ENERGICA

ENERGY ACCESS AND GREEN TRANSITION COLLABORATIVELY DEMONSTRATED IN URBAN AND RURAL AREAS IN AFR**ICA**

DELIVERABLE 3.2
ENERGICA Capacity building programme

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Main authors:	Paul Cairns, M.A.Sc.
Website:	https://www.energica-h2020.eu/

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DEM	Demonstrator, pilot, prototype, plan designs	
DEC	Websites, patents filing, press & media actions, videos, etc.	
OTHER	Software, technical diagram, etc.	

Dissemination Level		
PU	Public, fully open, e.g., web	X
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

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I. PROJECT SUMMARY

The ENERGICA project is a multifaceted consortium funded by the Horizon 2020 initiative of the European Commission. The project brings several consortium members together to support three Energy Access demonstration projects across Sub Saharan Africa (SSA). The overall concept of the project is "to develop and demonstrate in real environments that existing technologies can be tailored through efficient and sustainable community-based approaches in any type of societal contexts". [1]

As such, three different contexts for energy access were selected across SSA as demonstrators. They are:

1. A rural context in Madagascar that offers nano-grids as a form of green energy access.
2. A peri-urban/urban context in Sierra Leone that offers green energy access through biogas.
3. An urban context in Kenya that offers green energy transportation with electromobility.

The overarching objective of the project is to sufficiently "demonstrate the efficient implementation of renewable energy technologies to match local contexts' needs." [1] This will be achieved by taking a wholesome approach to technology development in each region. This report focuses on the capacity building programmes that will be implemented to ensure the success of each demonstrator.

II. OBJECTIVE AND EXECUTIVE SUMMARY

This report is comprised of three separate reports that make up deliverable 3.2 from the project "ENERGICA" which has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037428. It describes the capacity building programmes proposed for the Malagasy (Part A), Sierra Leonean (Part B), and Kenyan (Part C) demonstrators as part of the subtask 3.1.2 (Work Package 3).

This deliverable provides a summary of the TEES (Technical, Educational, Economic, Social) framework developed as part of this project, to assess the capacity building needs of each demonstrator and proposes a series of capacity building programmes to satisfy those needs. The objective of this work package is to aide in the development of capacity building and knowledge transfer programmes.

The document consists of two introductory chapters that introduce overarching frameworks and methodologies used across all three contexts. This is followed by four chapters dedicated to each demonstrator in parts A, B, and C that provide background info, identify needs, and present capacity building programmes.

In the first of the two introductory chapters, a general introduction to the overall project is given and an introduction to the TEES (Technical, Educational, Economic, Social) framework of capacity building is provided.

The second introductory chapter explains the methodologies and tools used. These include: a needs assessment, field visit, triage, and action plans. The objective was to assess:

- How to make the product simpler and more operable
- The capacity to maintain and repair the system
- The availability of parts and supply chain
- The technical abilities to operate and maintain
- The ability to train operators and maintainers in the region
- The educational background offered in the post-secondary institutions
- The affordability of the product offering
- The existing employers and employment in the region
- The major economic activities (exports and imports) on a national level
- The willingness of the local population to adopt the technology
- The existing employment opportunities vs. those created by the offering
- The adoption success of similar products

Following the first two chapters, the report is then divided into three parts (A, B, C). One for each demonstrator. In the first chapter of each part (A, B, C), pertinent background information is aggregated and shared to provide an understanding of the context in which the demonstrator operates.

In the second chapter of each part, we present the capacity building needs of each demonstrator, and what programmes will be needed to put in place to ensure the long-term viability of the project.

In the third chapter of each, various capacity building programmes tailored to the demonstrators' needs and regional context, are proposed and presented.

The programmes for each context include:

Madagascar context:

- A refrigeration and appliance maintenance capacity building programme.
- A university curriculum development programme for solar repair and rural sales.

Sierra Leone context:

- A biodigester plant operator and maintainer programme (three options are presented).
- A university graduate student programme for local laboratory testing.
- A waste disposal awareness and capacity building programme.

Kenya context:

- An electric motorcycle technician capacity building programme.
- An after-sales user onboarding programme.
- A battery fire safety programme.

These programmes will guide the implementation of activities in Task 3.2 of Work package 3: implementation of capacity building and adapted training programmes.

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V. ACRONYMS

3D	Three dimensional
AC	Alternating Current
APMF	Agence Portuaire Maritime et Fluviale
BECE	Basic Education Certificate Examination
BEV	Battery Electric Vehicle
BMD	Bachelor-Master-Doctorate
BODA BODA	Motorcycle/motorcycle taxi
CAPEX	Capital Expenditure
CBC	Competency Based Curriculum
CE	Christ Era
CFT	Concrete Filled Tubes
DC	Direct Current
ECOWAS	Economic Community of West African States
EDSA	Electricity Distribution and Supply Authority
EEZ	Exclusive Economic Zone
EU	European Union
EV	Electric Vehicle
FWT	Freetown Waste Transformers
GDP	Gross Domestic Product
HE	Higher Education
HEV	Hybrid Electric Vehicle
HH	Household
HVAC	Heating, Ventilation, and Air Conditioning
ICE	Internal Combustion Engine
IRENA	International Renewable Energy Agency
KES	Kenyan Shillings
KW	Kilowatt
LED	Light Emitting Diode
MESupRES	Ministry of Higher Education, Research, and Innovation
MTNDP	Medium-Term National Development Plan
NCTVA	National Council for Technical Vocational and Other Academic Awards
OPEX	Operating Expenditure
PCB	Printed Circuit Board
RE	Renewable Energy
SO	Specific Objective
SSA	Sub-Saharan Africa
SMT	Surface Mount Technology
SPV	Special Purpose Vehicle
STEM	Science, Technology, Engineering, and Math
TEES	Technological, Educational, Economic, and Social
TV	Television
TVET	Technical Vocational Education and Training
TWT	The Waste Transformers
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UV	Ultraviolet
V	Volts/Version (depending on context)
VAC	Voltage (Alternating Current)
VDC	Voltage (Direct Current)
W	Watts

1. INTRODUCTION

The objective of this deliverable is to identify the capacity building needs and propose tailored capacity building programmes for implementation in support of each demonstrator project. According to the United Nations:

> Capacity-building is defined as the process of developing and strengthening the skills, instincts, abilities, processes, and resources that organizations and communities need to survive, adapt, and thrive in a fast-changing world. [2]

In this report: we will provide necessary background information regarding the project; describe the capacity building framework (TEES framework) that was developed to assess the demonstrators needs; provide necessary context for each demonstrator relative to the TEES framework; present the needs that were identified by the demonstrators; and propose capacity building programmes that can be implemented to address those needs. To begin, we will provide some much-needed background regarding the ENERGICA project, and the work package for which this deliverable is submitted.

1.1. Link to the ENERGICA project

The ENERGICA project is a multifaceted consortium funded by the Horizon 2020 initiative of the European Commission. The project brings several consortium members together to support three Energy Access demonstration projects across Sub Saharan Africa (SSA). As stated in the grant agreement, the overall concept of the project is "to develop and demonstrate in real environments that existing technologies can be tailored through efficient and sustainable community-based approaches in any type of societal contexts". [1]

As such, three different contexts for energy access were selected across SSA as demonstrators. They are:

4. A rural context in Madagascar that offers nano-grids as a form of green energy access.
5. A peri-urban/urban context in Sierra Leone that offers green energy access through biogas.
6. An urban context in Kenya that offers green energy transportation with electromobility.

The overarching objective of the project is to sufficiently "demonstrate the efficient implementation of renewable energy technologies to match local contexts' needs." [1] The main objective will be achieved via the completion of eight specific objectives (SO) as listed below:

- SO1: Demonstrate integrated productive use systems in innovative nano-grids addressing the WEF nexus.
- SO2: Demonstrate water-purification and biogas low-tech cost-effective systems addressing the WEF nexus.
- SO3: Demonstrate urban grid flexibility and decarbonisation through smart battery management for e-mobility.
- **SO4: Create dedicated local community-based structures for the uptake of renewable energy technologies.**
- **SO5: Set up ambitious and tailored replicability strategies.**
- **SO6: Develop capacity building and knowledge transfer programmes.**
- SO7: Develop tailored business models, circular economy models and local value chains.
- SO8: Foster strong EU-AU collaborations

These SO's were targeted by defining several work packages (WP) numbered 1 through 11. The work presented in this ***deliverable responds to SO6***, but also contributes toward SO4 and SO5 and is ***submitted as part of the requirements for completion of Work Package 3 (WP3).***

Within WP3, three deliverables were designed to achieve SO6. They are:

- **D3.1: ENERGICA capacity building needs** - This report will identify common capacity needs, summarise the capacity building plans for each technology and provide advice on product modifications and will be shared amongst partners.
- **D3.2: ENERGICA capacity building and training programmes and tools -** For each technology developed in ENERGICA, training manuals and training course will be created in collaboration with the project partners and the local stakeholders' needs identified.
- **D3.3: Roadmap for the implementation of capacity building and training programmes** - This report will target dissemination and replicability strategies of the different programmes linked to the ENERGICA technologies and will detail strategies for future technologies incubation and market uptake.

As shown above, the objective of this deliverable (D3.2) is to outline the ENERGICA capacity building programmes. To achieve this, a framework was developed to assess each demonstrator's needs across four factors: technological, educations, economic, and social. These needs were assessed across three contexts: local, regional, and national. The framework developed throughout this project has been named the ***TEES (Technological, Educational, Economic, and Social) framework of capacity building***.

1.2. Purpose of capacity building

Capacity building is a critical element in assuring the success of projects in developing countries. Often-times, energy projects are designed a world away and with no consideration to the supply chain, human capital requirements, and service capacity to support the project in its local context. This often results in the project originator facing issues when parts fail, or maintenance is required, because they did not consider local capacity to support the technology. Due to this lack of consideration, the project originator is forced to fly specialized technicians into the work site or face considerable delays waiting for a replacement part to be shipped from abroad, leading to prohibitive costs. When these costs are compounded with the likelihood that the market is already low margin, the result is extensive revenue losses and often-times the need to abandon the project altogether. Furthermore, when building local capacity is not considered, the economic benefits and jobs created do not go towards increasing economic growth in the area or benefiting the local community. As a result, the community does not see the value of the project and thus does not take initiative to support it.

In contrast, when a wholesome approach to the project is taken, and capacity building considered: the project works towards training and employing people within the community; leading to economic growth; leading to secondary economic activity; leading to the attraction of talent to the region; leading to increased capacity to support the project; resulting in a virtuous cycle that further increases the likelihood of success.

For these reasons, the ENERGICA project is designed to have capacity building as one of its key tenets. Over the course of the project, an in-depth assessment of each demonstrator context will be performed to identify the capacity building needs, and tailored capacity building programmes will be proposed. Further, the capacity building model developed will be used to create templates that can be implemented in other regions to build capacity across the continent.

Some of the challenges encountered when designing a capacity building programme include balancing the project originator needs, with the needs of the community; under-considering societal and cultural norms; improperly designing for the context; and lack of human capital development in the region. For capacity building programmes to have a higher likelihood of success, it is important that care be taken to study and understand the context surrounding the project; that community and local partners be engaged; and that the local technology, supply chain, and educational context be considered. It is in this spirit, that the TEES framework of capacity building was designed. Details regarding this framework are discussed in the next section.

1.3. The TEES framework of capacity building

The TEES (Technological, Educational, Economic, and Social) framework of capacity building is a framework that was developed for the ENERGICA project that is used to evaluate and quickly identify the capacity building needs for a given demonstrator. The framework evaluates the technological, educational, economic, and social factors related to a specific solution across the local, regional, and national contexts. The objective is to closely examine each factor across each context and determine what capacity the demonstrator currently **HAS** versus what capacity they **NEED to develop** to ensure that the project will succeed. Following this exercise, we look at key partnerships that will be needed (more details in the methodology section) to help build out that capacity.

The framework was designed to ensure that all the essential elements critical to the long-term success of a solution are explored. These critical elements have been identified through a combination of the authors' experiences working on projects in developing countries and literature studies. The framework has been put together in such a way that its application enables the development of effective capacity building programmes for all future contexts. The guiding questions for the TEES framework are presented in **Table 1.1.**

Table 1-1: Guiding elements of the TEES (Technological, Educations, Economic, and Social) framework for capacity building

FACTOR	LOCAL CONTEXT	REGIONAL CONTEXT	NATIONAL CONTEXT
TECHNOLOGICAL looking at the product and technology itself	**Simplicity and operability** - how user friendly is the product/ technology relative to the local capabilities?	**Capacity to maintain and repair** - how well does the design account for the local supply chain? Can parts be easily found locally? Do local repair people exist?	**Supply chain** - for parts that cannot be locally sourced, how developed is the national supply chain to be able to import parts?
EDUCATIONAL looking at the skills required to support	**Technical abilities to operate and maintain** - what is the local technical capacity to operate and maintain the product/ technology?	**Capacity to train (training centres)** - what is the regional capacity to train people to operate, maintain, and repair?	**Educational background and skills** - do national education curriculums provide the background skills necessary to operate and maintain the product/ technology?
ECONOMIC looking at existing economic context	**Affordability (Capex and Opex)** - how affordable is the product/ technology for the local population? What is the local earnings cycle? Does the business model fit with earnings?	**Employers, production, and value creation** - who are the major employers? What is most produced in the region? What products are of most value in the region that support production?	**Major exports and economic activity** - what are the major exports on a national level? Who are the largest companies and employers nationally? What is the major economic activity?
SOCIAL looking at the existing livelihood	**Capacity and willingness of locals to support** - does the local community see value in your product/ technology compared to how things are currently done?	**Employment opportunities created vs. existing** - will your product/ technology complement or clash with existing employment opportunities?	**Adoption success of similar products** - have similar products been adopted in other parts of the country?

The questions given in the table above are guidelines for discussion. The author feels that the elements highlighted provide an accurate mapping of the key capacity needs for project success. To ensure effective implementation of the framework, it is imperative that a field visit be conducted to obtain an accurate depiction of the local, regional, and social contexts across each factor. Now that the framework has been introduced, the following section will depict the methodology used to implement the framework over the course of the project.

2. METHODOLOGY

In this section, will discuss the methodology used to perform the capacity building needs assessment and design the capacity building programmes. The needs assessment consisted of two parts. The first part was a needs assessment document completed with assistance of the demonstrator via several virtual meetings (Section 2.1). The second part was a field visit to obtain a better understanding of the situation on the ground (Section 2.2). The design of the capacity building programmes also involved two parts. The first was a triage exercise to determine the most critical and actionable needs (Section 2.3) and the second was the development of action plans (Section 2.4). These methodologies and the tools are presented in further detail in the following sections.

2.1. Needs assessment tool

The needs assessment document was developed by Energy Generation and entails ***several interviews with the demonstrators to complete the TEES framework needs assessment tool***. For each of the TEES factors, we ask on a local, regional, and national context what capacity the demonstrator HAS now, and what capacity they NEED. Through this exercise, we were accurately able to map and identify critical needs that need to be addressed. A copy of the TEES needs assessment tool is provided in **Table 2-1** below.

How the needs assessment tool works

When we study the needs assessment tool, we can see that it is broken into Technological, Educational, Economic, and Social factors vertically in the first column. In the second column, we describe the context for that factor (local, regional, national). The following column, labelled "overview", is meant to allow the demonstrator to provide a general overview of the context related to that specific factor. The exercise would begin by asking the question in the second column to the demonstrator and allowing them to respond first by what capacity they "HAVE" to improve that aspect, followed by what capacity they would "NEED". We will provide few example questions that the assessor can ask the demonstrator below. The example questions are given for the T1 factor:

Example Question T1 – Simplicity and operability (OVERVIEW column)

> *"Regarding the technology you offer, please provide a general overview of its simplicity and operability relative to the market, describe what features you HAVE that make it simple and operable, and describe what features you NEED, to make it simpler and more operable?"*

Once the demonstrator has responded, the assessor will fill in the details regarding what features the product currently has and what features are needed. Once this is complete, the assessor will then move to the core competencies column and as a follow-up question such as below:

Example Question T1 – Simplicity and operability (CORE COMPETENCIES column)

> *"Given the list of features that you NEED to add to make the product simpler and more operable for your market, what CORE COMPETENCIES do you have internally to make these changes, what core competencies do you NEED?"*

Again, the assessor will note the details of core competencies the demonstrator has and needs. Based on the response, the assessor will ask which KEY PARTNERS they have and need to help fill in the core competencies needed, such as below:

Example Question T1 – Simplicity and operability (KEY PARTNERS column)

> *"Given the list of core competencies that you will NEED in order to make the desired changes, what key partners do you currently HAVE with these core competencies, and what partners do you think you will NEED to assist with the missing competencies."*

As can be seen from the example questions. With each column, we are trying to find the key partners or core competencies we HAVE, to address the NEEDS of the previous column.

