One example of where it is practiced is at Matsapha Town Board at the engineered landfill site.	Composting will be done next to the Mafutseni landfill. Campaigns wil be done to encourage composting nationally.

4.1.2 Action Plan for Technology B1: Waste sorting

4.1.2.1 Introduction

Waste that is not separated all ends up in the landfill thus taking more space than necessary. As the waste degrades over time it can produce leachate or toxic mixture at the bottom that can that can contaminate surface and ground water. The waste can also produce methane, a greenhouse gas that is 21 time more potent than carbon dioxide. Not only is methane a greenhouse gas but it is highly flammable and can lead to explosions at the landfill. Waste separating leads to the recovery of useful materials found in waste streams some of which can be reused, recycled and upcycled thus minimizing the amount of material sent to the landfill. The reason for waste separation can be to extract value in waste or to comply with environment regulations.

Waste can be sorted at source or at the landfill. Sorting can be done manually, semi-automatically or automatically. For this TAP a semi-automatic sorting system is suggested. The system envisaged can sort a minimum of 6 tons of waste per day. This is to match the total waste of Manzini, Matsapha, Siteki and Sikhuphe which are to have a central landfill in Mafutseni.

How technology is expected to reduce GHG emissions

The technology is expected to reduce GHG emissions by removal of combustible and biodegradable waste from that destined for the land fill. Combustible materials could accidentally ignite in the landfill producing GHG emissions and other pollutants. Biodegradable waste could decompose in the landfill producing methane a 21 times more potent GHG gas than carbon dioxide.

Current status of technology at the country level

There is currently no national waste sorting policy in the country. It is, however, waste sorting is practised in one company the Royal Swaziland Sugar Company (RSSC). The Municipal Council of Mbabane developed the Waste Regulations 2011,[25] which encourages sanitary waste management. The Municipal Council of Mbabane is implementing waste sorting at source. It provides waste bins for separate waste types like plastic, glass, tins and paper waste. A total of 18 000 tons of waste were recycled in the financial year 2016/17.[26] In addition, the municipality also encourages residents, particularly the youth, to engage in upcycling of the different solid waste streams. Interested individuals are allowed to visit their waste upcycling centres to learn how waste can be converted to higher value products for income generation. There is no automatic waste sorting equipment operating in the country.

Support for technology prioritisation

Several reasons were put forward by stakeholders for selecting this technology. The main ones are outlined here.

Reduction of GHG emissions: The removal of biodegradable waste can lead to the reduction of methane produced in the landfill thus reducing GHG emissions.

Job creation: This technology can create better jobs for the waste pickers who are currently working in an informal basis. The recyclable, reusable and upcyclable waste can also create other jobs down-stream.

Improved leachate quality: The separation of waste can lead to the removal of waste products that can result in the production of toxic leachate.

4.1.2.2 Ambition for the TAP

The initial implementation of the technology shall be at the proposed waste management site at Mafutseni, where waste from Manzini City, Matsapha, Siteki and Sikhuphe, shall be handled. This waste sorting facility shall handle at least 6 tonnes of waste per hour, to meet the 13 000 tons per year waste produced from these municipalities. The avoided emissions shall be from the reduction of biodegradable biomass material reaching the landfill. Biodegradable materials release methane when they decompose which is a more potent GHG than CO2. The amount of organic waste to be diverted from the landfill is expected to be 974 Gt that can result in avoided emissions of emissions 1 270 ktCO2e per year.

4.1.2.3 Actions and Activities for inclusion in the TAP

Summary of barriers and measure to overcome them

The barriers in the deployment of the technology seem to be high cost of technology and low opportunities or awareness of the downstream uses of the separated waste. The barriers and measures to overcome them are summarised in Table 4-2 below. The measures cionverted into actions are listed following the table.

Table 4-2: Selected barriers and their measures for waste sorting technology

#	Barriers	Measures
1	High cost of building sorting equipment	Access international waste and climate change funds
2	Low awareness on benefits of waste sorting	Collect and disseminate information
3	No regulatory framework on waste	There is no comprehensive waste policy and there is inadequate regulatory framework on waste

Action 1: Subsidise waste sorting equipment *through accessing climate change and waste management funds.*

Action 2: Increase awareness on waste issues *through collecting and disseminating information to the different stakeholders in appropriate format.*

Action 3: Develop the downstream use of separated waste *through the engagement of consultants to educate and train people wishing to make a living from waste products.*

Action 4: Develop enabling policies and regulatory framework *through stakeholder consultations on waste management.*

The actions and activities that can lead to the successful deployment of the building insulation technology are outlined in Table 4-3.

Table 4-3: Actions and activities for waste sorting technology

TAP overview table								
Sector: Waste								
Sub-sector: Waste management								
Technology: Waste sorting								
Ambition: The initial implementation of the technology shall be at the proposed waste management site at Mafutseni, where waste from Manzini City, Matsapha, Siteki and Sikhuphe, shall be handled. This waste sorting facility shall handle at least 6 tonnes of waste per hour. The avoided emissions shall be from the reduction of biodegradable biomass material reaching the landfill. Biodegradable materials release methane when they decompose which is a more potent GHG than CO2. The amount of organic waste to be diverted from the landfill is expected to be 974 Gt that can result in avoided emissions of emissions 175 ktCO2e per year.								
Benefits:	**Social**	• Job creation potential was considered to be in the actual waste sorting facility, and the use of the separated materials in areas such as composting, plastic recycling plants, energy waste to energy plants etc.						
	Economic	• Income will be generated in the sale of the useable waste material and the industries processing the separated waste						
	Environment	– Reduced GHG emissions from decaying waste and accidental waste fires						
Action	**Activities to be implemented**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Risk mitigation or contingency measure(s)**	**Sources of funding**	**Budget per activity (USD)**
Action 1: Obtain funds to support waste management programmes	**Activity 1.1:** Set-up a body to solicit funds for waste management	MTEA, MHUD and SEA	-	-	-	-	GEF, GCF, IRENA, AfDB, and other international partners	Budgeted for in Chapter 2
Action 2: Increase awareness on waste issues	**Activity 2.1:** MTEA, MHUD meet with SEA to develop awareness	MTEA, MHUD and SEA	-	-	-	-	-	200,000

