SESA
Smart Energy
Solutions for Africa

DELIVERABLE 4.1

DEMONSTRATION IMPLEMENTATION PLANS AND SET-UP OF REGIONAL PLATFORM

May 2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreement No. 101037141. This material reflect only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

Summary Sheet

Deliverable Number	D4.1
Deliverable Name	Five (5) Demonstration Implementation Plans and Set-up of Regional Platforms
Full Project Title	SESA – Smart Energy Solutions for Africa
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Contributing Partner(s)	ELICO, GEP, GG, LEITAT, MIGS, MET, SEI, SIN, SIEMENS, RISE, UR, UNEP, UNH, UEMI
Peer Review	ICLEI ES, TUB
Contractual Delivery Date	31-05-2022
Actual Delivery Date	10-06-2022
Status	Final First Version
Dissemination level	Public
Version	V1.0
No. of Pages	127
WP/Task related to the deliverable	WP4/T4.1
WP/Task responsible	BTH
Document ID	SESA_D4.1_ Five (5) Demonstration Implementation Plans and Set-up of Regional Platforms
Abstract	This document summarizes the on-going activities of Work Package 4 and outlines the key aspects of the demonstration actions in the modular living lab demonstration in Kenya, 4 validation demos in Morocco, Ghana, Malawi, and South Africa; and outlines the set-up of the SESA regional platforms.

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List of abbreviations

AU	African Union
BAU	Business-As-Usual
BoS	Balance-Of-System
CEPs	County Energy Plans
CHVs	Community Health Volunteers
CIDP	County Integrated Development Plans
CO_2	Carbon Dioxide
COP	Convention Of Parties
CSP	Concentrating Solar Power
CSTR	Continuous Stirred Tank Reactor
DC	Direct Charge
EE	Energy Efficiency
ESI	Electricity Supply Industry
EU	European Union
EV	Electric Vehicle
FGDs	Focus Group Discussions

FiT	Feed-In-Tariff
GDP	Gross Domestic Product
GHG	Green House Gas
GoK	Government Of Kenya
GW	Gigawatt
HDI	Human Development Index
HVDC	High Voltage Direct Current
ICT	Information And Communication Technology
IEA	International Energy Agency
IEC	Information, Education And Communication
IEC	International Electrotechnical Commission
INEP	Integrated National Energy Plan
IPPs	Independent Power Producers
KWh	Kilowatt Hour
LED	Local Economic Development
LED (lighting)	Light Emitting Diode
LPG	Liquefied Petroleum Gas
MW	Megawatt
MWp	Mega Watt Peak
NASA	National Aeronautics And Space Administration
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organization
PERG	Programme d'électrification rurale globale (Global rural electrification program)
PUE	Productive Use Of Energy
PV	Photovoltaic
RE	Renewable Energy
REMP	Renewable Energy Master Plan
RET	Renewable Energy Technologies
SESA	Sustainable Energy Solutions Africa
SDG	Sustainable Development Goal
SDS	Sustainable Development Scenario
SMEs	Small And Medium-Sized Enterprises
TV	Television
TWh	Terawatt Hour
UASB	Anaerobic Sludge Blanket
UN	United Nations
UNFCCC	United Nations Framework Convention On Climate Change
USB	Universal Serial Bus
VAT	Value Added Tax
WP	Work Package

Executive summary

This deliverable summarizes the on-going activities of Work Package 4 of the Sustainable Energy Solutions Africa (SESA) project (European Union's Horizon 2020 research and innovation framework programme under Grant Agreement No. 101037141). The SESA project involves a modular living lab demonstration action in Kenya, 4 validation demonstration projects in Morocco, Ghana, Malawi, and South Africa, and 4 replication demonstration projects in Namibia, Rwanda, Tanzania and Nigeria.

This report comprises Five demonstration Implementation Plans (for Kenya, Morocco, Ghana, Malawi and South Africa) and set up of the regional platform to satisfy deliverable 4.1. The five implementation plans and the regional platform set up have been collated in this one report.

The SESA project draws upon thematic experts from Europe and Africa from relevant fields of application to provide insights and guidance to the support co-development of the living labs. The implementation plans describe the context, need and implementation activities innovative energy solutions activities across the identified thematic areas in the different living lab locations. The identified thematic areas include:

- Solar energy: Kenya (test), Ghana (validation), South Africa (validation), Morocco (validation), Namibia (replication), Tanzania (replication), Nigeria (replication), Rwanda (replication)
- Clean cooking/ Waste to energy (Biogas for cooking): Ghana (validation), Malawi (validation), Rwanda (replication)
- Second life EV (Li-ion batteries) batteries: Kenya (test), South Africa (validation), Morocco (validation).

The experts involved in the development of the implementation plans will share their specific expertise and experience and provide technical advice related to feasibility, costs and benefits, and monitoring for good performance over the project lifetime. Experts will also support replicability of innovative measures. The direct involvement of international networks and initiatives will ensure a high level of visibility and replication of the innovations tested in this project.

The implementation plans have been developed to meet both environmental and social sustainability needs of their context, typically in both an urban and a rural demonstration. A brief summary of the demonstration actions follows:

Kenya: The demonstration implementation activities will be carried out at two project sites, Kisegi, a rural village in Homa Bay county, and Katito a peri-urban community in Kisumu County. Both demonstrations are solar charging hubs that houses PV modules, central Li-ion battery storage, and balance-of-system (BoS) to increase energy accessibility for a range of electrical needs within the local community.

Morocco: The demonstration implementation activities will be carried out in urban location in Marrakech and low socioeconomic rural region currently without access to grid electricity. The urban demonstrator will make 40 electric motorcycles available for use by female students. The rural demonstrator will install 10 mini grids with Li-ion battery storage for use by families in remote and energy impoverished locations.

Ghana: The demonstration implementation activities are located in the Ga North Municipal district, which is an urban settlement, and Atwima Nwabiagya Municipal Assembly, which is a rural community. The innovation tested is biogas cooking systems to improve the knowledge, skills, trust and capacity of stakeholders in the design, construction, operation and maintenance of this clean, cheap cooking technology. Fuel will be sourced from waste feedstocks.

Malawi: The living lab is located in Mchinji district, Traditional Authority Mawvere. It will provide affordable and reliable energy in one of the most energy impoverished parts of Africa where only 13.4% of the population are connected to the national electrical grid. The innovation implementation activities will involve a portable cooker, which will be fueled from compressed briquets of residual agricultural byproducts. The design will both reduce smoke emissions and provide by beneficial bio char as a waste byproduct for use in agriculture.

South Africa: The demonstration implementation activities are located in the Eastern Cape township of Alicedale and the semi-rural area KwaNonzwakazi on the outskirts of Alicedale. The demonstration innovation will include electric vehicle batteries and stationary storage applications, the demonstration will include the provision of infospots for Internet access. The off-grid community energy hubs will support a range of local community activities.

Demonstration implementation plans provide further details for all above-mentioned living labs. These plans were formulated based on identified needs from WP1, preliminary technical specifications and business models from WP3. The plans outline the concrete steps within the demonstration phase, including the impact assessments (WP1), links to the capacity development (WP2) and the adaptation of the business models (WP3). The demonstration activities funded by Smart Energy Solutions for Africa (SESA) include the identification of services, charging and vehicle providers and models for cost reimbursement and sharing. For the demonstration actions funded through other sources, potential funding partners will be identified and steps towards implementation will be identified in Task 4.3.

To support co-development of solutions, capacity building, funding and financing (SESA, WP2, 4, 5) regional platforms are set up. Regional platforms will help organize regional teams and support partners coordinate with other relevant regional projects to maximize the potential for take-up and replication of the energy innovations tested in this project. The SESA regional platform set up is also described in this document.

The implementation plans presented in this document report on the status of the demonstration implementation as of May 31 2022. The implementation plans are ‘living documents’ and will be regularly updated during the project lifetime. In three months’ time, Task 4-2: Co-develop demonstration actions, will build upon this document as the living labs continue to evolve over the SESA project life.

Introduction

This deliverable summarizes the on-going activities of Work Package 4 and outlines the key aspects of the demonstration actions in the modular living lab demonstration in Kenya, and in the 4 validation demonstrations in Morocco, Ghana, Malawi, and South Africa.

Demonstration implementation plans were developed for all above-mentioned partner living labs. These plans were formulated based on identified needs from WP1, preliminary technical specifications and business models from WP3. The plans outline the concrete steps within the demonstration phase, including the impact assessments (WP1), links to the capacity development (WP2) and the adaptation of the business models (WP3). The demonstration activities funded by Smart Energy Solutions for Africa (SESA) include the identification of services, charging and vehicle providers and models for cost reimbursement and sharing. For the demonstration actions funded through other sources, potential funding partners will be identified and steps towards implementation will be identified in Task 4.3. The regional platforms are being established as part of this task, to help organize the regional teams, support partners and coordinate with the GEF-7 sister project and other relevant regional projects to maximize the potential for take-up and replication of the energy innovations tested in this project. A common implementation methodology was developed, with the lead-partners for all regional teams (Africa). This formed the basis of detailed implementation plans as presented in this document; and includes all the activities needed for preparation and execution of the demonstrations, technical and operations issues, business model adaptation, stakeholder engagement and replication. The implementation methodology supports the teams to closely monitor the status of the demonstration projects, identify delays and criticalities and suggest corrective actions. The regional platforms and implementation teams are working closely with the WP2 capacity building team to support the training activities for the Living Labs and share their experiences with others to replicate innovation actions.

This document reports on the status of the demonstration implementation as of May 31 2022 and it will be regularly updated during the project lifetime.

Plan 1 - Demonstration Implementation Plan: Kisumu & Homabay Counties, Kenya

This demonstration implementation plan summarizes the ongoing activities and outlines the current state of the co-development site in Kenya. This document reports on the status of the demonstration implementation as of May 2022 and it will be regularly updated during the project's lifetime.

1. Operating environment

1.1 Background

Kenya seeks to undertake an ambitious mitigation contribution towards the Paris Agreement. Kenya aims to abate GHG emissions by 32% by 2030 relative to the BAU scenario, in line with the national sustainable development agenda and keeping with the Paris agreement of "substantially reducing global greenhouse gas emissions in an effort to limit the global average temperature increase to below 2 degrees Celsius above preindustrial levels, while pursuing additional means to limit the increase to 1.5 degrees" (United Nations, 2015). The country is endowed with abundant renewable energy resources including hydropower, geothermal, wind and solar, which the government is committed to harness and foster the development of low-carbon energy initiatives that can contribute to job creation, income generation and the improved livelihoods of vulnerable rural communities. Kenya commits to bear 21% of the mitigation costs from domestic sources, while 79% of this is subject to international support in the form of finance, investment, technology development and transfer, and capacity building. Kenya's Updated (2020) Nationally Determined Contribution (NDC) includes both mitigation and adaptation components based on the country's national circumstances and in line with decisions 1/CP.19 and 1/CP.20 (Ministry of Environment and Forestry, 2020).

1.1.1 Key facts and figures (combined for Kisumu and Homabay)

Nyanza region in the south Western part of Kenya is a key development region for Kenya providing a gateway to the rest of the East African region. One of its greatest natural resources, Lake Victoria, is the largest freshwater lake in Africa and a key source of livelihood for the rural and urban communities adjacent to it. The Lake is an important revenue earner for the country as a huge proportion of fish distributed in Kenya is sourced from the lake and some irrigated farming is also dependent on it. The agricultural and fishing sectors dominate as key income drivers. In addition, there is a large number of micro and small businesses, mostly consisting of market trade, small retail products, artisanal services, small scale construction and transport as well as some larger wholesale outlets. More than 40% of the local population live below the poverty line with many facing the challenge of poor access to affordable electricity, dependence on fossil fuel energy, unemployment, and lack of clean drinking water.

Table 1: Key Facts and Figures - Kisumu and Homabay

Key Facts	Value
Total population	6,269,579
Urban Population	1,005,048
Rural Population	5,264,531
(Population density (persons/sq.km)	497.5
Estimated number of households	999,089
Average household size	5.79
Population growth rate	1.4%

Source: Census 2019[1]

[1] (2019 Kenya Population and Housing Census Volume I: Population by County and Sub-County - Kenya National Bureau of Statistics, 2022)

1.1.2 Overarching issues

Rural communities: Most of the smaller fishing communities are still not connected to the national electricity grid or, as in many communities; grid connection is available but not affordable for household connections. Furthermore, the national grid power supply in the rural areas is very unreliable. Regular power black outs are occurring which can take up to several days, so that it is not possible to build a business on power consumption as the fuel to run generators is even more costly. The majority of rural communities also lack access to affordable clean drinking water opting to drink water from Lake Victoria, which is unsafe for human consumption.

The peri-urban poor: Significant portions of peri-urban households are considered poor and have a challenge accessing affordable electricity. Many are not connected at all. Those who are connected suffer from unreliable power supply and frequent power black outs. In addition to the frequently inconsistent supply, there are extra line losses, which are twice as high in contrast to the global average due to a poorly maintained network infrastructure. Furthermore, local electricity rates are sometimes among the world's most costly. Despite increased electricity generation capacity, the cost of electricity in Kenya has risen. Kenya's power generation system is heavily reliant on hydrological sources, which are heavily impacted by frequent and severe droughts, resulting in dramatic drops in water levels in reservoirs supplying water to hydroelectric power plants and, as a result, reduced power generation capacity. To balance this drop and ensure that supply is not significantly affected, hydro power is replaced by thermal electricity, which is heavily reliant on expensive imported fossil fuel oil, leading to an increase in electricity prices and, as a result, making electricity very expensive. This is further exacerbated by high electricity connection fees of $350 for customers within 600m of the transformer a fee that is too expensive for a majority of the peri-urban and rural poor.

1.2 Sustainable Energy Access overview

1.2.1 Recent Initiatives

A number of companies have entered the local market in recent years for solar lights and small, home photovoltaic (PV) systems. Most of these offer pay-as-you-go services to make their products affordable to low income earners. The most commonly used are small solar lights, but systems are also offered that have the capacity for phone charging and radio or TV. While these solar lights and small systems have helped a lot to improve access to clean energy, they are quite limited in scope and capacity and will not meet the needs when community members go to the next level and need energy for pumping water, running a fridge or a small business. Some work has also been done on wind energy and biomass. However, these have been very limited and, as a result, wind and biomass energy is generally not available for the common citizen.

1.2.2 Policy environment

The productive use of energy (PUE) space in Kenya is primarily regulated by a number of policies and regulations. These policies and regulations primarily look to regulate the following:

- Quality or minimum performance standards for solar and appliances
- Solar technician certification requirements
- Tariff-setting guidelines for mini-grids
- Taxation of imported equipment

Table 2: Policies and regulations on productive use of Energy, Kenya

Regulatory Framework	Overview
Energy Act 201	The Energy Act requires the Cabinet Secretary for the Ministry of Energy and Petroleum to develop, publish, and review renewable energy plans in order to ensure the delivery of reliable energy services while keeping costs to a minimum and creating a conducive environment for the promotion of investments in energy infrastructure development. The Act establishes the regulations governing the production, transmission, distribution, and sale of energy, as well as the roles and responsibilities of various governmental agencies and authorities. It also governs the use of renewable energy sources, petroleum, and coal.
Feed-in-Tariffs Policy on Renewable Energy Resource Generated Electricity (Small Hydro, Biomass and Biogas) 2021	The Energy Act includes a Feed-in-Tariff (FiT) System aimed at diversifying electricity generation through renewable energy sources; encouraging local distributed generation, reducing demand on the network and the technical losses associated with long-distance electricity transmission and distribution; encouraging uptake of, and stimulating innovation in, renewable energy technology; and reducing greenhouse gas emissions by reducing reliance on fossil fuels. The current FiT updates the first rates enacted in 2008, and now includes geothermal, solar, and biogas-generated power. The FiT Policy is a tool for encouraging the generation of electricity from renewable energy sources by guaranteeing producers a pre-determined tariff for a period of 20 years.
The Energy (Solar Photovoltaic Systems) Regulations, 2012	These regulations, enacted under Section 110 of the Energy Act of 2006, establish guidelines and requirements for the installation of solar photovoltaic (PV) systems in Kenya. They apply to the manufacturer, importer, vendor, technician, contractor, and system owner of a solar PV system, as well as solar PV system installation and consumer products.
The Draft Mini-grids Regulations, 2021	The Regulations were developed in accordance with Sections 10, 11, and 208 of the Energy Act, 2019 (the "Act") and will serve as Regulations to the Act. The Regulations will, among other things, give mini-grid developers and other stakeholders with guidelines on tariff approval and licensing requirements.
The Renewable Energy Auctions Policy, 2021	The auctions policy's major goal is to buy renewable energy capacity at competitive costs that are consistent with the LCPDP and the Integrated National Energy Plan (INEP). The Auctions Policy applies to solar and wind power projects, as well as other renewable energy projects with a capacity of more than 20MW.
Kenya Electricity Grid Code	The Kenya Electricity Grid Code is the fundamental technical document of the electricity supply industry (ESI), compiling the vast majority of technical regulations governing the generation, transmission, distribution, and supply of electrical energy.
The VAT Act 2018 and Finance Act 2020	All specialized solar equipment and accessories are exempt from VAT under the VAT Act of 2013. The Act, however, limits specialized equipment to those employed in the development and generation of wind and solar energy, including deep-cycle batteries that consume or store solar electricity.

1.2.3 Business environment

There are several small companies that are working on improving access to clean energy. Power Hive has set up several solar mini-grids in neighboring Kisii County and are also piloting an e-mobility operation. There are a number of companies offering solar lights and small home systems. Many of these are on pay-as-you-go schemes to make the products more accessible. However, the product range is fairly limited.

1.2.4 Sustainable Energy financing

As mentioned above, small home systems are accessible on pay-as-you-go schemes. However, these are limited in size and scope.

1.2.5 Capacity

There are several companies marketing solar home systems, mainly for lighting, but also for phone charging and other small appliances such as TV, radio and torch. Again, some companies, such as Power Hive, are implementing solar mini-grids in some communities in the neighboring county of Kisii and including electric motorbikes as part of their program. However, while the solar companies have reached well into rural communities, what they offer is fairly limited. There is a need to develop the sector much more in order for access to clean energy solutions to be widely available to communities throughout the region.

1.3 Key Stakeholders

The SESA project is built on co-creation and engagement with key stakeholders at all levels to ensure the success of demonstration activities. This will necessitate positive and active participation at all levels of the energy sector, from the project's target users to local and national stakeholders. WETU will use stakeholder meetings to introduce the project and develop interest in supporting project activities, beginning with community sensitization workshops. Stakeholders will be continually engaged in order to understand their changing needs and to involve them in the generation of ideas for the intended use cases and services. This would also entail ongoing involvement of stakeholders with targeted messaging to communicate project history or reasoning, including technical and material justification, to key stakeholders and user groups whose participation is required and is crucial towards the success of the demonstration actions and use cases.

Table 3: Stakeholders and their Involvement

NAME OR GROUP Users, Government, Donor, Project Partners	ROLE	PREDISPOSITION Current commitment profile: resistant, ambivalent, neutral, supportive/committed	ANTICIPATED INVOLVEMENT What level of involvement is expected? (High, medium, neutral or Low)	ANTICIPATED ISSUES Known or potential issues
Host Community	Residents and prospective users hosting the project and will be co-creators of products and services developed based on local needs and priorities.	Supportive	High	_Lack of buy in and goodwill without proper engagement _Personal interests _Political interference (Negative effects of project 'owning') __Expectation of financial remuneration and free services or goods (negative NGO culture)
LOCAL GOVERNMENT ADMINISTRATION				
Chief Assistant Chief Village elders	_Legal Insights _Administrative support in project rollout & Implementation _Insights on community peculiarities _Historical	Supportive	Medium	_Lack of buy in and goodwill without proper engagement _Personal interests (seeking job opportunities in the

Ward administrator	perspectives on prior projects			organization for locals _Political interference (Negative effects of project 'owning') __Expectation of financial remuneration and compensation for time
Public Health Officers	_Oversight and implementation of public health communication and education initiatives _Supervision of community health volunteers (CHVs) _ Assessment of project site in compliance with GoK health and safety guidelines/standards	Supportive	Medium	_Expectation of financial facilitation and compensation for time _Request for Information, education and communication (IEC) materials
Community Health Volunteers (CHV)	_Community mobilization and engagement _Frontline health educators _ Data collection _Local community information dissemination _Distribution of IEC materials	Supportive	High	
COUNTY GOVERNMENT				
County Assembly	_The primary political institution representing the devolved unit of government where the project will be located.	Supportive	Medium	_Bottlenecks with licensing and approvals _Financial incentives for permits _Lack of political goodwill and project support _ Political transition of office bearers _ Availability of county government officials _Lack of awareness of anticipated project activities and objectives _Staff turnover and promotions
Fisheries Directorate	_Tasked with approving and licensing proposed projects (where applicable), as well as verifying community participation in the project and ensuring proper community and public consultation.	Supportive	Medium	
Water & Environment Department		Supportive	Medium	
Ministry of health - Department of Public Health		Supportive	Medium to High	
Ministry of Energy		Supportive	Neutral	
Ministry of Trade, Investments and Industrialization - Department of Industrialization		Neutral	Neutral	

Water Resources Authority (WRA)	_Regulation _ Strategic policy advice _ Sectoral expert advice Coordination of environmental management activities carried out by a variety of actors.	Supportive		De registration due to non-compliance _Policy changes
National Environmental Authority (NEMA)		Supportive	Medium	
Kenya Bureau of Standards (KEBS)		Supportive	High	
Energy and Petroleum Regulatory Authority (EPRA)	Responsible for the technical and economic regulation of the energy sector.	Neutral	Low	
National Gender and Equality Commission	Responsible for ensuring compliance and promoting gender equality and freedom from discrimination	Neutral	Medium	
Kenya Electricity Generation Company (KenGen)	Production of electricity and development of power plants.	Neutral	Low	
National Environment Trust Fund (NETFUND)	Mandated to facilitate research aimed at advancing environmental management requirements, capacity building, environmental awards, environmental publications, scholarships, and grants.	Supportive	High	
Rural Electrification and Renewable Energy Authority	Government lead agency for the development of renewable energy resources other than Geothermal and hydro power	Neutral	Low	
National Gender and Equality Commission	In accordance with Article 27 of Kenya's Constitution, they are responsible for ensuring compliance and promoting gender equality and freedom from discrimination.	Neutral	Medium	None
CIVIL SOCIETY				
E-waste Initiative Kenya (E-WIK)	The core business is electronic waste management in the informal sector, providing safe disposal options across the country by	Supportive	Medium	None

	leveraging informal sector networks.			
Practical Action		Supportive	Medium	
LOCAL ASSOCIATIONS				
Community leaders	Representatives of the respective ethnic community who are culturally and socially mandated	Supportive	High	_Negative effects of political changes in office _resistance to project activities and solutions _ Lack of willingness and ability to pay for services or products
Beach Management Units (BMUs)	Entities formed and designed by the government and the community to manage fishing activities around the lake.	Supportive	High	
Boda Boda Associations	Local representative association of the two-wheel motorcycles operators (boda bodas)	Supportive	High	
Womens Groups (Chamas) and Youth Groups	Women and young people in the local community face barriers to obtaining a living and finding work. In terms of products and services, services to assist women and youth in bettering their lives will be defined separately based on their needs and identified priorities.		High	
Existing businesses and social enterprises	Existing businesses and social enterprises will be able to use our services and products, so they will be important to consider in our project planning.	Supportive	High	
Vulnerable Groups	Vulnerable groups also reside or work in the chosen area and host community, and they must be taken into account as users and project participants. They may be vulnerable in different ways, such as being disabled or living with HIV, necessitating a diversified approach to meaningful participation in the project and access to information.	Committed	High	
PRIVATE SECTOR				

Kenya Renewable Energy Association (KEREA)	An independent non-profit association dedicated to the growth and development of renewable energy businesses in Kenya	Supportive	High	None
Kenya Private Sector Alliance (KEPSA) - Centre for Energy Efficiency and Conservation (CEEC)	In collaboration with the Ministry of Energy, the Kenya Association of Manufacturers (KAM) established the Centre for Energy Efficiency and Conservation (CEEC) to manage government-supported energy efficiency and conservation initiatives aimed at assisting facilities in identifying energy waste, determining potential savings, and recommending appropriate measures.	Neutral	Medium	
Africa Mini grid Developers Association (AMDA)	Industry association representing private utilities developing small, renewable, localized power grids.	Neutral	Low	
Association for Electric Mobility and Development in Africa (AEMDA)	Association based in East Africa that aims to establish and sustain an ecosystem for the quick transition to a low-carbon transportation sector fueled by electric vehicles.	Neutral	Medium	
INTERNATIONAL DEVELOPMENT PARTNERS				
European Commission	The project donor wishes to strengthen cooperation with the African continent in order to promote sustainable actions and find local solutions to global challenges that disproportionately affect the African continent.	Supportive	High	None
European Climate, Infrastructure and Environment Executive Agency (CINEA)	Manage the project's life cycle and monitor its technical and financial implementation, ensuring the SESA project's sound technical and financial management.			

SESA Project Consortium Partners	Co-development of demonstration, validation and replication actions Full analysis and evaluation of the demonstration action results			
RESEARCH INSTITUTIONS				
University of Nairobi - Institute of Climate Change and Adaptation (ICCA)	The ICCA academic programs at the University of Nairobi build climate change and adaptation capacity for national, regional, and international candidates seeking to enrich their studies through transdisciplinary approaches to learning and solving the modern challenges posed by climate change.	Neutral	High	None
Strathmore Energy Research Centre	An applied technology lab inside Strathmore University formed to provide high-quality research and advisory services to the renewable energy sector in Kenya through professional training, laboratory testing, and project development.	Neutral	High	
The Center for Research on New and Renewable Energies at Maseno University	Maseno University established the Center for Research on New and Renewable Energies with the goal of addressing all issues related to New and Renewable Energies locally, regionally, and internationally, with a focus on rural applications. The center's goal is to promote bio-energy, geothermal energy, hydro-energy, marine energy, solar energy, and wind energy processes.	Neutral	High	

2. Demonstration Action

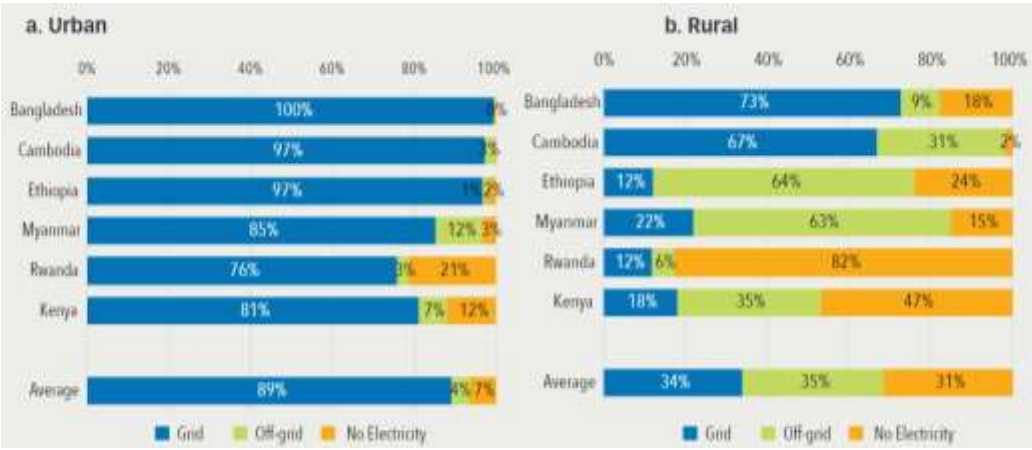
2.1 Overall Objective

The main objective is to develop a modular demonstration project to provide sustainable energy access solutions that are relevant for validation and replication in both urbanized and rural contexts in Africa, creating opportunities to generate sustainable off-grid electricity, with sector linkages such as fishing, water pumping, water purification, e-mobility and waste management and combining energy solutions with local Info Spots for access to information, on energy, climate change and digital skills. The proposed modular demonstration case aims to address the three main innovation focus areas in energy transitions, namely access, productive use, and a circular economy. It aims to provide sustainable energy access solutions that are relevant for both urbanized and rural contexts in Africa, by creating opportunities to generate sustainable off-grid electricity. The result will be increased access to energy and utilization of energy for productive use.

2.1.1 Situation analysis

Electricity: The Kenyan government's various efforts to expand the national grid and improve last-mile connectivity have resulted in increased access to electricity in recent years. Kenya's national electricity grid operates as an integrated network connected by 220kV and 132kV transmission lines, as well as a few 66kV transmission lines. However, design flaws that cause frequent power outages and technical and non-technical losses have posed the greatest challenge to the development of the energy sector, particularly in rural and peri-urban areas of Nyanza. This, in combination with the high cost of electricity imposed on consumers, as well as the high cost of connecting to unreliable and unstable electricity grids, has proven to be a barrier to grid connectivity for many households and businesses in peri-urban and rural communities. There are significant differences in access to electricity between urban and rural households (Figure 1). In rural areas, 46.5% of families lack access, compared to only 11.8% of urban households. Grid users face the greatest disparity. While over 80% of the urban population has grid connection, fewer than 20% of the rural population does. In the lack of grid access, many rural homes rely on off-grid sources, with solar solutions dominating the field, followed by rechargeable batteries and diesel generators. Off-grid alternatives are used by 35% of rural households but only 7% of urban households. The following table shows a percentage for transformation of the population with access to electricity in Kenya with comparisons for source of electricity for urban and rural populations:

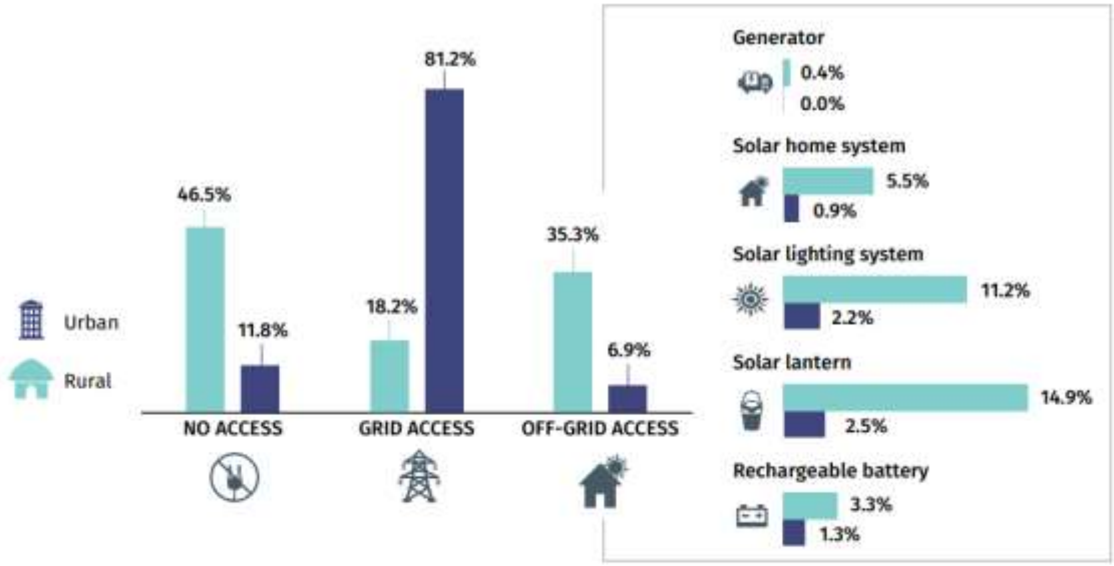
Figure 1: Electricity access rural vs urban areas of Kenya compared to Asian and East African countries



Source: MTF, World Bank [2]

[2] 2020. Kenya - Beyond Connections: Energy Access Diagnostic Report Based on the Multi-Tier Framework. World Bank, Washington, DC.