Table 2-1: Copy of the TEES capacity building framework assessment tool

FACTOR	CONTEXT	OVERVIEW	CORE COMPETENCIES	KEY PARTNERS
TECHNOLOGICAL	T1 - Simplicity and operability	Have:	Have:	Have:
		Need:	Need:	Need:
	T2 - Capacity to maintain and repair	Have:	Have:	Have:
		Need:	Need:	Need:
	T3 - Availability of parts	Have:	Have:	Have:
		Need:	Need:	Need:
EDUCATIONAL	ED1 - Technical abilities to operate (existing in local market)	Have:	Have:	Have:
		Need:	Need:	Need:
	ED2 - Capacity to train (local training centers) institutions)	Have:	Have:	Have:
		Need:	Need:	Need:
	ED3 - Educational Background and skills (existing in local educational	Have:	Have:	Have:
		Need:	Need:	Need:
ECONOMIC	EC1 - Affordability (Capex and Opex): how affordable is your product / technology for the local population?	Have:	Have:	Have:
		Need:	Need:	Need:
	EC2 - Employers, production, and value creation: who are the major employers? What is most produced in the area?	Have:	Have:	Have:
		Need:	Need:	Need:
	EC3 - Major exports and economic activity - what are the major exports on a national level?	Have:	Have:	Have:
		Need:	Need:	Need:
SOCIAL	C1 - Capacity and willingness of local business to support	Have:	Have:	Have:
		Need:	Need:	Need:
	C2 - Employment opportunities created vs. existing	Have:	Have:	Have:
		Need:	Need:	Need:
	C3 - Adoption success of similar products	Have:	Have:	Have:
		Need:	Need:	Need:

2.2. Field visit

To reinforce the findings discussed in the TEES needs assessment completed above, a field visit was performed. The field visit took place over a period of several days with the objective of obtaining a solid comprehension of the background TEES context (which helped to inform the information provided in ***Section 0***).

Typically, a field visit would consist of the following activities:

- ***Site visit and review of the technology:*** for this activity, we would sit with the demonstrator, visit the site, and get an idea of their underlying technology and how it worked. We would review points of failure and next steps for future development.
- ***Visit of local suppliers and vendors:*** for this activity, we would visit various suppliers and vendors to get an idea of the supplies offered as well as their prices.
- ***Meeting with staff and operators:*** for this activity, we would meet the staff and operators and discuss with them about their role and the work they do. This helped understand the current local capacity.
- ***Meet with customers (optional):*** if time allowed, we would meet with some customers and clients of the demonstrator to get an idea of the social and economic context in the region.
- ***Visit with training centres or partners (optional):*** If time allowed, we would also visit either existing training centres or meet with stakeholders knowledgeable about the training sector in the region. In some cases, when the demonstrator was the stakeholder delivering the training, we would visit the demonstrators' training facilities.
- ***General visit of the region:*** Typically, a field visit would also entail some time to visit and explore the region to get an idea of the social and economic context of the country and region. This would also typically involve getting an idea of the supply chain logistics, the road networks, transportation logistics, and other factors.

Many times, the field visit was elemental in inspiring the correct questions to help elaborate further needs. Over the course of the visit, we took lots of photos and notes regarding these topics to ensure they were considered.

This activity was critical in providing the full context of the demonstrator to help with the needs assessment and led to very fruitful discussions.

From this point forward, we will treat each context separately as three separate sections of the report denoted A, B, and C for Madagascar, Sierra Leone, and Kenya, respectively.

2.3. Triage tool

Following the completion of the needs assessment and the submission of the report for Deliverable 3.1, a triage exercise was undertaken to prioritise the needs that were the most important and easily actionable. The objective of the exercise was to narrow down the needs to the two or three most important items for which a capacity building program will be needed. For the exercise, we went through each need in detail and assigned them a label of either: already doing, do later, do, action plan, or done. Below is a description of each option:

- **Already Doing:** indicates that the demonstrator is already working on addressing the need through work in another work package and/or other projects.
- **Do Later:** indicates that the need does not need to be addressed urgently and can be done later.

- **Do:** indicates that the need does have to be addressed in the near term, but that it can be implemented without the need for added capacity or planning. It can be done with the resources that exist at hand.
- **Action plan:** indicates that the need does have to be addressed in the near term, but it cannot be implemented with the existing capacity in the region and thus an action plan is required.
- **Done:** indicates that the task was completed between the time of the D3.1 report and the triage exercise

Table 2-2 illustrates the triage tool used for the exercise, using only one of the TEES factors as an example. Following completion of the exercise, after all the needs had been assessed and given a triage label, the action planning exercise was performed for the items identified as requiring an action plan.

Table 2-2: Copy of the triage tool (showing Factor T1 only)

FACTOR	NEED IDENTIFIED	RECOMMENDATIONS	POTENTIAL NEXT STEPS	TRIAGE
T1 – SIMPLICITY AND OPERABILITY	NEED 1	Recommendation 1	Next Steps	Choose Item ▼
		Recommendation 2	Next Steps	Already Doing ▼
	NEED 2	Recommendation 1	Next Steps	Do Later ▼
		Recommendation 2	Next Steps:	Do ▼
	NEED 3	Recommendation 1	Next Steps:	Action Plan ▼
		Recommendation 2	Next Steps:	Done ▼

2.4. Action plan tool

The needs identified as requiring an action plan are those for which the capacity building programme will be based. These are the needs that fall outside the scope of the demonstrators' capabilities but are critical in fostering the environment to help the project succeed. The action plan items typically consist of training needs, human capital needs, or supply chain needs. The action planning exercise consisted of the following activities:

1. **Identify the desired outcome(s) of the action plan:** this task involves getting specific about what will be built and put in place to satisfy the need. For example, if the need identified is: *"need well trained operators who can repair solar installations"*, an example of a desired outcome could be: *"a 3-day solar repair/operator training program to be delivered by the demonstrator"*, or *"a solar repair/operator curriculum to be delivered by a partner TVET"*. It is important that the outcome specify what the outcome will be, and who will be responsible for delivering the outcome.
2. **List the steps required to achieve the desired outcome:** this exercise fleshes out the details and steps required to achieve the desired outcome. For example: *"To develop a solar repair/operator curriculum for a TVET we will need to: (1) Identify the key skills that we would like the operators to have; (2) break the set of skills down into various subjects for a curriculum; (3) define the key learnings required for each subject; (4) define an evaluation criteria; (5) design a method to perform the evaluation; (6) develop a program curriculum document; (7)*

find a partner TVET to deliver the training; (8) determine the training materials required and deliver them to the partner; (9) work with the partner TVET to deliver the training.

3. **Identify and plan for any potential hurdles:** in this exercise, the objective is to try and identify any potential hurdles that could arise when trying to implement the capacity building programme and plan for ways to overcome them. For example, one potential hurdle could be: *"*ensuring *that the partner TVET has the right equipment for the solar training"*, one way to overcome the hurdle would be: *"work well in advance with the TVET to understand the equipment they have on site, and work with them to send them the equipment they will need to train operators capable of repairing our equipment".*
4. **Identify key partners and players needed to implement the plan:** Lastly, this task involves identifying potential partner organisations by name that will be needed to implement the plan. For example, a suitable TVET in the region, or the department of education in the region.

Below is a copy of the action plan tool that was used.

Table 2-3: Copy of the action plan tool (showing the needs triaged as action plan)

NEED IDENTIFIED	RECOMMENDATIONS	POTENTIAL NEXT STEPS	DESIRED OUTCOME	KEY PARTNERS	STEPS	POTENTIAL HURDLES
NEED 1	Recommendation 1	Next Steps	Outcome 1 Outcome 2	Partner 1 Partner 2	Step 1 Step 2	Hurdle 1 Hurdle 2
	Recommendation 2	Next Steps	Outcome 1 Outcome 2	Partner 1 Partner 2	Step 1 Step 2	Hurdle 1 Hurdle 2
NEED 2	Recommendation 1	Next Steps	Outcome 1 Outcome 2	Partner 1 Partner 2	Step 1 Step 2	Hurdle 1 Hurdle 2
	Recommendation 2	Next Steps:	Outcome 1 Outcome 2	Partner 1 Partner 2	Step 1 Step 2	Hurdle 1 Hurdle 2
NEED 3	Recommendation 1	Next Steps:	Outcome 1 Outcome 2	Partner 1 Partner 2	Step 1 Step 2	Hurdle 1 Hurdle 2
	Recommendation 2	Next Steps:	Outcome 1 Outcome 2	Partner 1 Partner 2	Step 1 Step 2	Hurdle 1 Hurdle 2

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ENERGICA

PART A

ENERGICA Capacity building programme – Madagascar Context

1. MADAGASCAR CONTEXT BACKGROUND

The following background information was provided for the internal Deliverable 3.1 report. Given that this report is to be made available publicly, the background information is being included again here, as it provides necessary context for the reader. Note that some alterations have been made to remove any proprietary information.

1.1. Demonstrator context – Madagascar

In this section we will provide the context for the Madagascar demonstrator across the TEES factors at the local, regional, and national levels. With this background context, it will then be possible to discuss the needs assessment. The needs will be assessed in the methodology section.

1.1.1. Technological context

To begin outlining the context we must begin by looking at the technology of the demonstrator and what they offer. Nanoé offers a low voltage nano-grid solution for rural villages that lack any access to electricity. We will begin by providing further details about the technology.

What is a nano-grid?

In industry, the academic, and institutional world, the terms pico-grid, nano-grid, micro-grid, and mini-grid are used to define various levels of renewable off-grid systems. Given that the industry is nascent in its adoption, these terms are often-times ill-defined, have multiple conflicting definitions, and are interchangeably used. In 2015, the International Renewable Energy Agency (IRENA), published a working paper that attempted to standardize the categorisations of off-grid systems [3]. In their report, they proposed the following table for categorising different renewable energy grids.

Figure 1-1: Image of the IRENA proposed grid categorisation table [3]

	Size (kW)	Capability	Complexity
Stand-alone systems	0 – 0.1		
Pico-grid	0 – 1	• Single controller	
Nano-grid	0 – 5	• Single voltage • Single price • Controllers negotiate with other across gateways to buy or sell power	• Both grid-tied and remote systems • Preference for DC systems • Typically serving single building or single load • Single administrator
Micro-grid	5 – 100	• Manage local energy supply and demand • Provide variety of voltages • Provide variety of quality and reliability options • Optimise multiple-output energy systems	• Incorporate generation • Varying pricing possible
Mini-grid	0 – 100 000	• Local generation satisfying local demand • Transmission limited to 11 kV	• Interconnected customers

According to the IRENA definition ***a nano-grid is this defined as a renewable energy grid (typically DC) that is less than 5 kW that can be either remote or grid-tied***. Although IRENA's work has gone a long way to help bring clarity to the off-grid renewable energy definitions, it is still in need of refinement to account for contexts in developing countries in which energy use cases vastly differ from those in developed countries. For example, although IRENA envisions a nano-grid as a grid that typically serves a single load or building (as would rightly be the case in a developed country), in a developing world rural village, a small remote system (less than 1 kW), such as Nanoé domestic nano-grids deployed in Madagascar, can fulfill the basic energy needs of several households, commercial or community users.

Therefore, to the ENERGICA project partners have tried and updated the accepted definitions to be more inclusive of developing country contexts. [4]. The definitions that will be used in this report and in the ENERGICA project are presented in the table below.

Table 1-1: Adapted grid categorization that will be used in the ENERGICA project

GRID	SIZE (KW)	NUMBER OF USERS/BLDGS*	GRID PERIMETER**	DISTRIBUTION VOLTAGE***
Nano-grid	0 - 10	1 – 10	<100 m (typically cover a single building or a neighbourhood)	Extra-low voltage (<50 Vac or 120 Vdc)
Micro-grid	10 - 100	10 – 100	< 1 km (typically cover a small village)	Low voltage (<1 00 Vac or 1 500 Vdc)
Mini-grid	100 - 10 000	100 – 10 000	< 100 km (typically cover a municipality or district)	Medium voltage (< 50 000 Vac or 75 000 Vdc)
Grid	>10 000	>10 000	> 100 km (typically cover a region or country)	High voltage (> 50 000 Vac or 75 000 Vdc)

* USERS/BLDGS – refers to the number of individual users or buildings that are serviced by the grid. A user is defined as a customer/load that is metered.

** GRID PERIMETER – refers to the typical distance between the two more distant users connected to the grid

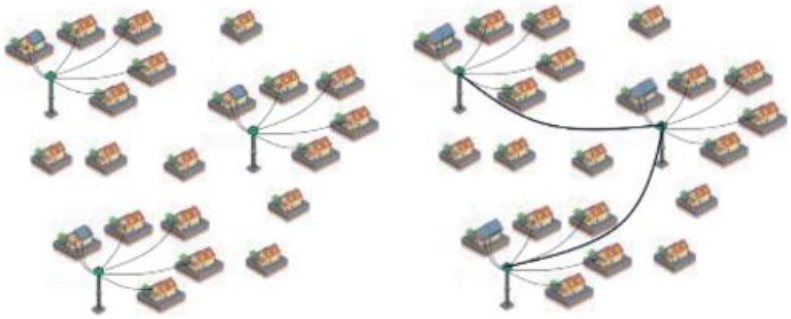
*** DISTRIBUTION VOLTAGE – refers to the highest voltage level used for the distribution of electricity from the production and storage points to the final users when several voltage levels are used. End-user voltages are independent from that distribution voltages.

As can be seen in the table above, a nano-grid, for the purposes of this project, is defined as ***an extra low voltage direct current (i.e. < 120 V) power production, storage and distribution infrastructure providing access to electricity to a small number of neighbouring users (typically less than ten located in a perimeter of <100 meters).***

The typical kind of nano grids deployed and operated by Nanoé in Madagascar since 2017 are DC solar smart and interconnectable nano grids designed to primarily serve domestic users. These systems, later called "domestic nano grids" in this document, are extra low-voltage (12-24V) DC solar

photovoltaic systems (100-300Wp) with lead-acid battery storage (90-260 Ah) that can service up to 6 homes/user per nano-grid controller. Several of these autonomous systems can be connected to form a micro-grid, or more accurately, a lateral micro-grid, using nano grids' interconnection modules. **Figure 1-2** below illustrates the connection of the nano-grid, and lateral micro-grid systems.

Figure 1-2: Illustrations of autonomous domestic nano-grids (left), and interconnected domestic nano-grids or lateral micro-grids (right) [5]



For the purposes of this report, we will not only be discussing these to use-cases regarding to the domestic nano-grid when discussing the nano-grid topic. There is another topic of the ENERGICA project relating to this demonstrator that will be discussed called the productive nano grids.

What are productive nano-grids?

Currently, Nanoé has a very good capacity to offer their nano-grid and lateral micro-grid solutions given their experience and context. They have developed a suitable business model, sufficient local maintenance, and repair capacity, and have a good handle on the supply chain. Although Nanoé has identified capacity building needs in this core business activity Error! Reference source not found.another topic of this project is the development of their containerized productive nano-grid solutions.

One of the key objectives of the ENERGICA project related to this demonstrator is the development of productive nano-grid solutions. With these products, Nanoé, in conjunction with other ENERGICA consortium members, aims to upgrade and adapt the nano-grid solutions to offer larger, more productive end uses tackling the Water-Food-Energy nexus.

Within this project, eleven productive nano-grid models have been specified They are [6]:

- A nano-grid that powers a well pump (NanoWater)
- A nano-grid that provides power and water for a local health center (NanoWaterHealth)
- A solar powered potable water production containerized solution (WaterWatt)
- A nano-grid that condenses drinking water from the atmosphere (AtmoWatt)
- A nano-grid that powers a freezer in a local building (NanoCold)
- A solar powered containerized solution with ice-block production (IceBlockWatt)
- A solar powered containerized solution with ice-flake production (IceFlakeWatt)
- A solar powered containerized solution with freezer storage for locals (FreezerWatt)
- A nano-grid that provides computers and internet connectivity (CyberWatt)
- A solar powered rice-huller containerized solution (AgriWatt)
- A solar powered machine shop/tools based containerize solution (BricoWatt)

For each solution, the idea is to offer a renewable energy supply and productive equipment that can provide a useful product in a rural area. The idea is that the solution will be rented by a local entrepreneur, so that they can provide value to the region. The solutions were co-designed by Nanoé based on needs they consider relevant to their experience in the region. The idea is to test these solutions on the market to see which create the most value and are most economically feasible. Error! Reference source not found.Error! Reference source not found. Details regarding the design and intended uses for each of the productive nano-grid solutions can be found in the ENERGICA Deliverable 4.1 Report [7].

Summary of the technological context background information

In this section, we provided a brief introduction and background of the technological offering of the local demonstrator Nanoé, in Madagascar. The objective here was to set the context of the technical solution pertaining to this report. Further detailed discussions surrounding availability of parts, capacity to maintain and repair, as well as the local, regional, and national supply chain will be presented in the results section.

1.1.2. Educational context

To begin outlining the context we must start with a brief overview of the educational system nationally, followed by looking at the training institutions available regionally, and lastly looking at what the demonstrator is doing locally.

Brief overview of the educational system in a national context

The educational system in Madagascar is directly inspired by the French education system. It is divided into three levels: primary, secondary, and tertiary.

Primary education is compulsory for children between the ages of 6 and ,11 and it is divided into two cycles: Cycle 1 (grades 1-3) and Cycle 2 (grades 4-6).

Secondary education lasts for seven years and is divided into two parts: a junior secondary level of four years from ages twelve to fifteen, and a senior secondary level of three years from ages sixteen to eighteen. At the end of the junior level, graduates receive a certificate, and at the end of the senior level, graduates receive the *baccalauréat* (the equivalent of a high school diploma) [8].