	programmes on waste issues							
Action 3: Develop the downstream use of separated waste	**Activity 3.1:** Engage consultant to identify possible downstream uses of separated waste	MTEA	2020	Non-exhaustive identification	Most relevant downstream uses of waste identified	Make sure that all current and future possibilities of waste use are covered	UNDP, GEF, GCF and other international funders	100,000
	Activity 3.2: Produce training programmes on use of waste products targeting different stakeholders	MTEA	2020	Failure to attract quality programme developers	Good training programmes developed	Monitor process of selecting consultants	UNDP, GEF, EU, GCF and other international funders	250,000
	Action 3.3: Provide education and training to targeted stakeholders on down-stream uses of separated waste	MTEA	2021 – 2022	Inadequate education and training conducted	Appropriately educated and trained stakeholders	Monitor integrity of education and training	UNDP, GEF, GCF and other international funders	200,000
Action 4: Develop enabling policies and regulatory framework	**Activity 4.1:** Develop a new policy on waste management to encourage reuse, recycle, upcycle and	MTEA and SEA	2018 - 2023	Delays because MOJ have other legislative priorities	Appropriate legal framework in place	Monitor processes towards development of legislation	MTEA, UNDP, GEF, GCF and other international funders	100,000

	waste to energy technologies							
	Activity 4.2: Develop a regulatory framework and strategies for waste management	MTEA	2018 - 2022	Delays because MOJ have other legislative priorities and low participation by key stakeholders	Regulatory framework and waste strategies developed	Develop strategy to Motivate stakeholder participation	MTEA, UNDP, GEF, GCF and other international funders	100,000
Action 5: Build infrastructure	**Activity 5.1:** Acquire land	Implementing company	2023	Land too expensive	Land rights obtained	Negotiate agreement for access to land within or in proximity to the landfill	UNDP, GEF, GCF and other international funders	200,000
	Activity 5.2: Select staff and start operations	Implementing company	2023	Poor staff selection	Good selection of staff	Monitor recruiting process	Implementing company	10,000
	Activity 5.3: Acquire equipment and train operators	Implementing company	2023	Poor selection of equipment	Right equipment selected	Monitor equipment selection process	Implementing company, GEF, GCF and other international funders	1,500,000
	Activity 5.4: Monitor environmental benefits	MTEA and Implementing company	2023 and on-going	Improper indicators selected	Proper selection of indicators	Conduct prioritisation of environmental benefit indicators	MTEA, UNDP, GEF, GCF and other international funders	250,000

4.1.2.4 Stakeholders and Timeline for Implementation of TAP

Overview of stakeholders for the implementation of the TAP

There are several key stakeholders that their full cooperation will be needed for the implementation of the TAP. Since the TNA project is under the UNFCCC and the Focal Point is in MTEA, this Ministry is therefore its proponent. The technology itself on the ground shall address waste which is under the SEA a parastatal of MTEA. Table 4-4 summarises the list of key stakeholders and their roles.

Table 4-4: Stake holders and their roles in the implementation of the waste sorting technology

#	Stakeholder	Action	Role
1	Ministry of Tourism and Environmental Affairs	1, 2, 3, 4, and 5	Proponent
2	Ministry of Housing and Urban Development	2 and 4	Advocacy and outreach to residents on waste and regulatory framework
3	Ministry of Natural Resources and Energy	3	Waste to energy issues
4	Swaziland Environment Authority	2 and 4	Lead development of waste policies and regulatory framework
5	Ministry of Justice	4	Formulation of waste policy and regulatory framework
9	Municipalities	2 and 4	Inputs in awareness raising, and policy and regulatory framework
11	Residents	2 and 4	Inputs in policy and regulatory framework
12	Waste sorting company	3 and 5	Technology implementers

4.1.2.5 Estimation of resources Needed for Action and Activities

Estimation of capacity building needs

4.1.2.6 Management Planning

Risks and contingency planning

Risks and risk and contingency measures are outlined in the respective actions in Table 4-4. Other general risks are outlined in Table 4-5.

Table 4-5: General risks for the waste sorting technology and their contingency actions

Risk item	Description	Contingency action
Cost Risks	An activity costs more than originally planned	There has to be a budget allowance of 25% to account for price increases and the fluctuating local currency.
Scheduling Risks	An activity takes longer to complete than originally planned	The equipment is the turnkey type and it will be required that the manufacturer do the

		installation and commissioning.
Performance Risks	A technology or human resource does not perform as planned or environmental and social benefits not being delivered	The equipment has to be purchased with performance guarantees. The stability of the supplying company will also have to be evaluated to ensure that it will take the project installation and commissioning to completion.

Next steps

The immediate requirements to deploy the technology are outlined here as follows:

1. ***Develop a collaboration team between MTEA, MHUD and SEA to do work toe=wards the implementation of the TAP***
2. ***Organise international funding for awareness raising on waste issues***
3. ***Downstream uses of separated waste.***
4. ***Develop suitable waste policy and regulations***

4.1.3 Action Plan for Technology B2: Composting

4.1.3.1 Introduction

Composting involves making an heap of green materials such as kitchen scraps, grass clippings, vegetable peelings, garden waste etc. and brown materials such as newspapers, cardboard, straw, wood shavings etc. in alternative layers in equal amounts, starting with brown material at the bottom. The compost heap must be moist but not soaked. It should allow air in the mixture, and must be turned every 2 to 5 weeks to move the material in the inside to the outside and vice versa. The compost can be ready for application in the soil within 3 months. The final product is a fertiliser that contains the nutrients that were absorbed by the plants during their growth. The microorganisms in the mixture a responsible to extract the nutrients from the decomposing matter.

How technology is expected to reduce GHG emissions

The technology is expected to reduce GHG emissions by removal of biodegradable waste from that destined for the land fill. Biodegradable waste could decompose in the landfill producing methane a more potent GHG gas than carbon dioxide.

Current status of technology at the country level

There is currently low practice of composting in the country. This TAP could help people realise its benefits and increase its adoption from small scale implementation by domestic users to large companies employing people.

Support for technology prioritisation

This technology was prioritised for the following reasons:

Maturity of technology: The technology is mature and is practiced all over the world. If done at small scale no expensive equipment is needed.

Job creation: The technology could lead to job creation through centralised large scale composting facilities.

Mitigation: This technology can reduce GHG emissions through the diversion of organic waste from reaching the landfill where it can decompose and emit methane a GHG.

Rehabilitate degraded land: Composting can be used to rehabilitate degraded land.

4.1.3.2 Ambition for the TAP

The preliminary target is within the waste treatment site to be located at Mafutseni at the centre of Swaziland. This site will receive waste from Matsapha, Manzini, Siteki and Sikhuphe. Currently the total annual municipal waste from the first three municipalities amount to about 13 000 tons per year. Sikhuphe is yet to be a municipality. The amount of compostable organic matter generated is 61913 tons per year. The target is to initially compost 4180 tons of waste per year in 1 ha of land. There will also be campaigns to have composting practiced throughout the country in households, farms, agricultural processing plants etc.