Figure 2: Electricity Access and off grid technology access for urban and rural areas in Kenya



Source: MTF, World Bank

Fishing: For fishing lights, many Omena (silver cyprinid) fishermen use small bulbs attached to a motorcycle lead-acid battery or kerosene pressure lamps. The main energy source for lighting around Lake Victoria has been kerosene, which is inefficient because only 0.1 % of the burnt kerosene is converted into light, resulting in relatively high CO_2 emissions. This demonstrates that kerosene pressure lamps are inefficient and polluting, exposing fishermen to toxic fumes and polluting the lake as kerosene leaks into the water and the lamps emit large amounts of CO_2. However, due to a lack of credible socioeconomic data on the number of fishermen and their fishing habits, it is impossible to estimate their CO_2 emissions accurately. However, a few fishermen still use kerosene pressure lamps, which are no longer widely used. Ugandan authorities appear to be particularly apprehensive about solar-powered fishing lights, which affect Kenyan fishermen who fish near the border or even within Ugandan waters. There are businessmen (competition) who want to stop the growth of the WeTu lights business and support Uganda's position.

Water pumping: A number of companies have developed solar powered pumps for small scale irrigation. These are continuing to gain in popularity and usage. However, the general level of uptake is still relatively low in the Nyanza Region. There is a lot of potential for expansion and development in the sector. Farmers were once provided with free irrigation facilities by the Kenyan government, but this is no longer the case. Farmers are now responsible for a larger, if not the entire, investment cost of providing water for their various uses. One of these uses has been water for irrigation in horticulture, which has played an important role in shaping the socioeconomic and sociotechnical landscape by utilizing petrol pumps as a central component in water pumping. Petrol pumps were first used and spread through social relationships based on seniority and kinship, and then by entrepreneurs and business people. Kinship and seniority have greatly shaped farming practices and strategies as they are centered around access to land and finances shaping the possibilities of purchasing or lease of petrol pumps. Introduction and widespread use of petrol pumps has led to evolution of the horticulture and agricultural sector as it has led to livelihoods diversification however at the detriment of the environment through use of fossil fuels and pollution due to seepage of petrol onto land.

Safe Drinking Water: Water quality throughout the lake basin has been severely harmed by both point and non-point pollution sources, with the latter being closely linked to land use and management practices. Catchment degradation caused by tree cutting and deforestation for biomass or construction, sand harvesting, unsustainable agricultural practices, and encroachment on wetlands has resulted in serious water contamination throughout the Lake Victoria basin. This is exacerbated by pollution of urban water sources caused by municipal wastewater, domestic sewage, and industrial effluents, which is also a major issue. Water-related diseases are thought to account for roughly 80% of all communicable diseases in Kenya. Currently, it is estimated that only about 31% of the urban population in the lake basin region has access to piped water provided by Water Service Providers, while the remaining 16% rely on unimproved water sources. The remaining 53% get their drinking water from groundwater sources such as unimproved and protected water sources. In rural areas, approximately 25% of the population draws water directly from rivers, ponds, and lakes, while the remaining 70% uses groundwater. In terms of piped water only 5% of the rural population has access to it, compared to 31% in urban areas. The current water demand accounts for approximately 5% of the total available water resources. Although the water balance indicates that total annual demand is less than available water resources, there are chronic water supply deficits, particularly during dry months or seasons when demand for safe drinking water exceeds availability.

Mobility: There are just a few companies working with e-mobility solutions in the region. Kisumu County and Kenya Power and Lighting Co. have introduced electric motorbikes for some county officers and meter readers in Kisumu. Other than these two initiatives, there is essentially no company promoting the use of electric vehicles in the region. Nearly all vehicles are fueled by petrol or diesel engines and the level of awareness of the development of electric vehicles is very low.

Agriculture and Cold Chain: The region's dominant economic activities are fishing and subsistence farming. Despite favorable climatic conditions, agricultural productivity remains low due to the use of traditional farming methods as well as cultural practices of generational land subdivision, which has resulted in the dominance of small land holdings with limited agricultural activities. In terms of fishing, hazardous fishing methods such as the use of non-compliant fishing nets, kerosene lamps, and lead acid battery powered lamps have resulted in declining fish stocks and lake pollution. Few fishermen, horticulture farmers and market traders in Nyanza's rural and peri-urban areas have access to cold storage facilities or refrigerated transportation to keep their produce fresh after harvest. This widespread lack of refrigeration infrastructure has been attributed to the high initial investment cost of purchasing cooling units, as well as the unreliability of local electricity grid supply. This lack of infrastructure causes widespread spoilage of fresh produce following the post-harvest process.

Electronic Waste management: There is currently no project or company promoting the safe processing of electronic waste in the region. Electronic wastes are generally dumped and some component parts removed in informal and hazardous conditions. Waste management is largely informal and dominated by informal sector players.

Information (infospots): Climate change information and energy monitoring services can be delivered more efficiently, flexibly, and reliably if they are built on an appropriate ICT platform. There is advanced mobile phone technology available, such as 4G and 5G, which are established global standards for mobile connectivity and allows remote control, operation, and monitoring of systems and appliances. Blockchain and IoT are rapidly evolving, presenting new opportunities for optimized energy performance and innovation for remote monitoring system performance of the mini-grid, real-time customer payments, climate change and health messaging dissemination. The main issue is that current off-the-shelf solutions are not designed or are unsuitable for rural and peri-urban environments and they are prohibitively expensive.

2.1.2 Barriers to establishing the local demonstration activities

Barriers related to environmental impacts: Water pollution, soil erosion, and water hyacinth are three major environmental challenges in the Lake Victoria basin region that could pose an inherent challenge to demonstration actions. Water pollution from industrial discharge, unregulated mining practices, and increased fertilizer use pose a significant threat to Lake Victoria waters. This is exacerbated further by a rapidly growing population, deforestation, poor sanitation practices, and unsustainable waste disposal practices, all of which contribute significantly to the Lake pollution challenge. Soil erosion caused by deforestation for wood fuel, timber for construction, and land annexation for crop cultivation all contribute to further pollution of Lake Victoria's waters. Strong winds blow water hyacinth towards the Lake's shores on occasion, clogging shallow waters that communities rely on for domestic use, crop irrigation, and livestock water. Water hyacinth is also contributing to the loss of biodiversity in the lake, owing to a lack of oxygen for certain species.

Capacity and awareness barriers*:* Introducing new or relatively new technologies has an inherent challenge in that people are comfortable with what they know and will always be extra critical and suspicious of something new. This is particularly relevant to e-mobility and battery packs for home and business use. There is still a relatively low awareness of solar power being used for charging batteries for e-mobility or for basically any use other than small lights. It will take some time for folks to get used to electric vehicles and to trust the technology. Again, the general level of awareness of the local environment and pollution is very low. Many people are not aware that they are drinking contaminated water and they do not see the pollution from ICE vehicles as a threat to their health. When awareness is low, there is not a lot of excitement about technologies that reduce pollution.

Policy Barriers: In its Vision 2030 development goals, the Kenya government has made it a goal to promote the development of renewable energy. However, on the ground, the government has continued to make it more and more difficult to implement the building of renewable energy infrastructure. Customs duties which were removed for solar energy products have slowly been coming back over the last 10 years. Again, the requirements for a business to deal in clean energy products has become very high making it more difficult to start up and operate in this sector. However, there appears to be a lack or delay in the formation or adoption of adequate legal and policy frameworks by county administration and respective county assembly at the county level. This is exacerbated by the county assembly's lack of technical expertise and inefficiency in formulating adequate renewable energy legislation. The Energy Act of 2019 transferred responsibility from the legislature to the executive branch of government, which is now in charge of developing the energy sector at the national and county levels. As a result, counties must domesticate national policies into county integrated development plans (CIDP). However, some counties continue to believe that the national government is in charge of all energy generation, and the county's role in this regard is unclear. This shift has also resulted in a lack of renewable energy policy as a result of staff turnover due to political appointments, which has been exacerbated by skillsets that are not aligned with technical competencies required for the formulation of energy sector policy.

Furthermore, the lack of renewable energy policies has resulted from County Integrated Plans (CIDPs) being developed independently, as have County Energy Plans (CEPs). CEPs must be developed alongside CIDPs to mainstream planning of renewable energy resources to meet local needs for sustainable energy policies and legislation at the county level. There must also be spatial planning in the development of CIDPs. Currently, CIDPs are not spatialized, and spatial planning is not a requirement for their development. For energy and renewable energy policy to be developed, spatial and sectoral planning are required. Unfortunately, there is still a lack of knowledge, tools, and human resources at the county level to carry out this critical function. Because energy has not been a top priority in some counties, there are people assigned to the energy sector who are not necessarily energy professionals.

Barriers due to Gender relations in the fish trade: There is a practice in the Lake Victoria region of distributing fish and benefits in exchange for sex known as "fish for sex," also known as jaboya in Luo. Sexual favors are usually exchanged between male fishermen and female fish processors or traders in exchange for preferential access to fish and fish for domestic consumption. However, the extent of this practice is not well documented, so there is no way of knowing how widespread it is. The prevalence of poverty, a lack of alternative livelihoods, and declining fish stocks have all been major motivators for this practice.

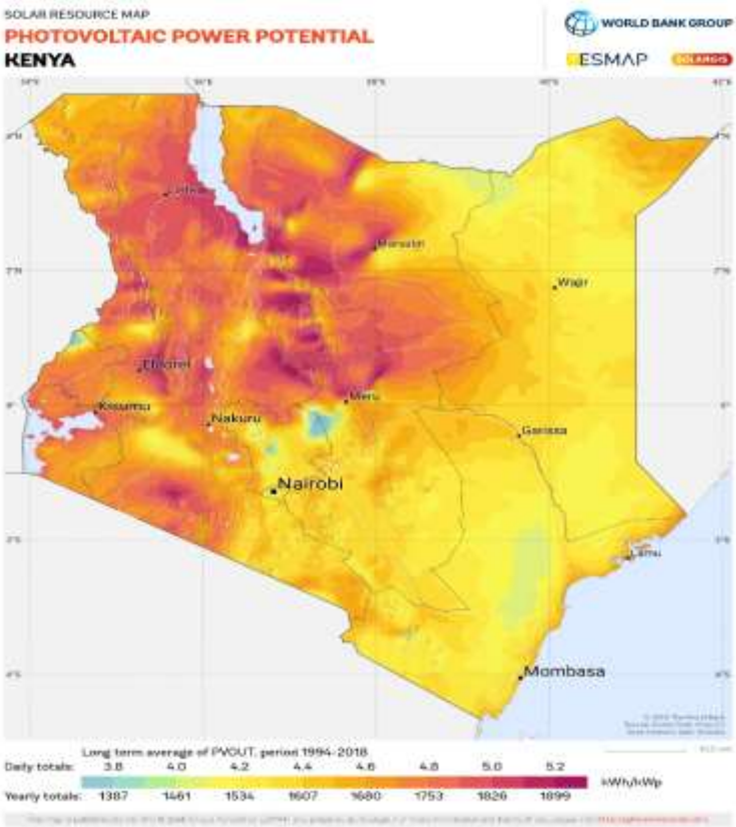
Barriers due to lack of information on energy resource base and demand: In terms of energy and related energy use, there is currently insufficient data on the energy resource use and base in and around the Lake Victoria basin region. In the region, the same is true for renewable energy sources and related technologies. There is no obvious distinction between on demand and consumption in the data given. This is a problem that has to be addressed as soon as possible. The manner in which information is communicated and presented is also critical. As a result, programs for correct inventory of energy resources, as well as reliable data on energy use, production, and conversion processes, should be designed and implemented. Further to this improved environmental assessment tools should be developed and implemented to appropriately analyze the socioeconomic and environmental impact of various energy options introduced to the region.

2.1.3 Opportunities to establish local demonstration activities

Value Added Tax Exemption on renewable energy products: Renewable energy, particularly solar power, presents a substantial opportunity for rural electrification and the provision of decentralized solar energy applications for productive use. Kenya's government has also set aside VAT exemptions for renewable energy products such as solar equipment. This emphasizes the need of localized renewable energy solutions, such as mini-grids, in providing critical energy services to Kenyan communities who are off the grid or have an inconsistent grid connection. Currently, 8.1 million Kenyans do not have access to electricity, and 92% of the rural population cooks with wood, which is hazardous to their health. Restoring VAT exemptions for solar items is a win-win situation for both the Kenyan government and many Kenyans, particularly those living in rural areas that are still cut off from the national grid.

Photovoltaic power potential*:* With an average of 5-7 peak sunlight hours and a daily insolation of 4-6 kWh/m2, Kenya has a high insolation rate. The overall annual capacity of solar systems is predicted to be 23,046 TWh. Communities in western Kenya rely heavily on solar power lamps and panels for lighting and heating, indicating a huge potential for energy for productive use applications. Direct solar energy technologies use photovoltaics (PV) and concentrating solar power (CSP) to produce thermal energy by harnessing the energy of solar irradiance. With most of the region having a prolonged sunshine period during the dry season, this can be of great importance in tapping solar power and promoting productive use of energy within the region.

Figure 3: Map showing Kenya's huge and largely untapped photovoltaic power potential



Source: Global Solar Atlas, 2022

2.2 Demonstration sites

Demonstration implementation activities will be carried out at two project sites, Kisegi, a rural village in Homabay county, and Katito a peri-urban community in Kisumu County, both demonstrations involve a solar charging hub as described below.

Figure 4: Proposed SESA demonstration sites: Katito and Kisegi

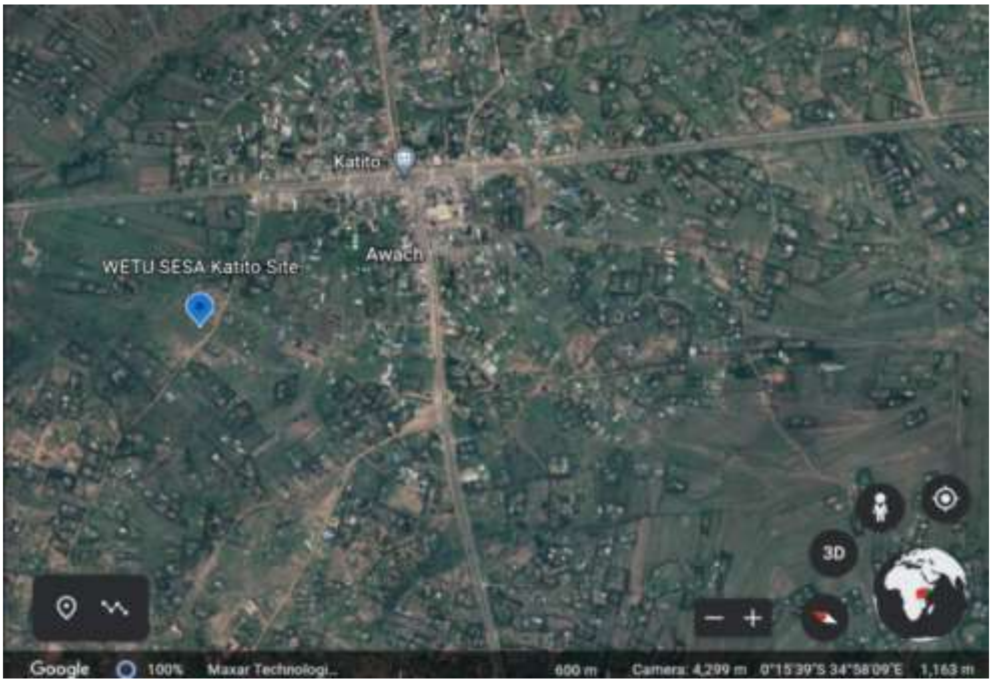
Source: Google. (n.d.). [Google Earth map[3]

[3] Google. (n.d.). [Google Earth map of SESA Katito site]. Retrieved February 10, 2022, from https://www.google.com/maps/d/u/1/edit?hl=en&mid=1Dq1GUt366jITvyLmpPsQxaXJ4JgRk78l&ll=0.22370030413879016%2C32.85904763205721&z=6

2.2.1 Peri urban Demonstration site: Katito

The peri-urban demonstration is taking place in Katito, Kisumu County, Kenya (latitude: -0.2667, 34.9664). Katito is a satellite peri-urban enclave in Kenya's Lake Victoria region that was awarded township status by the Kisumu County administration in 2019. In the community, there are public primary schools and two public secondary school, as well as a sub-county public hospital. Ahero, the nearest town, is 15 kilometers away via a tarmacked road. Katito's population is estimated to be around 23.000 people. The main economic activities in Katito are small business trading, rice farming, oil seed cultivation and some fishing.

Figure 5: Aerial satellite view Katito site



Source: Google. (n.d.). Google Earth map of Katito SESA peri urban site]. Retrieved February 22, 2022[4]

2.2.2 Rural Demonstration site: Kisegi

The rural demonstration is taking place in Kisegi village, Homabay county, Kenya (latitude: -0.6402, 34.0612). It is located in Kenya's Lake Victoria region. In the community, there is one public primary and one public secondary school, as well as a sub-district hospital. The nearest beach is Nyangwethe beach, which is 3 kilometers away along a difficult dirt road. Kisegi has a population of around 6000 people. The main economic activities in Kisegi are fishing, subsistence farming and small-scale horticultural farming.

[4] from https://earth.google.com/web/search/-0.2667,+34.9664/@-0.2667,34.9664,1163.77352666a,1056.52951206d,35y,0h,45t,0r/data=ClQaKhIkGf32deCcEdG_IV1txf6ye0FAKhAtMC4yNjY3LCAzNC45NjY0GAIgASImCiQJ4nnRDnaWREARC8nbVkLZIUAZzTsEX-lrUkAhY_OmgKE5U8AoAg

Figure 6: Aerial satellite view Kisegi site[5]

Source: Google. (n.d.). [Google Earth map of Kisegi rural SESA site]. Retrieved February 22, 2022

2.3 Vehicles/infrastructure/equipment provision

2.3.1 Solar charging hubs

A thorough load assessment and demand projection, as well as subsequent system sizing, have been carried out, all of which are necessary for the proper design of the solar charging hubs. The charging hubs economic viability is determined by the amount of the installed assets — and consequently the investments —, which must be backed by a predictable demand in the years following commissioning. The system's concept is to have a central energy hub that houses the PV modules, central battery storage, and balance-of-system (BoS). This will charge and power the many use cases as well as the battery storage system. The system size requirements, pricing, performance, and dependability must all be addressed while selecting modules for the energy hub system sizing. The following is the system specifications for the two sites:

Table 4: System specifications for Solar Hubs

	Kisegi	Katito
Single PV module voltage	530Wp (Jinko panels)	530Wp (Jinko panels)
Number of Batteries	12 Batteries minimum for the hot-swapping system	24 @3200 Ah
Battery type	Lithium-ion batteries 48VDC @4.6kWh	Llead acid batteries, 2v, 3200Ah
PV array	72 modules	64 modules
PV watt peak per site	38.16 kWp	33.992 kWp
System voltage	48V	48V
Inverter	6*6kWp Hybrid Growatt inverter	3*SI8.OH-12(SMA sunny Island 6.0)

[5] from https://earth.google.com/web/search/-0.6402,+34.0612/@-0.6402,34.0612,1181.72272641a,1056.46847049d,35y,0h,0t,0r/data=CigiJgokCfZ3T03Eo82_ETR0yGlBa9G_GcLBHm7KfEFAIbNEjdZGd0FA

To increase flexibility, it was decided to use two separate stand-alone systems for each site. This reduces the chance of system failure while also allowing for the measurement of two separate systems. PVSyst's stand-alone mode was used to size the systems. The user must submit solar radiation statistics, system orientation, an hourly load profile, and information on the far and near-shadings in order to utilize this application. It suggests a preliminary system size based on acceptable load loss and needed system autonomy days, and it allows the user to choose appropriate battery and panel technologies. System losses are also taken into account, such as soiling loss, ohmic losses, array mismatch losses, angle of incidence losses, thermal loss factors, and module efficiency loss. This is critical for calculating the system's yield, the battery's state of charge during the year, and any deficits in supplied energy.

As the two sites are so close to the equator in the southern hemisphere, the orientation for best total yield is 0° tilt and azimuth straight north. Throughout the year, system load sizes have been selected to fulfill the various load demands and use cases for the months with relatively low solar insolation. As a result, it is recommended that the panels be tilted to maximize the yield for the month with the lowest solar insolation. This tilt for the ideal angle will change depending on the sun radiation database used. System losses due to soiling will need to be carefully considered, and this will be addressed by tilting the panels horizontally, which will also help with run off during the rainy season. After considering the topography, it was agreed to utilize a tilt angle of 10° and an azimuth of due north for all computations for the two sites. Below is the illustration for panel orientation and charging hub development for the peri-urban site.

Figure 7: Illustration for panel orientation and charging hub development for the peri-urban site

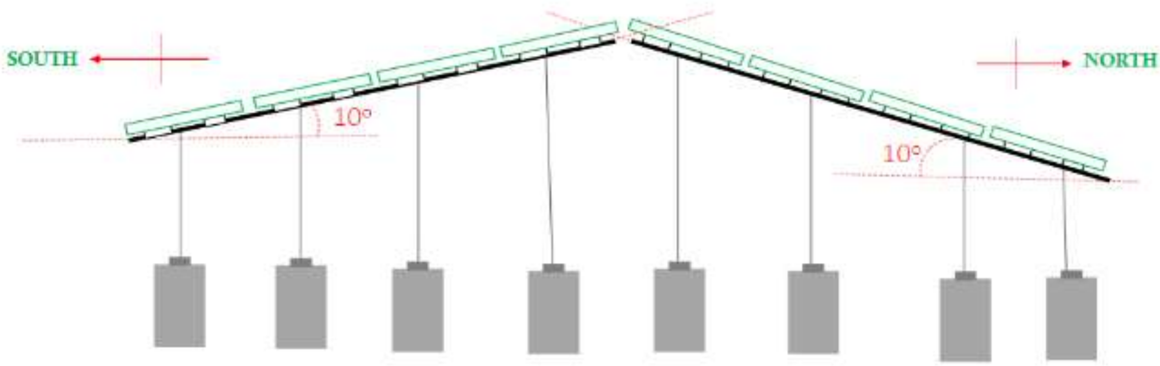


Figure 8: Peri urban site solar panel orientation and charging hub construction in progress

Below is the illustration for panel orientation and charging hub development for the rural site.

Figure 9: illustration for panel orientation and charging hub development for the rural site.

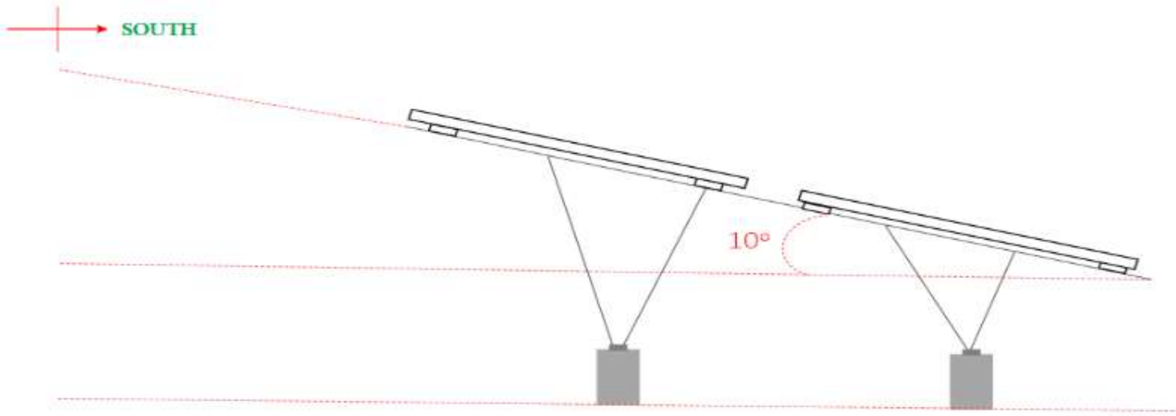
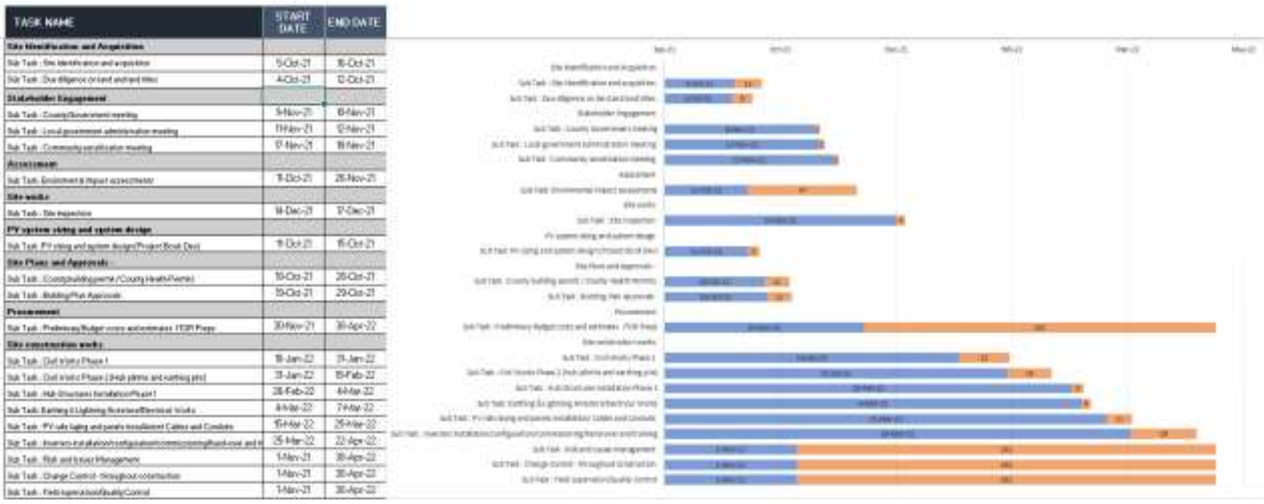


Figure 10: Rural site solar panel orientation and charging hub under development

2.4 Detailed Time-plan

The timeline for the Charging-Hub Construction is presented below and will be updated in the subsequent version of the demonstration implementation plan.

Figure 11: Timeline for the Charging-Hub Construction



2.5 Business model plan

Demonstration use cases will be tested through innovative business models and co-creation with users and key stakeholders. This will be accomplished through a combination of innovative shared economy and circular economy approaches, such as the development of new innovative products and services utilizing clean energy, such as battery packs for household and business use cases, solar cooling solutions (cold storage for fish and agricultural products), solar drying services for omena (silver cyprinid) fish and electric vehicles and agricultural appliances. Furthermore, WeTu intends to mix various products and services to generate new revenue streams, such as providing safe drinking water, fishing lamps, or ice to beaches via e-mobility vehicles. The detailing of the business model concepts, and the specific business plans relevant to the implementation action will be developed and collaboratively co-created with WP3. The table below summarizes the uses cases and solutions components that will be tested in the two demonstration sites.

Figure 12: Summary of uses cases and solutions components

Solution	Electric Motorcycle	Fisher Lanterns	Electric Tractor and agricultur appliances	Solar Cooling	Solar Drying	Battery Packs	Pumping and purification of drinking water	Solar powered/battery powered Small scale irrigation
In what way will solution innovate?	Adopting and modernizing electric drive trains, as well as presenting greener transportation alternatives and developing the transportation sector in rural and peri-urban areas Using swappable battery packs to extend the range and mileage of EV motorcycles.	Alternative to fuel based (kerosene) lighting and lead acid powered batteries for night fishing. Using solar energy as the primary source of energy for fish-attracting lights reduces the use of fossil fuels while maintaining a clean and healthy environment.	Modern agricultural vehicle an appliances (eg. grinder etc.) powered by clean, affordable energy via solar battery power.	Solar energy is being used for cold storage rooms and to manufacture ice flakes and cooling products in order to support sustainable fishing and increase product shelf life and reduce post harvest loss.	Using solar power and technology to improve fish handling standards and efficiency, as well as the production of high-value-added dried fish and associated products while reducing post-harvest loss.	Battery packs that serve as energy units, with mobile rechargable batteries that provide mobile electric energy that can be used to power a variety of applications such as powering homes, swappable batteries that can be used interchangeably to power electric mobility ebikes, and powering appliances such as solar irrigation pumps and solar tractors when they are not in use by households or businesses.	Solar energy is being used to provide sustainable water abstraction from surface or borehole water, treatment and pumping to water points using modern prepaid ATM dispenser systems 24/7.	Mechanization and improvement of agriculture through the use of dependable renewable energy to power irrigation and irrigation systems, as well as the use of climate-friendly energy sources with drip irrigation and other irrigation technologies to reduce water and energy use and increase harvest.
Solution Description	Two and three wheel electric drive train motorcycle with rechargable batteries	Lithium ion battery powered fishing lantern	Electric or battery powered tractor and appliances	Flake ice machine / Cold Storage Room	Solar-powered Fish Dryer	Portable exchangable battery	Solar powered ultra filtration /reverse osmosis water purification systems	Electric irrigation pump (Battery powered)
Target market	Private and public motorbike riders (eg. motorbike taxi) and fleet operators (eg. boda-boda associations) (two and three wheelers) / Logistics businesses in rural and peri urban areas	Omena Night Fishermen	Small scale farmers/Horticulture farmers / Rice outgrowers /Small scale irrigation schemes	Fishermen and fish processors, small scale farmers, horticulture farmers and market people	Fishermen and Fish processors	Farmers / Businesses / Households / Medical institutions / Schools /Government offices	Private households, Offices, HORECAS, Institutions, Shools etc.	Small scale farmers/Horticulture farmers / Rice outgrowers /Small scale irrigation schemes
Test environment	Peri urban site	Rural site	Rural and peri urban site	Rural and Peri urban site	Rural site	Rural and peri urban	Solar powered ultra filtration/ reverse osmosis water purification	Rural and peri urban
Business model to be tested	Battery swapping and lease hire of EVs	Pay per use and renting of fisher lanterns	Battery swapping and leasing business model for electric tractor	Direct sale of ice flakes	On site solar drying / Drying rack lease or rental	Pay per use and rental business model	Direct sales of purified drinking water	Lease hire of irrigation pump and battery charging/swapping

2.6 Local Implementation team

The table below presents the local implementation team and the corresponding roles.

Table 5: Local Implementation team and Roles - Kenya

Main Role	***Organization***	***Name***
WeTu Director	WeTu	Tilmann Straub
SESA Project Coordinator for WeTu	WeTu	Charles Ogalo
Business Development	WeTu	Stephen Omondi Ooko
Operations Manager	WeTu	Stephen Agola
Technical Responsibility Charging Infrastructure	WeTu	Tarwish Lemeeh
Technical Testing Business Cases	WeTu	Kevin Asika
Finance and HR	WeTu	Julia Ohore
Accountant	WeTu	Erick Oyugi

2.7 Risks Assessment

The following table presents the main overall risks and mitigations for the implementation process.

Table 6: Risk Assessment – Kenya demo

Risk	Probability assessmen t	Consequences	Risk mitigation/comments
Competition	Medium	Competitor activity negatively affecting our project	Undertake comprehensive stakeholder and competitor analysis to better understand competition and focus on building a loyal user base
Political/legal risk	Low	Delay in project approvals and permits	Prepare for all papers and establish c close corporation with relevant departments to ensure support for approvals and permits
Technique risk	Low	Injuries or worse; need to redesign; stoppage of demonstration	Technical performance and safety testing Training for operators to be conducted Check if all insurance mechanisms are covered
Lack of commitment from stakeholders	Low	Poor communication among the stakeholders	Encourage the pilot stakeholders to be committed to a long-term relationship with each other, and communication is an effective way to maintain the relationship.