A vocational secondary school system, the *college professionelle* (professional college), is the equivalent of the junior secondary level; the *collège technique* (technical college), which awards the *baccalauréat technique* (technical diploma), is the equivalent of the senior level [8].

Tertiary (post-secondary) education includes vocational training and higher education. Vocational training is offered at vocational training centers, while higher education is offered at universities and other higher education institutions.

According to the latest data from UNESCO Institute of Statistics (UIS), the net enrollment rate in primary education in Madagascar was estimated at 68.2% in 2018. However, the gross enrollment rate in secondary education was lower, at around 30%. Data on graduation rate for each level is not readily available [9].

Madagascar has a total of six public universities, these are: University of Antananarivo, University of Antsiranana, University of Fianarantsoa, University of Mahajanga, University of Toamasina, and University of Toliara. The main degrees offered at these universities are in the fields of medicine, engineering, law, and education [10]. An observation shared by the demonstrator indicates that the

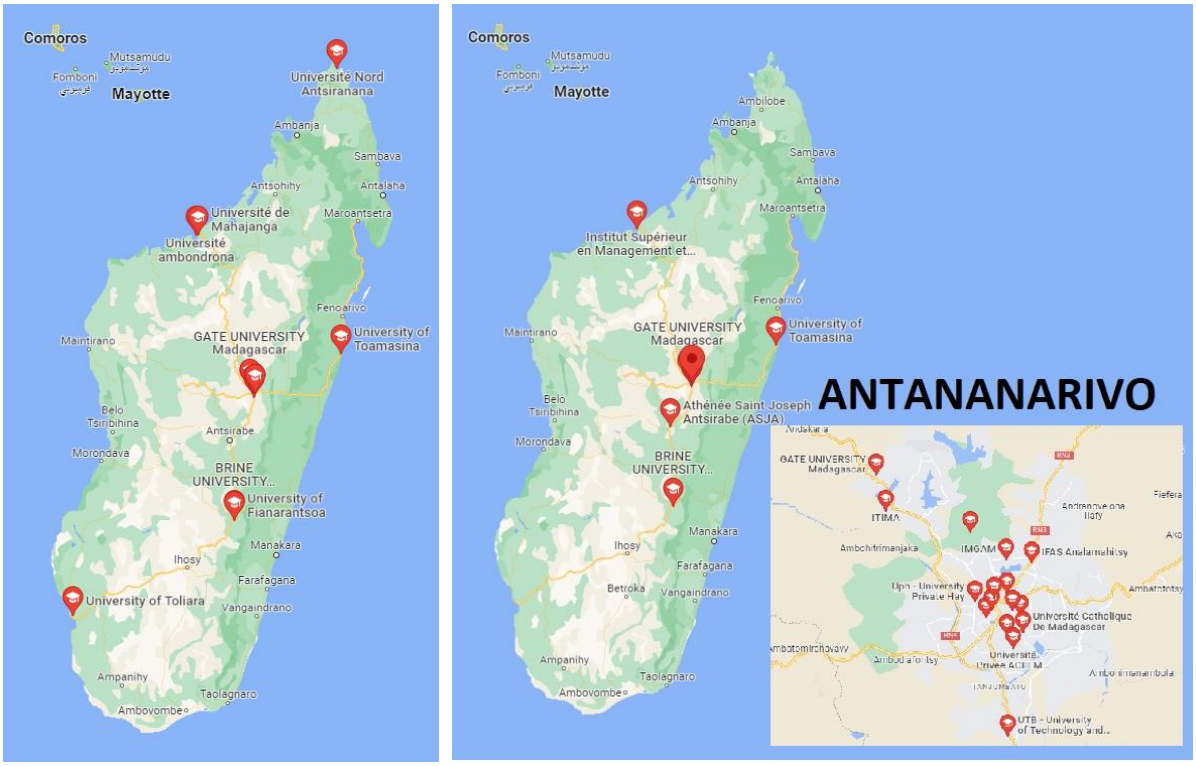
public systems can be quite unreliable at times due to strikes and labour disputes. This often increases the difficulty in collaborating with such institutions.

Ministry of Higher Education, Research, and Innovation (MESupRES)there are over 138 private institutes that offer various levels of post-secondary institutions as of 2021 [11]. This is much larger than the 27 institutes contained within the 6 public universities.

Although most of the post-secondary education institutions are private, most can be found in and around the capital of Antananarivo.A google map of the public universities in Madagascar, illustrating this lack of access is provided in **Figure 1-3**

Furthermore, the number of post-secondary institutions offering programs in the Science, Technology, Engineering, and Maths (STEM) fields are far less and even more concentrated in the capital region. A browse through the MESupRES document shows that only 71 of the private institutions around the country offer some form of a technical/engineering licence. All the public institutions of course do offer some form of engineering degree.

Figure 1-3: location of public (left) and private (right) universities in Madagascar.



Overview of the educational context in the northern region

In the context of this project, the demonstrator is operating specifically in the northern region of the country as illustrated in **Figure 1-4**. These regions are majorly comprised of rural plainous, mountainous, or coastal villages scattered throughout the area. It is important to look at the training institutions in a regional, rather than simply a national context for numerous reasons. These include:

- **Supporting family livelihood:** In rural contexts, many young adults are the backbone of maintaining the family's livelihood (small-scale farming, fishing, zebu cattle herding, local vendor, etc.). This requires that they remain close to their home village to maintain family operations.
- **Seasonal nature of work:** In northern Madagascar, much of the productive growing season takes place over several months, meaning that potential students must be nearby in those productive seasons to support the family livelihood as described above.
- **General affordability and cost of living in another region:** Many potential students can neither afford tuition fees nor the costs associated with moving to the capital for a significant period. It is difficult for a family to save enough money to pay for rent and food for a year for their child to study. Typically, it is necessary to find employment while studying.

When looking at public universities that service the area, there are only two: University of Mahanja, and University of Antsiranana (Table 1-2: Location, names, and training programs of public universities that service the northern region.***)***. When the list of private institutions provided by MESupRES is parsed, there only seem to be about 11 institutes that service the northern region (Table 1-3). Furthermore, most of these institutes focus on business and management training and/or tourism. ***This severely limits both: the talent pool for recruiting entrepreneurs and staff; and potential partner institutions that can host some of the training for the Nanoé systems.***

Figure 1-4: Regions of Madagascar in which Nanoé is operating (note: the demonstrator related to the ENERGICA project will be held in the Diana region). [12]

Table 1-2: Location, names, and training programs of public universities that service the northern region. [11]

LOCATION	NAME OF PUBLIC INSTITUTION	FACULTIES	RELEVANT SUBJECTS
Antsiranana	Université d'Antsiranana	Faculty of Science; Institute of Environment and Science; École Supérieur Polytechnique; Faculty of Education; Faculty of Human Studies; Faculty of Law and Political Science; Faculty of Medicine; Faculty of Business Administration	Physics, Chemistry, Nature and Environment, Civil Engineering, Electrical engineering, Mechanical Engineering, Information technology, Business Administration
Antsiranana	Institut Supérieure de Technologie d'Antsiranana	Industrial Engineering, Engineering Management, Institut Supérieur de Technologie	Finance, Commerce, Communication technology, maintenance and energy, information technology
Mahajanga	Université Mahajanga	Faculty of Science, Technology, and Environment; School of Dental Prosthetics; Institute of Civilisation and Languages; School of Tourism; Institute of Orthodontics; Institute of Science and Technology; Faculty of Law and Political Sciences; Institute of Management; Faculty of Medicine; School of Pharmacy; Veterinarian School; Institute of Agricultural Technology; The Social Sciences Unit	Environmental Science, Industrial engineering, Civil Engineering Applied Sciences, Technical Applied Sciences (Engineering), Finance Management,

Table 1-3: Location, names, and training programs of private institutes that service the northern region. [11]

LOCATION	NAME OF INSTITUTE	COURSES OFFERED	RELEVANT COURSES
Mahajanga	École Supérieure d'Informatique et de Gestion des Entreprises	Tourism, management, law, computer science	Management, computer science
Mahajanga	École Supérieure Saint Gabriel Mahajanga	Management	Management
Mahajanga	Institut Catholique Notre Dame	French studies	None
Mahajanga	Institut de Formation Technique	Environmental Science, management	Environmental Science, management
Mahajanga	Institut de Formation en Tourisme	Tourism and hotel management	None
Ambanja	Institut Supérieure pour l'avenirs des Polytechniciens et de la Santé Publique	Computer Science, Engineering science	Computer Science, Engineering science
Antsiranana	Institut Supérieure en Management et du Développement d'Antsiranana	Management	Management
Mahajanga	Institut Supérieur de Management et des Sciences Technologiques	Business Administration, Law, and Political Sciences	Business Administration
Antsiranana	Institut Supérieur Nord Madagascar	Management	Management
Antsiranana	Institut Supérieur Privé de la Region Diana	Management	Management
Hell-Ville (Nosy Bé)	Institut Universitaire Professionnel en Administration d'Entreprise et en Sciences Marines	Business Administration, Marine Science and environment	Business Administration

One final subject for investigation is the availability of Technical high schools (Lycées techniques) in the region. These could make relevant training partners as their facilities could be used to host local trainings. A quick search found the ***School Technique Professionnel*** (***Lycée Technique***). They have schools located in Nosy Be, Ambanja, and Antsiranana.

In summary, given the significant shortfall in access to training facilities in the regional context, and further, the lack of technical training; capacity will have to be built from scratch to provide the necessary educational and technical background necessary to implement the project technology effectively at scale. This is the approach that Nanoé has already taken since 2017 to support the deployment of its domestic nano-grids, and the recommended approach for the project solution as well. Next, we will discuss the training programme that Nanoé has already developed for its entrepreneurs building and operating domestic nano-grids.

Overview of the Nanoé Training Program

Given the regional educational context described above. Nanoé took the decision to develop and deliver its own training programme. This ensures that all their solar entrepreneurs are trained to their level of satisfaction, and more importantly, have the knowledge required to maintain and repair Nanoé's system. Nanoé's training program workflow goes as follows:

1. First step begins by recruiting students via informational meetings in the various districts of a county. Following the meetings.
2. Applicants express their interest in applying following the meeting by taking oral and written tests.
3. Of all the applicants, 15 – 20 are selected per cohort (2 or 3 per region)
4. Students travel to the training centre in Ambanja for a 3-week intensive commercial training, followed by two weeks of practical sales training in the field to try to convince potential clients to enroll for the service.
5. The students return to the training center for another 3 weeks of in class technical training, followed by two weeks in the field where they install nano-grid systems (hopefully for their first clients) under the supervision of a previous graduate and/or instructor.
6. The students return for a final three weeks of training in business management and entrepreneurship, followed by 1 week in the field.
7. Graduates receive a certificate and become Nanoé franchisees.

The training program in total covers a period of approximately 14 weeks and is typically held at a rate of one cycle per year.

Summary of the educational context background information

In this section, we provided a brief introduction and background of the educational context surrounding the demonstration project in Madagascar. The objective here was to set the context of in terms of background education and skills surrounding the technology of the project. The key takeaways are:

- Most higher education institutions are in the capital of the country, with two being in the Northern region.
- There do not exist many training facilities that are well aligned with the needs of Nanoé regionally.

Further detailed discussions and results surrounding technical competencies in the region, the capacity to train, and existing Higher Education information will be presented in the results section.

1.1.3. Economic context

The economic context is another important context in the TEES framework, as it has a significant effect on business development and growth, as well as on the ability to build capacity because the economic makeup of a context drives the everyday life of the individual. It further affects capacity building as economic activity is what most typically defines the supply chain, and transportation logistics.

Overview of the economy in a national context

Madagascar has a population of around 28.9 million and a Gross Domestic Product (GDP) of $14.5 billion in 2021 [13]. Despite its natural resources, including arable land, forests, and minerals, Madagascar remains one of the poorest countries in the world. The economy of Madagascar is primarily based on agriculture, with rice, cassava, and sweet potatoes being the main crops. The country also has a significant fishing industry, and a small but growing mining sector. The tourism sector is also becoming an important source of foreign exchange, with visitors coming to see the country's unique biodiversity and natural landscapes [14].

Major economic activities [14]***:***

- Agriculture: Agriculture is the backbone of the economy and employs around 80% of the population. The main crops are rice, cassava, and sweet potatoes, and they account for around 60% of agricultural production. Madagascar is also a major producer of cash crops such as vanilla, cloves, pepper, and coffee. Vanilla is the country's second-largest export after textiles and clothing.
- Fishing: Fishing is also an important economic activity in Madagascar, providing both food and income for coastal communities. The country's Exclusive Economic Zone (EEZ) is one of the largest in Africa, and it has abundant fish stocks. The fisheries sector accounts for around 3% of GDP.
- Mining: The mining sector in Madagascar is small but growing. The country has significant deposits of precious and semi-precious stones, graphite, and ilmenite. Madagascar is a major producer of sapphires, rubies, and emeralds. The mining sector accounts for around 1% of GDP.
- Textiles and clothing: Madagascar has a growing textile and clothing sector. This industry is exclusively concentrated in a tax-free zone in Antananarivo and does not exist in the rest of the country. The sector accounts for around 2% of GDP. Most of the production is exported, to the United States and Europe.
- Tourism: Tourism is a growing sector in Madagascar, and it is becoming an important source of foreign exchange. The country has unique biodiversity and natural landscapes, including rainforests, beaches, and wildlife. The sector accounts for around 1% of GDP.

Major forms of employment [15]***:***

- Agriculture: As previously mentioned, agriculture is the backbone of the economy and employs around 80% of the population. Most of these farmers are engaged in subsistence agriculture and rely on small plots of land to grow food for themselves and their families.
- Fishing: Fishing is also an important source of employment in Madagascar, providing jobs for around 150,000 people. The sector is dominated by small-scale, artisanal fishing and employs coastal communities.
- Mining: The mining sector in Madagascar is small, but it employs around 20,000 people. The sector is dominated by small-scale, informal mining, which is often illegal and environmentally damaging.
- Textiles and clothing: The textile and clothing sector employs around 40,000 people. Most of these jobs are in the informal sector, and wages are low.
- Tourism: The tourism sector employs around 20,000 people, in hotels and restaurants. The sector is dominated by small, informal businesses and wages are low.

In summary, Madagascar's economy is based on agriculture, fishing, and forestry, with a small but growing mining sector. The country's traditional system of subsistence agriculture is characterized by small farms, low productivity, and limited access to markets. The country's infrastructure is inadequate, and the transport system is underdeveloped. These factors contribute to the lack of integration of the country's economy and the weak linkages between sectors. Most of the population is engaged in subsistence agriculture and fishing, with a small percentage employed in the industrial and service sectors found in the capital.

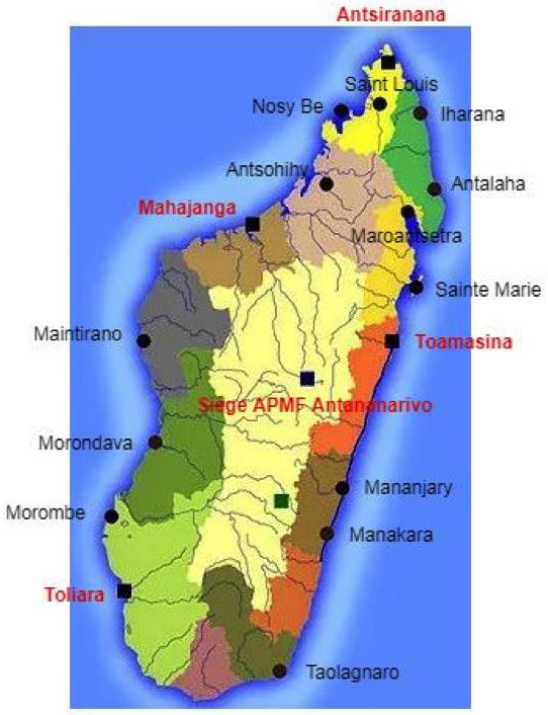
Overview of the supply chain:

Madagascar's supply chain is also affected by a lack of access to finance and a lack of technical and vocational education, which limits the ability of farmers and small businesses to improve productivity and access new markets. Additionally, Madagascar's lack of a well-functioning business environment and weak institutions further restrict the ability of the private sector to grow and create jobs.

To dive further into the existing infrastructure, we have included images that show the location of all the ports in Madagascar along with a table that denotes whether it is regional, national, or international (**Figure 1-5**). According to the information provided in the figure, there exist only 4 international ports (Antalaha, Ehoala, Toamasina, and Vohémar), of which ***only Toamasina is available to all parties for global imports.*** The other three international ports are subject to concessions, which means only certain companies have access [16].

Furthermore, according to the most recent report released in 2015 by the National Port Agency (Agence Portuaire Maritime et Fluviale -APMF***): Toamasina handled about 85% of all tonnage shipped (nationally and globally***) shipping a total of 6.2 million tons of the entire 7.3 million tons recorded across all 17 ports [17].