Summary of barriers and measure to overcome them

The main barrier in implementing the technologies is the cost for the land and compost turning equipment. The main barriers and measures to overcome them are summarised in Table 4-6 below. The list of measures turned into actions follows.

Table 4-6: Selected barriers and their measures for the composting technology

#	Barriers	Measures
1	High initial investment cost	Gain access to climate change and waste management renewable energy funds to subsidise deployment of the technology.
2	Low awareness on befits of composting	Collect and disseminate information on composting
3	No regulatory framework to guarantee market for reasonable priced RE power or a transparent power purchase agreement method	Develop regulatory framework to guarantee reasonably priced locally generated biomass power for energy security and establish a transparent power purchase agreement methodology.
4	Inadequate skills for the operation and maintenance of power generation equipment	Up-skill artisans and engineers to install and maintain power generation equipment

Action 1: Obtain funds to support waste management programmes *through identifying suitable people and training them for writing bankable proposals.*

Action 2: Increase awareness on waste issues *through the collection and dissemination of information through various media targeted to different stakeholders.*

Action 3: Impart composting skills *through capacitation of trainers who then train people around the country on the technology.*

Action 4: Develop compost quality assurance resources *through upgrading existing laboratories for the capacity to analysis the quality of compost.*

Action 5: Develop regulatory framework for composting *through stakeholder consultations.*

The actions and activities that can lead to the successful deployment of the building insulation technology are outlined in Table 4-7.

Table 4-7: Actions and activities for the composting technology

TAP overview table								
Sector: Waste								
Sub-sector: Waste management								
Technology: Waste composting								
Ambition: The initial formal implementation of the technology shall be next to the proposed waste management site at Mafutseni, where waste from Manzini City, Matsapha, Siteki and Sikhuphe, shall be handled. There shall also be a national campaign to encourage households, and farms to adopt this technology. The amount of composting at the site is estimated to be 20.9 Mt of organic waste that shall be composted resulting in 1.27 kt CO_2e avoided emissions per year.								
Benefits:	**Social**	• There will be job creation potential in composting activities, and selling and distribution of the end product.						
	Economic	• Income will be generated for the purchase of clean organic matter and selling of the fertiliser product						
	Environment	– Reduced GHG emissions from decaying waste and accidental waste fires						
Action	**Activities to be implemented**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Risk mitigation or contingency measure(s)**	**Sources of funding**	**Budget per activity**
Action 1: Obtain funds to support waste management programmes	**Activity 1.1:** MTEA leads process to solicit funds for waste composting	MTEA, MHUD and SEA	-	-	-	-	GEF, GCF, IRENA, AfDB, and other international partners	Budgeted for in Chapter 2
Action 2: Increase awareness on waste issues	**Activity 2.1:** MTEA, MHUD meet with SEA to develop awareness programmes on composting organic waste	MTEA, MHUD and SEA	-	-	-	-	-	

Action 3: Impart composting skills	**Activity 3.1:** MTEA organise meeting with stakeholders such as municipalities, NGOs, farmers, and agricultural extension officers on composting	MTEA	2020	Low interest in composting	Meeting held with adequate stakeholders	Number and groups represented	MTEA	15 000
	Activity 3.2: Engage consultants to train stakeholders on composting	MTEA	2020	Consultants difficult to get	Training done to key stakeholders	Guide available qualified people how to provide training and monitor the process	GEF, GCF, AfDB, and other international partners	300 000
Action 4: develop compost quality assurance resources	**Activity 4.1:** Assess the capability of local laboratories for certifying the quality of compost quality	MTEA	2020	Inadequate assessment of the capacity of existing laboratories	Proper assessment of existing laboratories	Develop process to monitor the assessment	GEF, GCF, AfDB, and other international partners	50 000
	Activity 4.2: Provide assistance if required to upgrade chosen laboratory	MTEA	2021	Inadequate assistance given	Proper upgrading of laboratories	Set up systems in place to evaluate levels of upgrades	GEF, GCF, AfDB, and other international partners	200 000

Action 5: Develop regulatory framework for composting	**Activity 5.1:** Develop regulatory framework for composting	MTEA and SEA	2018 - 2022	Delays because MOJ have other legislative priorities	Appropriate legal framework in place	Monitor processes towards development of legislation	GEF, GCF, AfDB, and other international partners	20 000
Action 6: Build infrastructure	**Activity 6.1:** Acquire land and equipment	MTEA	2018 - 2021	Failure to access land and inadequate funds to purchase equipment	Access to land achieved and proper equipment purchased	If land is not accessible within the landfill have enough budget to purchase nearby land and equipment	Composting company, GEF, GCF, AfDB, and other international partners	812 000
	Activity 6.2: Prepare premises	MTEA	2021	Delays due to contractors and weather	Premises prepared successfully and in time	Have contracts with contractors and accept weather risk	Composting company, GEF, GCF, AfDB, and other international partners	135 000
	Activity 6.3: Hire and train staff and begin operations	MTEA	2021	Inappropriate staff selected	Trainable staff selected and successfully capacitated	Develop proper selection criteria	Composting company, GEF, GCF, AfDB, and other international partners	10 000
	Activity 6.4: Monitor environmental benefits	MTEA	2021 and on-going	Improper indicators identified	Proper indicators selected	Evaluate the appropriateness of each indicator	Composting company, GEF, GCF, AfDB, and other international partners	50 000

4.1.3.3 Stakeholders and Timeline for Implementation of TAP

Overview of stakeholders for the implementation of the TAP

The key government stakeholder for the composting technology is the MTEA which is the proponent. Table 4-8 summarises the list of other key stakeholders and their roles.

Table 4-8: Stakeholders and their roles in the composting technology

#	Stakeholder	Action	Role
1	Ministry of Tourism and Environmental Affairs	1, 2, 3, 4, and 5	Proponent
2	Ministry of Housing and Urban Development	1, 2, 3, 4 and 5	Development of composting regulations
	Ministry of Tinkhundla Administration		Advocacy and outreach on the composting technology
3	Swaziland Environment Authority	2, 4 and 6	Stakeholder in raising awareness; development of composting regulations and environmental impact assessment
4	Ministry of Justice	3 and 4	Development of waste policy regulatory framework on waste
5	Municipalities	3	Stakeholder in raising awareness and the development of composting regulations
6	Composting company	5	Implementers of technology

4.1.3.4 Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

4.1.3.5 Management Planning

Risks and contingency planning

The risk for each action has been covered in Table 4-7 above. They are expected to conduct their own risk analysis and mitigation as part of their extensive feasibility studies. Other general risks are outlined in Table 4-9.