Construction/operation cost overrun	Low	Actual costs are higher than expected costs	Have a clear financial plan as well as optimize and control costs
End products not suitable for intended use	Low	SESA Equipment are not eventually used	User needs-based assessment at the core of the design phase
Low transaction and uptake during implementation phase	Medium	Not enough data or activities yet to properly weigh impact	Focus on user and stakeholder engagement throughout project lifecycle
System technical problems	Medium	Negative Impact on user and customer experience	Technical team testing system pre installation to identify issues before installation
System /Service complexity	Low	System or services are not attractive to end users	Continuous feedback and engagement of users and key stakeholder groups during design, implementation and iteration
Communication Barriers	Low	Lack of understanding of products and services	Planned regular communication with users and stakeholders – meetings/social media/FGDs/ KIIs/ mass media etc.
Completion risk	Low	Delay in demo process	Construction planning and timelines monitored and issues expedited
Intervention unintended consequences	High	Value addition to the fish value chain, such as fish solar drying and cooling, may benefit fish harvesters, who are traditionally men, while disadvantage fish processors, who are mostly women.	Gender sensitivity analysis and proper intervention design with relevant gender and local context analyzed
Construction/operation cost overrun	Low	Actual costs are higher than expected costs	Have a clear financial plan as well as optimize and control costs
End products not suitable for intended use	Low	SESA Equipment are not eventually used	User needs-based assessment at the core of the design phase

2.8 Monitoring

A monitoring plan will be crafted that will be based both on the “Regional” project key performance indicators (KPIs) to be developed within the Work Package 1 of SESA and the main objectives to be co-identified with the local partners. Essentially, a set of highly relevant KPIs will be selected and methodologies (who, what, when, where, how) for collecting data for calculating the indicators will be included in the monitoring plan. To be able to properly assess the impacts of the demonstration actions, there would also be a need for baselining activities, which would establish the benchmarks for the indicators. The baseline values would essentially capture “what would have happened in case the demonstration was not conducted.” The KPIs would capture operational performance, and service quality-related perceptions. These KPIs would be selected based on a holistic framework that considers operational (e.g. reliability, range, etc.), environment (and energy efficiency); social (e.g. safety, perceptions); and economic (e.g. total costs of ownership, operational costs and considerations, affordability).

3. Preliminary replication opportunities

This section will be updated in the subsequent version of the demonstration implementation plan after more data and feedback are collected from c-creation sessions and pilot use case tests.

4. Updates

This section will be updated in the subsequent version of the demonstration implementation plan after more data and feedback are collected from c-creation sessions and pilot use case tests, and will include the latest development from the implementation of the demonstration actions.

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Plan 2 - Demonstration Implementation Plan: Ga North and Atwima Nwabiagya Municipal Assemblies, Ghana

This demonstration implementation plan summarizes the ongoing activities of Work Package 4 and outlines the current state of the validation sites in Ghana. This document reports on the status of the demonstration implementation as of May 2022 and it will be regularly updated during the project's lifetime.

1. Operating Environment

1.1 Background

The availability of a modern and reliable energy supply is one of the most important developmental indicators for any society today. There is a direct link between access to cleaner and affordable energy, and poverty. In Ghana, the poor, mostly in rural Ghana, constitute the majority of the people who rely mainly on biomass for cooking and lighting. Ghanaians have traditionally relied on biomass and waste, particularly firewood and charcoal for cooking and heating purposes. However, the share of biomass in Ghana's energy mix has been steadily declining because of increasing fossil fuel consumption. According to Ghana's national energy statistics, the country's total primary energy supply was estimated to be around 12,038 ktoe in 2020, representing a compound annual growth rate of 3.3% from 2000 to 2020. In 2000, the total energy supply was around 6,255 ktoe. From 2000 to 2011, biomass accounted for the majority of the country's total energy supply, while oil has since become the primary fuel and a vital part of the Ghanaian economy. In 2020, biomass accounted for around 36% of the total energy supply, with oil and natural gas accounting for 34% and 25%, respectively. The remainder is catered for by hydroelectricity and a small percentage (0.003%) from solar.

1.1.1 Key facts and figures

The 2021 Ghana energy statistics indicated that about 82.8% of households in Ghana were connected to the national electricity grid. Electricity remained the main source of power for lighting for 93% of urban households, and electricity use for lighting in rural households was less than 72%. The report also highlighted that energy for cooking was primarily from biomass, largely in the form of firewood and charcoal (74.4%), LPG (25.3%) and only about 0.3% electricity. The LPG penetration is however lower in rural areas with only about 12.8% of the rural population using LPG compared to 34.1% in the urban settlement. There is however higher dependence on the use of biomass in the rural areas. It is worth noting that even in urban areas 43.6% of households use charcoal for cooking.

1.1.2 Overarching issues

The following highlights some of the overarching issues regarding the current energy situation of the validation sites:

- Electricity: All the communities are connected to the national grid and pay for the power using a pre-paid metering system. The electricity supply from the national grid is however not reliable as it is characterized by power outages, especially during peak hours. Also, the rural areas of the districts are not connected to the national grid.
- The communities, therefore, rely on standby diesel generators, which have very high operating costs (fuel cost).
- Boarding senior high schools in the districts spend an average amount of Gh¢7,000.00 (€1,000.81) each year on emptying a total of 11 Septic Tanks and food waste within the schools' premises. The sewage is later disposed of usually into the Ocean or

sometimes at unauthorized places due to Sewage Treatment Plants' inadequacy. This situation often poses a lot of health hazards to communities that live close to the final disposal sites.

- Also, on average, each of the schools spends about Gh¢12,000.00 (€ 1,729.88) monthly on Electricity Bills, whilst a total of Gh¢14,000.00 (€2,018.20) is spent each month on the purchase of Liquefied Petroleum Gas (LPG) to provide energy for cooking in the schools.
- The high cost of LPG and electricity makes most people in the communities especially in the senior high schools to rely heavily on firewood and for cooking meals for the students. The use of firewood and charcoal is harmful to the environment and directly exposes individuals who are cooking to harmful gases.
- The schools also rely on mechanized wells for the supply of potable water. Due to the erratic power supply, they are not able to pump water when needed. Also, Solar-powered pumping could give them a continuous water supply and also reduce their energy bills.

1.2 Sustainable Energy Access overview

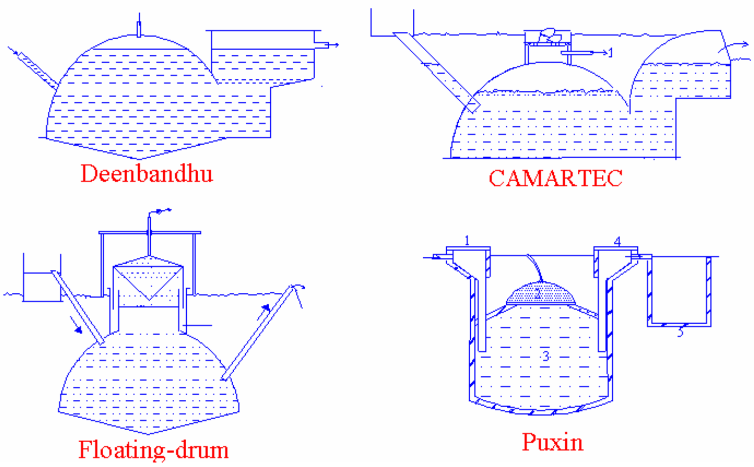
1.2.1 Recent Initiatives

There are several sustainable energy solutions that could be deployed in communities to improve on energy access and help drive the transition towards a safe and secure energy use and consumption. As the Ghana demonstration focuses on waste-to-energy solutions as well as solar energy innovations, the following section describes examples of such initiatives that were in the recent past undertaken to improve energy access to some communities and institutions.

The fixed-dome and floating-drum digesters

The fixed-dome and floating-drum digesters are the two most popular biogas digesters in Ghana. Both digesters are available in a variety of forms, with the four most typical variants shown in Figure 13.

Figure 13: Types of biogas digesters widely used in Ghana



Source: Bensah, Kemausuor, Antwi, & Ahiekpor, 2015

Fixed-dome digesters are the types that are mostly built since they are inexpensive. The Deenbandhu digester is made of bricks and includes a dome structure that serves as both the digester and the gasholder. Puxin digester features a concrete digester and a carbon fibre gasholder. Because the gasholder can constantly be withdrawn to eliminate scum as it occurs, water-jacket floating-drum digesters are perfect for digesting fibrous feed ingredients like slaughterhouse waste. Because of the high cost of steel drums, they are relatively expensive to build and maintain. Up-flow Anaerobic Sludge Blanket (UASB) and Continuous Stirred Tank Reactor (CSTR) plants are ideal for the treatment of industrial and municipal wastewater. UASB reactors have been built in Ghana for the treatment of wastewater from Guinness Ghana Limited in Kumasi and night soil at the Korle Gonno wastewater treatment plant in Accra.

Figure 14: Biogas digester in Guinness Ghana Limited

HPW Fresh and Dry Ltd Biogas Plant

HPW Fresh and Dry Ltd, a fruit processing company in the Eastern Region, has devised a novel way to protect itself from the country's unreliable and rising electricity costs. The company, which processes 450 tons of dry fruits per year such as pineapples, coconut, mangoes, and papaya, has installed solar panels as well as a modern biogas plant, allowing it to generate up to 60% of its energy needs from renewable sources consisting of PV and biogas systems. Figure 15 presents an Arial view of HPW showing rooftop PV and Biogas plants.

Figure 15: Arial view of HPW showing rooftop PV and Biogas plants

The biogas system at the company consists of two 450 m^3 concrete biogas digesters and three 100 m^3 gas holding balloons. The plant produces 500 m^3 of gas per day on average.

Ghana Oil Palm Development Company (GOPDC) Biogas Plant

GOPDC is an integrated agro-industrial company that specialises in oil palm cultivation, crude palm oil extraction, and palm kernel oil extraction. GOPDC manufactures refined special oils for the food industry. Furthermore, GOPDC expanded into the cultivation of rubber trees in 2012. The company built a biogas plant (Figure 16) to help manage its food waste and meet its energy requirements. In August 2014, the biogas plant was commissioned and operational. It is made up of two 10,000 m^3 storage tanks and one 12,000 m^3 storage tank. The system has the potential to produce 4,000,000 Nm^3/biogas per year. All biogas produced is used to replace fossil fuels in refinery boilers 1(Nm^3 Methane is equivalent to 1Lt of diesel).

Figure 16: Biogas plant at GOPDC

Biogas Facility at Ntiamoah Hotel

The hotel is located in Agona-Swedru in Ghana's Eastern Region. The hotel has a 10m3 biogas facility that was built to supplement LPG use in the kitchen. The hotel's silage and faeces are used as feedstock for the digester. The digested slurry is used to irrigate the hotel's garden. The gas is insufficient to meet the hotel's cooking energy requirements. Among the difficulties are a faulty flow metre and a broken-down effluent storage pump.

Figure 17: Biogas digester at Ntiamoah hotel

Source: (Ahiataku-Togobo & Owusu-Obeng, 2016)

Mfantsipim SHS Biogas Plant

The facility is a 200 m^3 fixed dome biogas toilet with an effluent filtration system. A 350 kVA biogas generator was also installed at the school to power one of the houses. The system is not operational. There isn't enough gas to power everything. A major issue is a lack of funds for maintenance and pipe clogging.

Figure 18: Biogas facility at Mfantsipim Senior high school

In Ghana, biogas technology has been used for household cooking, small power generation, and bio-sanitation. Biogas for household cooking has not been a success. The majority of household biogas plants have been abandoned. If the feedstock is obtained at little or no cost to the site, biogas for electricity generation is competitive with diesel plants. To ensure the successful implementation of the biogas plant for cooking, improved technology and a thorough feasibility study will be required.

Solar energy - PhotoVoltaic (PV) Systems

Solar energy development in Ghana has largely been in the following forms:

- The national grid-connected ones like the Navrongo project, Winneba, and the upper west ones are currently under construction.
- The national Rooftop Solar project introduced by the government in 2016 aims at subsiding urban households and low voltage consumers to install 500 W maximum for reduction of peak loads.
- Individual households in some rural areas install solar because they are not connected to the grid on which there's very little evidence on the extent of NGO involvement.

1.2.2 Policy environment

The Renewable Energy Master Plan (REMP)[6], which has set a 10% renewable energy target in Ghana's electricity mix by 2030 and aims to supply renewable energy to 1,000 off-grid villages by 2030, is a recent government policy initiative that attempts to explore Ghana's renewable energy potential. The REMP also aimed at promoting local content and participation in the renewable energy sector. Also, in response to the Paris Agreement, to keep climate warming to 1.5°C, Ghana has announced the following Nationally Determined Contributions (NDC):

- 19 policy actions in 10 priority areas to achieve by 2030 to meet her NDC goals
- The 19 policy actions translate into 13 adaptation and 34 mitigation measures to achieve absolute emission reductions of 64 MtCO2e by 2030 (from a 2019 baseline).
- Out of the 34, nine unconditional measures are expected to lead to a 24.6 MtCO2e emission reduction amount. An additional 25 conditional measures can be implemented to further achieve 39.4 MtCO2e if financial support from the international and private sector is made available to cover the full cost for implementation.

[6] http://www.energycom.gov.gh/files/Renewable-Energy-Masterplan-February-2019.pdf

The intention is that the NDCs act as a blueprint for transitioning into a climate-resilient, low carbon economy that would accelerate the country's development efforts. However, there is only a little amount of effort taken on the ground to meet these new renewable energy targets. Both governmental and non-state enterprises are working on solar energy projects in Ghana. Ghana, on the other hand, has not progressed from demonstration projects to large-scale adoption of solar and other new renewable energy. At the moment, new renewable energy makes up less than 1% of the grid's energy mix.

Table 7: Policy Gaps

Area	**Gaps**
Fiscal and non-fiscal incentives	• Inadequate access to finance and long-term capital, • Inadequate consumer financing options, • Unfavorable business climate (Currency fluctuation), and insufficient incentives.
Regulations	• Policy priorities: national electrification agenda have been tailored toward full electrification of the country through grid extension • Inadequate standards and codes • Lack of enforcement existing policy measures and regulations
Industry development	• Controlled market in favor of conventional systems • Failed experiences • Lack of successful reference projects • Challenges with license acquisition
Information and Educational Campaigns	• Poor or Lack of public awareness, • Poor or lack of information about the cost and benefits of RET • Public acceptance of RET
Human resource development	• Inadequate technical skills to operate and maintain RET • Inadequate project development skills • Lack of adequate training centres
Research and development	• Lack of understanding of local needs

1.2.3 Business environment

An initial scan of duly certified local SMEs in Ghana working on waste-to-energy particularly biogas solutions and solar energy systems reveals that there are several of such SMEs in Ghana. Below is a list of a selected few.

Table 8: List of some identified local SMEs

Photovoltaic Companies	Biogas Companies
AFA WestPoint Solar Systems Website: http://www.afawestpoint.com/	Das biogas Ghana Website: https://dasbiogas.com/
HAQQ Electricals & Electronics Company Limited	Africa Renewable Energy Technology Limited http://www.aretechgh.com
The Automation Ghana Group (TAGG) Website: https://www.automationghana.com/solar-ene-storage	Biofil digesters forever http://www.biodigesters.wordpress.com
Privis Electrical Engineering Services. Website: privisghana.com	Zesta Environmental Solutions Ltd. http://www.zestagh.com

1.2.4 Capacity

Ghana relies heavily on wood fuel (charcoal and firewood) for cooking in households, boarding senior high schools, and hospitals. While this practice is unsustainable due to health risks, it also places extreme stress on the country's declining forests, with far-reaching consequences for climate change, crop production, and water resources. The potential of waste-to-energy solutions such as biogas technology as a sustainable energy source or a medium for improving sanitation, and a rich organic fertiliser source has long been recognised. Despite the benefits mentioned above, Ghana's biogas industry is still in its infancy when compared to sister countries such as Kenya and Tanzania. Biogas service companies face a slew of challenges, including high biogas digester costs, a negative image of biogas as a modern energy source, and socio-cultural barriers to the use of 'faecal gas' for cooking and 'faecal fertiliser' in agricultural waste. Other major factors include the government's lack of commitment, biogas companies' lack of follow-up services, a lack of concrete biogas policy, a lack of well-tested standardised designs, and a lack of microfinance schemes. The current supply chain for biogas digesters is also weak, with few entrepreneurs based in Accra and Kumasi, the two big cities of the country. Furthermore, the manpower base (number of trained technicians/artisans) is deficient and woefully inadequate to meet any large demand for digesters.

1.3 Key Stakeholders

An initial list and contact details of key stakeholders is presented in the table below.

Table 9: Contact details of Key Stakeholders

Julius Nkansah-Nyako	Energy Commission of Ghana- Senior Manager, Renewable and Energy Efficiency Section
Mr Francis P. Yata	Ghana Education Service, Nkawie
Mr Francis Essandoh	Ga North Municipal Assembly (GNMA)– Planning department
Hon. Michael Awuku	Atwima Nwabiagya Municipal Assembly (ANMA) - Municipal Chief Executive

2. Demonstration Action

2.1 Overall Objective

The demonstration action in Ghana will focus on waste-to-energy solutions and solar energy for productive use in communities at Ga North and Atwima Nwaibiagya municipal assemblies. Exact locations will be decided in collaboration with the SME(s) that will be selected through the Siemens Foundation seed funding call for local innovators. In collaboration with the selected local SME(s), waste-to-energy solutions and solar energy innovations will be developed for productive use and applications. In addition, InfoSpots will be installed as part of the demonstration actions. To deliver a complete value chain, the solutions will include business models, capacity building on construction and maintenance, and other activities. The demonstration activities are expected to contribute to the provision of clean and reliable energy for cooking, as well as improve the availability of electricity for productive uses such as lighting for night-time learning activities and illumination to provide security at night. Free information access through the Infospots will promote energy knowledge acquisition and improve digital literacy. The expected impacts are:

- Provide clean and reliable energy for cooking in the communities
- Provide solar electricity for communities for productive use including educational purposes, night-time learning activities and illumination to ensure security at night.
- Improved access to potable water using solar pumps.
- Ensure food security by providing water for irrigation.
- Extend off-grid lighting with an Info-Spot for schools and community empowerment.

Also, one of the main aims of this demonstration activity is to raise public awareness of renewable energy systems such as waste-to-energy solutions and photovoltaic systems as well as their associated benefits. Other objectives include increasing local capacity for system operation and maintenance, as well as demonstrating the system's suitability for domestic, educational and agricultural purposes, particularly in communities that are not connected to the grid.

2.1.1 Situation analysis

Electricity: Most communities in Ghana are connected to the national grid. This is also the case of the four selected demonstration sites. The electricity supply from the national grid is however not reliable as it is characterized by power outages, especially during peak hours. The community and schools, therefore, rely on standby diesel generators, which have very high operating costs due to the high cost of fuel. For instance, at St. John's Senior High School located at GNMA, there is an existing PV system design for their computer lab. This worked for just two years. A preliminary assessment of the system in the first quarter of 2022 showed that there were defective batteries which may have been caused by improper sizing and poor operation and maintenance. This type of situation hurts the acceptability of similar projects. The same school also has a borehole without a mechanized pumping. A solar-powered pump system connected to the borehole could help improve water access.
St. John's Senior High School make use of both LPG and firewood for cooking. A further observation of two rural communities and senior schools at AWMA reveals the following: Nkawie and Toase both have LPG gas cooking systems which are currently not in use because of the high cost of the LPG. The schools rely on firewood for cooking (Figures 19). In addition, Toase SHS have an innovative stove that makes use of a palm kennel for cooking as shown in Figure 20.

Figure 19: Firewood at Toase SHS

Figure 20: innovative cooking stoves

The palm kennel system consists of an electric blower made up of a 0.55 kVA motor (Figure 21) that blows air to fire the palm kennel in stoves. The palm kennel is a by-product obtained from the extraction of oil which is obtained at no cost to the school except for transportation. The cost of the system is Gh¢10 000 (€1345.76). The cost of electricity for operating this system is approximately Gh¢24.5 (€3.30) monthly.

Figure 21: Electric blower

Again, a survey of many rural and agricultural settlements in Ghana shows that many water pumping systems are currently in use including engine-driven pumps, grid-powered pumps, manual-powered pumps, and generator-driven pumps. However, there are inconveniences associated with these systems as follows:

- Due to the steady increase in the cost of fuel and electricity in the country for the past few years, most of these systems have become expensive leading to an increase in the price of water for domestic consumption and irrigation.
- The frequent and unpredictable power outages make water pumping and supply not sustainable.
- Most of these systems like the generators require high maintenance since they have many moving parts.
- There is low grid power coverage in these parts of the country; therefore, grid-powered pumps cannot be used in most rural communities where access to electricity is low.

The introduction of solar-powered water pumping system in rural and agricultural communities could serve as a viable alternative to the currently available systems.

2.1.2 Barriers to establishing the local demonstration activities

In a bid to carry out the demonstration activities in the selected districts in Ghana, the following and as detailed in the policy section above are some of the barriers that implementers could take note of and address along the implementation process:

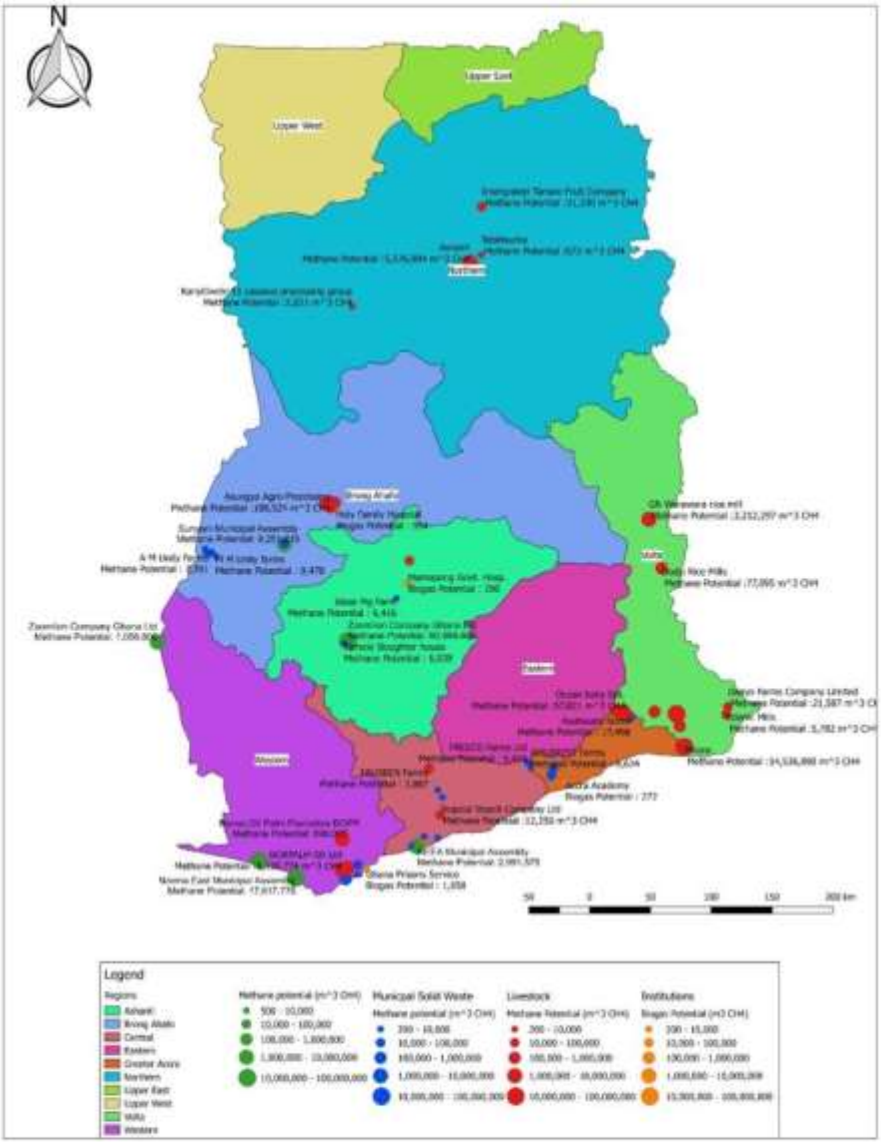
- Inadequate access to finance and long-term capital. This could affect replication efforts.
- Inadequate consumer financing options and insufficient incentives, which could affect consumer usage and adoption of the deployed innovations.
- Unfavorable business climate (Currency fluctuation) which could affect pricing of the solutions deployed.
- Inadequate standards and codes could exacerbate administrative processes relating to the certification or licensing of any solutions innovated
- Lack of enforcement of existing policy measures and regulations
- Poor or Lack of public awareness about the cost and benefits of renewable energy technologies could affect public acceptance of the innovated solutions
- Inadequate technical skills to operate and maintain renewable energy technologies

2.1.3 Opportunities to establish local demonstration activities

Biogas feedstock potential in Ghana

Agricultural residues and food-processing residues, livestock manures, slaughterhouse wastes, municipal solid waste (organic fraction), and municipal sewage sludge are the most common feedstock types readily available in Ghana for anaerobic digestion. Figure 22 summarises research findings and data gathered during a district-level biogas resource assessment conducted across the country. It documents the biogas resources available at some surveyed sites across the country, as well as the quantities and corresponding methane potential.

Figure 22: Map showing various feedstock and methane potentials in Ghana



Solar Energy Potentials

With the limitless potential of solar energy and the continuous decrease in PV module prices due to improvements in their operation and manufacturing efficiencies, research into building and improving PV systems for various applications has exploded over the last decade, particularly in countries with high solar potential. Ghana has year-round excellent solar radiation. The average solar insolation ranges from 4.6 to 6.1 kWh/m^2/day, with temperatures ranging from 25 to 31.725 degrees Celsius (NASA, 2014). As a result, the country is ideal for photovoltaic applications. Despite Ghana's vast potential for renewable energy resources, the adoption of these clean energy sources is low. The majority of rural electrification projects in Ghana focus on grid extensions and diesel power plants. Many rural communities in Ghana lack access to grid electricity or cannot afford to use it. Engine-driven pumping, on the other hand, is prohibitively expensive as well as unreliable due to the high cost of purchased fuel and insufficient maintenance and repair capabilities. Although the installation cost of a solar-powered pumping system is higher than that of a gas or diesel-powered generator-based pumping system, the maintenance cost is much lower. However, when compared to another conventional fuel-based pumping system's installation costs (including labour), fuel costs and maintenance costs over 2 to 7 years, the solar PV water pumping system can be a suitable alternate option.

2.2 Demonstration sites

Ghana as of the end of 2021 is divided into 261 administrative districts located in 16 geographical regions. The president of the republic appoints a Chief Executive for each of these districts. Depending on the development level of substantial areas of the district, this administrative district can be classified as urban or rural. The demonstration sites are drawn from two of these districts: Ga North Municipal, which is an urban settlement, and Atwima Nwabiagya Municipal Assembly, which is a rural community. A map of Ghana showing the locations of the two districts is presented in Figure 23.

Figure 23: Ghana Map showing demo districts

2.2.1 Urban Demonstration site: Ga North Municipal Assembly – Ghana

The Ga North Municipal Assembly (GNMA) was founded by Legislative Instrument (LI) 2314 in 2017 and was formally inaugurated on March 15, 2018. The Municipality has a wealth of human and natural resources, including a large pool of underground water, a skilled workforce, fertile soil for crop production, rivers and streams and a pleasant climate. It spans a total landmass of 636.28 km^2 and is located in the northern section of the Greater Accra Region between latitudes 5° 37' north and 5° 42'14`` north, and longitudes 0° 19' 31`` west and 0° 13'42`` west. The demonstration site in this district will be located in communities near and including St. Johns Grammar Senior High School and Amasaman Senior High/Technical School. Table 10 details the location of the two validation sides at GNMA.

Table 10: Location of Urban sites – Ghana *demo*

	GNMA	St John's Grammar	Amasaman SHTS
Location	Amamorley Community Town		
Digital Address	GW-0450-8542		M56Q+WV9, Toase
Website	http://gnma.gov.gh	https://www.stjohns.sa.edu.au/	
Google maps	https://goo.gl/maps/5X8GGh9gF1Ks5oB79	https://goo.gl/maps/UcEt6xkbXxkW4BpY8	https://goo.gl/maps/ppsF3mnJENdPWssz8
Contact Person	Mr Francis Essandoh, (Planning officer)	Dr Edmund Fianu (Head of school)	Headmistress

2.2.2 Rural Demonstration site: Atwima Nwabiagya Municipal Assembly

The Atwima Nwabiagya Municipal Assembly (ANMA) is located in the Ashanti Region, between latitudes 6°40'20" north and 1°49'17" west, with a total land area of 287.7 km^2. The district has a population of 161,893 (2021 census). The municipal capital is at Nkawie. The demonstration site in this district will be located in communities near and including Nkawie Senior High/Technical School and Toase Senior High School. A map showing the location of the site in this district is provided in Figure 24 while Table 11 presents the contact details.

Table 11: Location of Rural Sites – *Ghana demo*

	AWMA	Nkawie SHTS	Toase SHS
Office location	Nkawie	Nkawie	Toase
Google maps		https://goo.gl/maps/eVVfSgQDm8TEkX128	https://goo.gl/maps/pUAXbBiP3JHXPxbJ6
Contact Person	Hon. Michael Awuku (Municipal Chief Executive)	Mr Francis P. Yata (Head of school)	Mr Isaac Agyekumhene Ossei (Head of school)

Figure 24: Arial view of Rural Demonstration site – Ghana demo

2.3 Infrastructure/equipment

2.3.1 Biogas Technology

As mentioned above, the demonstration actions in Ghana will focus on waste-to-energy solutions and solar systems. This demonstration aims to improve the knowledge, skills, trust and capacity of stakeholders in the design, construction, operation and maintenance of such systems. It was also aimed at raising public awareness which will lead to the adoption of these technologies. Depending on the final solution(s) selected for implementation collaboration with the selected local innovator, a detailed description of the technology will be provided in the subsequent update of this demonstration plan. As an example, however, the following section provides an overview of a waste-to-energy solution – Biogas technology and a solar PV system. The process involved in biogas production is illustrated in Figure 25.

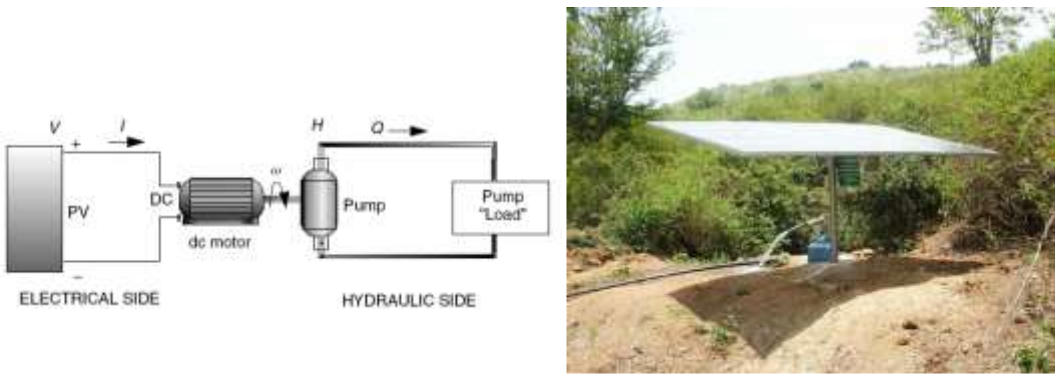
Figure 25: Biogas production system

Biogas production from crop residues can serve two functions: waste management and energy generation. Even though using biogas for cooking may reduce indoor pollution associated with respiratory diseases and eye infections caused by smoke exposure when using wood fuel, improper ventilation and exhaust systems may still cause significant pollution. Because rural households cook with low-cost, low-quality fuels, converting to a biogas system may be an expensive investment, as a compatible stove may be required. Nonetheless, local artisans can be trained to produce compatible biogas stoves at a competitive price, potentially creating more job opportunities.

2.3.2 Solar PV system

PV powered water pumping systems are the most viable PV application. Water pumping in remote areas involves raising water from a well or spring and storing it in a tank for irrigation, cattle watering or village water supply. A PV Array is directly attached to a DC pump as shown in Figure 26. There is no need for battery storage and this significantly reduces the cost. The system is simple, low cost, and reliable. A water purification system could be added to provide potable drinking water for the community and schools in Ghana. Considerations could be made for a PV system of 5 KVA to 10 kVA with storage for lighting application of 1.5 hp to 2.5 hp and water pumping system capable of supplying 5000 to 10000 litres of water daily. The actual water requirement will depend on the population and needs of the community to be served.