Figure 1-5: Location (left) and status (right) of shipping ports in Madagascar. Major ports are denoted in red in the image. [16]



PORTS	PIN	PIR	PGA	PCG
Antalaha	•			•
Antsiranana	•			
Ehoala	•			•
Mahajanga	•			
Maintirano		•		
Manakara		•		
Mananjary		•		
Maroantsetra		•		
Morombe		•		
Morondava		•		
Nosy Be	•			
Saint Louis		•		
Sainte Marie		•		
Taolagnaro		•		
Toamasina	•		•	
Toliara	•			
Vohémar	•			•

PIN = National ports, PIR = Regional Ports, PGA = Global port with autonomous managent, PCG = Global port with non-autonomous global concession

Therefore, when a demonstrator is looking to import certain products that are not manufactured locally (such as batteries or solar panels), the best option is the port in Toamasina because of it is the port that receives most of the countries imports and is equipped to handle these types of imports regularly. Indeed, the demonstrator has also tried shipping to the ports in Nosy Be and Antsiranana ports, which is feasible, but more complex because international boats go there only every few months and it is more costly.

Given the limitation in ports available for international shipping (importing), the next question becomes, how does one logistically transport goods from the port in Toamasina, to their desired location? To address this question, we must look more closely at the major road networks in the country (**Figure 1-6**).

When we observe the map in Figure 1-6, we can see that the road from Toamasina to the north passes through the capital and up through the middle of the island. The coastal road is not connected on the eastern sea-bord. This means that transporting goods to the north will take approximately 2 or 3 days by truck.

Summary of the economic context background information

In summary, the economy of Madagascar is heavily dependent on agriculture for its subsistence. There exist some ports regionally, but the most effective port to work with is in Toamasina. There do not exist many roads, and there are no national railways, meaning imports that come from other ports need to make a long journey to get into the northern region. Furthermore, work is quite seasonal. Therefore, these challenges will have to be strongly considered in terms of ensuring there is adequate inventory of parts, and when considering cash flows of the demonstrators' clients.

Figure 1-6: Map of major roads in Madagascar [18]

1.1.4. Social context

Madagascar is an island country that is bordered by the Indian Ocean on the east and the Mozambique Channel on the west. In this section we will provide a brief history of the country, discuss its people, and information relevant to access to energy.

Brief history of Madagascar

Below is an excerpt from the Central Intelligence Agency World factbook describing the history of Madagascar [19]:

> Madagascar was one of the last major habitable landmasses on earth settled by humans. While there is some evidence of human presence on the island in the millennia B.C., large-scale settlement began between A.D. 350 and 550 with settlers from present-day Indonesia. The island attracted Arab and Persian traders as early as the 7th century, and migrants from Africa arrived around A.D. 1000. Madagascar was a pirate stronghold during the late 17th and early 18th centuries and served as a slave trading centre into the 19th century. From the 16th to the late 19th century, a native Merina Kingdom dominated much of Madagascar. The island was conquered by the French in 1896 who made it a colony; independence was regained in 1960.
>
> During 1992-93, free presidential and National Assembly elections were held ending 17 years of single-party rule. In 1997, in the second presidential race, Didier RATSIRAKA, the leader during the 1970s and 1980s, returned to the presidency. The 2001 presidential election was contested between the followers of Didier RATSIRAKA and Marc RAVALOMANANA, nearly causing secession of half of the country. In 2002, the High Constitutional Court announced RAVALOMANANA the winner. RAVALOMANANA won a second term in 2006 but, following protests in 2009, handed over power to the military, which then conferred the presidency on the mayor of Antananarivo, Andry RAJOELINA, in what amounted to a coup d'état. Following a lengthy mediation process led by the Southern African Development Community, Madagascar held UN-supported presidential and parliamentary elections in 2013. Former de facto finance minister Hery RAJAONARIMAMPIANINA won a runoff election in December 2013 and was inaugurated in January 2014. In January 2019, RAJOELINA was declared the winner of a runoff election against RAVALOMANANA; both RATSIRAKA and RAJAONARIMAMPIANINA also ran in the first round of the election, which took place in November 2018.

People

In the following paragraphs we will discuss the people of Madagascar, including the various ethnic groups, the languages, religion, and settlements patterns. All this information is taken from the website Britannica (organisation that writes the Encyclopaedia Britannica).

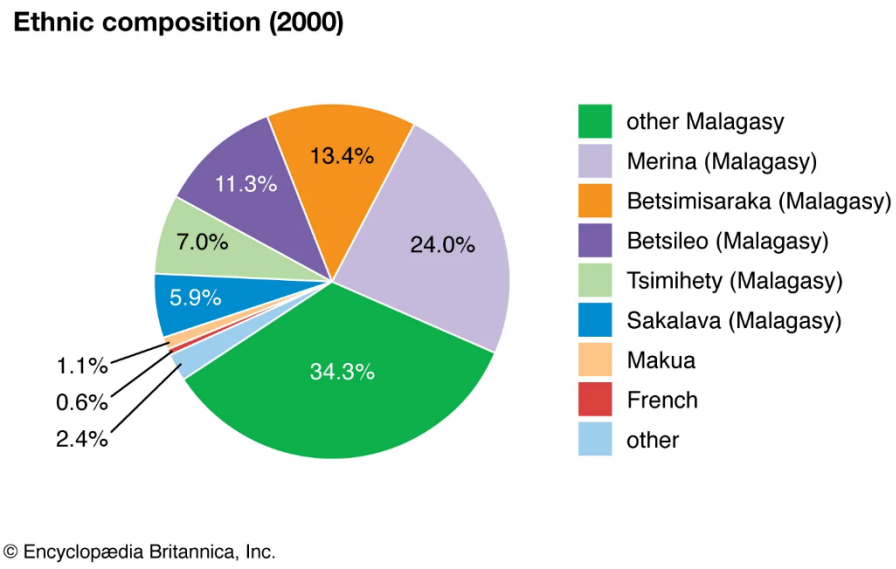
Ethnic groups

Madagascar has been inhabited by human beings for the brief period of about 1,300 years. Language and culture point unequivocally to Indonesian origins, but there is no empirical evidence of how, why, or by what route the first settlers came to the island. Some scholars argue that the first settlers came directly from Indonesia, in a single voyage, and that the African elements found in the population and its culture were added later, as the result of migration and the slave trade. Others suggest that the peopling of the island was the result of several voyages that proceeded along the coast of India, the Arabian Peninsula, and Africa and that the population that settled the island was already mixed. Below is a list of the various ethnic groups located on the island [20]:

- More than nine-tenths of the population is Malagasy, which is divided into about 20 ethnic groups. The largest and most dominant of the groups is the Merina people, who are scattered throughout the island.
- The second largest group is the Betsimisaraka (The Inseparable Multitude), who live generally in the east.
- The third most numerous group is the Betsileo (The Invincible Multitude), who inhabit the plateau around Fianarantsoa.
- Other important peoples are the Tsimihety (Those Who Do Not Cut Their Hair), the Sakalava (People of the Long Valley), the Antandroy (People of the Thorn Bush), the Tanala (People of the Forest), the Antaimoro (People of the Banks), and the Bara (a name of uncertain origin).
- Smaller groups are the Antanosy (People of the Island), the Antaifasy (People of the Sand), the Sihanaka (People of the Lake), the Antakarana (People of the Rocks), the Betanimena (People of the Red Soil), who are now largely absorbed by the Merina, the Bezanozano (Those with Many-Braided Hair), and the Mahafaly (Those Who Make Taboos).

A figure showing the breakdown of ethnicities is shown below:

Figure 1-7: Breakdown of ethnicities as reported in the Encyclopaedia Britannica [20]



Brief overview of the Sakalava people

The region in which this project will take place is inhabited mostly by the Sakalava people. The Sakalava are one of the smallest ethnic groups in the country, constituting about 6.2% of the total population [21]. Sakalavas are considered to be a mix of Austronesians and Bantu peoples [22]. The founder of the Sakalava legacy was Andriamisara. His descendant Andriandahifotsy ("the White Prince") extended his authority northwards, past Mangoky River after 1610. The first significant Sakalava kingdoms were formed around the 1650s. The influence of the Sakalava extended across what is now the provinces of Antsiranana Mahajanga, and Toliara [23]. The traditional religion of the Sakalava people, called *Fomba Gasy*, was centred around royal ancestor worship [24]. *Tromba* has been a historic feature of the Sakalava people, ad has centered around ceremonies and processions for the spirits of the deceased royalty. The procession is more than a religious event, it has historically been a form of community celebration and identity affirming festival [25].

Languages

Most inhabitants of Madagascar speak Malagasy, the national language, which is written in the Latin alphabet. Several inhabitants in the north speak Sakalava. Although Madagascar is located geographically close to Bantu-speaking Africa, Malagasy is a standardized version of Merian, and Astronesian language. Nevertheless, there are several Banut words in the languages, as well as some phonetic and grammatical modifiers of Banut origin [20].

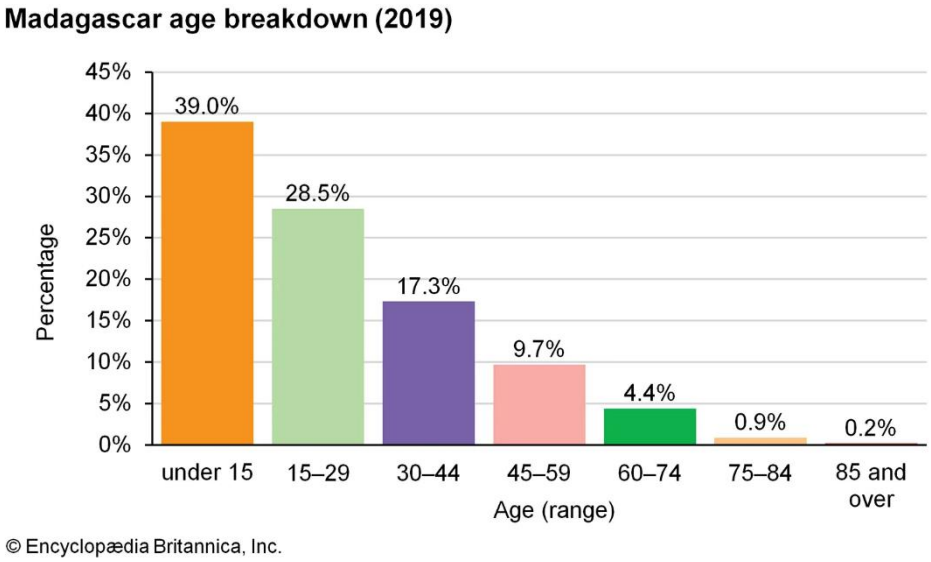
French is also widely spoken and is officially recognized. It is used as a medium of instruction, especially in the upper grade levels, as is Malagasy. English is also spoken, and its use has increased. Comorian is spoken among a sizable community of immigrants from Comoros [20].

Demographics

As of 2018, about 80.5% of the population lived in a rural context, vs. 19.5% who live in an urban area [20]. The major foreign communities are French, Comorian, Indian, Pakistani, and Chinese although emigration in the late 20th century significantly reduced their populations. There has been no significant emigration of the Malagasy peoples abroad.

Births greatly outnumber deaths and are well above the world average. The population is growing rapidly. Life expectancy for both men and women are below the world average. The eastern part of the central plateau is the region of highest population density and contains almost all the major cities and towns. Most of the western two-thirds of the country is sparsely inhabited [20]. Below is a figure showing the breakdown by age. Over 57.5% of the population is under 30.

Figure 1-8: Breakdown of age by group as reported by the Encyclopaedia Britannica [20]



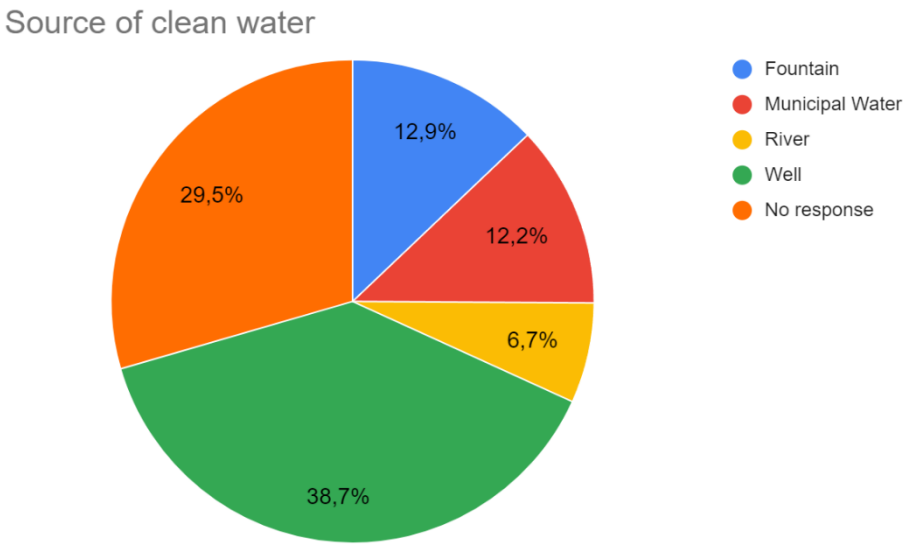
<u>Information relevant to access to energy</u>

As part of this project, an extensive baseline survey was done in the regions of each of the demonstrators for Work Package 2 (WP2) to get an idea of access to energy and background energy use information. In this section, we will present some background contextual information. *Error! Reference source not found.*Below is an overview of the findings from those surveys [26]:

- 31.6% of the respondents in the demonstrator region reported not having access to energy in the household. The 68.4% of the respondents who did report having access, reported being connected to nano grids and other sources like petrol- and diesel-powered generators. Note, the nationally reported average is much lower, and this survey was done using the existing network of Nanoé clients, therefore, the connectivity numbers are higher than average.
- 73% of users that do have access to energy use solar energy from neighbours for communication on phone, radio, TV, and other communication devices.
- 37.3% of the population expressed dissatisfaction with the energy sources they are using.
- The mean monthly HH income was $58.81.
- The mean monthly total HH expenditure on energy was $9.15.
- The maximum they would spend per month on access to cooling and freezing services on average is $5.78.
- 34% of respondents that had access, said that access to stationary agricultural machines was in their neighbourhood (less than 100 m).
- 68.8% of respondents stated the did not have access to cooling or freezing services for food and beverages.
- Only 18.7% of respondents stated they did not have access to clean water, with 58.1% stating that it was either available at home or within 100m.

Below is an image showing the source of their clean water.

Figure 1-9: Reported waste disposal as interpreted from survey question 88 [26]



Summary of the social context background information

Madagascar is a dynamic population with a highly unique ecosystem. It is a generally young population, with little access to clean and reliable energy. The majority live in rural zones and make a living through agriculture. There is currently low energy reliability, and little access to cooling and water. These factors, make the introduction of a distributed energy nano-grid system likely to be successful if implemented correctly according to the context.

2. RESULTS

2.1. Needs Assessment

A thorough needs assessment was performed, the details of which were shared with the demonstrator partner internally for Deliverable 3.1. That report contains proprietary information and as such will not be made publicly available.

2.2. Field Trip

A field trip was also performed, the details of which were also shared internally via Deliverable 3.1 and contained proprietary information.

2.3. Triage

Following the needs assessment completed for Deliverable 3.1 the triage exercise was performed to determine which needs could be actioned as part of the capacity building programme. Given that this is a report that is to be publicly released, a high-level version of the triage results will be shared below which omits some details specific to the demonstrator.