Table 4-9: General risks for the composting technology

Risk item	Description	Contingency action
Cost Risks	An activity costs more than originally planned	The equipment for commercial composting is high and has to be imported. It may be necessary to make the budget 30% above the quotation.
Scheduling Risks	An activity takes longer to complete than originally planned	Scheduling risks should be minimal once financial resources are secured. Implementing this technology will involve acquiring land, preparing the surface, building the premises, and

		acquiring the equipment. All service providers must have binding contracts to limit problems.
Performance Risks	A technology or human resource does not perform as planned or environmental and social benefits not being delivered	The main performance risk is associated with low market for the compost material. There is therefore need for a vigorous market campaign prior to launching the project.

Next steps

The immediate requirements to deploy the technology are outlined here as follows:

1. ***Develop capacity to access waste and climate change funds***
2. ***Raise awareness on the benefits of the composting technology***
3. ***Develop regulatory framework for composting***
4. ***Develop capacity to analyse compost quality***

4.2 Project Ideas for the Waste Sector

4.2.1 Waste Sorting in Mafutseni Landfill

Introduction/Background

Waste sorting is the separation of waste into different categories like plastics, glass, metals, clean biodegradable, combustible, hazardous etc. Separated waste can be directed to different treatment suites for reusing, recycling, upcycling, conversion to energy or to a landfill or treatment plant.

Objectives

The aim of this project idea is to construct a waste sorting facility at the Mafutseni landfill site. This landfill will cater for waste from several municipalities including Manzini City, Matsapha (which include Ezulwini), Siteki and Sikhuphe. This site shall initially receive about 13 000 tons of waste per year or 48 tons per working day requiring the sorting of 6 tons of waste per hour.

Outputs

The out will be the installation of equipment at Mafutseni to sort 6 tons of municipal solid waste per hour.

Relationship to the country's sustainable development priorities

The National Development Strategy –Vision 2022 states Swaziland recognises that environmental management is a necessary condition for sustainable development, and that the Government of Swaziland is committed to the concept of sustainable development and to the implementation of Agenda 21. The country is striving for the incorporation of environmental policies in all is development strategies and programmes both in the public and private sectors.[2]

Project deliverables

A project deliverable will be the installation of a waste sorting facility that can sort a minimum of 6 tons of waste per hour.

Project scope and possible implementation

The facility will sort waste from Manzini City, Matsapha (which includes Ezulwini), Siteki and Sikhuphe.

Project activities

- Set-up a body to solicit funds for waste management
- Conduct awareness programmes on waste issues
- Identify possible downstream uses of separated waste
- Provide education and training to targeted stakeholders on down-stream uses of separated waste
- Develop a new policy and regulatory framework on waste management to encourage reuse, recycle, upcycle and waste to energy technologies
- Select and install equipment
- Train operators and start operations
- Monitor environmental benefits

Project Timeline

Project time frame is from 2019 to 2024

Budget/Resources requirements

- Equipment
- Capacity development for downstream waste usage

Measurement/Evaluation

Set up a system for monitoring and evaluation of the performance of the facility.

4.2.2 Organic Waste Composting in Mafutseni

Introduction/Background

Composting is the production of a fertiliser or soil conditioner from decomposing organic waste. It involves the placing of green (e.g. grass clippings, vegetable waste and fruit scraps) and brown (e.g. dead leaves, wood shavings and newspapers) waste in equal alternative layers into a moist heap. This heap has to be turned every 2 to 5 weeks to allow air into the mixture. The final compost material is ready for use in about 3 months.

Objectives
The objective is to have in place a demonstration composting facility in Mafutseni next to the panned landfill.

Outputs
The expected output is a composting facility that will initially produce 4180 tons of compost per year.

Relationship to the country's sustainable development priorities
This supports the sustainable goals of the National Development Strategy – Vision 22 that has one of its key objectives sound environmental management and sustainable development.[2]

Project deliverables
The deliverable will be a composting facility in Mafutseni processing 4180 tons of biodegradable waste into a compost fertiliser.

Project scope and possible implementation
The composting facility in Mafutseni will be for demonstration purposes. It is envisaged that other facilities will be developed throughout the country and that composting will be generally practiced at household level.

Project activities
- Solicit funds for waste composting
- Capacitate local laboratories for certifying compost quality
- Develop regulatory framework for composting
- Acquire land, equipment and start operations
- Monitor environmental benefits

Project Timeline
The project timeline is from 2022 to 2024

Budget/Resources requirements
Land
Equipment

Measurement/Evaluation
A measurement and evaluation system will be put in place to report on the quality, quantity and economics of the compost produced.

5 Technology Action Plan and Project Ideas for LULUCF Sector

5.1 TAP for LULUCF

5.1.1 LULCF sector overview

Mitigation in land-use change and land-use change and forestry can be through the planting of trees that can remain uncut for long periods of time, thus storing carbon. The growing trees can absorb carbon dioxide from the atmosphere and the standing trees can act as carbon storage. There are several legal instruments that support the forestry sector in Swaziland. Some of these are listed here.

Poverty Reduction Strategy and Action Plan (PRSAP) 2007

This strategy and associated action plan is meant for the promotion of improving the well-being of communities. It promotes increased income generation from agriculture on Swazi Nation Land.[27]

The Environmental Management Act, 2002

This Act converted the Swaziland Environment Authority into a body corporate and also and established the National Environment Fund. It was created to promote the enhancement, protection and conservation of the environment, sustainable management of natural resources and other relevant matters.[22]

Forestry Bill (2010)

This bill promotes sustainable forest harvesting. It addresses all bodies operating at the national and local level.[28]

The Game Act, 1953 and The Game 9 (Amendment) Act, 1991

An Act was meant for the preservation of game and other types of wild life in Swaziland. This would imply that the animal habitat would in turn have to be protected. That means the trees and other vegetation sequestrating carbon dioxide would also be preserved. The Act also promotes the establishment of wildlife sanctuaries. The Game Act was modified in 1991 by the introduction of the Game Amendment.[29]

National Forest Policy of 2001

It covers principles for the conservation of forest Biodiversity both in Swazi Nation Land and Title Deed Land. It lays down principles for the protection of the indigenous forest of Swaziland. The policy lays ground for the equitable sharing of benefits accruing from the conservation of forests.[30]

Two technologies were identified for TAP development in the LULUCF sector. They included agroforestry and urban forestry and are briefly described in Table 5-1.