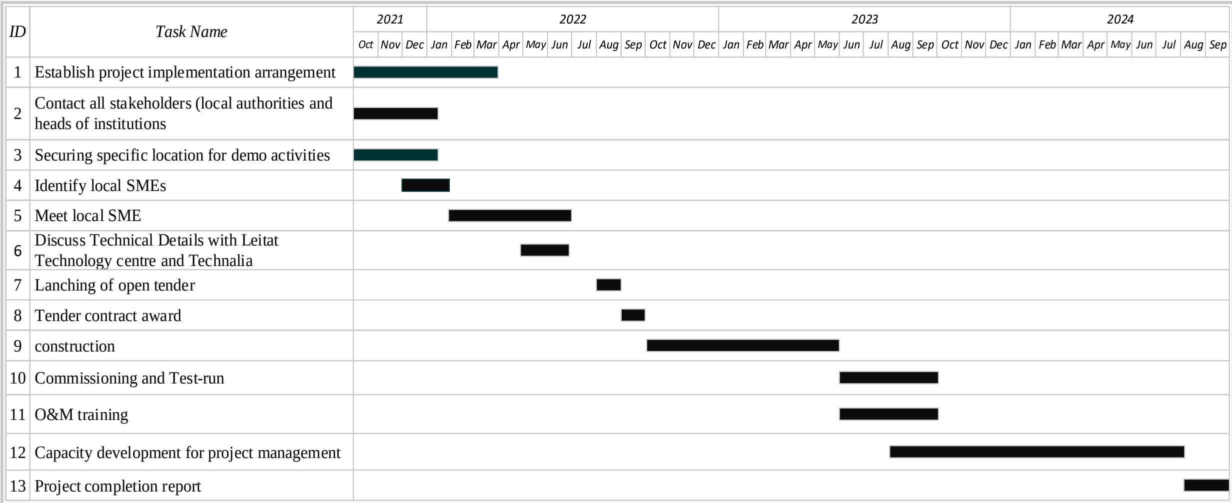
Figure 26: Example of PV Array application



2.4 Detailed Time-plan

The timeline for the implementation of the demonstration action is presented in the figure below.

Figure 27: Detailed time-plan - Ghana



2.5 Business model plan

Business models for renewable energy investment provide policymakers and investors with alternative business methods for deploying these technologies. The proposed models are designed to address various barriers to such investments, including the lack of awareness and knowledge of these systems and financial barriers. Two main business models are proposed here: 1. The facility is to be constructed and managed by local SME 2. Facility to be constructed and transferred to the beneficiary when the full cost is met. This demonstration activity will build on the outcome of business models deployed in the Kenya demonstration of the pumping and purification of drinking water system. The business models will be explored together with the selected SME that will collaborate on this activity. Examples of business models that could be considered for the demonstration are presented in the following sub-sections:

2.5.1 Build and Operate Model

In this model, the local SME will bear the full cost of the facility and manage the facility. The Local SME will maintain ownership of the facility in its entirety, and will operate and sell the energy to the consumer. Excess energy could be sold to the surrounding community.

2.5.2 Build and Transfer Model

In this model, the ownership and management of the facility will be transferred to the beneficiary after the recovery of the cost. Two options are proposed for this model.

- **Option 1 - Hire Purchase Model:** This model will allow users to purchase equipment in instalments. The equipment supplier provides equipment to an end-user for a specified period in exchange for a regular payment. At the end of the contract, ownership of the equipment passes to the lessee.
- **Option 2 - Dealer Financing Model:** This is a type of loan offered by a business entity to its customers and then sold to a bank or other third-party financial institution. The bank purchases these loans at a discount and then collects principal and interest payments from the borrower. The retailer function includes marketing, installation, customer training and after-sales service. The dealer can also perform both the credit and the technology.

2.6 Local Implementation team

The table below presents the implementation team.

Table 12: Local Implementation team – Ghana

Organization	Role
AAMUSTED	Local demonstrator/capacity building
Leitat Technological Centre, Spain	Technology advisor - bioelectrochemical system
Technalia, Spain	Technology advisor - solar PV - micro smart grids
BIF	Infospots experts
Siemens	Provide seed money to fund the Ghana call
Local SMEs	Support in local implementation of demonstration activities

2.7 Monitoring

Monitoring plans are developed in consultation with SESA partners and local SMEs to define the performance of the project. The team agrees on a set of indicators to monitor and evaluate the project's performance to achieve the project's objectives and dissent. These indicators can be improved and monitored during the implementation of the project. The indicators include for example: data on economic development monitoring, increased solar power generation, reduced wood fuel usage, reduced electricity prices, environmental impacts, social impacts, and institutional development. Monitoring and evaluation are carried out according to the agreed metric framework to determine the efficiency and effectiveness of the project. Results and output level baseline data are updated and reported at regular intervals.

3. Preliminary Replication Opportunities

Almost all the communities at the demonstration sites have the same challenge of lighting, cooking and water supply. If demonstrated well, this idea can be replicated for other communities beyond the life of this project. The demonstration actions can be subsequently replicated in all districts and municipal assemblies in Ghana. This section will be updated in the subsequent version of the demonstration implementation plan after more data and feedback are collected from co-creation sessions and pilot use case tests.

4. Updates

The next steps in the implementation of the demonstration action are:

- Identify additional SMEs that can participate to the open call to be launched by the Siemens Foundation and share the call opportunities with them
- After the selection process, establish a close coordination process with the selected local SME to implement the demo actions on the ground as well as monitor and evaluate demo actions.

This section will be updated in the subsequent version of the demonstration implementation plan after more data and feedback are collected from co-creation sessions and pilot use case tests, and will include the latest development from the implementation of the demonstration actions.

5. References

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Plan 3 - Demonstration Implementation Plan: Green Energy Park, Morocco

1. Operating Environment

1.1 Background

Morocco is a North African country with a high engagement in the development of clean and renewable energies. This motivation is mainly due to the increasing world interest in reducing carbon emissions and fighting climate change which has been demonstrated by hosting the 22nd Conference of the Parties to the United Nations Framework Convention on Climate Change (COP22 of the UNFCCC), held in Marrakech in November 2016 and marking the leadership of African countries towards clean energy transition and therefore becoming a regional energy hub. In June 2021 Morocco updated its Nationally Determined Contribution (NDC) as part of its Paris Agreement contribution, aiming at a 45.5% reduction of its greenhouse gases emissions by 2030. 18.3% of this target is unconditional, and the remaining 27.2% are conditional to international assistance. The motivation of Morocco comes also from the urge to enhance the energy security especially that the country relies mostly on imported hydrocarbons to satisfy its energy needs since the country doesn't produce any of the main fossil fuels (coal, oil and gas). As part of its NDCs, and to increase its energy security Morocco is increasing its uptake of renewable energy. The following figure describes the Moroccan energy mix in 2019 according to the latest statistics of the International Renewable Energy Agency (IRENA). By 2019 over a third of Morocco's energy mix was derived from renewables e.g., hydro-electricity, wind and solar.

Meeting the goals of NDC is a responsibility not only for the Moroccan government but also for the local communities and institutions which should be contributing to its achievement. The SESA project is an example of this contribution as it aims to support the green transition by creating innovative business models to boost the replicability of renewable energy solutions at a broader level by testing and validating sustainable demonstrators. Both demonstrators have a direct link with the two major polluting sectors in Morocco and the world: buildings and transport.

1.1.1 Key facts and figures

During the last decade, Morocco has experienced an average increase in primary energy demand of nearly 5% (Figure 28). This growth is mainly driven by electricity consumption, which follows a sustained pace, averaging around 6.5%, mainly due to the near generalization of rural electrification, the dynamism of the national economy, and population growth. Indeed, Morocco is at a turning point concerning its development. This new phase has been carried out on all fronts of the economy and has led to several proactive sectoral strategies and the completion of significant projects.

Figure 28: Moroccan Energy Mix in 2019 according to the Official Website of the International Trade Administration

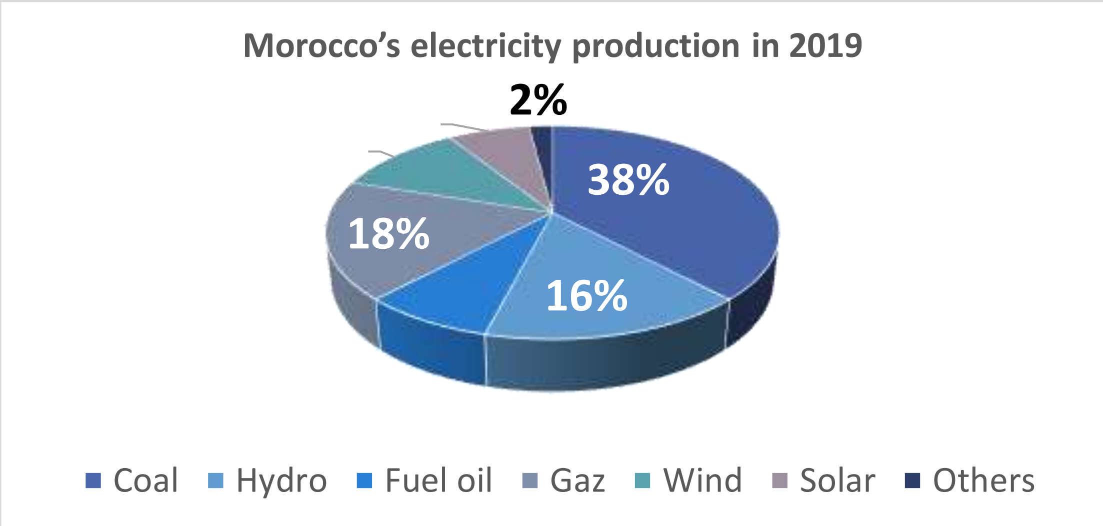
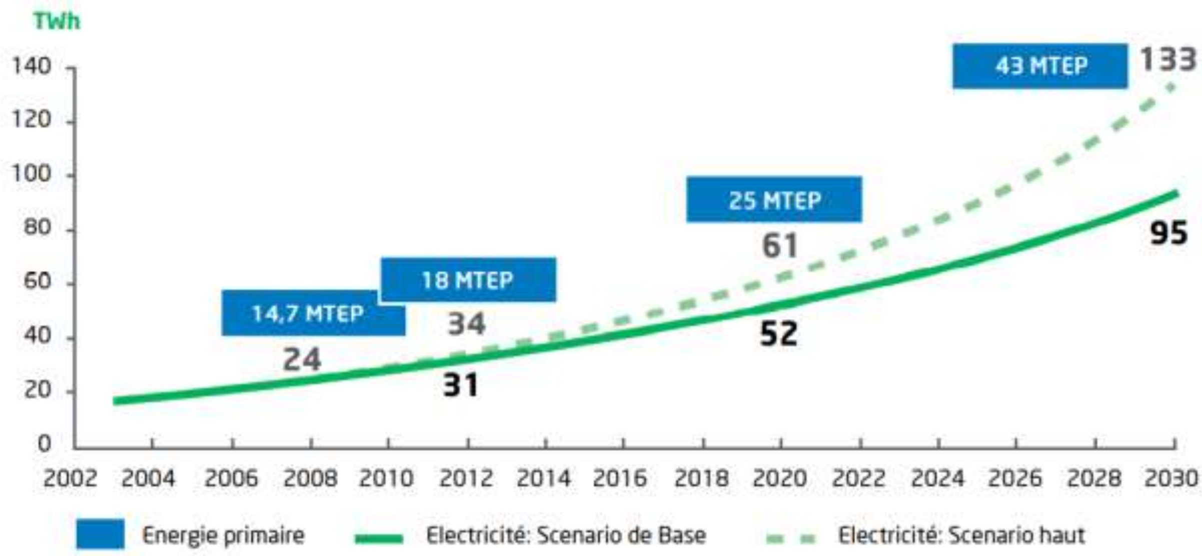


Figure 29: Electricity demand forecast based on two scenarios: a conservative scenario demand (continuous line) and a highly scenario demand (dotted line)



Source: Ministry of Energy, Mines, Water and Environment of Morocco) [1]

1.1.2 Overarching Issues

According to the Office of the High Commissioner for Planning (HCP), Morocco had a population of 36,029,138 in 2018, 59.37% of it live in urban areas, and nearly 40.63% live in rural regions with GDP per capita €2847. In 2019, Morocco ranked 121st among 189 countries and territories with a Human Development Index (HDI) of 0.676, a score that places the Kingdom in the medium human development category[2]. Moreover, Morocco also faces a strong energy constraint caused by its dependence on imports of commercial energy, which accounts for 94.6% of fossil fuels, making the country highly vulnerable to the growing scarcity of fossil fuels and the volatility of their prices. Moreover, the extensive use of traditional energy (firewood and charcoal), particularly in rural areas, poses a threat to forest cover and an increased risk to sustainable development. The fossil fuel combustion is responsible for a total of 62.4 Mt of CO_2 emissions in 2020 according to the latest statistics of the International Energy Agency (IEA). [https://www.iea.org/countries/morocco#reports].

The amount is expected to grow further to reach a total of 139 Mt of CO_2 equivalent in 2040 according to the forecasted scenarios if no actions are taken. Aware of this situation, Morocco made serious efforts to reduce GHG emissions responsible for the global warming threat. These efforts were formulated within an ambitious national plan that was presented in the Moroccan Nationally Determined Contribution (NDC) to the UNFCCC and was rated 1.5°C Paris Agreement compatible thanks to its ambitious actions aiming at 45.5% reduction of the greenhouse gases emissions by 2030. In order to achieve this goal, Morocco made a detailed action plan for each key sector and developed a National Energy Strategy consisting of the following targets:

- Provide 52 % of the installed electrical power from renewable sources, based on the following energy mix: 20 % is from solar energy, 20 % is from wind energy and 12 % is from hydraulic energy by 2030.
- Achieve 15 % energy savings by 2030, compared to current trends.
- Reduce energy consumption in buildings, industry and transport by 12 % by 2020 and 15 % by 2030.
- Install by 2030 an additional capacity of 3,900 MW of combined-cycle technology running on imported natural gas.
- Supply major industries with imported and regasified natural gas by pipelines.
- Government of Morocco, NDC plan submitted to the UNFCCC, 2016.

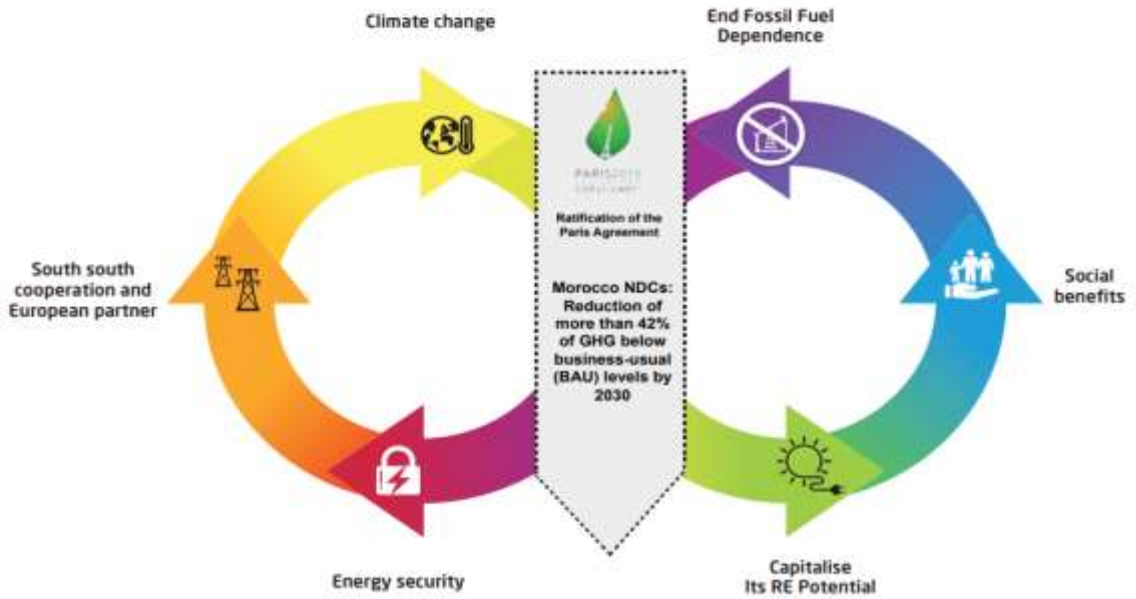
Taking into consideration the recent developments, updates to this strategy have been made and new targets were added. Figure 3 below describes the Moroccan renewable energy capacity target during the period 2020-2050. Regarding 2020, the achieved target is 37.1% against the planned 42%. The factors that contributed to this reduced performance is related to technological, financial and regulatory issues, especially that Morocco still have many flaws in its renewable energy legislation framework.

Figure 30: Moroccan Renewable Energy Capacity 2020-2050

Projections by the Ministry of Energy predict a tripling of primary energy demand and a quadrupling of electricity demand by 2030 (increasing from 14.7m tons of oil equivalent (TOE) in 2008 to 43m-65m tons in 2030). Meeting this growth requires diversification of energy sources both to secure the country's supply by implementing solutions that meet the requirements of the economic component but also to take into account environmental aspects and the resulting societal issues. In Morocco, similarly to any other country, energy is a determining factor for the development, even for the survival of rural populations (energy for cooking, pumping water, heating, etc.). Furthermore, in a context where poverty remains widespread, the satisfaction of basic needs is often hindered by numerous barriers, which discourages local development.

In order to achieve the goals of its NDC plan, Morocco established six major elements to drive its decarbonization policy (figure 31). They cover climate change challenge, fossil fuel dependence, energy security, renewable energy potential, social benefits and the South-South cooperation. Each of these aspects is a central pillar in the Moroccan's plan for decarbonization. The pillars are highly correlated and interdependent: the risk of fossil fuel dependence, for example, is what made Morocco rethink its energy policy and capitalise on its interesting potential of renewable energies to ensure its energy security and at the same time fight climate change.

Figure 31: The six elements driving a decarbonization of the electric sector



1.2 Sustainable energy access overview

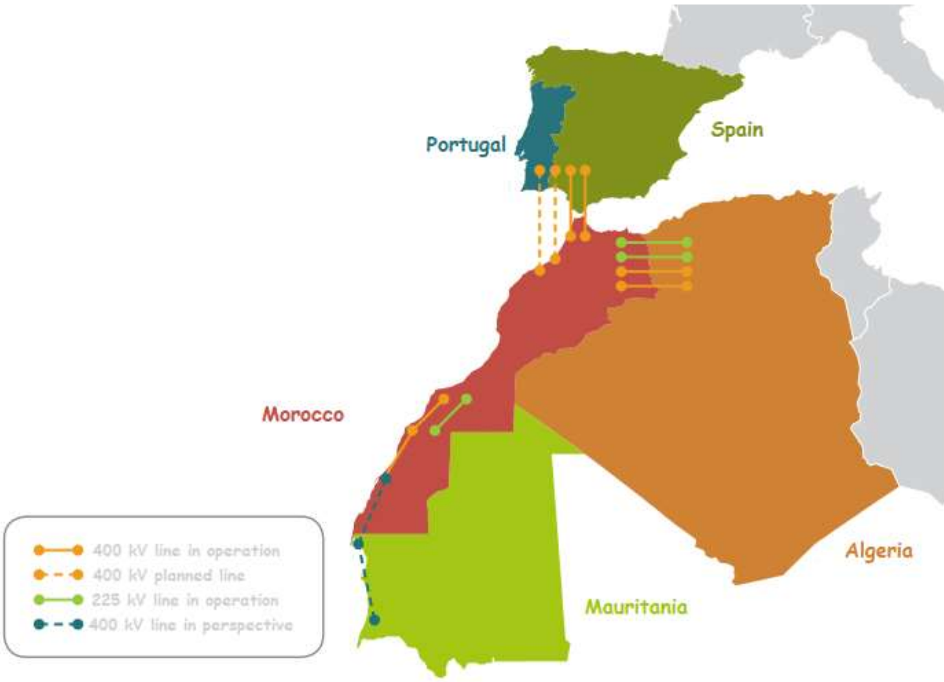
Morocco's energy demand is mainly provided by power plants running on fossil fuel. Fossil fuels represent about 68% of the installed power in Morocco. The remaining energy source comes from renewable energy; mainly hydroelectric, wind and solar. Although Morocco produces some of the oil and natural gas needed for its domestic consumption, the majority of its fossil fuel needs must be imported. 93% of Morocco's total primary energy consumption comes from oil, natural gas and coal. The country seeks to meet the growing demand for energy while reducing imports through the exploitation of its vast renewable energy potential. The following sections will give a general overview of the renewable energy deployment in Morocco.

1.2.1 Recent Initiatives

In twenty years, Morocco has revolutionized its energy sector, to the point that it has become a pioneer in renewable energy in Africa. For the African Development Bank, Morocco is a model of success in the march towards the electrification of the African continent by 2023. More investment in renewable energy sources and energy efficiency measures are already developed and other are planned to curb the energy imports while still meeting the electricity growth and achieving stable economic growth.

Morocco is the only African country having an electrical interconnection with Europe. The first interconnection connecting Morocco and Spain was put into service in 1998. This submarine line extends over 28 km with a capacity of 700 MW[3]. Another 31.3 Km long line between the two countries was inaugurated in 2016. These connections are mainly used to help Morocco satisfies its energy needs through using imported electricity from the neighbouring country. Morocco is also interconnected with Algeria, via an exchange capacity of 1200 MW. The Kingdom continues its role in accelerating regional integration of energy markets launching a feasibility study of a project to build a new electrical interconnection line with Portugal with a capacity of 1000 MW. An interconnection with the sub-Saharan countries via Mauritania is also under consideration. These interconnections help to secure the country's energy supply through the constant availability of electrical energy and the reduction of the electricity costs. Also, the continuous development and massive deployment of renewable energy power plants in Morocco and North Africa makes these connections even more critical as they will help manage and balance the energy flows and thus facilitate the integration of renewable energy into the grid.

Figure 32: Moroccan electrical interconnection network with neighbour countries



Source: [14]

Following the Moroccan energy program that aims to increase the share of renewable energies in the national energy network to 52% by 2030, Morocco has already achieved a share of 37% of renewable energy in 2020 translated by the general capacity of 3 950 MW: including 1430 MW of wind power, 1770 MW of hydro and 750 MW of solar.

Solar energy and wind energy represent a big share of the deployed renewables totaling a potential of 500 TWh. Those numbers are translated through 47 renewable energy projects with a total investment of 52.2 billion Dirhams (€ 4.9 billion). The map below shows the different renewable energy projects developed or under development in Morocco including solar, wind and hydro power.

Figure 33: Map showing the locations of RE projects in Morocco

The Moroccan national program is also launching a new program dedicated to mainly national SMEs, by preparing different tenders for small and medium size PV plants with capacities varying between 5 and 40 MWp. The project will also support the creation of new job opportunities as well as the diversification of the Moroccan industrial fabric. The future PV plants are expected to be commissioned by 2022. The Moroccan government is projecting to achieve 100% of the scheduled planned capacity by the horizon 2023. The public buildings are also of interest in the national program through equipping them with renewable energy sources to achieve energy sustainability, a view that will be extended to private buildings in the near future as well.

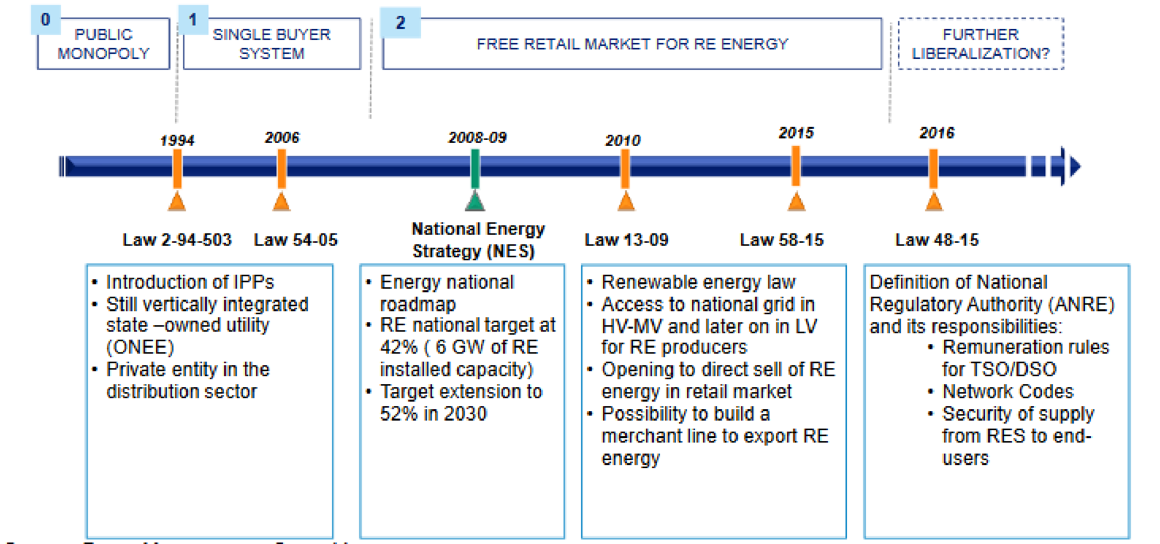
Another project that will see the light is The Xlinks Morocco-UK Power Project which will consists of a new electricity generation facility entirely powered by solar and wind energy combined with a battery storage facility. Located in Morocco's renewable energy rich region of Guelmim Oued Noun, it will cover an approximate area of 1,500km^2 and will be connected exclusively to Great Britain via 3,800km HVDC sub-sea cables. This "first of a kind" project will generate 10.5GW of zero carbon electricity from the sun and wind to deliver 3.6GW of reliable energy for an average of 20+ hours a day.[4]

1.2.2 Policy Environment

Photovoltaic (PV) Regulations in Morocco and Policy Framework

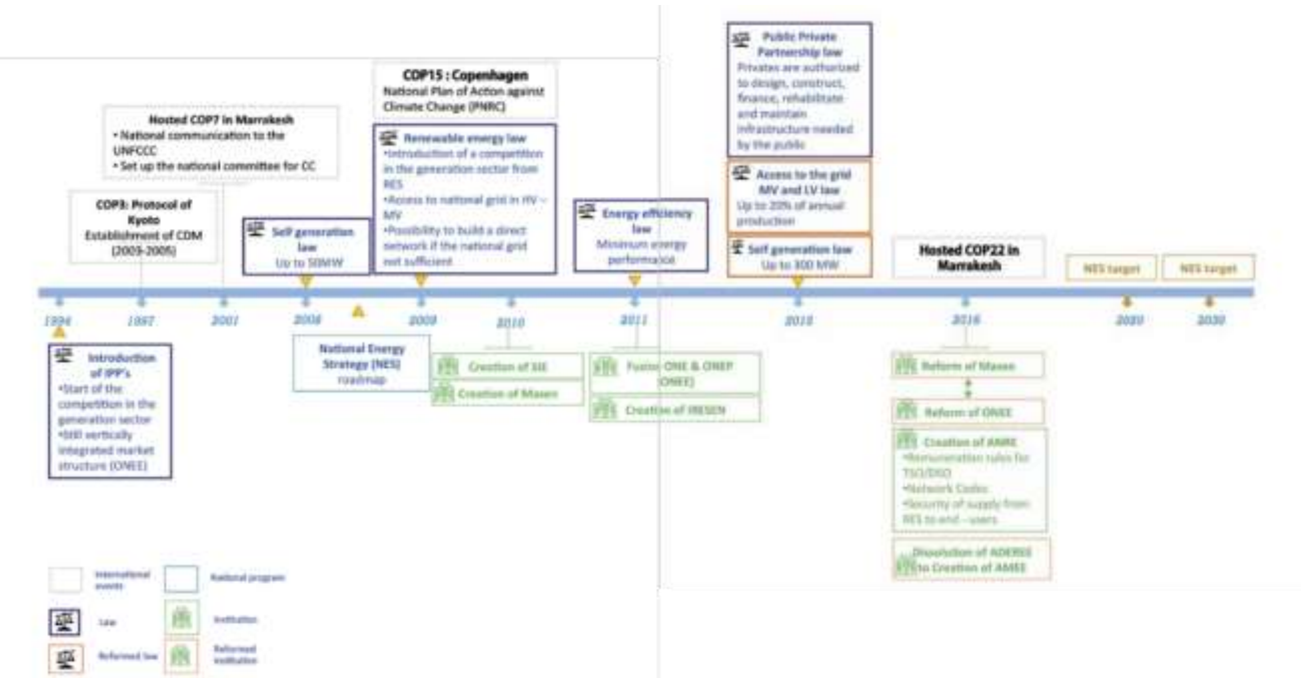
To achieve the national targets of energy transition towards the decarbonization regarding RE and EE it is important to have enabling environment and conditions which are the designated legislative and regulatory framework. The main driver enabling Morocco to realize its goal was the passing of the 'Renewable Energy Law' in 2010 (Figure 34 and 35). This legislation allowed the development of private energy production through IPPs and granted investors to establish renewable energy projects, sell electricity directly to customers on the high-voltage market and export unutilized energy. Despite the progress, the permission of renewable energy producers to sell electricity directly to lower-voltage users has yet to be seen and thus there is still room for improvement.

Figure 34: Timeline of Liberalization of Morocco Power Sector



Source: Pöyry Management Consulting

Figure 35: Timeline of the policy framework (1994-2030)



The Moroccan government has also set up a new roadmap for the certification of photovoltaic solar components (modules, inverters and batteries) aiming to protect the local market against fraud and reinforce its surveillance. Green Energy Park's testing laboratory has been designated as a qualified laboratory by the National Certification Body to perform the tests according to the Moroccan standards based on the IEC 61215 and IEC 61730. The MEME started as well since 2018 the label "Taqa-pro" for the certification of EPCs based in Morocco. The MEME is also leading a study to establish the national grid codes as well as a new process for the certification of electricity provided from renewable sources and injected into the grid, that will ease and reinforce the penetration of smaller scale solar installation in the middle and low voltage grid. A new law is under approval by the Head of the Government that will manage the modalities of injection of renewable energy in middle voltage grid. This law will allow the injection of around 10% of the produced capacity in the grid.

National Electrification Program

Since 1996, Morocco has had an ambitious plan aiming to increase the rural electrification to 90 % by 2010, to date it has averaged a yearly rate of 100,000 houses electrified. This strategic project, called PERG, provided access to electricity to 12.8 million Moroccans at the end of 2020, boosting the rural electrification rate to around 99.78%, according to the recent statistics of the National Office of Electricity and Drinking Water (ONEE) [11]. The program adopted the most suitable electrification technology for the socio-economic environment of each region. Thus, in addition to the utility grid extension, the program used off-grid electrification for the villages whose cost of connection exceeded 27.000 MAD (2538 €) per household due to their distance from the network. A total of 127 000 households was targeted during the 5th phase of the PERG program with a major focus on individual solar kits.