Table 2-1: Triage result for Madagascar context (action plan items in bold)

FACTOR	NEED IDENTIFIED	RECOMMENDATIONS	POTENTIAL NEXT STEPS	TRIAGE
T1 - SIMPLICITY AND OPERABILITY	Methods to manufacture certain components locally	· Purchase various machines and parts and train internal technician in the process	· Purchase and ship the required parts · Train operator on how to do the process	Do
	A solution for the next generation of utility poles	· Consider designs that can be fabricated locally	· Analyze the cost to implement new design · Get an engineering review	Do Later
T2 – CAPACITY TO MAINTAIN AND REPAIR	**A technician who knows how to repair machines and appliances to support containerized solution**	**· Try to find a repair person in the region who has experience repairing the kind of machines needed for the containerized solutions and collaborate on creating a training program**	**· Find a potential partner to lead the development of a training program**	**Action Plan**
T3 – AVAILABILITY OF PARTS	A solid comprehension of the parts that will need to be imported to maintain containerized solutions.	· Rigorously go through BOM and ensure there will be adequate supply and spare parts available for each. · Where possible try to use things that can be locally sourced	· Rigorous review of containerized solution design.	Already Doing
	A supplier in the country who can source machines and components.	· Explore partnerships with suppliers in Antananarivo for the supplemental parts required for the containerized solutions	· Find a strong supply partner in Antananarivo	Do Later
ED1 – TECHNICAL ABILITIES TO OPERAT	An increased capacity in sales and management training	· Reach out to local business schools to hire a local sales rep (or a couple) that accompanies each entrepreneur to make their first	· Hire dedicated sales reps. · Hire a business teacher to develop a formal sales and business training program	Do Later

		sale.		
	Training matricula and program material to repair appliances	**· Explore to see if this kind of training exists elsewhere. · Work with the local repair person to modify existing training programs for context**	**· Find potential existing training curriculum. · Work with repair person to modify to context.**	**Action Plan**
ED2 – CAPACITY TO TRAIN	An online (or offline) version of the theory that can be done in advance.	· Explore creating textbooks or handbooks that can be distributed with completable homework	· Find a partner who can productize the entrepreneur training into a handbook	Already Doing
	An increased capacity in training for repairing appliances and tools for containerized solution	**· Find a local repair person to help outline a curriculum for this training. · Develop the curriculum into a training program.**	**· Develop a training program and curriculum. · Explore ways to implement**	**Action Plan**
	A way to better train the entrepreneurs in sales and management.	· Work with a partner to develop a stronger entrepreneurial curriculum and content	· Find a potential partner that can provide entrepreneurial training content	Already Doing
ED3 – EDUCATIONAL BACKGROUND	**Electrical engineering and management curriculum in universities to increase the talent pool in the region**	**· Through the Energy Transition board, make recommendations to the ministry of education about what type of content would be important to add to engineering and management programs**	**· Make a list of desired training curriculum. · Join the Energy Transition board and connect with university administrations**	**Action Plan**
EC1 – AFFORDABILITY LOCALLY	To determine an adequate pricing scheme for the containerized solutions	· Perform a rigorous economic analysis · Ensure that the pricing scheme is easily modifiable	· Perform rigorous economic analysis. · Design a flexible payment scheme	Do
EC2 – EMPLOYMENT REGIONALLY	Ensure that there are skilled jobs in the rural regions to avoid brain drain	· Maintain the course on the current business model	· none	Already Doing
EC3 – MAJOR ECONOMIC ACTIVITY NATIONALLY	Introduce more renewable energy products to reduce dependence on oil imports	· Maintain the course on the current business model.	· none	Already Doing

S1 – WILLINGNESS OF LOCALS TO SUPPORT	To gain further understand about willingness for containerized solution	· Rigorously test the market with a couple of containers first and be prepared to make design changes. · Make the design, construction, and delivery loop as short as possible to learn as quickly as possible from each container	· Develop a strategy focused on quick implementation of containers and obtaining results as quickly as possible	Do
S2 – EMPLOYMENT OPPORTUNITIES CREATED VS. EXISTING	To attract more entrepreneurs to the employment opportunities being created	· Ensure there is a cohesive message and engagement strategy	- none	Do Later
S3 – ADOPTION SUCCESS OF COMPARABLE PRODUCTS	To prioritize investments into solutions with proven adoption success of similar products and test the others extensively	· Find one or two competent entrepreneurs to test the newer products · Ensure that the first roll-out of these are in a location that is easy to monitor and learn from	· Determine the best pool of entrepreneurs · Select best location to test WaterWatt and BricoWatt	Already Doing

As can be seen from the triage results, there were four needs identified as requiring an action plan. Three of which had to do with training of technicians who can repair appliances and refrigeration systems. The fourth, was a more national need around working with universities to introduce new skills and teachings into the curriculums. In the next section, we will explore the results of the action planning exercise more thoroughly.

2.4.Action plans

The next step in the process was to develop action plans in collaboration with the demonstrator site. These will form the basis for the capacity building programme to be implemented for each context. For the Madagascar context, the most apparent needs were:

- Need for refrigeration and appliance repair technicians.
- Need for increased sales and management training related to rural contexts in university curriculums.
- Need for more hands-on learning in university curriculums.

Below are details of the desired outcomes, steps, and potential hurdles required to satisfy these needs. Note: the content has been generalized to exclude sharing of any proprietary information, and key partners are not listed.

Table 2-2: Action plan result for Madagascar context

NEED IDENTIFIED	DESIRED OUTCOME	STEPS	POTENTIAL HURDLES
A technician who knows how to repair machines and appliances to support containerized solution	- A clear 5/10 yr maintenance strategy - Job descriptions for required maintenance aspects - Training curriculum if necessary (for staff and entrepreneurs)	1. Map the different appliances and get an idea of figures that will be deployed in 1, 5, and 10 years 2. Determine the maintenance strategy and requirements to understand the number of technicians that will be required over time 3. Develop job descriptions for the high priority appliances. 4. Work with suppliers to understand the maintenance and repair requirements for their products and determine whether they can provide some training aids 5. Develop the training (likely to need refrigeration and multimedia personnel (tvs, radios))	- Suppliers not being supportive - Ensuring the training is generalized enough (general theory, general refrigeration cycle/systems, etc.) - Some suppliers may not be supplying the DC fridges anymore
Training matricula and program material to repair appliances	Covered above		
An increased capacity in training for repairing appliances and tools	Covered above		
Electrical engineering and management curriculum in universities to increase the talent pool in the region	**An Updated Engineering Curriculum at a regional University that contains the following additions:** - More hands-on training (solar panels, multimeter) - Discussions about quality control - Diagnostics/Troubleshooting - Battery systems training (battery technologies, how to store, diagnosing, battery chemistries) - Data analysis (excel curve fitting) - Engineering Project management **An updated Marketing and Sales Curriculum at a regional University that contains the following additions** - Project Management - Last mile marketing (trained specifically in rural area sales) - Understanding of general business processes - Potentially an in the field internship - Specific training that is strongly linked to sales in rural areas - Ethics of financial management (handling cash) - Better understanding of how rural areas think and how they manage their money - Understanding of the revenue and consumption patterns of rural areas - A focus on traditional marketing/door to door sales	1. Make a list of potential partner Universities 2.Work with Centres of Excellence to get into contact with the Departments of Education 3. Establish a relationship with several partner Universities that may be interested in collaborating 4. Begin a dialogue with the Universities and Departments of Education to provide feedback and input into their programs 5. Work to develop curriculum and integrate the desired modules into their existing programs	- It could be difficult to find a suitable University partner

3. PROPOSED CAPACITY BUILDING PROGRAMME

Once the action planning exercise was completed, it was possible to begin developing the capacity building programmes. The programmes were based off the desired outcomes provided by the demonstrator. Based on the action plan exercise, the following capacity building programmes have been proposed:

- A refrigeration and appliance maintenance programme
- An engineering curriculum development programme
- A marketing & sales curriculum development programme

Detailed capacity building programme outlines are included in the following sections.

3.1. Refrigeration and appliance maintenance programme

The purpose of this programme is to build capacity surrounding refrigerator and appliance repair technicians to support the containerized solutions deployed as part of this project. Given the demonstrator will be deploying advanced refrigeration systems for ice making, televisions, power tools, and other electronic appliances; The need for several repair people was identified as important.

3.1.1. Programme goals and objectives

The program goals and objectives are as follows:

- Develop a clear 5-to-10-year maintenance strategy to determine the exact maintenance needs and skills required.
- Develop job description for the required maintenance aspects.
- Develop an internal staff training program if necessary.

3.1.2. Programme implementation strategy

The program will be implemented over three phases with an optional fourth phase. Phase 1 entails developing an understanding of the maintenance needs to support the project and developing a maintenance plan. Phase 2 entails stakeholder engagement, in which we will engage with appliance suppliers, and regional maintainers or repair people (if any) to develop the maintenance methodologies. Phase 3 entails either creating a job description and hiring maintainers to be trained internally; or developing a training programme to be delivered by a regional TVET; depending on the maintenance needs identified in Phase 1 and existence of willing stakeholders identified in Phase 2. The optional Phase 4 would include piloting and launching the TVET program, delivering the training, and evaluating and adapting it based on the delivery results. Each phase will be discussed in further detail below.

Phase 1: developing an understanding of maintenance needs

In this phase, an inventory of appliances that will require maintenance will be taken, an estimate on how often they will need to be maintained will be made, and a description on how they will need to be maintained will be outlined. Details for each activity are described below.

1. ***Create an inventory of appliances:*** review the Bills of Materials for the nano-grids and containerized solutions to identify the number and type of appliances that will be deployed over the next 1, 5, and 10 years. For each type of appliance try to group them into one of the following categories:

- **Thermal**: refrigerators, ventilation, air conditioners, etc.
- **Hydraulic:** plumbing, washers, etc.
- **Motor-based (small):** fans, blenders, etc.
- **Motor-based (large):** rice-hullers, wood-planers, etc.
- **Lighting and multimedia**: televisions, radios, etc.
- **Kitchen appliances:** electric kettles, blenders, stoves, ovens, etc.
- **Power tools:** electric saws, power drills, etc.
- **Mechanical equipment:** pumps, heat exchangers, valves, motors, etc.

2. ***Determine the maintenance needs for each:*** for each appliance identified, estimate their likelihood of requiring maintenance, whether it is more effective to replace the appliance all together (e.g., small appliances like blenders, and power tools) once they fail, and their expected lifetime before requiring maintenance. The objective is to narrow the list to the most critical and expensive appliances.

3. ***Determine the type of maintenance required:*** for the list that has been narrowed down in the previous step, identify the type of maintenance likely required for each. Below is a list of guiding questions:
   - Will it be in the field, or at the local headquarters?
   - Will it be refrigeration, electronics, mechanical etc.?
   - What kind of troubleshooting will be required?
   - Will it be minor (replacing a part, adjusting, etc.) or major (taking apart a motor or pump, etc.)

4. ***List the skills that will be required:*** once type of maintenance required has been identified, make a list of the skills that will be required for the ideal maintainer to have. This will serve to inform the job requirements and/or training curriculum.

Once the maintenance needs have been identified, the next phase entails engaging stakeholders.

Phase 2: engaging stakeholders

In this phase, various stakeholders will be informally engaged to determine relevant maintenance practices. The objective is to learn HOW to maintain the critical appliances above. This phase involves engaging suppliers for their maintenance programmes, engaging foundations for their support, and engaging other partners with aligned interests.

1. ***Engage global and local suppliers for their maintenance programmes:*** the best place to start with determining maintenance methodologies is with the suppliers themselves. Many times, the suppliers have training and maintenance manuals. Further, they are often keen to collaborate with customers in new markets to establish maintenance programmes as this increases their offering to potential new clients in the region. Therefore, the first step will be to reach out to the suppliers of each of the critical appliances and develop collaborations with them.

2. ***Engage foundations for their support:*** many of the larger suppliers (e.g., Schneider Electric, Victron Energy, Electricité de France) have a philanthropic arm or foundation that is typically keen in supporting projects and training programmes in developing economies. In this step, the objective will be to identify any such foundations that the suppliers may be involved with who might be interested in collaborating on this initiative.

3. ***Engage other partners aligned with interests:*** often there exist numerous parallel initiatives in a region with objectives that are aligned. In this step, the objective will be to identify any such partners and engage them. Many times, they have parallel training programmes being developed for which certain modules can be added as collaboration for the needs identified.

Once suitable partners have been engaged. The next phase entails creating a job description or a training programme depending on the results of the first two phases.

Phase 3: hiring and training maintainers internally or developing a training curriculum

Based on the results of the first two phases, a decision will be made on whether it is necessary to simply hire and train a few repair people internally or collaborate with a TVET to develop an entire training programme who can train numerous maintainers to support the demand. Details regarding the steps of each option are described below.

Option 1: Hire and train maintainers internally

This path will be pursued given either of the following findings from Phase 1 and Phase 2:

- The foreseen maintenance requirements will be minimal and/or over a longer period.
- There are no suitable stakeholders in the region that can deliver the training effectively.

If either of these conditions is found to be true, then it is recommended that the capacity be built internally to satisfy the need. If this is the path to be taken, the following steps for implementing this phase are recommended:

1. **Create job descriptions:** using the maintenance needs identified in Phase 1, create a job description that outlines the core competencies required for the job and the desired competencies being mindful of the talent pool in the area and the country.

2. **Initiate the hiring process:** begin advertising the position(s) and interviewing candidates. During the interview process, make note of the competencies that will require on the job training so that a training programme can be implemented once the desired candidate(s) is hired.

3. **Develop the training programme:** based on the number of maintainers that will need to be hired, develop a suitable training structure. If the number of maintainers is minimal, on the job training can be performed with the help of maintenance and repair manuals provided by vendors. If a larger number of maintainers is required, a more structured training approach should be considered.

Option 2: Develop a training curriculum for a partner TVET

This path will be pursued if all the following findings from Phase 1 and Phase 2 are true:

- The foreseen maintenance requirements will be significant.
- There are suitable stakeholders and partners interested in developing and delivering a relevant training programme.

If both conditions are met, then it is recommended that the capacity be built at a larger, more regional level. If this is the path to be taken, the following steps for implementing this phase are recommended:

1. **Design the programme:** work with the partners and stakeholders identified in Phase 2 as well as other subject matter experts to create a high-level curriculum outline and selected training methodologies.

2. **Assess resources:** identify preliminary resource requirements, such as budget estimates and potential funding sources.

3. **Develop the curriculum:** develop a detailed curriculum and training methodology that aligns with the identified needs.

4. **Pilot testing:** conduct a pilot test of the curriculum and training methods to ensure their effectiveness and relevance.

5. **Program promotion and recruitment:** develop a marketing and outreach strategy to inform potential participants and stakeholders about the program. Begin the recruitment and selection process for program participants.

6. **Facilitator selection and resource procurement:** identify and engage qualified facilitators or trainer for program delivery and begin procuring the necessary resources including training materials and facilities (or work with the TVET to assist).

7. **Program delivery, evaluation, and adaptation:** deliver the training sessions, implement a system for tracking participant progress, and adjust the program as needed.

3.1.3. Timeline and milestones

Now that the Phases and programme implementation steps have been defined, it is time to identify milestones and discuss a possible timeline for implementation. Below are the milestones for each phase.

Phase 1 milestones:

- **Completed inventory of appliances:** a list of all the appliances that could require maintenance in the coming 10 years.
- **Completed estimate of maintenance needs:** an estimate of the number of maintainers and quantity of maintenance required in man-days based on the estimation of the predicted failure rates.
- **Completed 1-year, 5-year, and 10-year maintenance strategy:** a table of the critical appliances with their expected lifetime and expected mode of failure.
- **Completed skillset inventory*:*** a list of the skills that will be required to maintain the critical appliances.

Phase 2 milestones:

- **Completed list of interested partners:** a list of all the suppliers, foundations, and other partners who have expressed explicit interest in collaborating.

Phase 3 milestones:

- **Completed job description:** a one-page job description document that highlights the required and desired skills for a maintainer based on the talent-pool in the region.
- **Training programme outline:** a high-level curriculum outline and selected training methodologies to be delivered for the new hires or developed into an entire training programme.
- **Completed training programme curriculum (optional):** a detailed curriculum and training methodology to be delivered by a partner TVET.
- **Completed training pilot (optional):** have piloted the TVET training programme and have a first round of graduates.
- **Completed training program evaluation (optional):** A one page summary of the pilot programme results as well as recommended adjustments for future courses.

Given the milestones above, the GANTT chart below summarises the timeline for each milestone.

Table 3-1: Milestones and timeline for maintenance programme

MILESTONE	M27	M30	M33	M36	M39	M42	M45	M48
Phase 1								
Inventory of appliances								
Maintenance strategy								
Skillset inventory								
Phase 2								
List of interested partners								
Phase 3								
Job description								
Training programme outline								
Training programme curriculum (optional)								
Training pilot programme completed (optional)								
Training programme evaluation (optional)								

3.1.4. Next steps and further development

The next steps in the process are to proceed with Phase 1 to obtain a clearer picture of the scope of capacity building required to satisfy this need. Once further information is available, it will be possible to assess the scale of Phase 3 and develop a capacity building roadmap for the region to be shared in Deliverable 3.3 at the end of the project.

3.2. University curriculum development programme

The purpose of this programme is to build general human capital in the region and develop a talent pool that will increase capacity for the demonstrator and other employers in the region. Given the expansion and growth of the demonstrator, the need for better qualified employee candidates was specified as important. Especially in the domains of engineering as well as marketing and sales. The demonstrator felt that core competencies relevant to working in rural areas of the country would be of benefit to be included in university curriculums.

3.2.1. Programme goals and objectives

The programme goals and objectives are as follows:

- Collaborate with Universities to add relevant engineering content to their curriculum.
- Collaborate with Universities to add relevant marketing and sales content to their curriculum.

3.2.2. Programme implementation strategy

This programme will be implemented over two phases. Phase 1 entails identifying and creating relationships with suitable Universities and surrounding stakeholders. Phase 2 entails working with those stakeholders to add and implement relevant content in their curriculums. Details regarding each phase are discussed below.

Phase 1: identify and create relationships with universities and stakeholders

In this phase, potential Universities and stakeholders will be identified in the region and even nationally. These stakeholders could include the ministry of education and other governmental departments. In this phase the aim is to leverage existing relationships between members in the consortium such as demonstrator partners, the Centres of Excellence, and members of the Energy Transition Boards. Details regarding activities included in this phase are discussed below.

1. ***Use our network to identify potential partners:*** begin by engaging the network within the consortium including demonstrators, Centres of Excellence, and other universities to determine whether they know any potential partners in the region. Make a list of the potential partners and classify them as having an existing connection, or whether a connection will need to be made.

2. ***Engage partners in a discussion to collaborate informally:*** reach out to the identified parties and initiate an informal discussion to determine ways in which a collaboration can occur.

3. ***Connect with the implementers within those organizations:*** within each organization, aim to connect with the people who are at the level of implementation of their programmes. Such as professors and department heads.

Once key stakeholder relationships have been established it is possible to move towards Phase 2.