Table 5-1: LULUCF sector selected technologies for TAP development

Subsector	Technology	Description	Level of uptake	Targets
Forestry	Agroforestry	Agroforestry is the use of the same land for	Formal uptake of the technology is currently low in the country. It is	

		agriculture or forestry, forestry and livestock at the same time. For example hay can be grown between trees or livestock can gaze in a forest when the tops of the trees are beyond reach.	practiced informally. There is forest company that has introduced cattle to their forest plantation to reduce the undergrowth that cause the spread of forest fires.	
Forestry	Urban forestry	Urban forestry is the planting or preserving trees within the urban boundary.	This technology is being practiced but in an informal way. Every urban area in Swaziland has trees growing on their own or planted for a variety of reasons and not specifically as a mitigation against climate change	

5.1.2 Action Plan for Technology C1: Agroforestry

5.1.2.1 Introduction

Agroforestry is the management and integration of trees, crops and/or livestock on the same plot of land and can be an integral component of productive agriculture. It may include existing native forests and forests established by landholders. It is a flexible concept, involving both small and large-sized land holdings. According to the Agroforestry Research Trust, here are some of the benefits of agroforestry:

1. They can control runoff and soil erosion, thereby reducing losses of water, soil material, organic matter and nutrients.
2. They can maintain soil organic matter and biological activity at levels satisfactory for soil fertility.
3. They can maintain more favourable soil physical properties than agriculture, through organic matter maintenance and the effects of tree roots.
4. They can lead to more closed nutrient cycling than agriculture and hence to more efficient use of nutrients. This is true to an impressive degree for forest garden/farming systems.
5. They can check the development of soil toxicities, or reduce exiting toxicities-both soil acidification and salinization can be checked and trees can be employed in the reclamation of polluted soils.
6. Trees can probably increase nutrient inputs to agro forestry systems by retrieval from lower soil horizons and weathering rock.
7. The decomposition of tree and pruning can substantially contribute to maintenance of soil fertility.
8. In the maintenance of soil fertility under agro forestry, the role of roots is at least as important as that of above-ground biomass.

9. Agro forestry can provide a more diverse farm economy and stimulate the whole rural economy, leading to more stable farms and communities. Economics risks are reduced when systems produce multiple products.

How technology is expected to reduce GHG emissions

The technology is expected to reduce GHG emissions by carbon storage. Trees absorb CO_2 from the air and store the carbon above and below ground throughout their lives which can be decades.

Current status of technology at the country level

Agroforestry is not done in a systematic manner in Swaziland. When people settle in an area with indigenous forest they tend to clear almost every tree for crop planting. They generally do not plant trees in between the fields as the benefit of such in generally not appreciated. When establishing a new field in forested areas most of the trees are cleared except for a few *Sclerocarya birrea* (marula) trees. A study by Allen, A, James showed that there was no complex or labour-intensive agroforestry practices in Swaziland and that the poorest of households did not have any trees at all. The richer households were found to be most likely to plant some fruit and ornamental trees, and woodlots.

The Small Enterprise Development Corporation (SEDCO) in 2014 launched a fruit tree programme to provide fruit trees of the same type to 100 households, 100 schools and 50 neighbourhood care points which are areas to provide meals to orphan and vulnerable children. The Department of Forestry also donates trees to communities from time to time and those trees have had a bad survival rate. Guba Farm also promotes Abor Day which is a day dedicated to planting trees in communities. The Anglican Church also has some activities where they plant trees around neighbourhood care points.

The stakeholders in the Workshop in Piggs Peak on 21 to 31 March 2017 identified the barriers such as water scarcity, the cost of seedlings, fencing, pests and disease control for the Agroforestry. The stakeholders in the workshop of 19 October 2017 and subsequent bilateral discussions pointed out that agroforestry through donated seedlings did not work before in Swaziland. A participant from the forestry sector said they once donated tree seedlings to a community. When they next visited a year later only 20% of the trees had survived. Stakeholders suggested that show need and can afford to take care of the trees must be sold seedlings at subsidised prices., have enough water already, have or can afford fencing, and can take care of the planted trees on their own. This was following the model used by SEDCO.

Support for technology prioritisation

Several reasons were put forward by stakeholders for selecting this technology. The main ones are outlined here.

Variety of resources from the same land: It was cited that one of the benefits of agroforestry is that there can be variety of products from the same land.

Mitigation against drought: Trees were said to be able to withstand drought in most cases. So if there is poor or no crop harvest, there could be some harvest such as fruits and nuts from the trees.

Reduce soil erosion: The plant roots could reduce soil erosion.

Viability: The technology was also considered viable in Swaziland.

5.1.2.2 Ambition for the TAP

The technology shall target 2 000 households each planting 20 trees giving a total of 40 000 trees. The target shall be areas where there are no water shortages for ease of implementation. The promotion of the technology shall be nationwide, also targeting private farms. The trees shall be allowed to bear fruit for 50 years, resulting in 69.2 Gt of CO2e sequestrated.

5.1.2.3 Actions and Activities for inclusion in the TAP

Summary of barriers and measure to overcome them

The barriers in agroforestry and measures to overcome them are summarised in Table 5-2 below. A brief discussion of why these measures were selected as actions follows.

Table 5-2: Selected barriers and their measures for the agroforestry technology

#	Barriers	Measures
1	Low awareness on the agroforestry technology	Increase awareness of the benefit of agroforestry
2	Lack of cooperation between stakeholders and working separately and not getting required results	Conduct awareness campaigns to stakeholders in the entire value chain and in all available platforms including brochures, traditional electronic media, print media, social media and community meetings
3	No coordinated training on agroforestry	Capacitate agriculture extension workers and to train farmers on agroforestry

Actions for the TAP

The actions for the TAP are discussed as follows below.

Action 1: Increase awareness on agroforestry issues *through various platforms to agriculture and extension workers, farmers and the rest of the agroforestry value chain.*

Action 2: Synchronise agroforestry initiatives in Swaziland *through identification and conducting a strength weaknesses opportunities and threats of the agroforestry value chain.*

Action 3: Train agriculture extension officers to support farmers on agroforestry *through engagement consultants to prepare teaching material and material to be provided to the farmers during their training.*

Action 4: Implement agroforestry TAP *through preparation of seedlings, distribution of subsidised seedlings; and monitoring the entire process of raising the trees.*

The actions and activities that can lead to the successful deployment of the agroforestry technology are outlined in Table 5-3.