This was a strategic vision aligned with the guidelines of the International Energy Agency and adapted to the economic and geographical constraints of the Moroccan rural regions which present a lot of similarities with all the African regions. Since the launch of the PERG program, many photovoltaic installations have been deployed within rural and remote areas in the service of poor populations. The tables and figures below summarise the achievements of the ONEE initiative:

Table 13: Solar Kits implemented during PERG Program

Period	Number of solar kits deployed	Number of beneficiary villages
1998-2009	51.559	3663
2015-2018	19.438	900

Source: National Office of Electricity and Drinking Water (ONEE) [11]

Table 14: Number of targeted households during the PERG Program

Method of Electrification	Phase	Implementation period	Number of target households	Electrification rate (%)
Improvement of electricity grid	PERG 1	1996-2000	390 993	45
	PERG 2	1999-2002	485 616	55
	PERG 3	2002-2004	387 182	70
	PERG 4	2004-2007	567 796	91
Independent power generation (Solar Power)	PERG 5	2002-2007	127 000	98

Source: National Office of Electricity and Drinking Water (ONEE) [11]

Figure 36: Trend of Electrification rate in Morocco

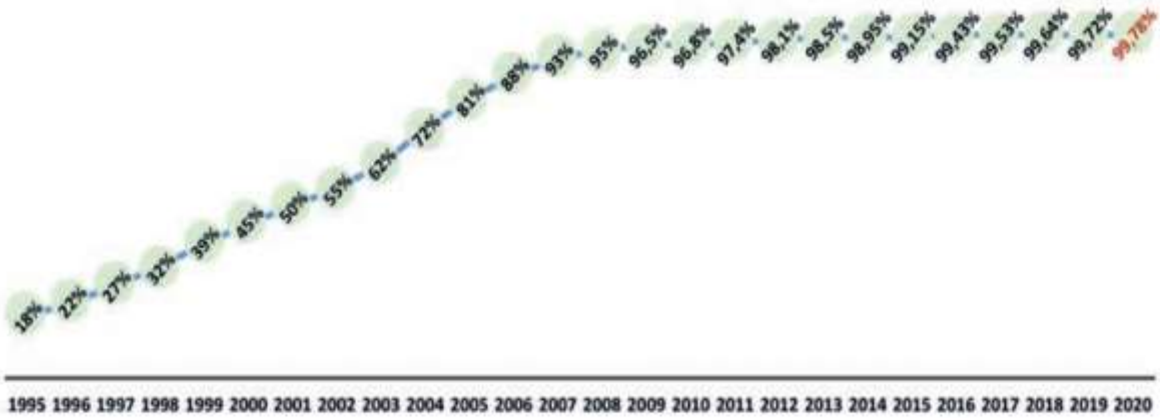
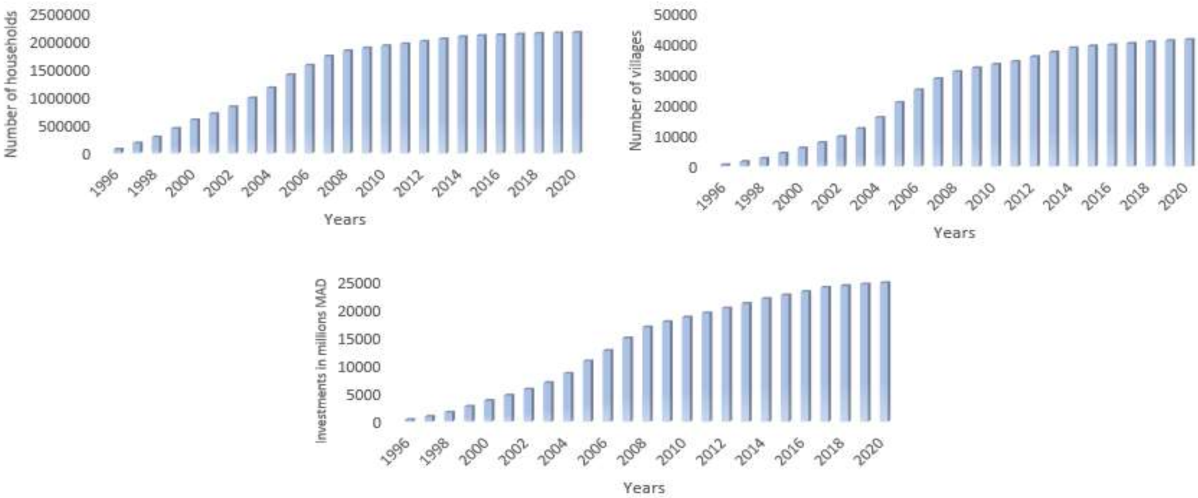


Figure 37: Evolution of the rural electrification program during 1996-2020



Source: [12]

In addition to this, the PERG action plan has another ambitious plan during the period 2021–2024, concerning the electrification of 927 villages, totaling 21,150 households. This period will also see the electrification of 2,250 schools, 30 dispensaries and 1,000 mosques. The total budget dedicated to accomplishing this objective is set to 723 million MAD (€69.6 million). In fact, the investments in energy needs are the major goals of the Sustainable Development Scenario (SDS), one of the four scenarios developed by the World Energy Outlook report of the IEA and consisting of ensuring universal access to affordable, reliable, sustainable and modern energy services by 2030 (SDG 7); substantially reducing air pollution (SDG 3.9); and taking effective action to combat climate change (SDG 13). Regarding solar PV and wind, the International Energy Agency (IEA) estimated that the annual investments will need to achieve a growth rate of 2800 % in order to attain universal energy access within the African continent. These investments will be mainly used to electrify remote and rural areas through off-grid installations. One of the major solutions proposed to tackle this problem was the development of mini grids which is regarded as a better option and a least cost solution to connect people and improve the quality of living in rural communities. [13]

Moroccan Strategies to boost electric mobility

In Morocco, the transport sector consumes 38% of the country's energy mix and represents the second largest CO_2 emitting sector in the national market. Aware of the continued growth in the motorization rate, Morocco is now accelerating its energy transition in order to avoid future issues, which are often difficult and costly. Electric mobility is considered a fundamental aspect of Morocco's energy transition which is being driven by a global context of urgent climate change, environmental challenges, economic crises and social challenges.

While the number of electrical vehicles in Morocco reached only 0.01% of the national market in 2017, the Ministry of Energy, Mines and Sustainable Development, adopted a National Strategy for Sustainable Development by 2030 including the following strategic axes:

- Speed up the implementation of energy efficiency and transition policies;
- Promote sustainable mobility;
- A pact on the exemplarity of the state was signed which includes measures that the administration will undertake such as the strengthening of the use of hybrid and electric vehicles;
- A roadmap for Sustainable Mobility in Morocco was established by the Ministry of Transport with the support of National and international specialized agencies;
- An implementation of charging standards and infrastructure through Morocco, launched by the Ministry of Industry;
- The Energy Efficiency 2030 strategy plans to reduce transport energy consumption by 35% in 2030;
- An inter-ministerial commission on sustainable mobility has been set up under the chairmanship of the head of government.

1.2.3 Business Environment

An active research on the different SMEs active in the sectors related to the two demonstrators and taking into account the experience of the Green Energy Park (GEP) on similar projects, we have been able to establish the list of companies which will be consulted for the orders and installations of the demonstrators.

Table 15: Existing SMES active in PV and E-mobility sectors

PV Panels Companies		
COMPANIES	**WEBSITE**	**SERVICE PROVIDED**
Low tech	https://www.kerix.net/fr/annuaire-entreprise/low-tech-services	Solutions for energy optimization using PV and battery storage
Bathiterm	https://batitherm.ma	Solutions for solar heating, pumping and PV installations
Misen	https://www.misen.ma/	
Econosol	https://www.econosol.ma/	Solutions for energy optimization using PV and battery storage
Solarmen	https://www.solarmen-maroc.com/	Solutions for renewable green energy systems
Atlas power	http://atlaspower.ma/somme.php	Installation of solar PV systems
Heliantha	https://heliantha.ma/	Solutions for energy optimization using PV and battery storage

Electric Mobility Companies		
COMPANIES	**WEBSITE**	**SERVICE PROVIDED**
E-mob	https://emob.ma/	Distribution of electric motorcycles, bikes and scooters
E-brands	https://ebrands.ma/	Distribution of electric motorcycles, bikes and scooters
Oba Motors	https://www.obamotors.com/	Distribution of electric scooters
Emoto	https://e-moto.ma/	Distribution of electric scooters

1.3 Key Stakeholders

The main institutions involved in the energy market are:

Ministry Of Energy, Mines and Evironment (MEME): The Ministry is responsible for the regulation of the energy sector. MEME establishes the legal framework for the sector, ensures the practical implementation of the national strategy and oversees a number of subordinate departments and agencies.

Ministry Of Interior: Supervises the overall performance of the public enterprises responsible for the distribution of water and electricity in large urban areas.

Moroccan Agency For Sustainable Energy (MASEN): Established in 2010, MASEN is a private company endowed with public capital. It is in charge of the design of integrated solar development projects, conducting the technical, economic and financial studies that are necessary to the qualification of the sites, the design and exploitation of solar projects, the complete tendering process, project management for the realization of solar projects and contributing to research and to the raising of the funding necessary for the realization of solar projects.

Office National De L'electricite Et De L'eau - ONEE (National Office for Electricity and Water): Created in 1963 as a national power monopoly, the company ensures generation, transmission, and distribution/retail. ONEE manages the overall power demand and manages and develops the transmission network. In addition, it works on expanding rural electrification and on promoting and developing renewable energy (Steps and PV's end of line only).

Institut De Recherche En Energie Solaire Et Energies Nouvelles – IRESEN (Solar Energy and New Energies Research Institute): Established in 2011 to develop, coordinate and enhance the efficiency of research in RES, translating the national strategy into Research & Development projects, implementing and participating in the financing of projects carried out by research institutions and by industrialists and exploiting and popularizing the results of research projects.

Moroccan Agency For Energy Efficiency (AMEE): This agency focuses on energy efficiency.

Societe D'ingenierie Energetique - SIE (Energy Engineering Company) Established in 2010 with the main mission of supporting national renewable energy programs as a lender, investor or project co-developer.

2. Demonstration Action

Rural Demonstration: Rural houses test bed

Despite the many initiatives of development and the efforts deployed by all the actors facing of demographic challenges, changes in lifestyles and job creation in rural areas, the situation in rural areas remains very worrying. Many disparities are also obvious between the rural and the urban world, particularly in terms of access to basic social services, infrastructure, energy and equipment. These disparities lead to the rural exodus and the pressure on the cities. Access to electricity can improve socio-economic conditions in developing countries by having an impact on the essential components of poverty, namely health, education, income and the environment. Regarding the Moroccan rural demonstrator, a rural site localized in very poor and isolated region of Morocco was selected as a typical example. The exact localization of this site is given in the following section (Figure 39).

Urban Demonstration: Electric mobility test bed

Morocco is launching many programs related to energy efficiency where it is committed to lowering its energy bill by 20% by 2030. To achieve this objective, Morocco has decided, in addition to the various projects already in progress (green mosques, public lighting with low-consumption lamps, solar pumping in agriculture, solar water heaters in the residential sector, installation of photovoltaic panels in industry, bi-hourly pricing, compulsory energy audit, smart meters, launch of 100% Moroccan electric charging stations, etc.), to “green” its transport sector, responsible for 23% of its greenhouse gas emissions. Fueled motorcycles are widely used in Marrakesh City where it contributes to huge pollution of the atmosphere. This justifies the choice of this city to implement the urban demonstrator as it’s considered as the typical example to replicate nationally and in Africa.

2.1 Overall Objective

Rural Demonstration: Rural houses test bed

Access to energy offers important benefits to development by the provision of consistent and efficient lighting, heating, cooking, transport and telecommunication services. Providing clean and cost-efficient electricity in these rural areas will help to ‘breathe’ an acceptable social life and will generate income through activities largely dependent on the existence or not of electricity. The rural demonstration action consists of the installation of photovoltaic panels, with batteries as energy storage technology, in a dozen houses located in isolated villages whose population are vulnerable and with little or no means to connect to the national network. Thus, the overall objective of this demonstrator is to provide electricity to vulnerable populations that will enable social and business activities. This demonstrator will serve as a model and will be used for replication in Morocco and Africa. The choice of the validation sites to host the project’s activities follow the same vision of the Moroccan electrification program and aim to boost the economic development in rural areas, by promoting the creation and modernization of income-generating activities through the energy transition and the integration of off-grid solar energy systems.

Urban Demonstration: Electric mobility test bed

Marrakesh, an internationally recognized touristic place, is inseparable from motorcycles which will remain the most "popular" mode of transport, especially among the middle and poor populations. With a fleet exceeding 300,000 gasoline-powered motorcycles, this mode of transport occupies a large part of road traffic in Marrakesh. This tendency to use these motorcycles in Marrakesh is explained by the plain surface marked by the absence of salient reliefs which can stand as obstacles in front of the circulation of motorcycles. However, this mobility mode, using fossil energy, causes a huge pollution making Marrakesh the 2nd most polluted Moroccan city. Marrakesh is also the unique University city in the region (University Cadi Ayyad) hosting a large group of students, from the small surrounding villages to pursue their higher education. So, the overall objective of this urban demonstrator is to provide 40 electric motorcycles for female students from around Marrakesh which will be located in the students’ accommodation halls called Dar Ettalliba. This will ensure the pursue of high education of these students and also reduce the pollution in Marrakesh. The main objectives are to introduce/reinforce electrical mobility as an alternative to the fuel driven motorcycles, base the concept on the female users (as females are highly represented among motorcycle drivers in Marrakech), implement the concept in cooperation with the NGO (Dar Ettaliba), which provides female university students coming from poor rural and isolated areas with accommodation, food, etc..) and private companies providing business concepts to support the sustainability of the demonstration.

2.1.1 Situation Analysis

Rural Demonstration: Rural houses test bed

To face the difficulties of extending the traditional electricity network to isolated populations, the development of decentralized off-grid or production solutions (especially local mini-grid) presents an interesting alternative in African countries. This could be considered as a real solution for the future. It is relevant considering the continent's exceptional solar resources, but it is also economically viable to service small and isolated rural communities because an off-grid solar micro-grid, supported by batteries, can offer a relatively stable energy supply without requiring the high cost long transmission lines that would be required to connect to the national grid. These rural areas of developing countries are often isolated, scattered populated and characterized by poor infrastructure and services.

- Lighting: Gas lamps, candles or dry cell flashlights are commonly used to light the houses and some populations have limited income to get light all the days,
- Education: The school, far from the houses, is connected to the national grid. Nevertheless, when back to their houses, the children cannot achieve their home work during the night
- Social activities: There is no obvious social activities
- Business activities: Very limited to some mining jobs but no alternative (agriculture, breeding…) is implemented

The lack of basic services as schools and sanitary infrastructure are among the main raisons to the depopulation of the Moroccan rural villages. There is a need of better living conditions, which can be achieved through actions at different level of the rural context. First, housing should satisfy needs for a good living standard, at low costs. New constructions technics, based on the use of traditional building material (dammed earth, cob, raw-clay or CSEB = compressed stabilized earth blocks) and combined with solar PV and new energy storage technics, will contribute to good living condition. The new technologies used to provide housing units with solar energy, could be extended to other uses as water recycling and irrigation.

Urban Demonstration: Electric mobility test bed

The rate of vehicle ownership in Morocco is 9% (91% don't have their own vehicle and depend on public transportation systems, families or friends for their trips). People in Marrakesh, using mostly public buses, working only between 6 a.m and 9 p.m, and gasoline-powered motorcycles. Moreover, taxis are too expensive for most Moroccans. In Morocco, the universities are located in the main cities, making the accessibility of potential students from rural area and isolated regions problematic. Furthermore, local transportation facilities are expensive, unreliable and not sufficient. This transportation issue is one of the major factors explaining why Moroccan students (principally female students) leave university without a diploma. So, in addition to the environmental sustainability impact (reducing CO_2-emission), the urban demonstrator will focus on social sustainability issues related to female students' access to the University to pursue their studies in relatively comfortable conditions.

2.1.2 Barriers to establishing the local demo activities

Rural Demonstration: Rural houses test bed

While the installation expenditures will be ensured by SESA, there is two major barriers to establish:

- The management of the installed PV + Batteries in the selected houses to ensure their integrity, longevity and preservation,
- While it is not enough to reach the maintenance and the replication of the demonstrator due to weak investment conditions and weak purchasing power of the local population in these areas, the choice of an adequate business model is vital

The realisation of the business model solutions will be a continuous activity during the implementation of the rural demonstrator, some ideas that should be developed are established:

- Weak contribution from the users with a cost of the KWh less than that proposed by the National electricity company,
- Creation of social cooperatives dealing with agriculture products, poultry farming using electricity produced by the demonstrators. This will ensure moderate incomes to the project for replications to other houses growing the number of the users.

While the technical specification of the targeted equipment are provided in the section below, many research and innovation activities in relation with the living labs will be developed including :

- Development, test and validation of energy management and load scheduling algorithms in the rural houses.
- Diagnostic, reuse and recycle the spent lithium-ion batteries to recover the high value components.

Research and Development activities are conducted within the Green Energy Park facility and the Faculty of Science of Marrakesh within the Battery testing Laboratory.

Urban Demonstration: Electric mobility test bed

To establish the demonstration activities with better efficiency, some barriers are detected and should be fixed during the period of the implementation:

- Training of the final users on e-motorcycles driving,
- Efficient use of the 40 units by the maximum of students (turn over)
- Definition of the convenient contribution of the users (less than that of public transport)
- Business model based on the generation of revenues by e-share approach consisting of services very easy to use: riders can book the e-motorcycles, start ride, pause ride and stop ride through simple buttons in e-share application.

2.1.3 Opportunities to establish local demonstration activities

Potential for PV development

Morocco has a very high level of solar resources with about 3,000 hours per year of sunshine and an average annual sum of global horizontal irradiation ranging from 1,753 up to 2,264 kWh/m² in the desert [5]. By 2030, Morocco's energy plan consists of having more than half of its energy coming from renewable energy sources, with 4.5 GW from solar[6]. In 2018, Morocco reached a capacity of 206 MW (Figure 6) due to several installed utility-scale plants combining solar PV and CSP plants (such as Noor Solar Plan)[7]. In the first three phases of the plan, Morocco invested in CSP (160 MW in 2016, 200 MW in 2018 and 150 MW still to be build). The next phases of the plan should be dedicated to solar PV, in 2019, a first tender of 200 MW has been launched and others are planned to complete the project[8]. Over the next five years, there is an estimated potential for up to two GW of PV installation.

Figure 38: Total PV installed capacity – Top 10 in Africa

Total PV installed capacity
Top 10 of the African countries

South Africa	2,561 MW
Egypt	1,647 MW
Algeria	519 MW
Morocco	206 MW
Reunion	191 MW
Namibia	135 MW
Senegal	134 MW
Zambia	96 MW
Kenya	145 MW
Mauritania	88 MW

Source: [9]

Even if most Moroccan renewable energy power plants are large-scale centralized projects, decentralized renewable energy projects have also been developed. During the period 1996-2012, Morocco spent huge investment (Capex) in rural electrification, bringing electricity to an estimated 12 million people in more than 39,000 villages[10] by installing more than 70,000 solar panels kits for households[11].

Hence, the electrification rate is very high, and over 98 % of the population has access to electricity, both in rural and urban environments[10]. Further, solar PV for water pumping in the agricultural and water sectors is relatively diffuse in Morocco. In addition, few small-scale solar PV projects, with less than 2 MW capacities, have been developed by private firms and factories for their own consumption. Solar lanterns are used for public lighting in different large, medium and small towns in the country.

Electric Mobility development

Also, Morocco established many boosting financial actions for the deployment of the electric vehicles including the lowering the import duties to 2.5% instead of 17.5% and the exemption for the transport and luxury taxes as well as the following:

Electrical Mobility Roadmap: While the objectives were not fully reached by 2020, more facilitations and recommendations were actually included in the roadmap of the electrical mobility in Morocco expected to be launched in 2022:

Implementation of incentives for electric vehicles (For at least 10 years)

- Implementation of a purchase financial support for electric cars (estimated at 50,000 MAD, € 4707)
- VAT refund for the purchase of electric cars for companies
- Implementation of preferential rates for the financing of electric vehicles
- Application of advantages for the use of electric vehicles (free tolls, parking, tax exemption, reduction of registration fees, moped approval rate)

Development of the charging infrastructure for electric vehicles

- Gradual deployment of a network of fast charging stations of electric vehicles covering the overall national road network, mainly at service stations (estimated at 1500 recharging stations, i.e. 1 every 100 km);

- Deployment of normal and accelerated charging infrastructure, within local authorities for the urban network, by using public lighting panels;
- Establishment of a "pilot city" project for the development of recharging infrastructure in urban areas

Strengthening the electric mobility ecosystem

- Implementation of standard payment solutions for recharging electric vehicles;
- Establishment of an institutional framework for the development and promotion of sustainable mobility;
- Development of popularisation /communication programs on electric mobility;
- Establishment of the exemplarity acts of the governmental institutions, urban and rural and communities (30% of new vehicles acquisitions should be electric 2030)

Support for the industrial sector of electric mobility

- Support for the establishment of electric vehicle production plants in Morocco;
- Support for the establishment of battery production plants in Morocco;
- Support for the emergence of an ecosystem of the electric automotive industrial sector (*electronic systems, infrastructure, energy supply and storage, recycling and recovery….)*

Implementation of adequate regulations (laws) dedicated to electric mobility

- Implementation of incentive or restrictive measures related to electric mobility;
- Establishment and regulation of a framework for electric mobility *(roaming platform, installation standards, home charging management, etc.)*;
- Establishment of a framework for the sale of electrical energy by the operators of charging stations

2.2 Demonstration Sites

2.2.1 Rural Demonstration action: Rural houses test bed

The targeted rural sites are divided into two major categories: Schools and Households. With the help of the NGO Act4Community (http://act4community.ma/). In fact, the main objective of Act4Community is to significantly, sustainably and concretely improve the standard of living of rural populations, and to be an active player that creates added value in different areas: Entrepreneurship, agriculture, employability, culture and sports. With the help and coordination with this NGO, we have selected 13 households and 7 schools based in 6 different rural villages, all in the region of the phosphate mines of Benguerir and Bouchane.

Regarding the demonstrator, the selection criteria were mainly social, as it can be seen in the images below, the households suffer from a lack of access to vital services such as electricity, drinking water, heating, cooking and sanitation. Another criterion of selection was the proximity to the ecosystem of Green Energy Park and its living labs, that will be important for the perennity and the control of this living lab. As it can be seen in the map below, the villages are within 5 to 20 km from the research center. Furthermore, a model of a housing unit will be developed at the Green Energy Park, in cooperation with the School of Architecture in Marrakesh (ENAM), the University Cadi Ayyad and the Green Energy Park.

Figure 39: Localisation of the demonstration sites used for the rural houses testbed

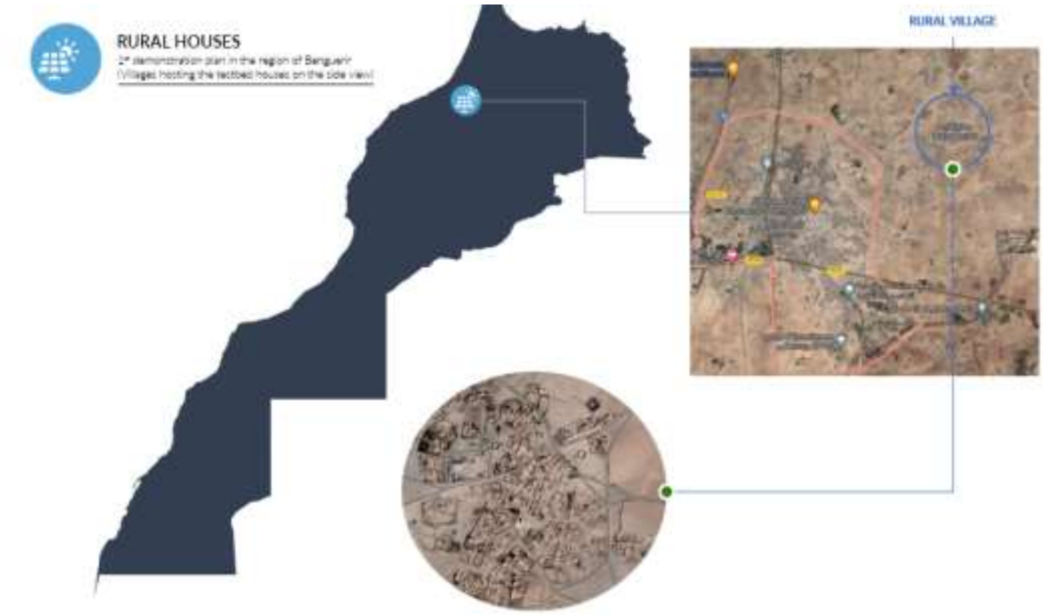


Figure 40: Overview of the difficult living conditions of the houses chosen to host the testbeds : lack of the sanitary infrastructure, no access to electricity and no access to clean cooking

2.2.2 Urban Demonstration action: Electric mobility test bed

Regarding the testbed, we have identified the student accommodation halls (or Dar Taliba) to deploy electric motorcycles for female students. Dar Taliba is a program launched by the Mohammed V Foundation dedicated to enable thousands of young rural girls to escape dropping out of school. It is responsible for providing affordable accommodation, catering and sport activities to students (especially girls) with very low incomes, the majority of these students come from remote areas. Marrakesh has 3 active student houses. Our initial target is the one closest to the faculty of science which is 100% dedicated to women. The testbed targets the deployment of 40 electric scooters to the profit of female students residing within Dar Taliba. Regarding the social aspect, the action will contribute improving the female students quality of schooling by helping them access easily and permanently to classes and at the same time raise their awareness regarding sustainable transportation.

Figure 41: Localisation of the demonstration sites used for the electric mobility testbed

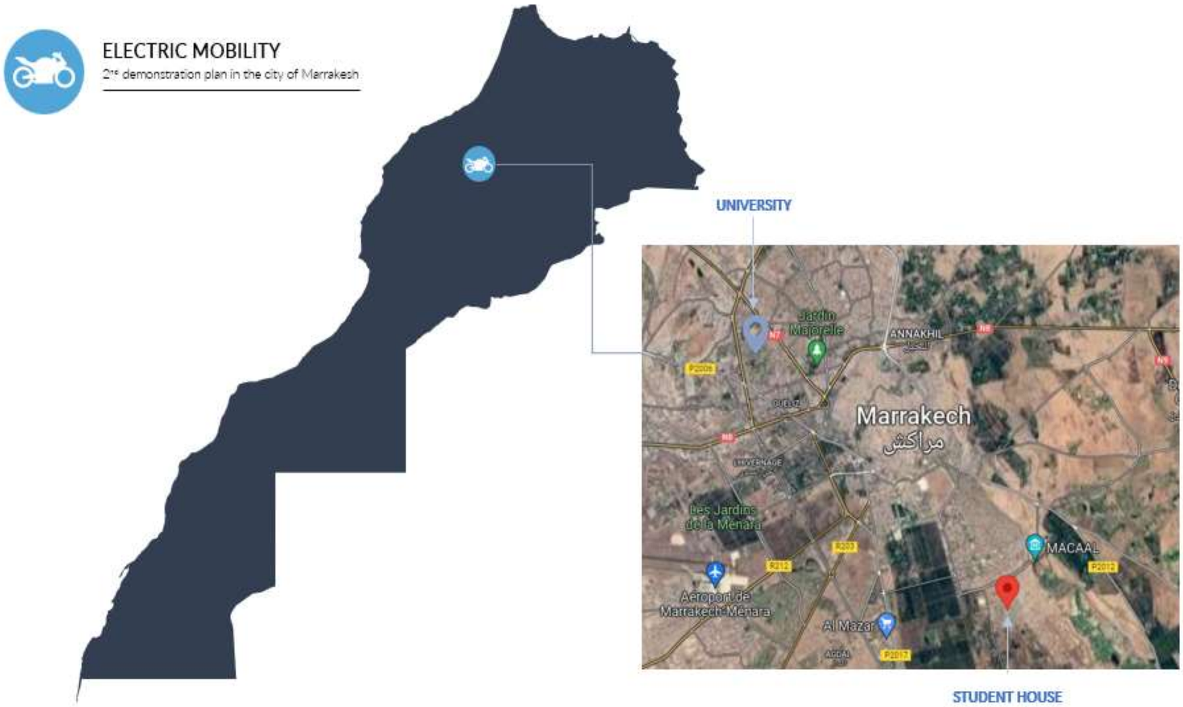


Figure 42: Dar Ettaliba residence hosting the test bed of electric mobility

2.3 Vehicle/equipment/Infrastructure

Rural Demonstration action: Rural houses test bed

While discussion on the efficient specifications of the targeted equipment is in progress with other SESA partners, we propose here some specifications that where already used by GEP for other and similar projects.

Figure 43: Proposed Panel module: 320-340 Watt Poly Crystalline Module

Table 16: Proposed Panel module: 320-340 Watt Poly Crystalline Module Specifications

Item	Specification
Cell Type	Poly-crystalline 157×157mm (6 inch)
No.of cells	72 (6×12)
Dimensions	1956×992×40mm (77.01×39.05×1.57 inch)
Weight	22.5 kg
Maximum power (Pmax.)	320 Wp
Maximum power voltage (Vmp)	37.4 V
Maximum Power Current (Imp)	8.56 A
Open-circuit Voltage (Voc)	46.4 V
Short-circuit Current (Isc)	9.05 A
Module Efficiency STC (%)	16.5 %
Operating Temperature(°C)	-40 to 85 °C

Figure 44: Proposed Battery system specification

Table 17: Proposed Battery system specification – Morocco demo

Item	Specification
Nominal Capacity	75 Ah
Nominal Voltage	48 V
Nominal Energy Storage min.	3600 Wh
Discharge voltage	44.5-53.5 V
Charge voltage	52.5 – 53.5 V
ChargE/Discharge Current	35 A
Temperature	0 to 50 °C
L x l x H	420 x 420 x 132 mm
Weight	32 Kg
Number of cycles	> 4500 at 25°C

Figure 45 represents an example of an already implemented rural house (from an old project) where PV + Battery System is installed (since 2019).

Figure 45: An example of a sustainable house model

Urban Demonstration action: Electric mobility test bed

As for the urban demonstrator, we present hereafter the proposed e-Motorcycle specifications:

Table 18: Proposed technical specifications – Morocco urban demo

Item	Specification
Electrical Motor Power	1200 W
Battery type	48V28AH, Lithium ion
Max. Speed	45-50 Km/h
Autonomy	50 km

2.4 Summary of Outputs and Activities

In summary, the outputs, planned activities and sub-activities and the milestones for the rural and urban demonstration actions are summarized in the tables below.

Table 19: Output activities and milestones of rural demonstrator

Outputs	Activities	Major sub-activities	Milestones
Acquisition of PV & batteries materials for installation in 10 houses	- Consultation of two suppliers - Reception of the bids - Selection of the best offer	- Meetings with different Suppliers - Preparation of the technical specifications - Launch of the consultations according to Moroccan rules - Study and Validation of the technical offers - Selection of the best cost/technical specification ratio	Reception of the offers Selection of the best Supplier Make the order of the PV & Batteries equipment's
Delivery of the hybrid PV/Batteries installation materials for the 10 houses located	- Sharing basic knowledge about renewable energy integration, how to use it, its benefit etc. - Signature of an agreement between GEP,	- Acquisition of the administrative documents (price of kWh, production per day, the forecast on the month and year and O&M covering)	10 Solar installations put to work Supervision system will be installed

	Act4Community and PV company	- Training sessions (incidents and emergency) - Training session on how to increase self-consumption (when do we need to be more energy active and why we should do that)	
Implementation of a Business Model	- No renewable energy contribution to supply rural needs - Incomes from customers in rural areas	- Agreement with Act4Community (representative of the citizens) for the payment rate of the kWh - Agreement with the Solar Installation company	Increase of the fleet by at least 20% at the end of the project
Dissemination and presentation of the project to the policy makers	- Meetings - Disseminations	- Meetings with Benguerir Municipalities - Meetings with Ministry of the environment - Meetings with the presidents of the involved universities - Creation of the Demonstrator diffusion tools (web page, LinkedIn, Facebook.)	Local and National Replication of the demonstrator

Table 20: Output activities and milestones for urban demonstrator

Outputs	Activities	Major sub-activities	Milestones
Acquisition of 40 Electrical Motorcycles	- Consultation of three suppliers - Reception of the bids - Selection of the best offer	- Meetings with different Suppliers - Preparation of the detailed specifications - Launch of the consultations according to Moroccan rules - Study and Validation of the technical offers - Selection of the best cost/specification ratio	- Reception of the offers - Selection of the best Supplier - Test of the purchased Motorcycles
Delivery of the Motorcycles to 'Dar Ettaliba' (Female Students' house)	- Training of Students (Female) on the Motorcycle driving and maintenance - Signature of an agreement between GEP and 'Dar Ettaliba'	- Acquisition of the insurances - Training sessions (driving in the city) - Training on the charging and driving modes to preserve the Batteries	40 Motorcycles in service
Implementation of a Business Model	- Low contribution from female users - Incomes from e-share	- Agreement with Dar Ettaliba for the payment rate - Agreement with EMOB (s-share) company	Increase of the fleet by at least 20% at the end of the project

Dissemination and presentation of the project to the policy makers	- Meetings - Disseminations	- Meetings with Marrakesh Mayor - Meetings with Ministry of the environment - Meetings with the presidents of the involved universities - Creation of the Demonstrator diffusion tools (web page, LinkedIn, Facebook..)	Local and National Replication of the demonstrator

Table 21: Summary Impact Table for the demonstrations

Impact	Outcomes	Outputs	Activities linked to outputs	Problem addressed
Technologically reliable and economically viable solutions	Improved productive use of energy. Increased local RE%. Increased Green e-Mobility. Increased electrification levels in the rural communities Improved quality of life in the rural communities	Sustainable off grid RE-powered productive business. Smart, Secure, and flexible RE electricity and green e-mobility. Increased electrification levels in the rural communities.	Installation of 10 mini-grid for rural Use of 40 electrical motorcycles	Lack of electricity. CO2%. Reduction of dependency on fossil fuel decreases the negative Environmental impact. Quality of life & local economy.
Strengthening of the joint EU-AU Climate Change and Sustainable Energy Partnership efforts, with emphasis on improving the visibility of EU Science Diplomacy actions in Africa.	Potential to export the European technologies Enhancing scientific & technological collaboration	New Training Programs The new capacities in the society, engagement of SMEs and entrepreneurs increases the innovative use of energy in the community.	WP2 Capacity building tools Exchange on Sustainable Energy Innovation	Local skills Innovative SME. business and innovation issues.
Acceleration of the achievements of the African continent's targets of the Paris Agreement	**-SDG4 (Quality education):** Specialized training in electric tools, equipment, e-mobility, renewable energy and revenue generation models. -**SDG5 (Gender equality):** minimum 50% female customers, Female drivers, female manager of SME. **SDG7 (Affordable clean energy):** Fully solar powered available, new revenue generation model identified. SDG8 (Decent work and economic growth): Accessible hub services, Local innovative manufacturing **SDG11 (Sustainable cities and communities):** Less smog generated with solar generators and low noise pollution with electric transport. **SDG13(Climate):** decrease the emissions through building capacities	Contribute to the SDGs 4, 5,7, 8, 9, 11 and 13	Development of innovative rural mini-grid and e-Mobility services	Sustainable development Goal

3. Preliminary replication opportunities

This section will be updated in the subsequent version of the demonstration implementation plan after more data and feedback are collected from co-creation sessions and pilot use case tests.