Phase 2: collaborate to add relevant content to curriculums

In this phase, collaboration will begin with the universities and stakeholders to find ways to add relevant content to their existing curriculums and courses. Adding content could take the form of developing modules, developing training and evaluation criteria, or developing an entire course outline. For simplicity, the most desired option is to add modules or adjust existing courses and curricula. Below is a summary of the activities to be carried out in this Phase. This will be carried out for an engineering course and/or a marketing and sales course.

1. ***Identify the training content and evaluation criteria:*** work with the demonstrator to gain an understanding of the skills they are looking for in a graduate. Determine a method to evaluate the skills (written test, practical test, etc.). Once the evaluation criteria and skills have been set it will be easier to understand how to implement training.

2. ***Determine how to implement the content most easily:*** work with the implementation partner to understand their capacity and existing methods. Find a way to develop a training module or programme that can be implemented using their methods that will satisfy the skills and evaluation criteria set out by the demonstrator.

3. ***Pilot the implementation of the content:*** perform a pilot test of the simplest form implementation identified in step 2 above. The objective is to start with the smallest, simplest, and most likely to succeed version of the programme.

4. ***Evaluate and adapt the program as necessary:*** evaluate the success rate by determining the number of graduates who succeeded the evaluation criteria. Allow one or two of the best graduates to do an internship or work with the demonstrator to evaluate their competency. Provide feedback to the implementor based on the competencies of the graduate.

3.2.3. Timeline and milestones

Now that the Phases and programme implementation steps have been defined, it is time to identify milestones and discuss a timeline for implementation. Below are the milestones for each phase.

Phase 1 milestones

- **Entered a collaboration with one university:** are working with someone within a university to implement the programme with.

Phase 2 milestones

- **Completed training content and evaluation criteria:** a one-page document that details the desired skills of a graduate and a method to evaluate each skill.
- **Completed strategy to implement the training(s):** a short document that breaks the desired skills into modules and lessons that can be implemented using the implementing partner's existing infrastructure.
- **Successful integration of one student from pilot:** a student from the pilot programme is either starting an internship or is working with the demonstrator so their competencies can be evaluated.

Given the milestones above, the GANTT chart below summarises the timeline for each milestone.

Table 3-2: Milestones and timeline for university programmes

MILESTONE	M27	M30	M33	M36	M39	M42	M45	M48
Phase 1								
Collaborating with one university								
Phase 2								
Training and content evaluation criteria								
Strategy to implement training								
Integration of one student from pilot								

3.2.4. Next steps and further development

The next steps in the process are to proceed with Phase 1 and the training and content evaluation criteria of Phase 2. It is imperative that a partner university be found as soon as possible. Once a partner university has been found and the training content and evaluation criteria have been set in collaboration with the demonstrator, it will be possible to begin working to implement and integrate the training into the curriculum.

4. SUMMARY

This report, one of three reports that make up deliverable 3.1 of the ENERGICA project, assessed the capacity building needs for the demonstrator in Madagascar. The report used the TEES framework, a framework developed as part of the ENERGICA project and intended for comprehensive application in future contexts, to develop and propose capacity building programmes to assist in the development of the demonstrator project and ensure its long-term success in its associated context.

The results of the study outlined a need for capacity building efforts related to:

- Hiring and training appliance repair technicians who can support the implementation of the numerous productive nano-grids and containerized solutions for ice-making, water pumping, rice-hulling, power-tool rental, etc.
- Working with Universities in the region to include more hands-on solar and battery maintenance in the engineering programmes, and more rural zone business and sales training in the business programmes.

Given the needs outlined above, the following capacity building programmes were proposed:

- A refrigeration and appliance maintenance capacity building programme.
- A university curriculum development programme for solar repair and rural sales.

The results presented in this report, make up the work outlined in ***Sub-task 3.1.2: Creation of capacity building and adapted training programmes tailored to each product***. The recommendations and next steps presented in this report will be taken up and implemented in the following tasks:

- Task 3.2: Implementation of the capacity building programmes.
- Subtask 3.3.1: Definition of local value chains and innovative circular economy models
- Task 4.2: Development and testing of adapted agri-specific solutions
- Task 4.3: Sizing and testing of adapted water-specific solutions
- Task 4.4: Development and testing of adapted cooling-specific solutions
- Task 4.5: Demonstration in Madagascar
- Subtask 7.1.1: Development of a socio-technical model
- Task 8.2: Social acceptance analysis

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ENERGICA

PART B

Capacity building programme – Sierra Leone Context

1. SIERRA LEONE CONTEXT BACKGROUND

The following background information was provided for the internal Deliverable 3.1 report. Given that this report is to be made available publicly, the background information is being included again here, as it provides necessary context for the reader. Note that some alterations have been made to remove any proprietary information.

1.1. Demonstrator context – Sierra Leone

In this section we will provide the context for the Sierra Leone demonstrator across the TEES factors at the local, regional, and national levels. With this background context, it will then be possible to discuss the needs assessment. The needs will be assessed in the methodology section.

1.1.1. Technological context

To begin outlining the context we must begin by looking at the technology of the demonstrator and what they offer. The demonstrator context looks at waste treatment and transformation, including collection of waste (Freetown Waste Transformers) and valorisation of certain elements (organic components) of that waste into production of electricity, heat, and fertilizer using a biodigester (The Waste Transformers). To provide background context, we will discuss a little about biodigesters and then discuss the technology being tested at the demonstration site.

Background information regarding biodigesters

A biodigester is a system that uses microorganisms to break down organic materials and produce biogas and nutrient-rich fertilizer. Biogas is a mixture of gases, primarily composed of methane (CH4) and carbon dioxide (CO2), that is produced during the anaerobic digestion process. The composition of biogas can vary depending on the feedstock used and the specific conditions of the biodigester.

Biogas has several applications, including:

- **Energy production:** Biogas can be burned to generate heat and electricity. In fact, biogas is considered a renewable energy source because it is produced from organic materials that would otherwise go to waste. Biogas can be used to power homes, businesses, and even vehicles.
- **Fertilizer:** The nutrient-rich slurry left over from the anaerobic digestion process can be used as fertilizer, providing a source of nutrients for crops, and reducing the need for synthetic fertilizers.
- **Waste management:** Biodigesters can be used to treat organic waste, such as agricultural waste, food waste, and sewage sludge. This can help to reduce the amount of waste going to landfills and can also reduce greenhouse gas emissions by capturing and utilizing biogas.

There are many ways to classify biodigesters including feedstock and temperature. The two main categories of biodigester with relation to feed include, wet biodigesters, and dry biodigesters. [27]. Furthermore, the operating temperature of the biodigester can be used to describe the type. The two temperature types of digestion are mesophilic (35 ^{o}C) and thermophilic (50 ^{o}C) [28]

Lastly, there exist several types of reactors that can be one or two stage systems that can be continuous or batch reactors. [29]. For this project, we will be concerned with continuous wet systems. Common types of reactors/configurations for continuous systems include: [30] [31]

- Continuous stirred-tank reactor (CSTR) biodigester: This type of biodigester is a closed system with a stirring mechanism that continuously mixes the organic material and microorganisms to maintain a consistent environment for anaerobic digestion.
- Plug-flow biodigester: In this type of biodigester, organic material and microorganisms flow through a long, narrow tank in a continuous process. The organic material is added at one end of the tank and exits at the other end, after which the remaining digested material can be used as fertilizer.
- Fixed-dome biodigester: This type of biodigester consists of a sealed, underground chamber with a dome-shaped roof made of concrete or brick. The organic material is fed into the chamber through an inlet, and biogas is collected at the top of the dome.
- Floating-drum biodigester: This type of biodigester is like the fixed-dome biodigester but has a flexible dome-shaped roof that rises and falls with the production of biogas. The organic material is fed into the chamber through an inlet, and biogas is collected in the space above the roof.
- Horizontal biodigester: This type of biodigester is designed to handle large volumes of organic waste and is typically used in industrial applications. The organic material is loaded into the biodigester and mixed with microorganisms to start the anaerobic digestion process.

Overall, biodigesters and biogas have many potential benefits, including energy generation, waste management, and improved agricultural practices. However, the effectiveness of biodigesters depends on several factors, including the type of biodigester, the feedstock used, and the management practices employed. Proper design and operation of biodigesters are crucial for maximizing their potential benefits.

The differentiating factor between TWT's systems vs. commercial and/or small holder agricultural, is the scale and environment in which they work (i.e., small-scale, and urban), whilst simultaneously complying with a range of EU health and safety rules for application in urban and peri-urban environments. Which we will discuss next.

Overview of The Waste Transformers' (TWT) biodigester system

Below are excerpts from an article on TWT's website for an interview about being featured in the Swedish book Symbios [32].

> TWT, A young company from Amsterdam has developed a small-scale biogas plant for local food waste streams. The solution is decentralized and is aimed at emerging economies where there is no waste management infrastructure, and at actors in developed countries who want to create a local food waste circular economy.
>
> Their technology consists of a modular biodigester design that fits in the dimensions of two 20 ft shipping containers, enabling to process a minimum 350kg/day. The design is modular and can process up to 3,000kg/day, by adding containers to scale up the system. Two main value streams are created from the food waste, one is biogas that can be used for locally produced electricity and heat/air conditioning. The second is the digestate which can be used as a natural fertilizer to replace fossil fuel-based (synthetic) fertilizers.
>
> TWT has projects in several African countries and in the Middle East. In Amsterdam, there will be a Waste Transformer adjacent to a large sports arena and IKEA is testing a Waste Transformer adjacent to a department store in the Dutch city of Haarlem.

The biodigester is sold with a service agreement. In Africa, a model for “Rent to ownership”, called Business in a Box has been developed. An entrepreneur initially rents a Waste Transformer and operates it and works towards ownership. The income it generates makes it possible for the contractor to buy the facility within a few years. **[32]**

Their system takes organic food waste as feed to produce biogas, electricity, heat, and agricultural organic fertilizer. In Freetown, they have partnered with Freetown Waste Transformers (FWT) to install a biodigester next to a women's hospital in the countries’ capital of Freetown to power part of the hospital's energy needs and are exploring how to provide them with hot water from the heat generated by the system.

Figure 1-1: Photos of TWTs biodigester system

Photo of one of the TWT biodigester systems being installed in Freetown Sierra Leone

Photo of the electricity generation compartment of the biodigester system being installed in Freetown Sierra Leone

Photo of one of their installations, from another perspective showing the shipping container doors

Photo of the digestate compart of the biodigester system being installed in Freetown Sierra Leone

Background information regarding FWT's waste collection app

The local partner in Freetown (FWT), is working with TWT not only as the pilot site for the biodigester technology, but as a partner to collect waste for the biodigester and sell the agricultural fertilizer that is produced. As a result, FWT has been working to streamline the waste management sector through a digital approach by developing a digital waste collection tool called 'DortiBox', a mobile application that cordinates waste collection activites across residents, waste collectors, and recyclers in Freetown. The product was launched in May 2023 and is fully operational across the municipality in partnership with the Freetown City Council (FCC) and Waste Collection Management Association (WCMA) who have been charged with the responsibility of public space cleaning. The DortiBox mobile application is developed for both waste generators (households, factories, etc.) and Waste collectors, allowing households/ customers to [33]:

- Schedule waste pickups
- Request for urgent waste collection service
- Track waste service provider location
- Track recycling of disposed waste
- Track their contribution to climate change mitigation.

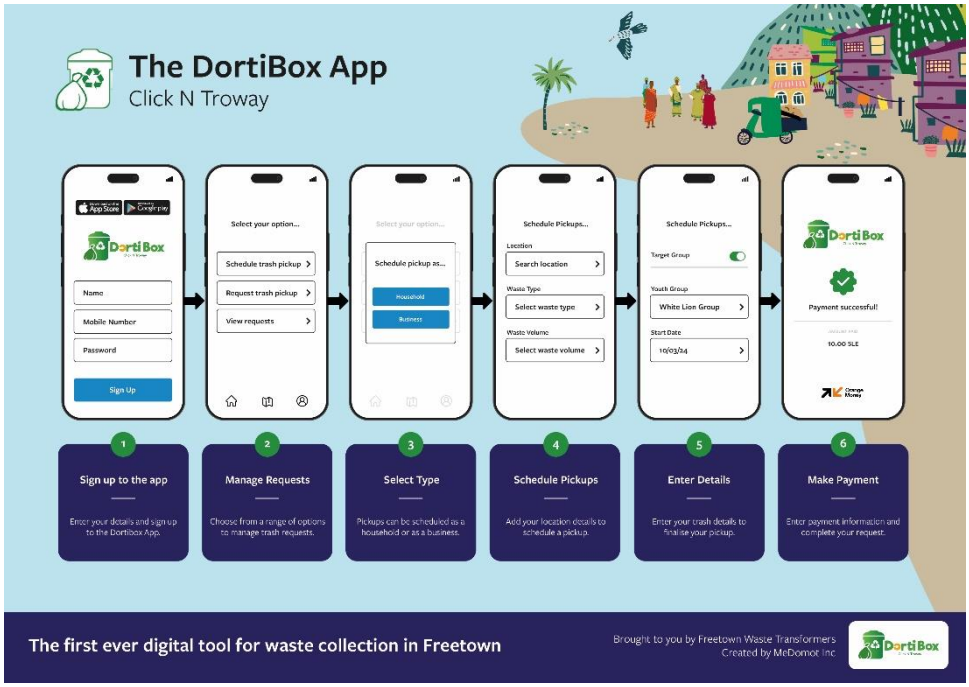
With the Waste Collectors being able to;Locate trash ready for pickup

- Locate waste transfer stations
- Efficiently plan their travel routes
- Effective manage their customer base
- Track the profitability of their business.

Freetown Waste Transformers in partnership with the Mayor's office is stongly committed to shaping behaviours of Freetown residents to sort their waste at the source for recycling before disposing.

The mobile application will allow FWT to gather, analyse, and predict valuable waste collection data for its waste treatment partners, streamline, and automate waste collection processes for its waste collection partners as well as for its own internal use as the company scales its operations [33]. Below is an image of the product.

Figure 1-2: Preview of the FWT's DortiBox app under development [33]



Summary of the technological context background information

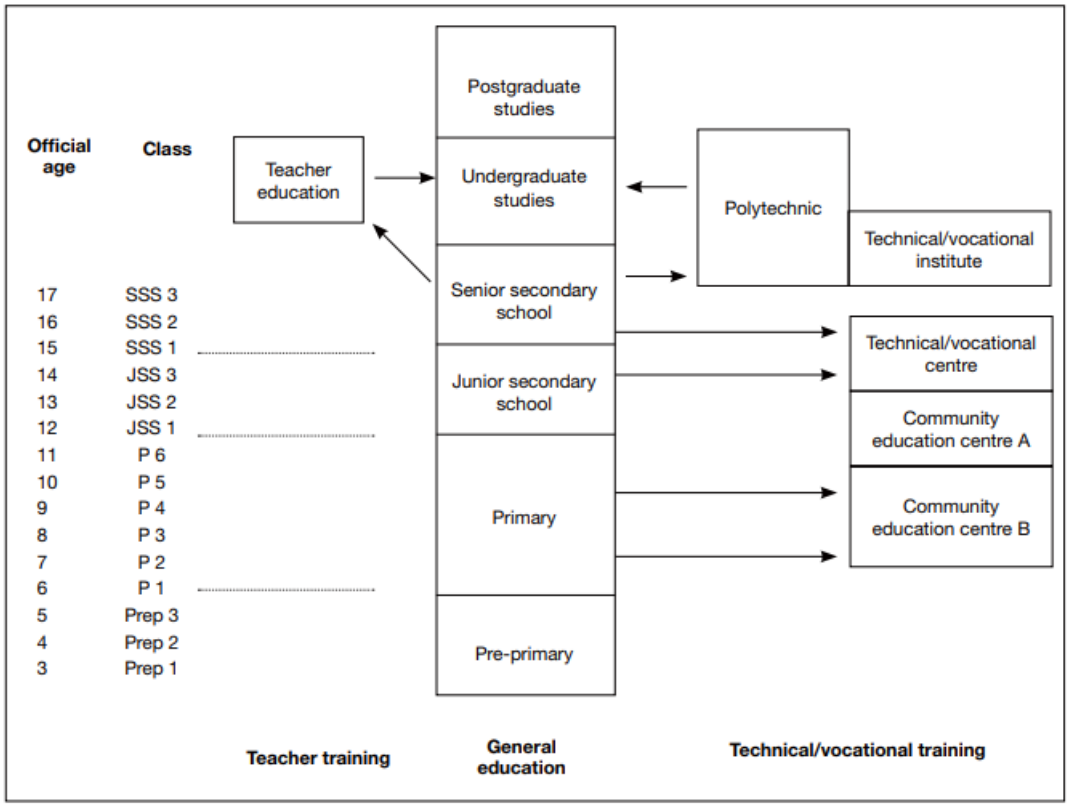
In this section, we provided a brief introduction and background of the technological offering of the demonstration project in Sierra Leone. The objective here was to set the context of the technical solution pertaining to this report. Further detailed discussions surrounding availability of parts, capacity to maintain and repair, provide training on the adoption of a digital approach for waste management, as well as the local, regional, and national supply chain will be presented in the results section.