Table 5-3: Actions and activities for the agroforestry technology

TAP overview table								
Sector: LULUCF								
Sub-sector: Forestry								
Technology: Agroforestry								
Ambition: The technology shall target 2 000 households each planting 20 trees giving a total of 40 000 trees. The target shall be areas where there are no water shortages for ease of implementation. The promotion of the technology shall be nationwide, also targeting private farms. The trees shall be allowed to bear fruit for 50 years, resulting in 69.2 Gt of CO2e sequestrated.								
Benefits:	**Social**	– The ease of availability of fruits could have health benefits in the community						
	Economic	– Income could be generated from the sale of fruits, timber and wood fuel						
	Environment	– GHG sequestration						
Action	**Activities to be implemented**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Risk mitigation or contingency measure(s)**	**Sources of funding**	**Budget per activity**
Action 1: Increase awareness on agroforestry issues	**Activity 1.1:** Collect and disseminate information on agroforestry	MTEA	2019	-	-	-	-	150 000
Action 2: Synchronise agroforestry initiatives in Swaziland	**Activity 2.1:** Identify agroforestry stakeholders and call a meetings to asses agroforestry activities	MTEA, MOA and DOF	2020	Poor identification and response to call for a meeting	Good attendance at meetings	Do a cross-check if all stakeholders were identified and contacted	GEF, GCF, and other international partners	15 000

	Activity 2.2: Conduct an analysis SWOT analysis of agroforestry activities	MTEA	2021	Poor SWOT analysis	Accurate SWOT analysis	Monitor the SWOT analysis process at every stage	GEF, GCF, and other international partners	100 000
	Activity 2.3: Link current agroforestry activities (seedling farmers, farmers, fruit and timber buyers) in a systematic way	MTEA, MOA, SEDCO and DOF	2021	Some players in the value chain may not exist in Swaziland	Entire value chain linked	Where there are a missing links develop them	GEF, GCF, and other international partners	50 000
Action 3: Train agriculture extension officers to support farmers on agroforestry	**Activity 3.1:** Hire consultants to develop a training programme for agriculture extension officers	MTEA	2020	Consultants may not be readily available	Consultants available and offer training	Use available personnel to develop capacity to train extension officers	GEF, GCF, and other international partners	50 000
	Activity 3.2: Engage consultants to prepare material to be used by extension officers in their	MTEA	2021	Poor material prepared	Quality material produced	Set-up system to check the quality of the material produced	GEF, GCF, and other international partners	200 000

	interaction with farmers							
	Action 3.3: Train agriculture extension officers on agroforestry	MTEA	2022	MOA may not release enough extension officers for training	Enough extension officers trained	Have several training sessions in smaller groups to accommodate	GEF, GCF, and other international partners	200 000
	Activity 3.3: Deploy trained extension officers to train farmers	MTEA, MOA and DOF	2022	Few farmers may attend training	Adequate farmers trained	Conduct another campaign prior to training	GEF, GCF, and other international partners	200 000
Action 4: Implement agroforestry TAP	**Action 4.1:** Prepare seedlings for farmers			Preparation may be impacted by pests and disease	Good quality seeds at the right quantities	Monitor the seedling preparation exercise to ensure that they are ready for spring planting	Farmers, GEF, GCF, and other international partners	1.328 million
	Action 4.2: Distributed seedlings to farmers			Problems with distribution logistics	Seedlings reach farmers accordingly	Pre-plan the distribution process and manage bottle necks	GEF, GCF, and other international partners	100 000
	Action 4.3: Monitor survival and growth of trees			Poor development of monitoring system	Proper monitoring and reporting	Develop good monitoring and reporting system	GEF, GCF, and other international partners	500 000

5.1.2.4 Stakeholders and Timeline for Implementation of TAP

Overview of stakeholders for the implementation of the TAP

The TNA project is under the UNFCCC and the Focal Point is in MTEA, it is therefore imperative that this Ministry champions the TAP. There are several key stakeholders that will be required for the implementation of the TAP, and are listed in Table 5-4 together with their roles.

Table 5-4: Stakeholders and their roles in the agroforestry technologies

#	Stakeholder	Action	Role
1	Ministry of Tourism and Environmental Affairs	1, 2, 3, and 4	Proponent
2	Department of Forestry	1, 2, 3 and 4	Provide guidance, consultants and prepare seedlings
3	Ministry of Agriculture	1, 2, 3 and 4	Provide extension workers
4	Swaziland Environment Authority	4	Look at issues of biodiversity
5	SEDCO	4	Promote tree planting for income generating opportunities
6	Timber industry	4	Provide knowledge and consultants
	UNISWA	1, 2, 3, and 4	Provide knowledge and consultants
7	Guba Farm	4	Advocacy and outreach
8	Anglican Church	4	Advocacy and outreach
9	Farmers	4	TAP implementers

5.1.2.5 Estimation of Resources Needed for Actions and Activities

Estimation of capacity building needs

5.1.2.6 Management Planning

Risks and contingency planning

Agroforestry risks and their associated mitigation actions are highlighted in Table 5-3. with low uptake, pests and diseases, breakage of the value chain. Other general risks are outlined in Table 5-5.

Table 5-5: General risks for the agroforestry technology and their contingency actions

Risk item	Description	Contingency action
Cost Risks	An activity costs more than originally planned	The requirement that only households with fencing, adequate water and adequate resources to take care of the

		trees limits the risks for the success of the project.
Scheduling Risks	An activity takes longer to complete than originally planned	The important thing is that the trees must be made available just before spring so that rain could supplement the watering. Also planting the trees in spring will give them all summer to grow.
Performance Risks	A technology or human resource does not perform as planned or environmental and social benefits not being delivered	Tree species have to be chosen so that they are suitable for the soil and weather conditions in the particular area. The value chains need to be continuously updated on the tree development to avoid link breakages. There also has pest and disease control measures in place.

Next steps

The immediate requirements to deploy the technology are outlined here as follows:

1. ***Get funding to for awareness-raising and implement information collection and dissemination*.**
2. ***Identify and strengthen agroforestry value chain*.**
3. ***Capacitate extension workers and train farmers*.**

5.1.3 Action Plan for Technology C2: Urban Forestry

5.1.3.1 Introduction

According to Climatetechwiki [1], "Urban forestry is the care and management of tree populations in urban settings for the purpose of improving the urban environment." According to the CIA Fact Book [2], Swaziland is urbanising at an annual rate of 1.3%. Urbanisation results in the transformation of areas with vegetation into settlements, formal and informal. This results in GHG emissions and reduces the carbon sequestration capacity of the transformed land. The urban forestry technology can help compensate for this negative impact on the environment sequestrating carbon-dioxide generated around the urban dwelling. The urban forestry technology has to be made an integral part urban development. The trees can be planted in a variety of places to serve different purposes of urban life. All green elements under urban influence comprise the urban forestry Examples include the following:

1. Street trees and road plantations
2. Public green areas, such as parks, gardens, cemeteries,
3. Semi-private space, such as green space in residential areas and in industrial or specially designated parks

4. Public and private tree plantations on vacant lots, green belts, woodlands, rangelands, and forests close to urban areas
5. Natural forests under urban influence, such as nature reserves, national parks and forests for eco-tourism.
6. Urban agricultural land, such as orchards, allotments etc.