4. Updates

This section will be updated in the subsequent version of the demonstration implementation plan after more data and feedback are collected from co-creation sessions and pilot use case tests, and will include the latest development from the implementation of the demo actions.

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Plan 4 - Demonstration Implementation Plan: Waliranji Community, Malawi

This demonstration implementation plan summarizes the ongoing activities of Work Package 4 and outlines the current state of the validation sites in Malawi. This document reports on the status of the demonstration implementation as of May 2022 and it will be regularly updated during the project's lifetime.

1. Operating Environment

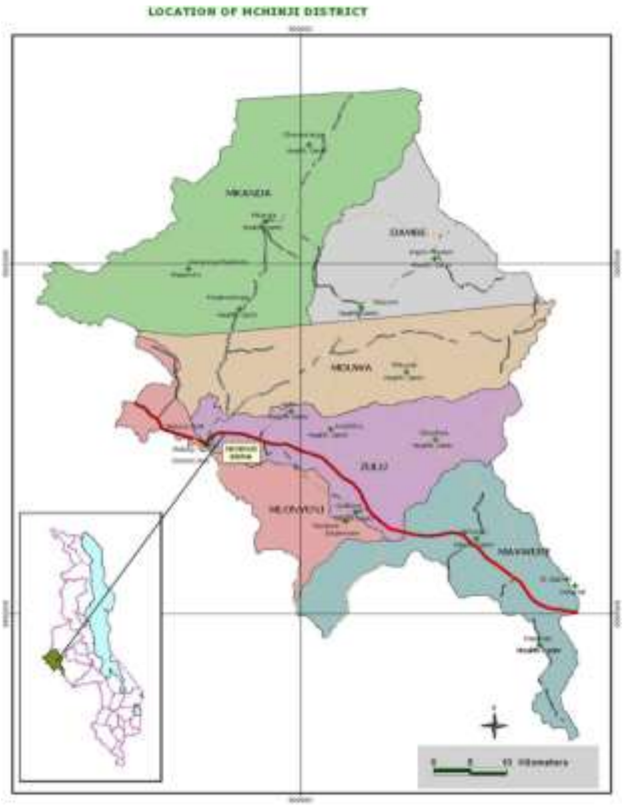
1.1 Background

Malawi's power sector is one of the most severely constrained in sub-Saharan Africa – only 13.4% of the population, lower than the Sub-Saharan African regional average of 47.9%,[2] is connected to the national electrical grid: 3.9% in rural areas and 48.7% in urban areas. More than 84.7% of the total population in Malawi live in rural areas and has access only to wood and paraffin as major energy resources. It is worth noting that Malawi's electrification statistics are the lowest in the Southern Africa Development Community (SADC) region. It trails Madagascar and Mozambique which are at 23% and 24% respectively. The primary energy supplies of the country are hydropower, biomass, petroleum products, coal and other renewable energy sources. Petroleum and petroleum products are imported, and the country spends about 10 % of its foreign currency reserves on the import of petroleum products. Spending 10% of foreign currency reserves for energy imports is distressing considering the fact that the country's massive resource of renewable hydropower, wind and solar energy remains virtually untapped.

1.1.1 Key facts and figures

Malawi is a landlocked country in South-eastern Africa that was formerly known as Nyasaland. It is bordered by Zambia to the west, Tanzania to the north and northeast, and Mozambique to the east, south and southwest. Malawi spans over 118,484 km2 (45,747 sq mi) and has an estimated population of 19,431,566.[1] Malawi has three administrative regions (the Northern, Central, and Southern regions), which are divided into 28 districts, and further into approximately 250 traditional authorities and 110 administrative wards. All the regions and districts are headed by administrators and district commissioners, respectively. The living lab is located in Mchinji district, Traditional Authority Mawvere. Mchinji is one of the nine districts in the Central Region of Malawi bordering with Kasungu District, Lilongwe District, and Zambia and Mozambique. The district has a population of 602,305, and the main tribes are Senga, Chewa and Ngoni. Below is a map of Malawi and Mchinji district where the validation site is located. Figure 46 shows a map of the Mchinji district.

Figure 46: Map of Malawi and Mchinji district



1.1.2 Overarching issues

Accessibility

Malawi is lagging behind in terms of access to energy and is among the countries with the lowest electricity access rates in the world due to a number of reasons mostly linked to lack of knowledge, skills gap, affordability and problems related to supply chain. The problems include rising energy and electricity demand, insufficient power generation capacity, increasing high oil import bills, lack of investment in new power generation units, high transmission and distribution costs, transmission losses, poor power quality and reliability, heavily subsidized pricing, insufficient focus on alternative energy sources, and lack of access to modern electricity for a large segment of the population. In 2020, the overall electrification rate in Malawi was 14.9 %, with 54% of the urban population and only 6.6% of the rural population having access to electricity. Overall, there is energy accessibility crisis in Malawi. However, this is not only a disadvantage, but also an opportunity for Malawi. As energy supplies are scaled up in Malawi, energy technologies that are climate-resilient, affordable and environmentally friendly can be introduced instead of unsustainable sources.

Affordability and reliability

Goal number 7 of the SDGs 'Affordable and clean energy' calls for provision of cheap clean energy that is not depended on fossil fuels. Here is the tricky part; Affordability is different for each country depending on economic status and distribution. The issue of affordability is even more critical in a country like Malawi with almost half of its population living in poverty (below US$ 1.90), and 80% of population living in rural areas. In rural areas, it is not just a matter of providing access. It is more crucial to ensure affordability in terms of upfront, operation and maintenance costs to ensure usability and sustainability of the energy technologies.

Safety and Health of Women

The direct use of wood, charcoal and crop residues as fuel on open fires and traditional stoves results in indoor air pollution which causes severe human health impacts directly to the users, especially rural women and girls. Moreover, the Malawi landscape has completely changed as compared to the 90s. The forest cover is rapidly disappearing and in rural communities, people have started buying firewood. This was something unheard of as women were ready to go and fetch firewood. But those who cannot afford to buy are compelled to travel very long distances to get the firewood. Fetching firewood very far from human settlements pose a threat to safety and dignity of women. They can be raped and exposed to other forms of sexual violence. This burden is borne by women and children, who are then sidetracked from other activities such as doing school and farm work that has potential to improve their productivity and living conditions. Thus, improving the energy supply situation and in particular, increasing access to electricity, are of prime concern in Malawi. Figure 47 shows women carrying firewood, and below is a case explaining what some women faced while trying to collect firewood.

Figure 47: Women carrying firewood

Source: [8]

Assault case

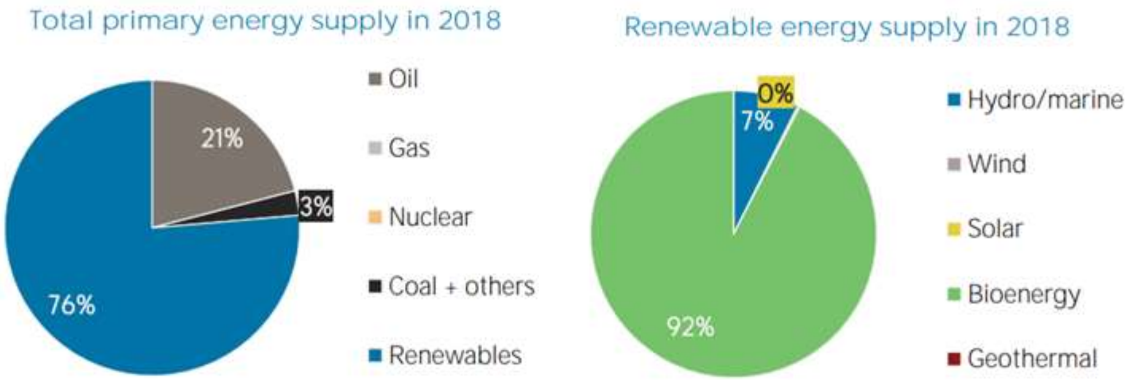
A court in Kasungu has ordered 15 game rangers and forestry guards to stay in remand for ten days to allow police conclude investigations into their case. The 15 were arrested on charges of acts intended to cause grievous harm after they allegedly assaulted civilian women in a forest in that district. The arrests followed a video clip that went viral in the social media depicting some game rangers and forestry guards forcing a helpless woman heavily whip another laying belly down. The women had apparently been caught picking firewood in the protected forest. It later transpired that this was in Chimaliro forest in Kasungu district and that more people than the two known victims had been subjected to the alleged assault.

1.2 Sustainable Energy Access overview

1.2.1 Recent Initiatives

The total installed capacity for electricity generation as of March 2022 is 532 MW, in which 80% is contributed by the Electricity Supply Corporation of Malawi. The rest of the energy is supplied by the private sector. Total installed capacity of the grid-connected hydropower systems and isolated small hydropower plants is around 351.8 MW and 20.2 MW, respectively. There are also a number of coal generations and diesel power plants with a total installed capacity of 141.5 MW, which are not connected to the grid and owned by the private sector. The installed capacity of solar and solar/wind hybrid-based power station is estimated to be 60 MW. Figure 48 shows the total primary energy supply and renewable energy supply in Malawi 2018.

Figure 48: Energy share in Malawi 2018



Traditional biomass is the main renewable fuel in Malawi. The use of biomass, however, is not sustainable, and Malawi has set some ambitions for decarbonization that will help the country transition to sustainable energy. The future decarbonized energy aspirations for Malawi are summarized in the countries Nationally Determined contributions (NDC) to meet the Paris Agreement. Malawi's mitigation contribution takes the form of a reduction in GHG emissions relative to a business-as-usual (BAU) emissions baseline over the period to 2040. The contribution comprises of two components:

- Unconditional contribution: A reduction of 6% relative to BAU in the year 2040; equivalent to an estimated mitigation level of 2.1 million tonnes of carbon dioxide equivalent (tCO2e) in that year. This is an unconditional target, based on domestically supported and implemented mitigation measures and policies.
- Conditional contribution: An additional reduction of 45% relative to BAU in the year 2040; equivalent to an estimated mitigation level of 15.6 million tCO2e in that year. This represents an additional targeted contribution, based on the provision of international support and funding.
- The combined unconditional and conditional contribution is therefore a 51 per cent reduction in GHG emissions compared to BAU in 2040, expressed as a single year target; this is equivalent to an estimated mitigation level of up to 17.7 million tCO2e in 2040.

1.2.2 Policy environment

Currently, there is full support from the policy holders on clean cooking sector. There is also a National Cookstove Steering Committee which is run by a variety of major stakeholders in Malawi’s clean cooking sector. The key policy documents and strategies pertinent to modern energy cooking services in Malawi include:

National Charcoal Strategy: It has seven pillars, and the second pillar is directly related to clean cooking. Pillar 2’s focus is to promote the adoption of improved charcoal and firewood cook stoves for household cooking and heating, as it was concluded that increasing adoption of fuel-efficient charcoal and firewood cook stoves presents the most immediate option to slow deforestation and forest degradation.

National Energy Policy (2018): The National Energy Policy (NEP) has identified 8 policy priority areas. Priority area 2 (biomass) is firmly rooted in strategies to incentivize and scale-up the adoption of more efficient wood/charcoal burning cook stoves. The country’s policy and strategy in energy are aligned with the Sustainable Development Goal 7 which seeks to ensure access to affordable, reliable, sustainable and modern energy for all.

Malawi Renewable Energy Strategy: The vision of the Malawi Renewable Energy Strategy (MRES) is universal access to renewable electricity and sustainable bio-energy sector. The strategy outlined specific actions to take to realize this vision. Three goals were set in relation to clean cooking. These goals were: produce 2 million clean stoves by 2020; develop efficiency standards for cleaner cookstoves; and the roll out of district energy officers across the country by 2022.

Malawi Growth and Development Strategy (MGDS III: 2017-2022): The third MDG identifies energy as one of the Key Priority Areas (KPAs).

1.2.3 Business environment

There are clean stoves providers in Malawi. The stoves are different in functions and components but they are all trying to replace the traditional three-stone open fires and the traditional stove that use biomass more inefficiently. Table 22 below shows the most notable service providers.

Table 22: Main Stove producers and distributors in Malawi

COMPANY	NAME OF STOVE	DESCRIPTION	MIG BIOCOOKER COMPETITIVE ADVANTAGE
MAEV **United purpose** **GIZ** **Women Village Savings Loans Associations** **(Civil society organizations and community groups)**	Chitetezo Mbaula	• It is made from mud which makes it easier and cheap to be produced. • ChitetezoMbaula is a stove that uses minimal amount of firewood, produce enough heat to cook different foodstuffs and better yet emits minimal emissions compared to three stone fire system. • The stove is widely available because it is manufactured and distributed by many organizations and community groups • ChitetezoMbaula is made and sold under different companies (MAEV, United Purpose and several women groups like village and savings groupings)	• It will be durable than this stove • It will allow a wide range of biomass types • The quality standard for our stoves will be uniform • The cooker will try to eliminate the use for firewood unlike this stove that simply reduced the amount of firewood to be used. • The pricing strategy of MIG Biocooker will ensure its long-term availability on the market on the market • The product will be designed, marketed and sold in a sustainable because manner so that even in absence of donors, the production will continue and people will still be benefiting from the product • The cooker targets to reduce biomass usage by 50%, and thus it will beat every stove on the market
C-Quest capital **(energy Africa)**	Stoves	• They mainly focus strongly on reducing smoke related illnesses and deforestation. • They also encourage use of crop residues as biomass.	• MIGBiocooker will reduce smoke emission by less than 10% • MIG BIO Cooker has more advantages with its Biochar in agriculture unlike the biochar from C2quest stove which is just wasted.

		• Study shows that the stove reduces smoke emission by 40%	• MIG Bio cooker is more advanced and goes beyond cooking. • The cooker will be distributed national wide in agro-dealer shops, retail and wholesale shops. • The cooker will use both dried raw residues and briquetted residuals of a wide range making it superior to all other cook stoves in Malawi
Ripple Africa **(Non-governmental organization)**	ChanguChangu Moto Stove	• The ChanguChangu Moto (which means Fast Fast Fire in the local language) • It provides a simple and culturally appropriate alternative to the traditional three-stone fire, which are most commonly used in developing countries. • Each stove requires only 26 mud bricks, which are supplied by each household and made from local, easily accessible materials. • This low-tech, 100% sustainable cook stove assists in counteracting deforestation by substantially reducing the need for fuel-wood.	• The stove uses firewood. While as MIG BIO cooker is trying to do away with the use of fire wood. • The stove will be portable unlike this one. • The stove gives more than heat for cooking. It gives electricity for lighting as well. There is no stove that is producing and storing electric energy.

1.3 Key Stakeholders

Even though the energy supply is still inadequate, there are a number of stakeholders that are supplying energy. There are those supplying energy to the National grid, micro grids placed in communities and private connections to individuals and institutions. A huge number of fragmented suppliers are available in the country distributing solar products like water pumps and are also installing solar systems. The most notable ones are Yellow solar, Sukam solar Malawi and Influx solar. Table 23 shows the major service providers and the type of energy they provide.

Table 23: Major energy service providers

Name of company	Name of energy	Type of energy
Electricity Supply Commission of Malawi	Hydroelectric	Renewable
Power Africa	Solar	Renewable
Press Cane Limited	Ethanol from sugarcane molasses	Renewable

2. Demonstration Action

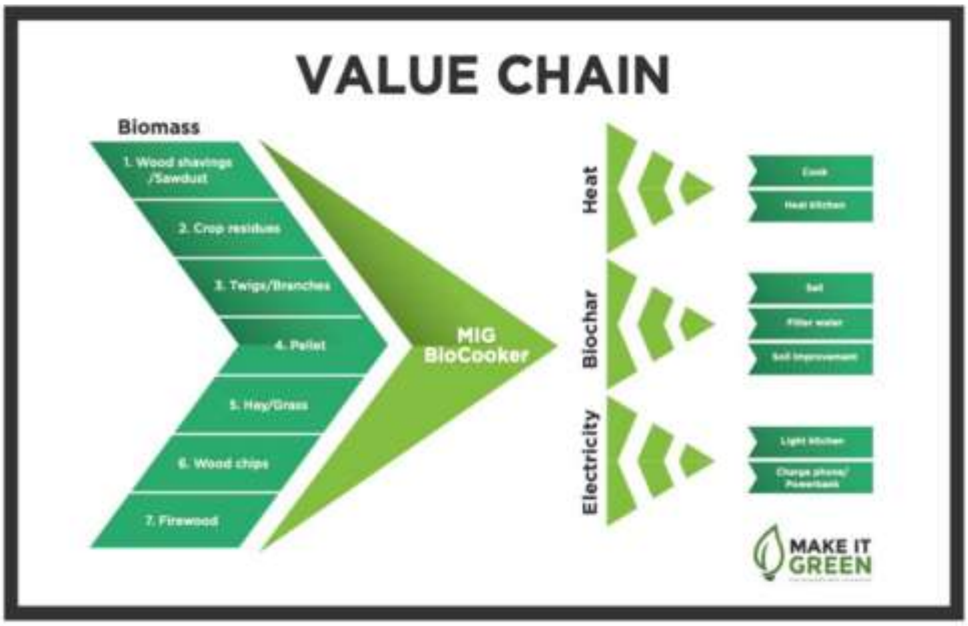
2.1 Overall Objective

The objective of the Malawi demonstration innovation is to adapt and validate the BioCooker to a small-scale and commercial product, in order to be easily implemented in the selected area. The validation site will co-produce the bio cooker and strengthen the applicability and replicability of the technologies as well as the basic business concepts. Going Green is going to co-produce the bio cooker in-partnership with other organizations that will be responsible for research and design of the stove. The research will also guide as on designing our marketing approach so that people can get to know our cooking stove and its benefits. The main objective is to develop a cooking stove with several values to be used in a circular business model and consider a sustainable biomass supply. Specifically, we are looking at achieving the following:

- Develop a more cost-effective biomass cooking solution that is affordable, less time consuming, produces a low carbon footprint and creates a valuable by product.
- Create a local alternative biomass supply chain to reduce deforestation and ease the pressure on the local environment.
- Better indoor air quality in terms of tar particles, and consequently better health.
- Enhance the recovery of nutrients by producing secondary bio-products: soil improvers as biochar.
- Develop new value chain and a circular business model for local entrepreneurs
- and communities.
- Increase the level of knowledge among the people through provision of free hotspots and generation of free electricity that will enable them to read at night and charge their phones without any hassles.

The role of the BioCooker in the refinement of biomass is shown in Figure 49.

Figure 49: The role of the biocooker.



2.1.1 Situation analysis

In terms of energy for cooking, the integrated household survey indicates that the main sources of fuel are firewood, electricity, charcoal, crop residue, saw dust, animal waste, or other, which includes gas and paraffin [9]. Various types of solid materials are used as fuel to provide heating, usually released through combustion and these are referred to as solid fuels. The integrated household survey also shows that almost all households (98%) were using solid fuels for cooking in Malawi and that almost all households in rural areas use solid fuels as compared to 90% in urban areas. Furthermore, the National energy policy estimates that burning of charcoal and wood fuel provides approximately 94% of the cooking energy in Malawi, and that households consume 84% of the total primary energy. Figure 50 summarizes the household use of fuel for cooking.

On the other hand, when it comes to lighting, the integrated household report indicates that the most common source of lighting was battery-fed torches at 75%, seconded by electric light at 11% and candles were third at 6%. Rural areas reported a higher proportion of households using torches as their source of lighting at 85% while urban households were at 35%. The commonly used torches are the ones with disposable batteries. Overall, the report shows that the energy sector is still underdeveloped in Malawi and more has to be done not only to improve the cooking standards but also lighting.

Figure 50: Proportion of households by main source of fuel for cooking by background characteristics, Malawi 2016/17

Background characteristics (Malawi, Place of residence)	Proportion using solid fuel	Fire-wood	Charcoal	Electricity	Crop residue/ Saw dust	Other	Total
Urban	90.3	27.9	62.2	9.4	0.3	0.3	100
Rural	99.7	92.9	5.2	0.2	1.7	1.8	100

In summary, given Malawi's relatively small land-mass, huge (and growing) population and heavy dependence on unsustainable solid fuels, Malawi is rapidly becoming an energy-stressed country. The forest reserves are being depleted at a faster rate with a deforestation rate of 2.8%. Energy stress is not favorable for a country like Malawi that is in much need of development to improve livelihoods of its people. Even the government of Malawi has recognized the importance of energy by putting it in the Malawi Growth and Development Strategy (MDGS3) as one of its key priority areas towards achieving growth and development [10]. The strategy also stresses that the future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible, and environmentally friendly. However, the energy sector is already being faced by a number of challenges that must be addressed imminently if sustainable development goals are to be achieved.

Currently, the prices of charcoal and firewood have been rising sharply due to depletion of forest reserves, and people have to travel long distances to find them. For example, three pieces of firewood are being sold at 25 cents and a household needs about 8 pieces to cook per day. The prices of charcoal, electricity and gas are also on a rise due to a number of reasons including changing weather patterns, depletion of forest reserves and international environment including wars and pandemics. Below is an anecdotal evidence extracted from UNDP Malawi website which shows that in Malawi, we are in need of affordable cooking energy solutions that consider use of alternative energy sources or else, we will face unspeakable energy poverty in the coming few years.[11]

The energy issue is becoming very critical and it might soon turn into crisis if nothing happens to aid in transitioning to clean cooking technologies. Therefore there is a need to help the country's transition to sustainable and diversified renewable energy production and use. Overreliance upon charcoal and firewood as fuel sources for cooking are not the only energy issues we are facing in Malawi. There are also issues of:

- Unavailability of technologies
- Inefficient production and distribution of clean energy and clean stoves

- Inefficient cooking practices like use of three stone open fires and traditional stoves
- Lack of access to information pertaining to clean energy options: Essentially, when it comes to knowledge and access to information, there is a big difference between the urban and rural areas in Malawi. In rural areas people do not have much access to useful information of any development and there is need to invest in capacity building. Even in urban areas where there is access to energy and electricity, finding information is difficult. Most of the information is still on paper as many organizations do not have websites or they have dead websites that are not updated. It is indeed a hassle to quickly get information in Malawi.

All these problems have negative impacts on climate, environment and human health. The inefficient cooking practices use a lot of charcoal and firewood contributing to excessive environmental degradation, such as high deforestation. In addition, the wood, charcoal and crop residues as fuel also results in indoor air pollution which causes severe human health impacts directly to the users, especially rural women. Moreover, the task of gathering traditional supplies of fuel wood is time consuming and exhausting. This burden is borne by women and children, who are then diverted from other activities such as education and farming that could eventually have improved their productivity and living conditions.

2.1.2 Barriers to establishing the local demonstration activities

The adoption of clean and efficient cooking technologies requires attention to how to bring the stove adoption to scale. Adoption is affected by various factors that cut across the value chain. These are:

- Poor transportation links and high cost of transportation might make it difficult to gather raw materials
- Information and skills gaps might lead to reluctance and lack of willingness to participate in the project testing and even adoption of the new technology.
- Concerns about safety during cooking might lead to reluctance to use the technology.
- The wide availability and low cost of illegal charcoal is a barrier to sustainable charcoal market entry. Sustainably harvested fuels are produced by formal companies, which incur production costs and taxes on the sale of their fuels unlike informal, illegal charcoal entities which do not pay taxes. This difference results in a lower cost of illegal charcoal to the end customer.

2.1.3 Opportunities to establish local demonstration activities

The main source of electricity is hydropower which generates about 95% of the electric power in Malawi, and the total installed capacity does not meet the peak demand. Three of the four hydropower generating stations are situated along the Shire River in the southern region of the country. Apart from the low energy generation capacity, there is also a problem of insufficient transmission and distribution facilities. As a result, of all these problems, the country faces frequent power outages which make electricity supplied by the national grid unreliable. The electricity board raised the tariffs by 10.62% in March 2021 making it even more unaffordable for some households to use for cooking.

Solar energy, the world most celebrated technology is also considered one of the potential renewable clean energy options. The solar energy potential in Malawi is very high and it can to a great extent fill the gap of energy supply in the country. Many parts of the country receive 8 to 12 hours of sunshine per day of 244 W/m2. The total available solar energy potential over the total geographical area (i.e. 90,776 km2), of Malawi is calculated to be 356,284,837 MWh/year. The most commonly utilized method of supply of energy from solar has been independent private connections, and most in urban areas. On the other hand, in rural areas, the solar energy is mainly used for lighting. Solar-powered torches - very small photovoltaic systems - are increasingly becoming a sight in rural areas thanks to organizations like Yellow solar that are distributing solar products on loan in rural communities while also creating jobs for the youths.

In general, solar energy has a lot of potential and the solar technologies are available. But the issue is that of affordability as the upfront costs for the available technologies are high for an average Malawian. The issue of low adoption and utilization of technologies might not only be about affordability but also ownership of the house as it is very rare to make a full-scale solar installation on a house you are simply renting.

As for wind energy, utilization is considerably low and localized in agriculture sector mainly for irrigation. The preliminary studies conducted by Malawi's Meteorological Department suggested that the wind resource in Malawi cannot contribute significantly to a firm power generation due to low speed (2.0 - 7.0 m/s). Thus, it was deemed suitable for low-speedaero generators that can be operated for various applications such as milling of grains, pumping water and even lighting purposes in small remote villages around Malawi. However, such assertion is contrasted by recent research findings which indicate that there is considerable potential for wind in the country. Even though there is considerable potential, it will take time before its potential can be fully tapped due to high upfront costs.

Bio-energy potential in Malawi is estimated between 0.1 and 0.5 EJ/year. The bio-energy can be both affordable and reliable as Malawi is mostly an agricultural country and the resources to be used are locally sourced. The main challenges pertaining to use of bio-energy in the county are inefficient production, lack of awareness of existing technologies, lack of skills to turn biomass into bio-energy and lack of structured financing options.

2.2 Demonstration site

As indicated above, there is only one living lab in Malawi and is known as Waliranji community. The community has a population of 150,000 and covers an area of 35,592 km². It is located in Mchinji south and it lies within a plain of mostly arable land, Dambos (grass-covered broad depressions) and waterways drain the plains into Bua River. As the rest of Mchinji district, the main economic activity in Waliranji community is agriculture since it supports over 99% of the population. The common agricultural practice is crop production done on land using the traditional methods (use of machines and other land management practices are still a novel concept in Malawi especially rural areas. People are still using hoes for land cultivation). Land cultivation requires extensive land clearing. This has led to massive depletion of natural forests reserves. Depletion of forests has been exacerbated by heavy reliance on charcoal and firewood as the main sources of cooking energy. More and more pressure is expected to be put on forest reserves as the population of Malawi is projected to reach 26 million by 2030. Thus, it is imperative to act now to protect the forest reserves by exploring alternative sources of biomass for cooking.

The predominant cooking practices are cooking on three stone open fires and/or cooking mostly on a traditional stove. In the communities, most houses have a kitchen separated from the house. It is small in size and inside it, you will find three stones. Firewood and other solid fuels like sacks, and bottles and other plastics are placed between the stones. Smoke is produced and inhaled by those cooking and even children who await their mothers and sisters while they are cooking. The roofs of the kitchens are filled with soot that is rarely cleaned. It is a very painful sight. The open fire cooking systems consumes a lot of biomass, and thus other organizations are trying to reduce the amount of biomass consumed by building a structure that leaves only one space for putting the biomass but the threat of air pollution is still there. Cooking on thev traditional unimproved simple metal stove is done by filling the stove with charcoal made from trees. The whole tree is cut and burned in the forest and then charcoal is filled in the bags and sold in communities. Plastics, paraffin and other flammables are used to ignite the fire on the stoves. Some plastics smell really bad and for a while. All these issues pose a threat to development of Malawi, environment, health and even household income. As the supply of the biomass is decreasing, the prices are increasing making it even harder for an average household to meet its energy demands.

2.2.1 Logical framework

A logical framework, shown in Table 24, has been developed to make all stakeholders understand what we want to achieve. This logical framework clearly states explicit and measureable descriptions of what will happen if the project is successful. It also displays the key elements of project design and their relationships to each other in a way that facilitates project analysis.

Table 24: Logical framework.

	PROJECT SUMMARY	**INDICATORS**	**MEANS OF VERIFICATION**	**RISKS / ASSUMPTIONS**
Goal	G1 Develop a highly efficient clean cooking stove with several values to be used in a circular business model G2 Create a sustainable alternative biomass supply chain.	G1 MIG Biocooker produced and operational G2 Sustainable biomass supply chain created	G1 Check physically G2 Household surveys G2 Observational visits	The proposed stove is successfully produced Alternative biomass sources will be available
Outcomes	Cost-effective biomass cooking solution that is affordable, less time consuming, produces a low carbon footprint and creates a valuable by product is created Alternative biomasses businesses created Demand for improved stoves and alternative biomass increased	1a. Number of hours spent cooking 1b. Availability of disposable income 1c. Availability and quantity of usable biochar produced everyday 1d. Stove thermal efficiency 1e. Availability of usable electricity 2a. Number of jobs created 2b. Number of biomass businesses created 2c. Availability of alternative biomass sources in the markets 3.Number of people expressing willingness to buy and use the stove	1 2 &3 Household surveys and Observational visits 1.Stove performance report	People will be willing to patronize the new businesses People truly express their needs
Outputs	1. Households use efficient clean stove 2a. Different biomass types tested and analysed 2b. Fire briquettes' manufactures trained 2c. Alternative biomasses sources value-chain created 3.Increased knowledge on climate change, energy, health, education, business	1. Stove usage 2a. Types of alternative biomass allowed in the stove 2b. Number of briquettes manufactures trained 2b & 2c Availability of operational alternative biomass sources businesses 3a. Change in behaviour and cooking practices	1 2b 2c & 3a. Observational visits 2a. Lab and field tests 2b Reports 1 2b 2c & 3a Household surveys	People are willing to answer questions Availability of resources for lab and field tests

	management and entrepreneurship	3b. Demand for clean stoves and alternative biomass sources		
Activities	1. Development of a highly efficient clean stove that produce biochar, electricity, and use different biomass types is developed 1 & 2a. Lab and field tests 2b 2c & 3 Training on fire briquettes' making, business management and entrepreneurship 2c & 3 Awareness campaigns on climate change, energy, health, education 1 2 & 3 Monitoring and evaluation	1.Availability of the clean stove 2a. Number and type of lab and field tests conducted 2b & 2c Number of trainings and people attending the trainings 2c. Number of awareness campaigns and number of people attending the campaigns 1 2 &3 Evidence of monitoring and evaluation being carried out	1 & 2a. Laboratory and field test results 1. Physically check 1. Household surveys 2b 2c & 3 Reports	The resources are available to make and test the stove People are willing to be part of the project Repots produced reflects the real situation on the ground

2.2.2 Expected Impacts of the Project

The project will have a direct contribution to the attainment of Malawi Growth and Development Strategy (MDG3)[10]. It will also have a direct positive impact on the Sustainable Development Goals. It will specifically have impacts on the following SDGs:

- Good Health and well-being (SDG 3)
- Promote Gender Equality (SDG 5)
- Promote quality and Inclusive education (SDG 4)
- Decent work and economic growth (SDG 8)
- Climate Action (SDG 13)

Table 25 shows how the project will contribute to the SDGs.