1.1.2. Educational context

Overview of the educational system in a national context

The education system in Sierra Leone consists of six years of primary education, followed by three years of junior secondary education and three years of senior secondary education. The language of instruction is primarily English, with some schools using local languages for certain subjects. The government provides free education for primary and junior secondary levels, but senior secondary education is not free and often requires students to pay fees. [34] Below is an image displaying the structure of the education system.

Figure 1-3: Structure of education system taken from UNESCO report [34]

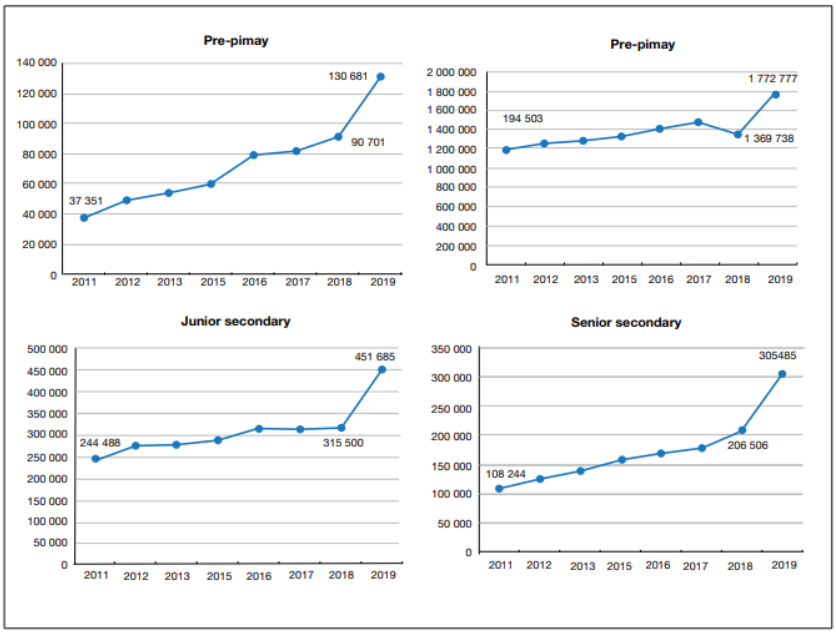


The quality of education in Sierra Leone was hampered in the past by various challenges, including inadequate funding, poorly trained teachers, insufficient teaching materials, and low enrolment rates. According to UNESCO, the adult literacy rate in Sierra Leone was estimated to be 43.3% in 2021, with a net enrolment rate of 60.6% for primary education and 28.2% for secondary education. [35]

In recent years, the government of Sierra Leone has made efforts to improve the education system, such as increasing the budget for education, providing training for teachers, and improving access to education for girls. [34] Overall enrolment has been increasing drastically in the last few years. The image below illustrates this trend.

In 2017, a Sierra Leonean child could expect to receive an average of 9.1 years of schooling, against 8.1 in 2011, with no significant difference between boys and girls. This is longer than the 8.2 average estimated from the ECOWAS countries. [34]

Figure 1-4: Total enrolment trends as reported in the UNESCO report [34]

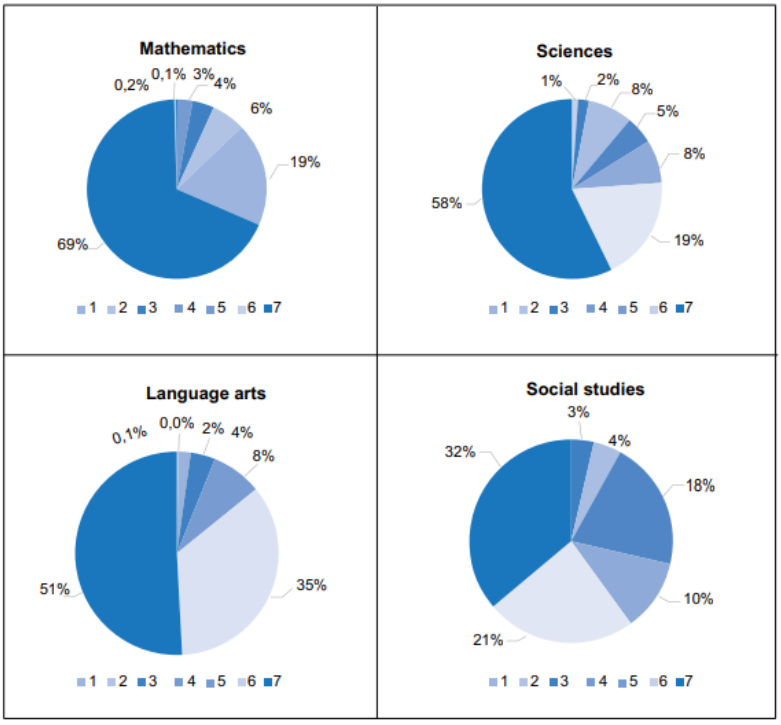


Source: Authors' computation– annual school census reports (2011-2013), annual school census data (2016-2019), * ESA, 2013, **2020 National Technical and Higher Education Census (NTHE)

The Basic Education Certificate Examination (BECE) is administrated at the end of the junior cycle and signals the completion of basic education. In 2019, only one in two students who sat to complete the BECE met the minimum requirements to enter general senior secondary school. [34]

For each subject, scores are given on a reversed seven-point standard scale and range from one to seven, with one being the best score and seven being a failure. The percentage failing is prominent in mathematics (69%), integrated science (58%) and language arts (51%). [34] These statistics are summarized in the image below.

Figure 1-5: BECE scores as per UNESCO report (1 is highest, 7 is a fail) [34]



The Sierra Leonean Higher Education (HE) system used to outperform other countries in West Africa, but standards dropped because of the civil war and the Ebola pandemic. At present, HE in Sierra Leone is hampered by inferior quality, weakened learning environments, inadequate materials, as well as accessibility and affordability issues. [34]

Higher Education in Sierra Leone is currently offered at five universities operating under the Bachelor-Master-Doctorate (BMD) system. The five universities are [34]:

- The University of Sierra Leone (USL) located in Freetown (public).
- The Njala University located in Njala and Bo (public)
- The Ernest Bai Koroma (EBK) University of Science and Technology with campuses in Magburaka, Makeni, and Port Loko (public)
- The University of Makeni (UNIMAK) with campuses in Makeni and Yoni (private)
- Limkokwing University located in Freetown (private)

Given the large investment in education discussed earlier, as well as the growing number of enrolments in secondary education as shown above, Sierra Leone is planning to increase its capacity with 3 new Universities across the country coming in the next few years. [34] They are:

- University of the East
- University of Science and Technology
- Centre of Excellence

Furthermore, there are a few private institutions currently working on having their status regularized and approved by the Tertiary Education Commission. [34] The location of public and private universities across Sierra Leone are shown in the figure below.

Figure 1-6: location of public and private universities across Sierra Leone.

Overview of the educational context in the capital region

In the context of this project, the demonstrator is operating specifically in the capital region of Freetown known as the Western Area. Therefore, there is an abundant supply of Higher Education (HE) university campuses, but also a considerable number of Technical Vocational Education and Training (TVET) institutions available as potential partners and places to recruit staff and operators. Below is a list of relevant TVET institutions in the Freetown area taken from a report by the National Council for Technical Vocational and Other Academic Awards (NCTVA). [36]

Figure 1-7: List of relevant TVET institutes [36]

LOCATION	NAME OF INSTITUTE
Congo Cross, Brookfields, Goderich	Milton Margai College of Education and Technology
Circular Road	College of Health and Environmental Sciences
32 Campbell Street	SAMKAM Institute of Technology
PWD Junction, Kissy	Kankalay Computer Institute
8 c Congress Road	East Freetown International College
Goderich Street	Sulisha Institution of Management and Computer Studies
92A Kissy Road	Nabserrah College of Management, Science and Technology
Allen Town	Luban College of Social Sciences and Technology
7 Station Road, Newton	Adkan Institute of Management and Technology
2 Pike Street	Crown Technical University College
147 and 152 Circular Road	Banktec Institute of Management and Information Technology
35 Circular Road	REAPS Vocational Tech Education and Vocational Training Centre
Earl Street	Washington College of Management and Technology
Goderich	SOS International College & Technical Vocational Institute
Goderich St.	FLS Academy – College of Energy, IT and Telecommunication
Kossoh Town	Freetown Polytechnic*

*Note: this is a government agency not part of NCTVA but included here for completion.

Summary of the educational context background information

In this section, we provided a brief introduction and background of the educational context surrounding the demonstration project in Sierra Leone. The objective here was to set the context of the technical solution pertaining to this report. The key takeaways are:

- Past political instability and the Ebola crisis caused major disruption to the education system.
- BECE results show weak math and science scores.
- The government has made extraordinary investments in education with three new universities coming, meaning it could be open to input in curriculum design.
- TVET institutes are a potential avenue to explore to implement vocational training.

Further detailed discussions and results surrounding technical competencies in the region, the capacity to train, and existing Higher Education information will be presented in the results section.

1.1.3. Economic context

The economic context is another important context in the TEES framework, as it has a significant effect on business development and growth, as well as on the ability to build capacity because the economic makeup of a context drives the everyday life of the individual. It further affects capacity building as economic activity is what most typically defines the supply chain, and transportation logistics.

Overview of the economy in a national context

Sierra Leone, located in West Africa, has a population of over 7 million people. The country's economy is characterized by a heavy reliance on natural resources, particularly mining and agriculture. However, the country faces several challenges, including limited economic diversification, poor infrastructure, and a high unemployment rate. This report provides an overview of Sierra Leone's economy, including key economic indicators, major economic activities, and major forms of employment.

Key Economic Indicators

Sierra Leone's GDP was estimated at $4.04 billion in 2021, with a real growth rate of -4.1%. [37] The country's inflation rate was estimated at 11.87% in 2021, while the unemployment rate was estimated at 5.3% in 2019. Sierra Leone's current account balance was estimated at a deficit of $275.6 million in 2020, with a trade balance deficit of about $700 million. [38]

Major Economic Activities

Sierra Leone's economy is dominated by the mining and agriculture sectors. The agriculture sector contributes over 60% of the country's GDP and employs 61.1% of the labor force [38]. The sector is subsistence-based and characterized by low productivity, limited access to markets, and poor infrastructure. Sierra Leone's main agricultural products include rice, cassava, palm oil, cocoa, and coffee.

The mining sector, which is dominated by large-scale mining companies, contributes to a smaller portion of the country's GDP but is an important source of revenue and foreign exchange. The sector produces diamonds, gold, bauxite, and rutile [38].

The formal sector, which includes manufacturing, services, and government jobs, provides employment opportunities for a smaller portion of the population. However, the sector is constrained by limited investment, poor infrastructure, and a challenging business environment [38].

Challenges and Opportunities

Sierra Leone faces several challenges to its economic development, including limited economic diversification, poor infrastructure, and a high unemployment rate. Addressing these challenges will require diversifying the economy, improving infrastructure, and creating a more business-friendly environment to attract more investment and create more job opportunities.

Sierra Leone has made some progress in recent years in improving its business environment and attracting foreign investment. For example, the country implemented several reforms to improve its business environment, such as reducing the time and cost of starting a business [39]. Additionally, the government has been working to improve infrastructure, particularly in the transport and energy sectors [40].

Overview of the supply chain:

Sierra Leone's supply chain is primarily focused on the export of raw materials such as diamonds, gold, and iron ore. The country has experienced significant growth in the mining sector in recent years, which has boosted economic growth. [38]. In addition to mining, agriculture is another key sector in Sierra Leone, with most of the population (54%) engaged in agriculture [37]. However, the country still faces significant challenges in terms of infrastructure and logistics, which can hinder the efficiency and effectiveness of its supply chain [41].

Despite these challenges, there have been efforts by the government and international organizations to improve the country's supply chain through investments in infrastructure and regulatory reforms, with the aim of making Sierra Leone a more attractive destination for foreign investment and improving the livelihoods of its citizens. These are a key focus of the countries' Medium-Term National Development Plan (MTNDP) [42].

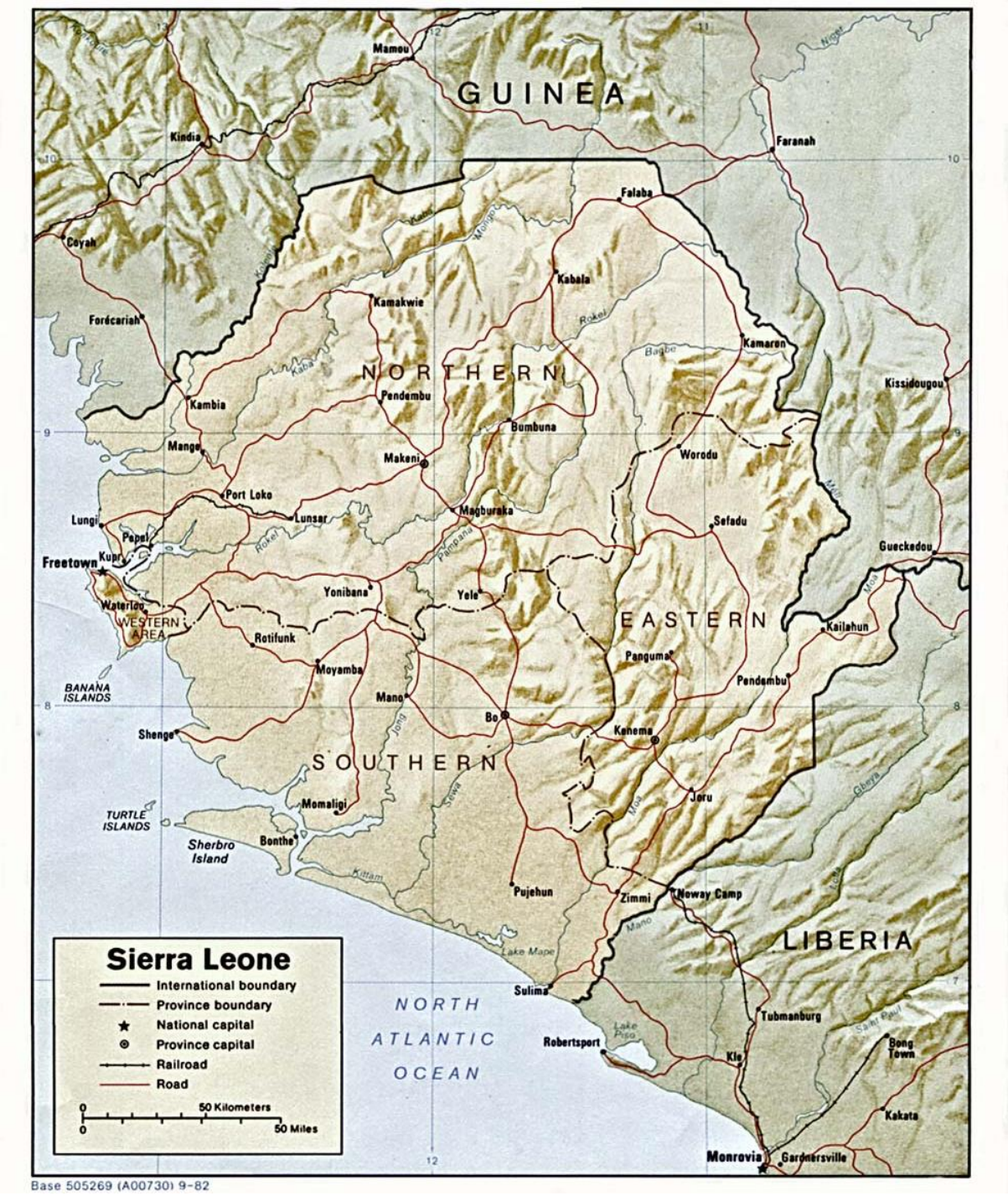
To dive further into the existing infrastructure, we have included a transportation and logistics map provided by the World Port Source that show the major cities, railways, and roads in Sierra Leone. According to the World Port source, there are only three ports in all of Sierra Leone. They are summarized in the ***Table 1-1*** below. The Port of Freetown is the only port in the country that offers container service, and its wharf is small as shown in the photo.

Table 1-1: Summary of the registered ports in Sierra Leone [43]

PORT NAME	LOCATION	PORT AUTHORITY	DESCRIPTION
Port of Freetown	Freetown	Sierra Leone Ports Authority	Container service; Pier, Jetty, or Wharf; Small
Port of Pepel	Pepel	Marampa Iron Ore Mining Co	Pier, Jetty or Wharf; Very Small
Port of Sherbro Island	Sherbro Island	Sierra Leone Ports Authority	River Port; Very Small

Figure 1-8: Photo of the Port of Freetown [44]

Figure 1-9: Transportation and logistics map of Sierra Leone. [45]



Summary of the economic context background information

Although the economy of Sierra Leone was affected by previous crises, growth is positive, and the government is making significant investment in improving infrastructure. With regards to supply chain, the fact that Freetown has a part nearby is a surplus, but the size restriction of ships make shipping there a challenge and will result in lead times that are too long for a "just-in-time" type of supply chain management. This will need to be heavily considered in ensuring an adequate supply of parts.

1.1.4. Social context

Sierra Leone is bordered on the north and east by Guinea, on the south by Liberia, and on the west by the Atlantic Ocean.