How technology is expected to reduce GHG emissions

The technology is expected to reduce GHG emissions by the sequestration of carbon dioxide from the atmosphere through growing trees.

Current status of technology at the country level

Urban forestry is practiced throughout the country although mainly informally. Every urban area in Swaziland is characterised by the growth of trees some naturally growing and others planted.

Support for technology prioritisation

There were a number of reasons put forward by stakeholders for selecting this technology. The main ones are outlined here.

- **Cleaning urban air:** Urban forestry improves air quality by producing oxygen and trapping dust and smoke.
- **Aesthetic:** Urban forestry makes the urban area more accommodating and feeling homely.
- **Mitigation:** The urban forest absorbs CO_2 and stores carbon.

5.1.3.2 Ambition for the TAP

There are 12 recognised municipalities in Swaziland. These can be initially targeted for urban forestry development. In particular preliminary targets for urban technology are small towns and new suburbs around larger towns and cities. The number of trees to be planted in the different municipalities are indicated in brackets next to each municipality name: Mbabane (17500); Manzini (17500); Piggs Peak (17500); Mankayane (1750); Matsapha (7 000); Siteki (3 500); Lavumisa (1 750); Vuvulane (1 750); Hlathikhulu (1 750); Nhlangano (3 500); Ngwenya (1 750) and Ezulwini (3 500). This shall make a total of 63 000 trees.

5.1.3.3 Actions and Activities for inclusion in the TAP

Summary of barriers and measure to overcome them

The main barriers and measures to overcome them are summarised in Table 5-6 below. The list of actions derived from these measures follows.

Table 5-6: Selected barriers for the urban forestry technology

#	Barriers	Measures
1	Low knowledge of the benefits of urban forestry	Raise awareness on urban forestry and it benefits, and educated administrators of its importance.
2	No regulatory framework that supports urban forestry	Amend municipal bylaws to cater for urban forestry
3	Low knowledge on suitable trees for urban areas and how to care for them	Train general services personnel on urban forestry, suitable trees and how to care for them.

Action 1: Increase awareness on agroforestry issues *through information dissemination to politicians, administrators and residents in various platforms*

Action 2: Get buy-in from administrators for urban forestry support *through providing direct education on the need for urban forestry.*

Action 3: Amend municipal bylaws *through extensive stakeholder consultation to get the buy-in from residents.*

Action 4: Implement urban tree planting *through capacitating general services personnel on how to select suitable trees and how to take care of them.*

The actions and activities that can lead to the successful deployment of the building insulation technology are outlined in Table 5-7.

Table 5-7: Actions and activities for the urban forestry technology

TAP overview table								
Sector: LULUCF								
Sub-sector: Forestry								
Technology: Urban forestry								
Ambition: The technology shall target the planting of 63 000 trees around urban areas in Swaziland. Areas most targeted are the areas under development in municipalities.								
Benefits:	**Social**	– Have aesthetic appeal; provides shade, oxygen, recreation and food; act as noise dampers; and cleans the urban air by settling out, trapping and holding particulate pollutants like ash, smoke and dust.						
	Economic	– Income could be generated from the sale of timber, acts as wind breaks thus reducing the energy needed for heating and cooling.						
	Environment	– Benefits include GHG sequestration; reduced air pollution around the urban area; and reduced soil erosion thus reducing water runoff and increasing ground water recharge.						
Action	**Activities to be implemented**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Risk mitigation or contingency measure(s)**	**Sources of funding**	**Budget per activity (USD)**
Action 1: Increase awareness on agroforestry issues	**Activity 1.1:** Collect and disseminate information on agroforestry	MTEA and MHUD		-	-	-	-	100 000
Action 2: Educate administrators on local benefits of urban forestry	**Activity 2.1:** Engage consultants to prepare material for conducting workshops with	MTEA and MHUD	2020	No suitable consultants found	Proper education material prepared	Select from local institutions people that can be guided to prepare the training material	GEF, GCF, and other international partners	200 000

	municipality administrators							
	Activity 2.2: Hold workshops to inform administrators on the benefits of urban forestry	MTEA and MHUD	2020	Low level of interest	Adequate number of people trained	Hold meetings with municipalities to stress the importance of urban forestry	GEF, GCF, and other international partners	40 000
	Activity 2.3: Establish a budget line for urban forestry	MTEA, MHUD and Municipalities	2021 - 2022	Resistance to use ratepayer's money for urban forestry	Urban forestry budget line established	Find other sources of funding to ensure that urban forestry is budgeted for	GEF, GCF, and other international partners	10 000
Action 3: Amend municipal bylaws	**Activity 3.1:** Organise meeting with residents to introduce urban forestry	MTEA, MHUD and Municipalities	2021 - 2022	Low interest in the agroforestry subject	Adequate representation of stakeholders at meeting	Use encouragement and risk of being left for stakeholders in the consultations	GEF, GCF, and other international partners	20 000
	Activity 3.2: Make presentations on the benefits of urban forestry for amendment of bylaws	MTEA, MHUD and Municipalities	2021 - 2022	Presentations accepted by residents	Residents do not accept to change bylaws	Allow for discussions to continue in other platforms	GEF, GCF, and other international partners	10 000

	Activity 3.3: Establish forums to further exchange views on urban forestry	MTEA, MHUD and Municipalities	20 21 - 2022	No consensus reached	Consensus reached	Facilitate through the provision of information to the forums	GEF, GCF, and other international partners	50 000
	Activity 3.2: Amend municipal bylaws to accommodate urban forestry	MTEA, MHUD and Municipalities	2023	By laws amended with small majority	Agreement reached by reasonable numbers	Recommend the planting of trees that will be of direct benefit to the residents for acceptance	GEF, GCF, and other international partners	50 000
Action 4: Implement urban tree planting	**Activity 4.1:** Train general services personnel on urban forestry	MTEA, MHUD and Municipalities	2023 - 2024	Not enough staff to send for training	Staff trained on urban forestry	Organise freelance labourers to be trained for engagement as needed.	Municipalities	70 000
	Activity 4.2: Acquire tools and seedlings	Municipalities	2023 - 2024	Budget not enough	Enough budget available	Ask for donations of seedlings and tools	Municipalities, GEF, GCF, and other international partners	26.8 million
	Activity 4.3: Plant and take care of trees	Municipalities	2023 -2024	Plants do not grow as planned	Plants grow very well	Change plant species	Municipalities	3 000 Per year per municipality

5.1.3.4 Stakeholders and Timeline for Implementation of TAP

Overview of stakeholders for the implementation of the TAP

The MTEA has to lead in the implementation of the TAP as it holds the UNFCCC Focal Point. Table 5-8 gives the list of key stakeholders and summarises their roles.