Table 25: The impact table – Malawi demonstration action

Impact	Outcomes	Outputs	Activities linked to Outputs	Problems addressed
Promote Good Health and well-being (Contribute to SDG 3)	Reduced indoor air pollution Women protected from ails they can meet while fetching firewood	Households use improved stoves No smoke generated during cooking Less emissions generated while cooking Eliminate airborne soot Stove uses less biomass	Development of a highly efficient clean stove Lab testing Field testing and monitoring	Smoke and emissions related illnesses including respiratory and eye infections Unavailability of clean energy technologies Exposure to the risks of rape, assault and other forms of violence while fetching firewood away from human settlements

Promote Gender Equality (Contribute to SDG 5)	Women have more time to do other productive activities	Stove uses less biomass Stove use alternative biomass sources Sustainable alternative biomass supply chain created Reduction in cooking time	Development of a highly efficient clean stove that allows different types of biomasses Training women groups and entrepreneurs on fire briquettes making from wastes Field testing and monitoring	More time spent on firewood collection activities Travelling long distances to collect firewood
Promote quality and Inclusive education (Contribute to SDG 4)	Women and girls empowered with new skills and knowledge	Electricity for lighting, reading and phone charging generated Free info-spots provided	Development of a highly efficient clean stove generate usable electricity Provision of info-spots for free internet access Training women as sales agents Training women groups in fire briquettes' making Field testing and monitoring	Unreliable electricity High cost of batteries used in torches for lighting purposes every night Knowledge and skills gaps Lack of access to internet
Decent work and economic growth (Contribute to SDG 8)	Improved Livelihoods Demand for stoves and alternative energy sources created Families have more disposable income (cost of cooking and lighting costs reduced, and thus freeing more money to be used for other things)	Job Creation Improved soil structure by biochar Sustainable biomass supply chain created Stove that has higher thermal efficiency and produce free usable electricity is generated	Employing the locals to work in the Stove production factory Training women groups and SMEs to make fire Briquettes', and in turn they will employ others Creating an enabling environment for biomass and biochar business opportunity Monitoring Marketing campaigns	Lack of decent jobs Poverty Unemployment

Climate Action(Contribute to SDG 13)	Forests Conservation Reduction of Green House Gasses emissions	Reduced pressure on forest reserves Reduction in emissions Increased knowledge on climate change, forest conservation, health and efficient cooking practices.	Development of a highly efficient clean stove Awareness campaigns on climate change, forest conservation, health and efficient cooking practices	Lack of knowledge Lack of access to appropriate technologies Inefficient cooking practices

2.3 Infrastructure/equipment

2.3.1 Technology adopted

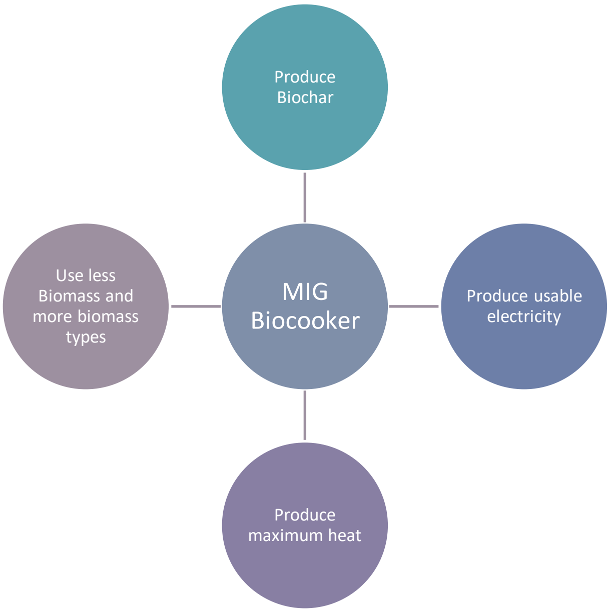
To help the country transition to clean energy, Going Green in partnership with other organizations is going to design, manufacture and distribute an improved cooking stove called MiG Biocooker, shown in Figure 51. This stove will be using fire briquettes made from solid waste biomass that is not sourced from forest reserves. Some of the biomass will be from crop residuals like groundnuts straws, and maize and sunflower stalks.

The stove technology uses pyrolysis to produce heat for cooking. By heating biomass under oxygen-limited conditions the development of smoke is significantly reduced, and a biochar product is also produced. Biochar is used as a soil improver in agriculture. In addition to binding plant nutrients in the form of cations and anions, biochar binds water molecules. Thus, biochar can reduce stress during, for example, drought. Biochar can also have a positive effect on the structure of the soil and has also shown positive effects on soil micro-life. In general, it can be said that the use of biochar makes a difference, especially in many developing countries where the soil often lacks organic material, has a poorer structure and where there is a lack of water and a risk of erosion.

The properties of biochar vary depending on the source biomass material used and the temperature during the pyrolysis. RISE and MIGS will test the cooking stove with several biomass fuels and characterize the biochar product. The MiG Biocooker can also turn heat into electricity. The stove generates usable electricity and stores it in its internal power bank for USB charging of lights and mobile phones. The electric power is generated using thermoelectric coolers which operate according to the Peltier effect. The effect creates a temperature difference by transferring heat between two electrical junctions. When the current flows through the junctions of the two conductors, heat is removed at one junction and cooling occurs. It is also possible to extract electricity from the battery even when you do not use the stove, if there is energy left in the battery. When you use the stove, the battery is recharged.

Figure 51: Design of MiGBioCooker

Figure 52: The features of MiG Biocooker



Biomass Residues

The MiG Biocooker is suitable for waste biofuels, which is more sustainable than fuels taken directly from growing plants, which causes deforestation. At the validation site in Waliranji there is a small-scale sunflower oil pressing plant. The sunflower production comes mainly from smallholders. This is due to the fact that sunflower is an easily manageable crop that smallholders use to cycle and back up other crops such as maize. About 1000 farmers now supply the production plant with sunflower seeds. From the sunflower production there will be biomass residues that can be briquetted and used as a potential fuel for the cooking stoves. Figure 53 shows sunflower fuel samples. Before use the residues must be dried in the field. For own use the residues can be cut and combusted as it is. However, briquetted residues constitute a fuel with higher density and one that can be stored and transported for later use. Within the project the fuel will be analyzed and tested in the cooking stove by RISE and MIGS.

Figure 53: Residues from sunflower plant and briquettes from dried sunflower residues

Source: [Photographer: Mathias Berglund, RISE]

There is a need for a cookstove production factory, additional cutting machines and small bending machines. The validation site is located in Mchinji district in the central region of Malawi. It is 60 km from the capital city Lilongwe and 88 km from the Kamuzu international airport in Lilongwe. It is all tarmac roads but the factory is located 1.5 kilometres from the tarmac road. The factory is very accessible and there are no challenges in accessing it. However, most villages are over 10 km away from the tarmac roads, and that’s where the farmers are. To access these villages in rainy season is a challenge and requires a field vehicle.

2.4 Detailed Time-plan

Figure 54 shows a Gantt with a visual representation of the project timeline and also the lead organization for every activity.

Figure 54: Gantt Chart – Malawi demo

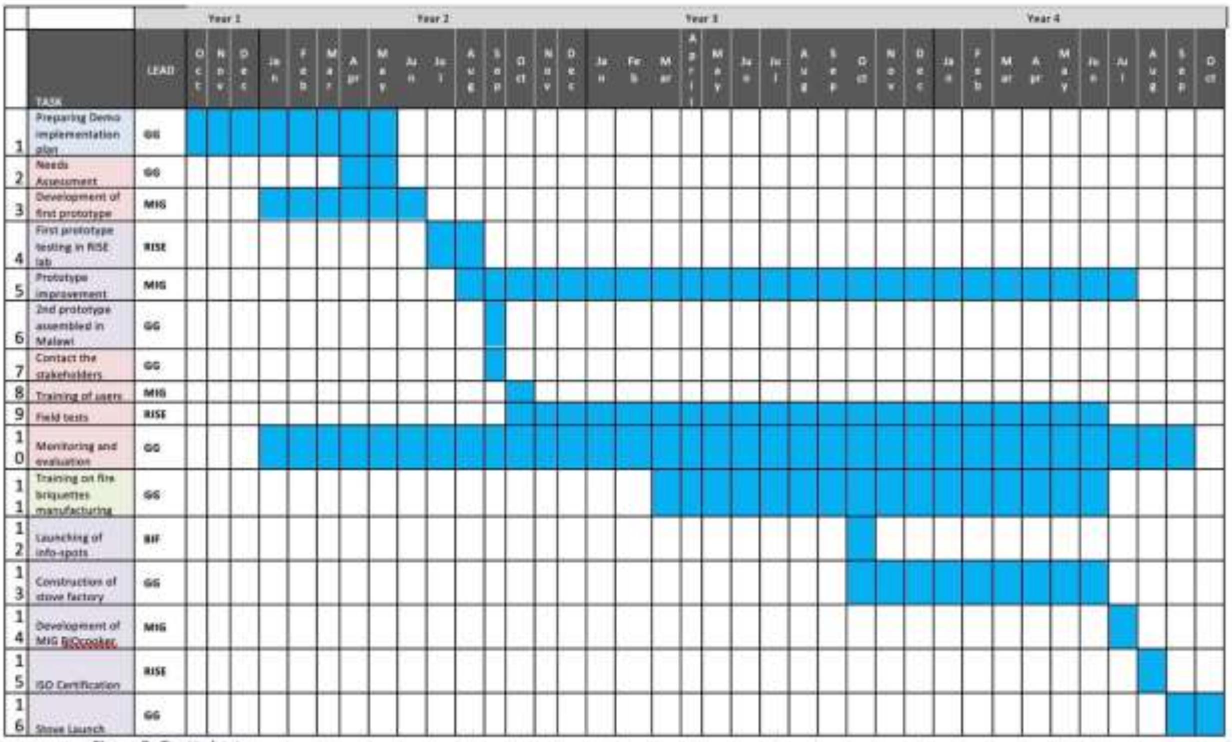


Figure 9: Gantt chart

2.5 Business model plan

The MIG Bio Cooker is being designed and created by Make it Green, a Swedish company. However, it will be tested and mass produced in Malawian communities. After the development of the stove, it will first be sold in Malawi. The MIG Bio cooker is a very good innovation but some people in the rural areas might not afford to buy the stove. That's why we have come up with different business models and strategies for rural and urban areas. Table 26 summarizes the proposed business model for the innovation.

Table 26: Summary of business model.

Rural Areas		Urban Areas
Commission Based Distribution Model	**Shared Economy Model**	**Straightforward Distribution Model**
Local sales agents will be recruited and trained by Going green (GG). These people will be responsible for marketing and sales of the stove in their communities. The buyers will be required to pay 25% upfront fee before they receive the stove. Then they will be paying the balance monthly up to five months	In this model, we are going to experiment with 10 women groups. We will lease the stoves to the women so that they can sell on our behalf. It will be a win-win solution as they will also earn something. They will decide how to sell and how to collect the payments in their communities.	We will identify and select intermediaries that appeal to a broad market base. These will include wholesalers, retailers and filling stations We will ensure that the intermediaries are charging the same price Commission will also be paid for every product they sell in order to motivate them to help us market the MIG Biocooker The stove will also be sold online

In our stove, we are trying to incorporate a certain component that can enable us to disconnect the stove if the buyer does not owner his/her commitment to pay back. This will enable us to collect every penny without hurting our brand The agent will be required to sell an average of 30 stoves every month Everything will be rolled out slowly, lessons will be learnt and best practices capitalized.	The groups will be fully trained and assessed to ensure that they don't hurt our brand reputation Lessons will also be learned and best practices will be capitalized.	

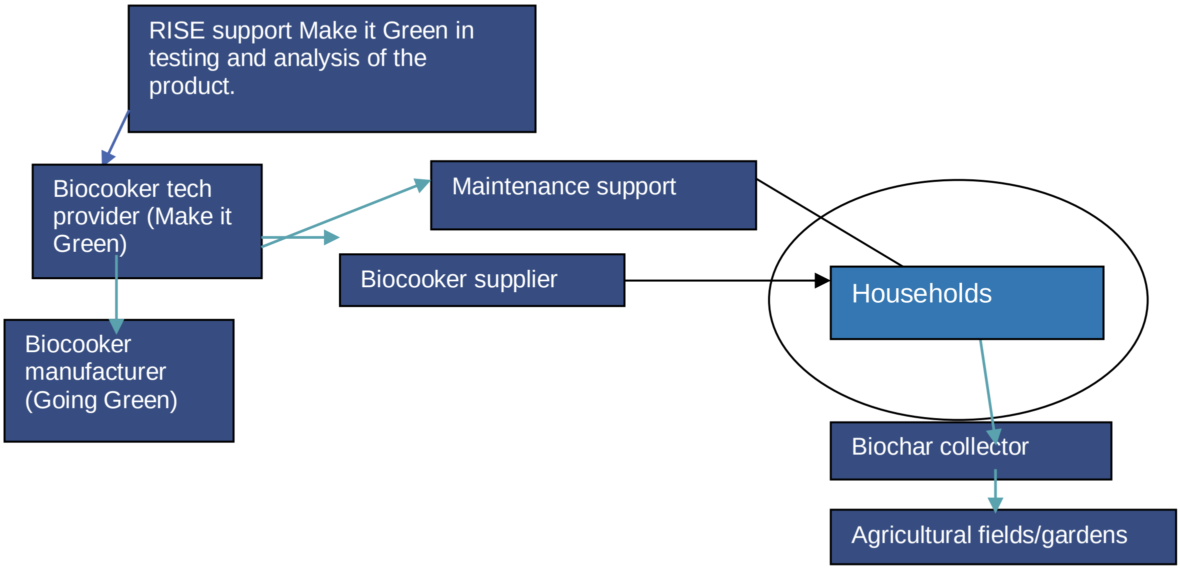
Table 27 shows the business model canvas outlining our key activities, value proposition, key resource and everything else we need to take the innovation to the public and sell it.

Table 27: Business Model Canvas.

<table>
<tr>
<td rowspan="2">Key Partners
Farmers
Biomass entrepreneurs
Local hardware and
Electronic shops</td>
<td>Key Activities
Procurement of stove materials
Stove research and development
Biomass analysis
Assembling of the stove
Training on stove use and maintenance
Delivering the stove to select distribution partners
Robust marketing on different challenges
Continuous monitoring and review of stoves performance, and distributors performance</td>
<td rowspan="2">Value Proposition
Help those who cook over the flame to cook in a smoke free zone, use less biomass and time, and generate free usable electricity while cooking.</td>
<td>Customer Relationships?
Going Green will use a face book page, website, distributors and the local sales representative to market our products, and hear customer concerns and address them as quickly as possible. Interacting with our customers as they will be using our product will be our number one priority</td>
<td rowspan="2">Customer Segments
Households who cook over the flame.
Specifically, these are middle and low-class families living in rural communities, semi-urban areas and slums who cook over three stone fires and other traditional stoves. Also those who are looking for a modern stove they can use when there is a black out as a cook stove and also as a lighting tool</td>
</tr>
<tr>
<td>Key Resources
Competent staff members
Technical knowledge and skills
Software
Patent
Financial resources
Physical buildings
Motor vehicles</td>
<td>Channels
Television
Radio
Kitchen top-ups
Community engagements
Facebook
Website
Sales reps</td>
</tr>
</table>

Each partner and user has a part in the value chain supply system, shown in Figure 55.

Figure 55: Value chain – Malawi demo



2.6 Local Implementation team

Key stakeholders and their roles are presented in Table 28. Others will only be crucial at the onset of the project but their role is equally important for the success of the project. Going Green Limited is the local partner. Its main roles are the stakeholder engagement, production, distribution and training of the stove users. It is providing the project premises and will also be responsible for the replication and scaling-up of the project. The local implementation team is described in Table 28. The SESA consortium, policy makers, community leaders, community members and the educators will be very critical for the success of the project in the long run and short term. The innovation must be adopted by community members and supported by the policy makers. The project will be implemented by four different organizations. Three organizations are Swedish and the remaining one is Malawi. Table 28 summarizes the implementation team and their roles in the project.

Table 28: List of implementing stakeholders – Malawi demo

KEY STAKEHOLDERS	ROLES
Going Green Ltd (Local Partner)	Production of the cook stove. Distribution of the cook stove. Training on how to use the cookstove. Supervision to make sure that the stove is being used in the right way. Contact: Chikondi Khonje
Make It Green Solutions AB	Develop and construct a biochar cookstove prototype to be tested in the field. Contact: Martin Karlsson
RISE Research Institutes of Sweden	Lead and support the Malawi innovation case and will also contribute with testing and verification of the developed product. RISE will also contribute with experience on biomass feedstock and energy conversion technologies. Contact: Susanne Paulrud and Kent Davidsson
Basic Internet Foundation	The Basic Internet Foundation will focus on information & training supporting the energy transition towards sustainable energy. Main focus is the combined deployment of Info-Spots in conjunction with micro-grids and renewable grid installations.

Cooking Stoves Association of Malawiand National Cookstoves steering committee	Being members of the stove association will gives us credibility and competitive advantage They provide latest information on improved cooking stoves Offer a wide range of partnerships and marketing opportunities
Community leaders	Approval of the project in their communities Facilitate the adoption of the clean energy technologies
Community members	Adopting and using the cooking stoves and biochar Providing the biomass to be used to be used in the stove
Educators	Capacity building on how to use the cooking stoves and produce the fire briquettes. Accelerate the adoption of clean cooking practices. They will help us with capacity building and awareness campaigns to increase knowledge and understanding in issues to do with energy, climate change, cooking practices, education, health, business management and entrepreneurship. The increased level of knowledge will induce behavior change and create demand for clean technologies and thus creating a new market for our stove and alternative energy sources.
Farmer groups and entrepreneurs	Buying the stoves Marketing the stoves Supplying the biomass
Sales agents and distributors	They will help us sale the stove and ensure continuity of the stove production operations
Stove materials suppliers	They are very essential in the supply chain and they also hold a key to the project success. We are specifically looking at local suppliers to remove the import hassles and ensure that the product is affordable to an average Malawian.

2.7 Risk Assessment

The key project activities will be carried out in the production building, people's households (the field) and also in the laboratory. There are risks that might affect implementation of the project activities, and hence the success of the project. Therefore, we found it necessary to identify the risks and put mitigation measures to ensure success and sustainability of the project. Table 29 gives the detailed account of the identified risks and mitigation measures if the risk is deemed highly likely to happen and its impact magnitude is high. However, it must be noted that all the risks will be constantly reviewed and monitored during the project course.

Table 29: Risk Assessment table – Malawi demo

Risk	**Probability assessment**	**Consequences**	**Risk mitigation/comments**
Accidents	Medium	Injuries	Team members will be wearing protective gear when working
Conflict of interest	Low	The waste biomass especially crop residues are also targeted for other agriculture projects so there might be a conflict of interest which may delay approval of the project or prompt project redesigning	Explaining and demonstrating to relevant governments department that the biomass feedstocks are not necessarily supposed to be dead. There can also be entrepreneurs who can cultivate certain biomass feedstock in some places like highlands. This will also contribute to the Malawi's greenification aspirations
Stove technique failure or problems	Low	Injuries or worse, redesign the stove or stop the research Negative Impact on user and customer experience	Technical performance and safety testing will be conducted Training of users to be conducted Through lab and field testes will be done prior to final product development
Bad working relationship among stakeholders	Low	Project delay or worse	Encourage the pilot stakeholders to be committed to a long-term relationship with each other, and communication is an effective way to maintain the relationship.
Budget creep	Low	Actual costs are higher than expected costs	Have a clear financial plan as well as optimize and control costs
Technology not appropriate for users	Low	Low uptake and users can stop using the technology	User needs-based assessment at the core of the design phase Focus on user and stakeholder engagement throughout project lifecycle
System technical problems	Medium	Negative Impact on user and customer experience	Technical team testing system pre installation to identify issues before installation
System /Service complexity	Low	System or services are not attractive to end users	Continuous feedback and engagement of users and key stakeholder groups during design, implementation and iteration

2.8 Monitoring

The project success is our ultimate goal, and thus monitoring the activities and stove development process are our prime priorities. Monitoring and evaluation (M &E) of the project will enable the project team to measure their performance and track progress towards achieving desired goals. (M &E) will be incorporated carefully within all the stages of a project cycle. This will strengthen the project design and implementation by helping us notice variations quickly and make necessary adjustments to avoid product creep. The team came up with a set of qualitative and quantitative indicators which will be used to monitor and evaluate the project's performance to achieve the project's objectives. These indicators will be updated and monitored during the implementation of the project. The indicators include data on cooking time, emissions, cost of cooking and lighting and many more Monitoring and evaluation will be carried out according to the agreed metric framework to determine the efficiency and effectiveness of the project. The M & E framework in Figure 56 shows the indicators, baseline data, targets and many others.

Figure 56: Monitoring & Evaluation (M&E) Framework.

	INDICATOR	**DEFINITION** *How is it calculated?*	**BASELINE** *What is the current value?*	**TARGET** *What is the target value?*	**DATA SOURCE** *How will it be measured?*	**FREQUENCY** *How often will it be measured?*	**RESPONSIBLE** *Who will measure it?*	**REPORTING** *Where will it be reported?*
Goal	The quality of the stove developed	Lab and field tests to check the stove features	-	The stove must have several values to be used in a circular business model	Lab and field tests reports	Annually	MIGs, GG & RISE	SESA Consortium and partners
Outcomes	Amount of Particulate matter (PM) found in a room while cooking	Reading on the indoor air quality monitor	More than 24 hours average concentration of 25 µg/m³	24 hours average concentration of 8 µg/m³	Air quality monitor	daily	RISE	SESA Consortium and partners
	Average amount of money spent on energy (cooking and lighting)	Average cost spent on cooking and lighting in a household	$50 per month	$30 per month	Expenditure records	Daily	GG	SESA Consortium and partners
	Change in reported level of drudgery for women related to fuel procurement and cooking in target population	Time spent on sourcing biomass and cooking	20hrs per week	15hrs/ week	Household survey reports	quarterly	GG	Consortium and partners
Outputs	Stove thermal efficiency	Thermal efficiency represents the ratio of the work done by heating and evaporating water to the energy supplied by burning fuel.	-	80%	Thermal efficiency test results	Annually	RISE	Consortium and partners
	Amount of usable electric energy released and stored	Electric meters	0 Amps	750 Amps	Electric meters recordings	Monthly	RISE and GG	Partners
	Amount of usable biochar released	Amount of biochar released per day	0	500g/day	Cooking records	Monthly	RISE and GG	Partners

	Reduction in percentage of quantity of biomass used	Quantity of biomass used divide by quantity of biomass used in open fires times 100.	-	65%	Cooking records	Quarterly	RISE and GG	SESA Consortium and partners
	Reduction in percentage of time of cooking	Time taken to cook the same things on the stove as compared to open fires	-	55%	Cooking records	Monthly	RISE	SESA Consortium and partners

3. Preliminary Replication Opportunities

The MiG Biocooker is not just a cooking stove like the others on the market. It has been designed to specifically go beyond the function of efficient cooking practices and solve the other energy related pain points of the people of Malawi. The electricity feature of the cooker will help us penetrate the market so easily because many people. Going Green will initially market the stove and sell through farmer groups whereby farmers through their groups will be purchasing the stove on credit and pay over a specified period of time. Currently, Going Green works with 72 farmer groups and 2000 plus sun flower farmers in the validation site, and are expected to be the first users, customers and biomass suppliers. The company has built good work relationship with the farmers and we believe that the adoption rate of the technology among them will be over 95%. Lessons learned will help us to easily replicate the solution and scale up. We are targeting 1900 households within a year.

4. Updates

The energy Policy strongly advocates for the private sector to take a leading role in the implementation of energy sector interventions. There are also a number of opportunities for Civil Society Organizations (CSOs), communities and other partners to participate in the implementation of the Policy. It's noted that Renewable energy contribution to the energy mix is still low and that there is limited dissemination of information or awareness and inadequate human capacity building. The policy states that government will intensify training and nationwide promotional activities for improved cook stoves, brick kilns, charcoal kilns, and biomass briquettes through building and strengthening capacity in new biomass technologies, increasing public knowledge and utilization of improved biomass technologies and their economic opportunities and developing and implementing a Biomass Energy Technologies Training Strategy. On the other hand, there is lack of data on energy in Malawi and most of the available extensive data is outdated.

5. References

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Plan 5 - Demonstration Implementation Plan: CARE Alicedale, South Africa

This demonstration implementation plan summarizes the ongoing activities of Work Package 4 and outlines the current state of the validation sites in South Africa. This document reports on the status of the demonstration implementation as of May 2022 and it will be regularly updated during the project's lifetime.

1. Operating environment

1.1. Background

The Eastern Cape is the second largest province in South Africa. The central and eastern part of the province is the traditional home of the indigenous Xhosa people. In 1820 this area began to be settled by Europeans who originally came from England and some from Scotland and Ireland. The Eastern Cape is the poorest province in South Africa and has the highest expanded and official unemployment rate in the country. Subsistence agriculture predominates in the former homelands, resulting in widespread poverty. There is much fertile land in the Eastern Cape, and agriculture remains important. With three import/export harbours and an excellent road and rail infrastructure, the province has been earmarked as a key area for growth and economic development in modern South Africa.

At the beginning of 2003 a joint initiative between a leading conservation-focused hospitality group and the Eastern Cape government was established to redevelop the Alicedale town. The initiative seeks to become a model of transformation for a previously disadvantaged community and the turnaround of a rural town. An exemplary location was transformed from barren farmland into one of the world's leading conservations. Renewable energy provides Eastern Cape with a new growth opportunity. The proposed demonstration site for the SESA project is within the Makana Municipality which is located within the western part of the Eastern Cape Province falling under the Sarah Baartman District Municipality. This demonstration site will aim to test, validate and replicate a containerized off-grid renewable energy system comprising of solar photovoltaic panels and utilising second life electric vehicle batteries for stationary energy storage, together with a small fleet of micro-utility electric vehicles. The demonstration will:

- extend the productive use of renewable energy for the community, and also offer sustainable charging of a small fleet of micro utility electric vehicles
- understand the technical and commercial feasibility, performance, and replicability of the system for rural and peri-urban applications in South Africa and across the African continent
- understand performance, value and repurposing potential of electric vehicle batteries for stationary storage applications
- provision of Infospots for internet services

1.1.1 Key facts and figures

Eastern Cape

The table below presents facts and figures about Eastern Cape.

Table 30: Key facts and figures – Eastern Cape

	Value
Demographics	
Total population	6,734,001
((Population density (persons/sq.km)	39/km^2 (100/sq mi)
Urban population	35.2%
Non-urban population	64.8%

	Value
Estimated number of households	1,702,000
Average household size	5.48
Population growth rate	2.88%
Unemployment rate	54.5%
Percentage living below poverty line	72%
Percentage women-headed households	50%
Children living arrangements	
Does not live with mother or father	32.7%
Lives with mother	40.9%
Lives with both parents	23.5%
Main source of income	
Salary	36.1%
Social security agency grant	44.8%
Other sources	5.2%
Remittances	10.5%
Pension	3.5%
Area	
Area (km^2)	170,616
Concreted roads (km)	4,952

Sources:
Mid-year population estimates 2021 Statistics South Africa
South Africa: number of households, by province | Statista
SANRAL-Hello-EASTERNCAPE-CAPE-2021.pdf
Quarter Labour Force Survey Statistics South Africa: Quarter 3: 2021
General Household Survey 2020: Statistics South Africa
Province of the Eastern Cape: Department of Social Development
South Africa: female-headed households, by province | Statista
Socio-economic and demographic profiles of provinces

KwaNonzwakazi, Alicedale

There are two main areas within Alicedale: Alicedale (urban area) and KwaNonzwakazi (non-urban: semi-rural area).

Table 31: Population - KwaNonzwakazi, Alicedale

	Value
Demographics	
Total population	3,868
Alicedale	1,930
KwaNonzwakazi	1,938
Estimated total number of households	1060
Estimated number of households Alicedale	467
Estimated number of households KwaNonzwakazi	593
Unemployment rate	68%
Unemployment rate KwaNonzwakazi	77%
Area	

	Value
Area (km^2)	4.7km^2

Source: Makhana Local Municipality: Eastern Cape: population

Figure 57: Annual Household Income - KwaNonzwakazi, Alicedale

Annual household income	No income	0€ - 300€	301€ - 600€	601€ - 1 226€	1 227€ - 2 390€	2 391€ - 4 781€	4 782€ - 9 624€	9 625€ - 19 248€	19 249€ - 38 446€	38 447€ - 76 892€	76 893€ - 153 783€	153 784€ or more
Alicedale	57	25	25	86	117	91	51	10	5	0	0	0
KwaNonzwakazi	120	32	45	140	141	66	28	18	3	0	0	0

Source: Makana Local Municipality: Eastern Cape: annual household income

Figure 58: Employment Status - KwaNonzwakazi, Alicedale

Official employment status: ages 15 - 64	Employed	Unemployed	Discouraged work-seeker	Other not economically active
Alicedale	394	186	117	532
KwaNonzwakazi	299	287	56	632

Source: Makana Local Municipality: Employment status

1.1.2 Overarching issues

Makana municipality has a supplier agreement with Eskom (state power utility) to purchase electricity for its area supplied by the municipality. Eskom operates 15 coal-fired power stations[7] that generate more than 80% of the country's electricity[8]. These power stations regularly break down causing load shedding and/or pro-longed black outs. National government has an initiative called the Renewable Independent Power Producer Programme (REIPPP)[9] aimed at bringing additional megawatts onto the country's electricity system through private sector investment in renewable energy such as wind and solar.

1.2 Sustainable Energy Access overview

1.2.1 Recent Initiatives

The Eastern Cape provincial government's renewable energy project investments include 16 wind farms and one solar farm[10]. National government is also implementing a plan to allow municipalities in good financial standing to be allowed to procure their own power from independent power producers. The latest data from Makana Local Municipality show that there is no solar and/or renewable energy access within KwaNonzwakazi [11]and upon site visit to the area in March 2022 there was no signs or indication of solar energy supply in the area. However, within the greater Alicedale area there are certain sites and buildings, that have access to solar energy, most of which are closer to more developed towns, tourist attractions and destinations[12].