Table 5-8: Stake holders and their roles in the urban forestry technology

#	Stakeholder	Action	Role
1	Ministry of Tourism and Environmental Affairs	1, 2, 3, and 4	Proponent
2	Ministry of Housing and Urban Development	1, 2 and 3	Work directly with MTEA to promote urban forestry to municipality administrators and residents
3	Municipality administrators	1, 2, 3 and 4	Persuade residents to accept the adoption of the urban forestry technology; amend bylaws; and implement the technology
4	Department of Forestry	3 and 4	Provide guidance on suitable trees for the urban environment and means to care for them
5	Residents	1, 3 and 4	Participate in the decision making of adopting the urban forestry technology, and take part in implementing the technology

5.1.3.5 Stakeholders and Timeline for Implementation of TAP

Estimation of capacity building needs

Estimation of costs of actions and activities

5.1.3.6 Management Planning

Risks and contingency planning

The greatest risk in the implementation of the technology is resistance by stakeholders to have a line budget for urban forestry. This can be overcome through extensive consultations with the residents as stated in actions in Table 7. Other general risks are outlined in Table 5-9.

Table 5-9: General risks for the urban forestry technology and their contingency actions

Risk item	Description	Contingency action
Cost Risks	An activity costs more than originally planned	The cost risks are minimal for urban forestry. It will involve the use of available labour and the tree seedlings are not likely to cost a lot.
Scheduling Risks	An activity takes longer to complete than originally planned	Ensure that planting is done in spring.

Performance Risks	A technology or human resource does not perform as planned or environmental and social benefits not being delivered	Trees may not be able to cope with the urban stress conditions.

Next steps

The immediate requirements to deploy the technology are outlined here as follows:

1. ***Raise awareness of the benefits of urban forestry.***
2. ***Achieve buy-in from urban areas administrators.***
3. ***Achieve buy-in from residents***
4. ***Amend municipal bylaws to accommodate urban forestry***

5.2 Project Ideas for the LULUCF Sector

5.2.1 Agroforestry in Swaziland

Introduction/Background

Agroforestry is the intentional integration of trees and shrubs into crop and animal farming systems to create environmental, economic, and social benefits. One example could be planting crops between rows of trees to provide income while the trees mature. The system can be designed to produce fruits, vegetables, grains, flowers, herbs, bioenergy feedstocks, and more. Another example is silvopasture that combines trees with livestock and their forages on one piece of land. The trees provide timber, fruit, or nuts as well as shade and shelter for livestock and their forages, reducing stress on the animals from the hot summer sun, cold winter winds, or a downpour.

Objectives

The objective is to plant 20 mangoes trees in 2 000 farms on SNL. The trees will produce fruit for income generation activities for the farmers and sequestrate carbon as a mitigation action.

Outputs

A total of 40 000 mangoes trees raised to fruit production.

Relationship to the country's sustainable development priorities

This project idea is in line with the Poverty Reduction Strategy and Action Plan as it can bring income to subsistence farmers on Swazi nation Land. It is also in line with broader environmental protection strategies.

Project deliverables

The project deliverable can be at least 80% of the plants raised to fruition.

Project scope and possible implementation
The project will be national to reach farmers in the four regions of the country. Through awareness raising the practice can be extended beyond the 2 000 farmers and to commercial farms.

Project activities

- Conduct an analysis SWOT analysis of agroforestry activities
- Link current agroforestry activities (seedling farmers, farmers, fruit and timber buyers) in a systematic way
- Train agriculture extension officers on agroforestry
- Deploy trained extension officers to train farmers
- Distributed seedlings to farmers
- Monitor survival and growth of trees

Project Timeline
The project timeline is from 2020 to 2021

Budget/Resources requirements
Consultants to develop agroforestry value chains
Capacitation of extension workers to provide training
Capacitor to monitor and report on all stages of progress

Measurement/Evaluation
Monitor the readiness and performance of the entire value chain.

5.2.2 Urban Forestry in Swaziland

Introduction/Background
Urban forestry aims to maximize the aesthetic, environmental, and economic benefits that trees provide to city residents and visitors by preserving, managing, and enhancing existing trees and other vegetation and promoting the reforestation of the urban area, through an active integrated program with community support and participation.

Objectives
The objective of the project idea is to plant 63 000 trees in 12 municipalities in Swaziland.

Outputs
The output will be the planting and growing of 63 000 trees in urban areas around Swaziland. The trees shall result in the sequestration of 1 785 t CO_2e over 30 years.

Relationship to the country's sustainable development priorities
This project addresses the National Development Strategy that promotes environments protection. The NDS also promotes interventions that help prevent infections such as respiratory diseases amongst others.

Project deliverables

The project deliverables will be sensitisation on the importance of urban forestry amongst residents and administrators. It will also support climate change mitigation through the planting and raising of the said number of trees.

Project scope and possible implementation

The scope of the project is nationwide. It will be implemented in all mucipalities in Swaziland.

Project activities

- Hold workshops to inform administrators on the benefits of urban forestry
- Establish a budget line for urban forestry
- Make presentations on the benefits of urban forestry for amendment of bylaws
- Amend municipal bylaws to accommodate urban forestry
- Train general services personnel on urban forestry
- Plant and take care of trees
- Monitor tree survival and growth rate

Project Timeline

The project timeline for the technology is 2020 to 2022

Budget/Resources requirements

Seedlings and planting: 1.328 million USD

Measurement/Evaluation

A system must be put in place to monitor the survival and growth of trees.

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Appendix Stakeholders involved in the Development of the TAPs

These are the stakeholders who attended the TAP workshop on 19th October 2017 and participated in the development of the TAP through further bilateral communication.

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6	Gcebekile Dlamini	Construction Industry Council		
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Interviews done

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3	Nomcebo Monareng (Public Health Officer)	Municipal Council of Manzini		76739308
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5	Trevor Smith	Suxe International	tds@suxe.co.uk	76446501