1.2.2 Policy environment

The municipal policy environment of Alicedale, under the Makana Municipality is guided by the Eastern Cape Province Provincial Development Plan (PDP), which is guided by South Africa's National Development Plan (NDP) towards 2030. The NDP's goal is to reduce poverty,

[7] Reuters, 'Eskom CEO sees end to crisis in shift from coal', 1 December 2021, https://www.engineeringnews.co.za/article/eskom-ceo-sees-end-to-crisis-in-shift-from-coal-2021-12-01 (accessed 22 April 2022)
[8] Reuters, 'Eskom CEO sees end to crisis in shift from coal'
[9] Government of South Africa, 'Renewable independent Power Producer Programme', https://www.gov.za/about-government/government-programmes/renewable-independent-power-producer-programme (accessed 22 April 2022)
[10] Government of South Africa, 'Renewable independent Power Producer Programme'
[11] Statistics South Africa. *Geography by Energy or fuel for lighting for Household weighted.* 19 July 2013 http://www.makana.gov.za/wp-content/uploads/2013/07/Energy-for-lighting.pdf
[12] Statistics South Africa. *Geography by Energy or fuel for lighting for Household weighted*

inequality and unemployment by 2030. Some key intervention areas of the NDP that affect municipalities are:

- Economy and employment
- Environmental sustainability and resilience

The Eastern Cape PDP has a long-term vision guided by the NDP with strategic priority areas that include:

- Stimulating rural development, land reform and food security
- Transformation of the economy to create jobs and sustainable livelihoods
- Building cohesive, caring and sustainable communities

Sarah Baartman District Municipality which covers Makana Municipality has a Long-term vision strategy which includes economic development that supports energy and the green economy through mass employment and poverty eradication programmes. Makana Municipality's Local Economic Development (LED) plan includes local economic and rural development and community and social development. Alicedale falls under the Makana municipality which has a full Local Development Strategy aimed at addressing the socio-economic challenges. The main challenge is not policy gaps but funding and capacity development to implement policy.

1.2.3 Business environment

Alicedale was a railway training facility in the late 1800s and 1900s. Often referred to as quaint village, Alicedale has the potential to attract revenue from tourism as the town is surrounded by superb game viewing destinations with luxury accommodation and tourist attractions. Challenges facing this small settlement with tourism potential is poor road infrastructure, unreliable electricity supply, limited ICT infrastructure resulting in limited internet access and network coverage and water supply challenge due to ongoing drought in the region. Residents also have to travel far for basic necessities such clothes and medicine. The town has no bank and only one Automated Teller Machine (ATM). There is a post-office, and two mini markets but no pharmacy. There are also no government offices (e.g. Social Security Agency or Department of Home Affairs) and retail stores and since most residents are unemployed and cannot afford the transport costs to get to their nearest town that has government offices and retail stores.

Figure 59: Alicedale is often referred to as a quaint village in the Eastern Cape

Source: uYilo

Figure 60: Alicedale: white car in picture was driven by a local tourist

Source: uYilo

Figure 61: Alicedale: residents walking along the only main road

Source: uYilo

1.2.4 Capacity

Current needs and opportunities of the community are:

Entrepreneurship training:

- Expansion of current entrepreneurship programme to cover the following topics: Sustainable business models for agriculture
- Tourism business models: catering, restaurants (e.g. community tea garden), accommodation (B&B) community tours, clothing, beadwork to provide an authentic experience with an isiXhosa flavour.
- Transportation services business models: shared vehicle use

Technology training:

- Introduction to EVs: EVs and its related infrastructure
- Introduction to renewable energy and productive use of energy
- Computer literacy: how to design a website

Basic maintenance and operational training:

- Training for people for operating the Infospots
- Training for people on driving the micro utility EVs

Information technology:

- Access to information:
- Health
- Community events and activities
- Education

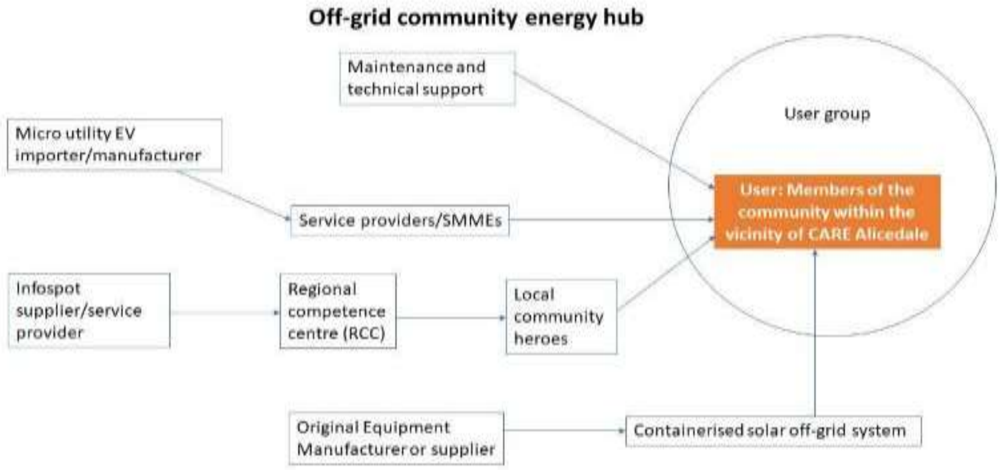
1.3 Key Stakeholders

Beneficiaries: CARE Alicedale: local community of KwaNonzwakazi

Local Government bodies and public organisations: Makana Local Municipality via KwaNonzwakazi ward councilor and local community representatives.

Partner: Shamwari Private Game Reserve (community liaison representatives)

Figure 62: Off-grid community energy hub: actors



2. Demonstration Action

2.1 Overall Objective

Accessibility, affordability, reliability, mobility, or gender, health and safety aspects can lay at the core of the question of research and the problem to be addressed. The validation demonstration will test, validate and evaluate the performance of a containerised off-grid solar energy system comprising PV panels in combination with second life EV batteries for energy stationary storage for community energy access as well as to charge a small fleet of micro utility EVs. The energy hub will be extended by information spots (Infospots) for the provision of internet services and providing free access to information on energy usage, maintenance and business opportunities. The aim of the project is to investigate the performance of these batteries, the technical and financial viability of such systems, as well as the scalability and replicability of this use case. The demonstration will also identify the commercial case for local authorities to invest in these solutions and study the repurposing potential of retired EV batteries for energy storage and as a means to create new jobs.

2.1.1 Situation analysis

Energy access: Although the area has access to electricity, the supply is unreliable and there are prolonged blackouts. Electricity is available from the utility grid as a pre-paid system

Mobility access: Access to reliable affordable transport is a challenge as majority of the population is unemployed and cannot afford to pay costs for transport. Most of them must hitch-hike to their destinations. A trip to transport goods and services can cost up to 95€.

Digital access: There is lack of access to information and the internet most likely due lack of ICT infrastructure in the area, cost of access (mobile broadband), cost of devices, digital literacy and the lack of understanding the value coming from the Internet.

Unemployment: There is a high unemployment rate in the area which means that the residents need to become entrepreneurial and find ways to generate and income for themselves that is not reliant on a salary or social security grant.

2.1.2 Opportunities to establish local demonstration activities

Current state and initiatives at the demonstration site are:

- Youth Bank which provides grade 7-12 learners with homework, schoolwork assistance and grade 11 and 12 mathematics tutoring.
- An entrepreneurship programme to assist youth with starting their own small businesses and a crèche where parents can leave their toddlers during the day when they go to work or attend to daily errands.

Figure 63: Creche: CARE Alicedale

Source: uYilo

Figure 64: Children at creche and aftercare: CARE Alicedale

Source: uYilo

A food security programme which includes a communal food garden which provides an income for locals to grow their own vegetables and a weekly feeding scheme, which provides meals via a soup kitchen for the community.

Figure 65: Communal food garden: CARE Alicedale

Source: uYilo

Figure 66: Communal food garden: CARE Alicedale

Source: uYilo

A home base care programme which provides care for the vulnerable, sick and elderly at home, laundry services and transportation of medical supplies from the local clinic to the sick and elderly at home.

Figure 67: KwaNonzwakazi Municipal Clinic

Source: uYilo

Figure 68: CARE Alice staff with uYilo team

Source: uYilo

Counselling services are provided by qualified social workers to victims of gender-based violence and other people in the community who are facing personal problems particularly within their home environment. The community centre is also an advocate for gender equality and the empowerment of women and has a gender-based violence support group. There is also a small income generating project with clothing, hats and beadwork.

Figure 69: Clothing, income generating initiative: CARE Alicedale

Figure 70:Hats income generating initiative: CARE Alicedale

Figure 71: Beadwork income generating initiative: CARE Alicedale

Figure 72: Hats income generating initiative: CARE Alicedale

Source: uYilo

2.2 Demonstration site

Name of site: CARE Alicedale (community centre)
Location: KwaNonzwakazi, Alicedale, Eastern Cape South Africa
Plus code: M3JM+XV Alicedale
GPS coordinates: -33.31756, 26.0846

Figure 73: Map location of care Alicedale

Source: Google Map

Figure 74: Proposed location of off-grid containerised solution.

Source: uYilo

2.2.1 Project Outputs and Impacts

The table below show the demonstration's expected outputs, outcomes and impacts.

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Table 32: Demonstration Outputs and Impacts – South Africa demo

Impact	Outcomes	Outputs	Activities linked to outputs	Problem addressed
Contribution to the following SDGs: SDG7: Access to affordable, clean energy. SDG 9: Industry, innovation and infrastructure SDG 11: Sustainable cities and communities SDG 13: Climate action Contribution to the following South Africa NDP 2030 goals: Chapter 5: Ensuring environmental sustainability and equitable transition to a low-carbon economy Contribution to South Africa's achievement of 2030 NDC target through reduction in GHG emissions Contribution to following Eastern Cape PDP 2030 strategic focus areas Focus area 2.3: Sustainable energy and electricity provision Focus area 5.2: Respond to climate change and green technology innovations	Reduction in GHG emissions by transitioning from coal to renewable energy for the production of electricity	A turnkey containerised renewable energy and storage solution that extends the productive use of energy with a fleet of micro-utility electric vehicles	Test, validate and evaluate the performance of a containerised off-grid solar energy system comprising PV panels in combination with second life EV batteries for energy stationary storage for community energy access	Energy access: unreliable electricity supply and prolonged black outs

Impact	Outcomes	Outputs	Activities linked to outputs	Problem addressed
Contribution to following SDGs: SDG7: Access to affordable, clean energy. SDG 11: Sustainable cities and communities SDG 13: Climate action Contribution to the following South Africa NDP 2030 goals: Chapter 5: Ensuring environmental sustainability and equitable transition to a low-carbon economy Contribution to South Africa's achievement of 2030 NDC target through reduction in GHG emissions Contribution to following Eastern Cape PDP 2030 strategic focus areas Focus area 5.2: Respond to climate change and green technology innovations	Reduction in GHG emissions by transitioning from the use of fossil fuel vehicles to zero-emission vehicles	A sustainable, affordable, zero-emission mobility solution for semi-rural applications	Offer access to small fleet of micro utility EVs with sustainable charging and affordable use and maintenance	Mobility access: lack of affordable and sustainable transport
Contribution to the following SDGs: SDG 9: Industry, innovation and infrastructure Contribution to following Eastern Cape PDP 2030 strategic focus areas: Focus area 1.4: Digital transformation and development of the ICT sector	Improved access to ICT which gives access to a wide range of resources such as the internet, information, healthcare, education, financial services	Infospot that provides internet services and free access to information	Test and validate the integration of Infospots with off-grid solar energy as an integrated package. Testing and validation of development and infopackages on energy	ICT access: lack of access to information and the internet
Contribution to the following SDGs: SDG 1: No poverty	Reduction in GHG emissions by:	The technical and commercial feasibility of the off-grid containerised	Investigate the performance of second life EV batteries, the	Unemployment: There is a high unemployment rate in the area

Impact	Outcomes	Outputs	Activities linked to outputs	Problem addressed
SDG7: Access to affordable, clean energy SDG 9: Industry, innovation and infrastructure SDG 13: Climate action SDG 11: Sustainable cities and communities Contribution to the following South Africa NDP 2030 goals: Chapter 5: Ensuring environmental sustainability and equitable transition to a low-carbon economy Chapter 3: Economy and employment - broadening access to employment Contribution to South Africa's achievement of 2030 NDC target through reduction in GHG emissions Contribution to following Eastern Cape PDP 2030 strategic focus areas: Contribution to the following South Africa NDP 2030 goals: Focus area 1.1: Create an enabling environment that supports economic enterprise development Focus area 1.4: Digital transformation and development of the ICT sector Focus area 2.3: Sustainable energy and electricity provision Focus area 5.2: Respond to climate change and green technology innovations Contribution to Makana Municipality LED strategic objective 2: Promoting the generation of work opportunities	Transitioning from coal to renewable energy for the production of electricity. Transitioning from the use of fossil fuel vehicles to zero-emission vehicles Improved ICT access which gives access to a wide range of resources such as the internet, information, healthcare, education, financial services	renewable energy system is tested and validated for replication in South Africa and across the African continent Infospot is integrated with off-grid containerised renewable energy system as an integrated package. Infospot provides free access to information on the use of energy and business opportunities through energy	technical and financial viability of off-grid containerised systems, the scalability and replicability of the use case Identify the commercial case for local authorities to invest in these solutions and study the repurposing potential of retired EV batteries for energy storage and as a means to create new business opportunities and jobs Test and validate the freemium model for access with free access to information and premium access to broadband services.	which means that the residents need to become entrepreneurial and find ways to generate and income for themselves that is not reliant on a salary or social security grant.

Impact	Outcomes	Outputs	Activities linked to outputs	Problem addressed
Contribution to the following SDGs: SDG 1: No poverty SDG 9: Industry, innovation and infrastructure Contribution to the following South Africa NDP 2030 goals: Chapter 3: Economy and employment - broadening access to employment Contribution to following Eastern Cape PDP 2030 strategic focus areas: Focus area 1.1: Create an enabling environment that supports economic enterprise development Contribution to Makana Municipality LED strategic objective 2: Promoting the generation of work opportunities	SMEs boost economy by creating new job opportunities	SMEs are included as suppliers and services providers for off-grid containerised energy system and micro-utility EVs	Validation call for innovators in South Africa to supply technical components and services for the off-grid containerised energy system and micro utility EVs.	Unemployment: There is a high unemployment rate in the area and the development of SMMEs can create new job opportunities.

2.3 Infrastructure/equipment

2.3.1 Containerised solar off-grid system

The following table shows the proposed Containerised solar off-grid system.

Table 33: Proposed Containerised solar off-grid system

Proposed Solution: Containerised solar off-grid system	
Test category	Test, validate and evaluate the performance of a containerised off-grid solar energy system comprising PV panels in combination with second life EV batteries for energy stationary storage, community energy access Test and validate technical and commercial feasibility of the off-grid containerised renewable energy system will be tested and validated for replication in South Africa and across the African continent.
Extent of work	The supply, installation, and commissioning of Solar PVs, 10 kVA hybrid inverter and battery storage system complete with system protection. Container modifications for access, cable entry, ventilation, weatherproofing and polyurethane flooring. Handover of as-built drawings, datasheets, warranty certificates, maintenance manuals, recommended spare parts lists and recommended maintenance schedules. All internal power and communication wiring inside the containerised solar system up to and including the change-over panel. Mounting of the canopy over the generator set Mounting of Solar Panels Fire-retardant cold room insulation c/w fire-panel, Fire detection and fire extinguisher Data management system with serial and Ethernet ports for data and event logging Partition for battery room Suitable provision of recommended standard tool spares and maintenance manuals and fire extinguisher as specified.
Insulated converted shipping container requirements	Pre-equipped for ease of construction and transportation to site. An ISO container converted into a small office with insulated walls fitted with interior with LED lighting, light switches, socket outlets, exterior lighting and air-conditioning unit.
Solar photovoltaic modules mechanical requirements	Lightweight Anti-theft clamping
Solar photovoltaic electrical parameters	Rated Maximum Power(W) 530 Open Circuit Voltage (V) 49.45

	Maximum Power Voltage(V) 41.47 Short Circuit Current (A) 13.72 Maximum Power Current(A) 12.83 Module Efficiency (%) 20.5
Inverter requirement	48V hybrid inverter With Remote logging
Inverter electrical minimum specification	Battery Type Lithium-ion Battery Voltage Range (V) 40~60V Max. Charging Current (A) 190A Max. Discharging Current (A) 190A Charging Curve 3 stage/ Equalization External Temperature Sensor Yes Charging Strategy Li-Ion Self-adaption to BMS
Second life EV batteries for stationary energy storage	Repurposed EV batteries for cost-effective storage solution Modular On board battery management system On board protection
Storage battery minimum requirement	Battery Type Second Life Cell Chemistries LI-ION PHOSPATE (LiFEPO4) Nominal Voltage (V) 51.2 Capacity (Ah) 200 Energy (kWh) 10.2 Max charge Current (A) 60 Communication RS485, CANBUS Modular Yes
Time span (testing activities)	11 months
Time span (data collection)	11 months
Potential use cases	Monetary savings on energy costs Use of retired EV batteries for energy storage and as a means to create new business opportunities and jobs

Figure 75: From left to right: Examples of two types of containerised off-grid solar systems, hybrid inverter

Source: Sustain Solar

Figure 76: Examples of batteries

Sources from left to right: REVOV, EATON, Betteries

2.3.2 Micro utility electric vehicles

The table below shows the proposed solution for Micro utility electric vehicles

Table 34: Proposed Solution for Micro utility electric vehicles

Proposed Solution: Micro utility electric vehicles	
Test category	Test and validate the technical and commercial feasibility of the use of micro utility EVs for semi-rural applications.
3-wheeler micro utility electric vehicle requirements	The micro utility shall be a three-wheeler and have the great load capacity. Sufficiently powerful motor and suitable for off road conditions. The vehicle shall utilize lithium-ion batteries have a robust frame allowing for a higher loading capacity limit. The vehicle shall be fitted with rolled up or zipped side PVC or nylon clear tents and be fitted with a waterproof roof structure. Interchangeable three wheels for ease of maintenance
3-wheeler micro utility electric vehicle minimum specification	Loading Capacity: 300kg-400 kg Motor: 60V 1.5kW synchronous motor Battery: 64V 60Ah LiFePO4 Battery Max Speed: 45 km/h

	Charge Time 6-8h Type of roof Iron Roof Range ±65 km
Time span (testing activities)	11 months
Time span (data collection)	11 months
Potential use cases	More efficient service delivery through use of affordable transportation of goods and services

Figure 77: Examples of 3-wheeler micro utility electric vehicles

Sources from left to right: ElekSA, Luiperdskop

2.3.3 Infospots

The table below shows the proposed solution for Infospot integrated with off-grid containerised solar system as an integrated package

Table 35: Proposed Solution: Infospot integrated with off-grid containerised solar system as an integrated package

Proposed Solution: Infospot integrated with off-grid containerised solar system as an integrated package	
Test category	Test, validate, and evaluate the integration of Infospots with off-grid solar energy as an integrated package. Testing and validation of development and infopackages on energy. Test and validate the freemium model for access with free access to information (text and pictures) and premium access to broadband services (video contain).
Equipment and components	Internet link reception (from 3G/4G to Wi-Fi) (RBSXTR&R 11e-LTE) Local Network Control Center (LNCC) (RBD52G-5HacD2HnD-TC) Village server with pre-configured information (Raspberry Pi 3 model B+)
Time span (testing activities)	6 months

Time span (data collection)	24 months
Potential use cases	Bringing connectivity and free access to information packages and learning materials on energy usage gives the local community the opportunity to develop and acquire new skills, ease the chance to collaborate and build competitive teams, facilitate the search for new job and business opportunities, enhance the economic growth and the overall sustainability. Infospot with energy information, see http://Yeboo.BasicInternet.org

2.4 Detailed Time-plan

The table below shows a preliminary work plan.

Table 36: Preliminary Workplan – South Africa demo

Description of activity	Date
Engagement with community stakeholders	October 2021 – March 2022
Identification of suitable site	October 2021 – March 2022
User requirement specification	March 2022 – May 2022
Sourcing, procurement and delivery of equipment and energy components	June 2022 – mid-December 2022
Implementation	January 2023
Monitoring and evaluation	February 2023 – November 2023

2.5 Business model plan

The community in within the vicinity of CARE Alicedale (i.e. KwaNonzwakazi location) have been disappointed by local government officials who have made empty promise in relation to service delivery and the socio-economic upliftment of the community. As a result, CARE Alicedale would prefer to finalise potential business models during the implementation phase of the project. Potential business models include:

- The freemium model for access with free access to information and premium access to broadband services.
- Establishment of a community internet café, selling advertising space on community website
- Commercial case for investment into containerised off-grid renewable energy solutions in semi-rural and rural areas that also includes the repurposing of retired EV batteries for energy storage.
- Shared mobility: shared used of micro utility EVs for sustainable transport solution through micro utility EVs for efficient service delivery and transportation of goods and services: catering, grocery shopping, visiting the doctor (medical practitioner comes every 1-2 weeks from Makhanda (formerly known as Grahamstown), trips to local clinic.
- Tourism: Tour packages, which include use of micro utility EVs to show tourists around the settlement.

2.6 Local Implementation team

The table below shows the local implementation team.

Table 37: Local Implementation Team – South Africa

Name/Organization	Role
Mr Hiten Parmar:	Director: uYilo Electric Mobility Programme
Ms Edem Foli:	Programme Manager: uYilo Electric Mobility Programme
Mr Mthobisi Thwala:	Senior Engineer EV Systems and Infrastructure: uYilo Electric Mobility Programme
Mr Nyasha Gonda:	Project Engineer: EV Systems and Infrastructure: uYilo Electric Mobility Programme

2.7 Risk Assessment

The table below shows the risk assessment of the demonstration.

Table 38: Risk Assessment -South Africa demo

Risk	Probability assessment	Consequences	Risk mitigation/comments
Competition	None		
Political/legal risk	Low	Delay in project approvals and permits	Establish open lines of communication with local municipality, community liaison representatives and beneficiaries to ensure support for project approvals and permits
Technique risk	Low	Injuries or worse; need to redesign; stoppage of demonstration	Technical performance and safety testing Training for operators to be conducted Check if all insurance mechanisms are covered
Lack of commitment from stakeholders	Low	Poor communication among the stakeholders	Encourage the pilot stakeholders to be committed to a long-term relationship with each other, and communication is an effective way to maintain the relationship.
Completion risk	Low	Delay in demo process	Keep track of time-plan
Construction/operation cost overrun	Low	Actual costs are higher than expected costs	Have a clear financial plan as well as optimize and control costs
End products not suitable for intended use	Low	SESA Equipment are not eventually used	User needs-based assessment at the core of the design phase

2.8 Monitoring

A monitoring plan will be crafted that will be based both on the “Regional” project key performance indicators (KPIs) to be developed within the Work Package 1 of SESA and the main objectives to be co-identified with the local partners. Essentially, a set of highly relevant KPIs will be selected and methodologies (who, what, when, where, how) for collecting data for calculating the indicators will be included in the monitoring plan. To be able to properly assess the impacts of the demos, there would also be a need for baselining activities which would establish the benchmarks for the indicators. The baseline values would essentially capture “what would have happened in case the demonstration was not conducted.” The KPIs would capture operational performance, and service quality-related perceptions. These KPIs would be selected based on a holistic framework that considers operational (reliability, range, etc.), environment (and energy efficiency); social (e.g. safety, perceptions); and economic (e.g. total costs of ownership, operational costs and considerations, affordability).

3. Preliminary Replication Opportunities

Once the solutions have been validated and tested together with their technical and financial viability. Public-Private Partnerships can be pursued for investment towards replication in other rural and semi-rural communities within South Africa and across Africa. This section will be updated in the subsequent version of the demonstration implementation plan after more data and feedback are collected from co-creation sessions and pilot use case tests.

4. Updates

This section will be updated in the subsequent version of the demonstration implementation plan after more data and feedback are collected from co-creation sessions and pilot use case tests, and will include the latest development from the implementation of the demo actions.

SESA Regional Platforms

1. Joint Africa platform for the co-development of solutions, capacity building, funding and financing

Regional platforms are being established to organise the regional teams and support partners and coordinate with other relevant regional projects to maximise the potential for take-up and replication of the energy innovations tested in this project (ELICO, Leitat, RISE, UNH, UNP, UEMI). A common implementation methodology will be developed, with the lead-partners for all regional teams (Europe, Africa). This forms the basis of detailed implementation plans, which include all the activities needed for preparation and execution of the demo, technical and operations issues, business model adaptation, stakeholder engagement and replication (Siemens, GEP, UR, GG, SEI).

2. Co-development Partnerships

SESA is working closely with local, regional and national decision-makers, industry and local businesses to co-develop innovative energy solutions that fit into living labs' local context but are also scalable and replicable. Co-development partnerships will be established during the initial phase of the project involving the innovation experts and local teams from within the consortium along with the host local authorities and innovators. Within the project, partner cities and counties will form regional partnerships, supported by thematic experts, to ensure targeted work and expert exchange on local integration of specific solutions.

Thematic experts from Europe and Africa from relevant fields of application are gathered in the consortium regional platforms to provide insights and guidance to the co-development process. The experts involved will share their specific expertise and experience and provide technical advice to support the living labs and to assess the feasibility, costs and benefits, good performance during their entire lifetime and replicability of innovative measures. The direct involvement of international initiatives, other networks and initiatives will ensure a high level of visibility and replication of the innovations tested in this project. The identified thematic areas include:

- **Solar energy**: Kenya (test), Ghana (validation), South Africa (validation), Morocco (validation), Namibia (replication), Tanzania (replication), Nigeria (replication), Rwanda (replication),
- **Clean cooking/ Waste to energy (Biogas for cooking)**: Kenya (test[13]), Ghana (validation[14]), Malawi (validation), Rwanda (replication)
- **Second life EV (Li-ion batteries) batteries**: Kenya (test), South Africa (validation), Morocco (validation)

Through the regional platforms, a global programme and local teams, the project aims to co-develop highly effective and innovative approaches to support a diversity of affordable solutions that help to provide access to reliable, efficient and sustainable energy services for all, creating business opportunities and developing concepts that can directly contribute to a low-carbon development. Regional platforms will be established to organise the regional teams and support partners and coordinate with other relevant regional projects to maximise the potential for take-up and replication of the energy innovations tested in this project (ELICO, Leitat, RISE, UNH, UNEP, UEMI).

3. Regional platforms

Regional platforms based on geographic regions include:

- **North & West Africa region**: Ghana (validation), Morocco (validation), Nigeria (replication)
- **East Africa region**: Kenya (test), Tanzania (replication), Rwanda (replication)

[13] There is no test case that is being carried out by WeTu on clean cooking or waste management
[14] They did not include a budget for setting up of the project, so they will wait for WP3 SME selection

- **South Africa region**: Malawi (validation), South Africa (validation), Namibia (replication)

The regional platforms will be organised based on both thematic areas, and on geographic areas. The meetings for the regional platforms can be held monthly for the thematic groups to enable the development of the implementation plans and quarterly for the geographic groupings to enable sharing and cross pollination of ideas and strategies. These platforms will work in close cooperation with the SOLUTIONSplus project and other relevant projects and partners, facilitate knowledge exchange, capacity building and replication with and across the partner regions.

Each regional platform and thematic grouping will consist of partners working on a respective theme in the co-development process as detailed below. The co-development process will involve:

Living Lab Partners will receive extensive technical and process-oriented support from the thematic experts and peer-learning partners in developing and testing solutions. Demonstration and validation sites will also profit from financial support for the implementation of the customized solutions

Local and national authorities and decision makers who will:

- benefit from the lessons learned from a set of solutions, tested in different contexts,
- have the opportunity to use the tools and methodologies developed in the project, as well as guidance for potential adaptations of legal frameworks to support the shift towards sustainable energy.
- receive the support of regional platforms for adapting such solutions to their own situations

Manufacturers, and energy suppliers will contribute several examples of various deployment and operational frameworks to develop business models that fit the local context.

Energy services providers will have specific business models that are economically viable, and that encourage the development of new products and services.

4. Proposed Inclusion in Regional Platform Events

The discussion under the Regional Platforms will cover stakeholder and finance dialogues targeting participation from financial institutions, and the research and innovation community to match local project objectives and funding priorities. Together with WP5, active support will be provided to the public and private sector partners in the regional platforms to set up investment platforms and plans for financing solutions.

5. Description of Work Related to the Regional Platforms

Task 2.5 Global trainings, Community of practice, e-learning

(Lead: UNEP Partners: ICLEI ES, AAMUSTED, ICLEI WS, MET, NMU, RISE, UR, UNH, UEMI, WI) (M12-M40)

A global capacity building programme targeted at decision makers, practitioners and businesses will be implemented (UNEP). Selected conferences, in which consortium members are active, are targeted as platforms for regional and international trainings such as Clean Air Asia's Better Air Quality (BAQ), UN Environment and UN Habitat Assemblies, World Urban Forum, the climate Conference of Parties (COP), and others. A complete list will be developed jointly with Task 6.2 at project start and updated annually (AAMUSTED, MET, UNH, UR, UEMI, WI).

Task 4.1 Demonstration implementation plans and set-up of regional platforms

(Lead: BTH; Partners: ELICO, GEP, GG, LEITAT, MIGS, MET, SEI, SIN, SIEMENS, RISE, UR, UNEP, UNH, UEMI) (M1-M10)

For all partner cities or counties, demonstration implementation plans (at least 5) will be developed (BTH). This will build on the identified needs from WP1, technical specifications and business models from WP3 and will outline the concrete steps within the demonstration phase, including the impact assessments (WP1), links to the capacity development (WP2) and the adaptation of the business models (WP3). Regional platforms will be established as part of this task, which will organise the regional teams and support partners and coordinate with other relevant regional projects to maximise the potential for take-up and replication of the energy innovations tested in this project (ELICO, Leitat, RISE, UNH, UNEP, UEMI). A common implementation methodology will be developed, with the lead-partners for all regional teams (Europe, Africa). This will form the basis of detailed implementation plans (at least 4), which include all the activities needed for preparation and execution of the demo, technical and operations issues, business model adaptation, stakeholder engagement and replication (Siemens, GEP, UR, GG, SEI). The implementation methodology supports the teams to closely monitor the status of the demonstration projects, identify delays and criticalities and suggest corrective actions. The regional platforms and implementation teams will also work closely with the WP2 capacity building team to support the training activities for the living lab partners and share their experiences with others to replicate innovation actions (MIGS, MET, Leitat, UEMI, RISE).

Task 5.1 Development of concepts and pre-feasibility studies for transformational sustainable energy projects

(Lead: ICLEI WS; Partners: ICLEI ES, AAU, ICLEI AS, TUB, LEITAT, SIN, SIEMENS, DTU, UEMI, WI) (M12-M37)

Concepts for projects will be developed to aim at scaling-up the demonstration and validation actions within the project and also reflect on demonstration action happening elsewhere (e.g. pilots for repurposing and reuse of batteries in Kenya, Tanzania and South Africa). This will be done in consultation with key private and public sector stakeholders in the partner countries (ICLEI WS, ICLEI ES, ICLEI AS, Leitat, DTU, UEMI) The concepts will aim to sustain the innovations tested in the demonstration actions and to develop them into a project proposal for a transformational, innovative and integrated sustainable energy project that can be submitted to domestic, bilateral, multilateral or international financing institutions (at least 4 institutions). The concepts outline the key aspects of these projects, key partners and steps in the process as per the requirements of the targeted financial institution. The concepts will be based on the evaluation reports and impact assessments of the demonstration and validation actions. At least 4 pre-feasibility studies showing climate adaptation and mitigation opportunities will be developed. Successful concepts will be further developed into pre-feasibility studies as per the requirements of the targeted financial institutions (WI, UEMI, SIN, AAU, TUB). To maximise the benefits from the project, the development of pre-feasibility studies for scale-up projects will focus on the countries where demonstration and validation sites are located. This will involve expanding the implementation scope to involve other potentially viable business models or geographic areas in the demonstration countries. Initial 4 replication actions will be initiated. These projects identified for up-scaling will be designed in consultation with the funding entities (facilitated in task 5.3). This task will make use of the partnerships and networks established through the support and investment platforms associated with the project UEMI, Siemens, SIN).

Conclusion

This document presents a common implementation methodology which was developed, with the lead-partners for all regional teams (Africa). This formed the basis of detailed implementation plans as presented in this document; and includes all the activities needed for preparation and execution of the demonstrations, technical and operations issues, business model adaptation, stakeholder engagement and replication. The implementation methodology supports the teams to closely monitor the status of the demonstration projects, identify delays and criticalities and suggest corrective actions. The regional platforms and implementation teams are working closely with the WP2 capacity building team to support the training activities for the Living Labs and share their experiences with others to replicate innovation actions. This 'living document' will be continually updated with input from project partners, the revised and updated implementation plans will form SESA project deliverable 4.2.

Project partners

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