Brief history of Sierra Leone

Below is an excerpt from the Central Intelligence Agency World factbook describing the political history of Sierra Leone [38].

> Continuously populated for at least 2,500 years, the dense jungle around Sierra Leone allowed the region to remain protected from invaders from empires in West Africa. Traders introduced Sierra Leone to Islam, which occupies a significant role in Sierra Leonean culture and history. In the 17th century, the British set up a trading post near present-day Freetown. The trade originally involved timber and ivory but later expanded to enslaved people. In 1787, following the American Revolution, Sierra Leone became a destination for Black British loyalists from the new United States. After the abolition of the slave trade in 1807, British ships delivered thousands of liberated Africans to Sierra Leone. During the 19th century, the colony gradually expanded inland.
>
> In 1961, Sierra Leone became independent of the UK. While Sierra Leone held free and fair elections in 1962 and 1967, Siaka STEVENS - Sierra Leone's second prime minister - quickly reverted to authoritarian tendencies, outlawing most political parties, and ruling from 1967 to 1985. In 1991, Sierra Leonean soldiers launched a civil war against STEVENS' ruling party. The war caused tens of thousands of deaths and displaced more than 2 million people (about one third of the population). In 1998, a Nigerian-led West African coalition military force intervened, installing Tejan KABBAH - who was originally elected in 1996 - as prime minister. In 2002, KABBAH officially announced the end of the war. Since 1998, Sierra Leone has conducted uninterrupted democratic elections, dominated by the two main political parties, the Sierra Leone Peoples Party (SLPP), and All People's Congress (APC). In 2018, Julius Maada Bio of the Sierra Leone People's Party won the presidential election that saw a high voter turnout despite some allegations of voter intimidation. The next presidential election is scheduled for June 2023.

People

In the following paragraphs we will discuss the people of Sierra Leone, including the various ethnic groups, the languages, religion, and settlements patterns. All this information is taken from the website Britannica (organisation that writes the Encyclopaedia Britannica)

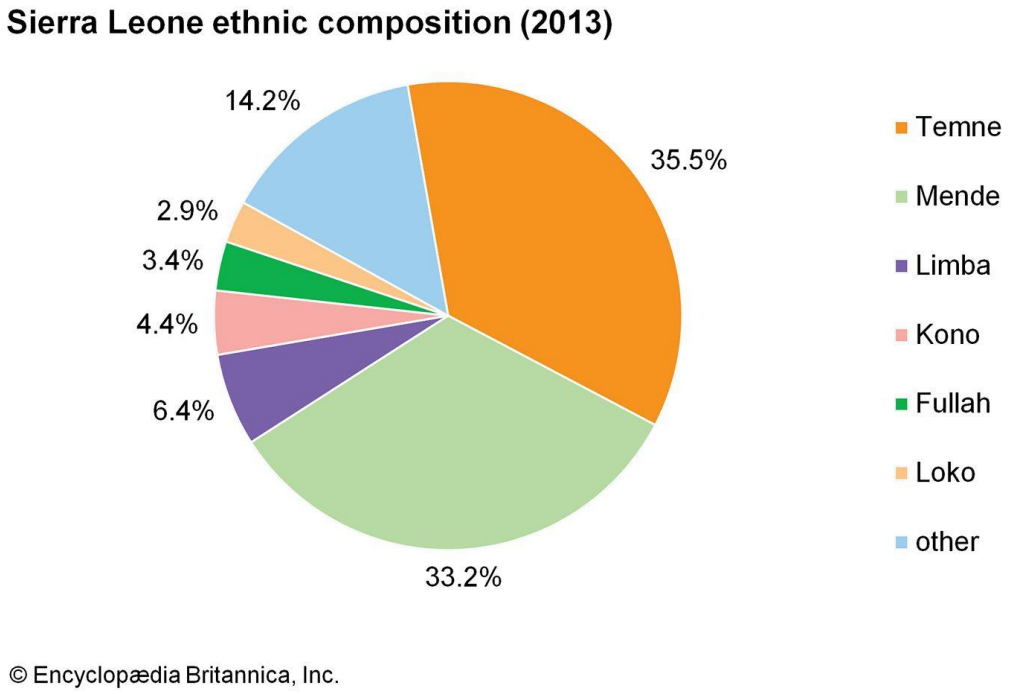
Ethnic groups

There are about 18 ethnic groups that exhibit similar cultural features, such as secret societies, chieftaincy, patrilineal descent, and farming methods. They are categorized as [46]:

- The Mende, found in the east and south, and the Temne, found in the centre and northwest, form the two largest groups.
- Other major groups include the Limba, Kuranko, Susu, Yalunka, and Loko in the north; the Kono and Kisi in the east; and the Sherbro in the southwest.
- Minor groups include the coastal Bullom, Vai, and Krim and the Fulani and Malinke, who are immigrants from Guinea concentrated in the north and east.

- The Creoles—descendants of liberated blacks who colonized the coast from the late 18th to the mid-19th century—are found in and around Freetown.
- Throughout the 19th century, blacks from the United States and West Indies also settled in Sierra Leone.
- Ethnic complexity is further enhanced by the presence of Lebanese and Indian traders in urban centres.

Figure 1-10: Breakdown of ethnicities as reported in the Encyclopaedia Britannica [46]



Languages

Krio, a language derived from English and a variety of African languages, is the mother tongue of the Creoles and the country's lingua franca. Among the Niger-Congo languages, the Mande group is the largest and includes Mende, Kuranko, Kono, Yalunka, Susu, and Vai. The Mel group consists of Temne, Krim, Kisi, Bullom, Sherbro, and Limba. English, the official language, is used in administration, education, and commerce [46].

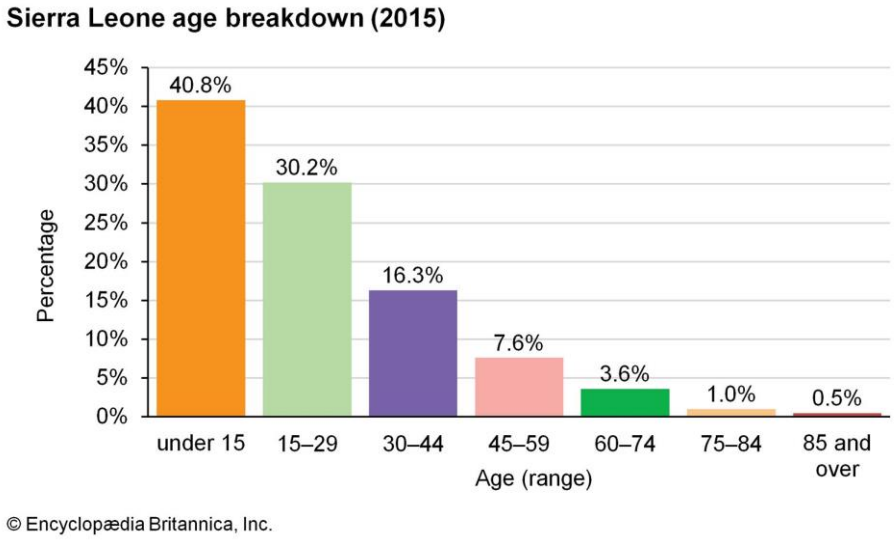
Settlement patterns

As of 2018, approximately 58% of the population lived in rural zones, with 42% living in urban areas [46]. Apart from Freetown, the development of large towns occurred only after World War II. Bo, in the southeast, was an early administrative and educational centre. Other important towns include Kenema, east of Bo, which has grown because of diamond mining, and Makeni, a major commercial centre, in the north. Mining of diamonds has also been important to Koidu, Sefadu, Yengema, and Jaiama in the east. Port Loko, Kabala, Bonthe, Moyamba, Kailahun, Kambia, Pujehun, and Magburaka are administrative centres with retail trading and produce marketing. Many towns were damaged or destroyed in the civil war [46].

Demographics

Sierra Leone is youthful country, 80% of the population is aged 35 and below [34]. It is evenly split in terms of gender (male/female). About two-thirds of the population are Muslims, while about one-fourth are Christians. Less than one-tenth of the population practice a variety of traditional religions. However, this number does not include the many Sierra Leoneans who practice traditional religions in tandem with their professed Muslim or Christian faiths [46].

Figure 1-11: Age demographics as reported by the Encyclopaedia Britannica [46]

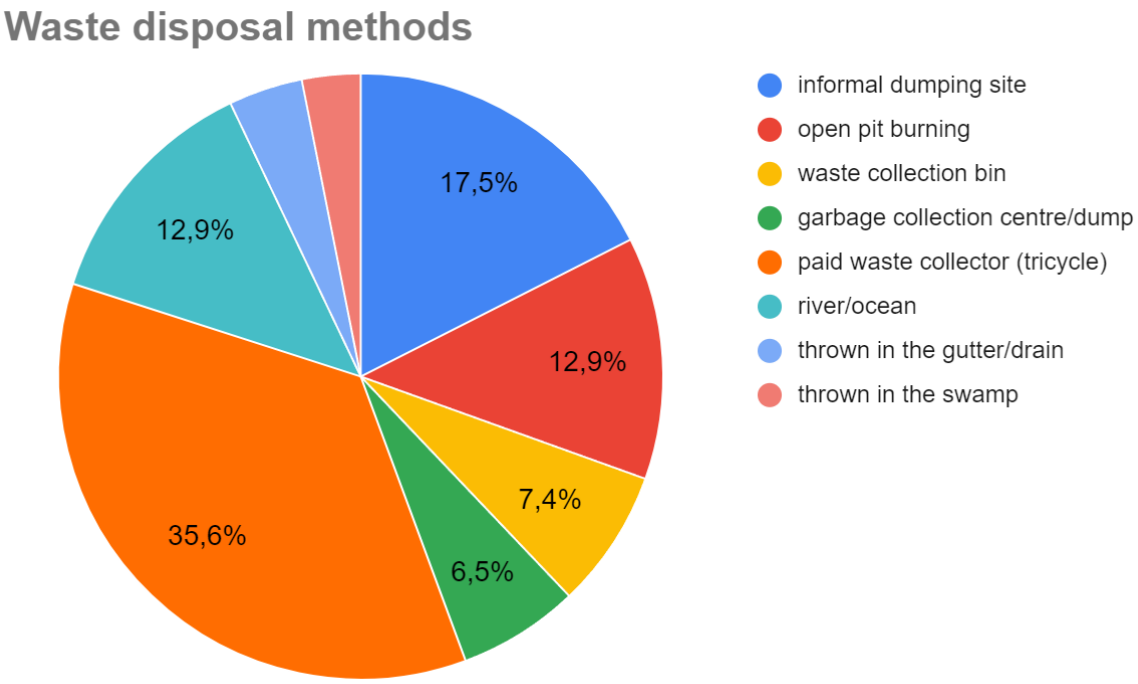


Information relevant to access to energy and waste disposal

As part of this project, an extensive survey was done in the regions of each of the demonstrators for Work Package 2 (WP2) to get an idea of access to energy and background energy use information. In this section we will present some background contextual information. We will present more detailed results in ***Section*** *Error! Reference source not found.*. Below is an overview of the findings from those surveys [47]:

- 64.7% of the respondents do not have access to energy in the Household (HH).
- The main energy service provider was Solar home systems (21.71%), EDSA and diesel generators were also common.
- 31.1% indicated the reliability of the energy they use, with the majority indicating access to energy for an average of 5-8 hrs per day.
- 43% use outside electricity (Not available in the house) for communication on phone, radio, TV, and other communication devices.
- 44.7% of the population expressed dissatisfaction with the energy sources they are using.
- The mean monthly total HH expenditure on energy was $17.70.
- About 50% of respondents reported disposing of their waste informally (informal dumpsite, open pit burning, throwing in river/ocean, throwing in gutter, throwing in the swamp) see **Figure 1-12.**

Figure 1-12: Reported waste disposal as interpreted from survey question 88. [48]



As can be seen from the results of the study, Sierra Leone is in dire need of a suitable waste collection and treatment strategy that provides value for the community. Moreover, in future studies, it would be relevant to know the destination of the waste that is collected by waste collectors (does it end up in landfill or informal dumping sites?).

Summary of the economic context background information

Sierra Leone is a highly diverse country with over 18 ethnicities rich and culture and a complicated history. It is a young population, with little access to energy. The majority live in rural zones and make a living through agriculture. There is currently low energy reliability, and waste disposal is highly informal. These factors, make the introduction of a distributed energy biogas-based system likely to be successful if implemented correctly according to the context.

Now that we have laid a sufficient background of the context, we cannot discuss the methodology around how the demonstrator was assessed across the TEES framework and determine the needs to be met to ensure the long-term success of the project.

2. RESULTS

2.1. Needs Assessment

A thorough needs assessment was performed, the details of which were shared with the demonstrator partner internally for Deliverable 3.1. That report contains proprietary information and as such will not be made publicly available.

2.2. Field Trip

A field trip was also performed, the details of which were also shared internally via Deliverable 3.1 and contained proprietary information.

2.3. Triage

Following the needs assessment completed for Deliverable 3.1 the triage exercise was performed to determine which needs could be actioned as part of the capacity building programme. Given that this is a report that is to be publicly released, a high-level version of the triage results will be shared below which omits some details specific to the demonstrator.

Table 2-1: Triage result for Sierra Leone context (action plan items in bold)

FACTOR	NEED IDENTIFIED	RECOMMENDATIONS	POTENTIAL NEXT STEPS	TRIAGE
T1 - SIMPLICITY AND OPERABILITY	To maintain the constant pace of innovation and evolution of the plant that has been maintained to date	· Continue the path that is being pursued in terms of constantly updating and simplifying the system	none	Already Doing
T2 – CAPACITY TO MAINTAIN AND REPAIR	**To ensure spare parts and maintenance training are included in delivery and commissioning**	**· For elements that cannot be aligned with the local supply chain, ship spares with the container on delivery. · Create a maintenance training that is delivered during commissioning where the operator learns how to replace high-tech parts using a training system.**	**· Review parts list and ensure critical parts have spares. · Develop a training system design that can be constructed to train the operator.**	**Action Plan**
T3 – AVAILABILITY OF PARTS	To find a local control systems' supplier	· Try to get into contact with the local control's system supplier.	· Contact local suppliers in the region	Do
	To find local suppliers for spare parts	· Begin a relationship with local suppliers	· Contact local suppliers in the region	Do
ED1 – TECHNICAL ABILITIES TO OPERATE	**To collaborate with a TVET to develop a biodigester course**	**· Work with a local TVET to develop a biodigester course to help increase the candidate pool for operators**	**· Contact the local TVET**	**Action Plan**
	To develop an operator training program for local operators	**· Develop an operator training program that is given during commissioning where the operator is trained to replace high-tech parts. · Design a hands-on training system**	**· Identify high-tech parts that will require training. · Design a training system.**	**Action Plan**

ED2 – CAPACITY TO TRAIN	**To work with local TVETs to develop training programs**	**· See ED1**	**· See ED1**	**Action Plan**
ED3 – EDUCATIONAL BACKGROUND	**To encourage more chemical engineering and process engineering degrees in higher education**	**· Work with the local Higher Education systems to have curriculum put in place to teach more chemical and process engineering**	**· Establish a collaboration with someone from the ministry of higher education and a local university**	**Action Plan**
EC1 – AFFORDABILITY LOCALLY	To continue to innovate on the economic model to continue increasing affordability	· Continue with the course that is being followed to make the plant ever and ever more affordable	· Assess the economics given the realistic prices a vetted company can and will pay per month.	Already Doing
	To reduce CAPEX of the system overall to ensure it can be more affordable	· Find ways to reduce CAPEX	· Review equipment list and see where costs can be reduced even further	Already Doing
EC2 – EMPLOYMENT REGIONALLY	none	· none	· none	Do Later
EC3 – MAJOR ECONOMIC ACTIVITY	none	· none	· none	Do Later
S1 – WILLINGNESS OF LOCALS TO SUPPORT	**To raise more awareness regarding waste disposal for the waste collection service**	**· Perform an awareness campaign to create a cultural shift in the treatment of waste**	**· Reach out to potential government partners to assist in campaign. · Involve the local youth groups**	**Action Plan**
S2 – EMPLOYMENT OPPORTUNITIES CREATED	none	· none	· none	Do Later
S3 – ADOPTION SUCCESS OF SIMILAR PRODUCTS	To continuously increase reliability to maximize probability of adoption	· Continue with the pace of innovation and design improvements already underway	· none	Already Doing

2.4. Action plans

The next step in the process was to develop action plans with the demonstrator site. These will form the basis for the capacity building programme to be implemented for each context. For the Sierra Leone context, the most apparent needs were:

- Training for technicians and operators of biodigesters
- To develop an operator training program for local operators
- To encourage more chemical engineering and process engineering programs
- To raise more awareness regarding waste disposal for the waste collection service

Below are details of the desired outcomes, steps, and potential hurdles required to satisfy these needs. Note: the content has been generalized to exclude sharing of any proprietary information.

Table 2-2: Action plan result for Sierra Leone context

NEED IDENTIFIED	DESIRED OUTCOME	STEPS	POTENTIAL HURDLES
To ensure spare parts and maintenance training are included in delivery and commissioning	An operator training program to be given during commissioning by a regional trainer that includes the following: - A Training manual (for commissioning and installation) - O&M plan specific to installation - Training delivered to operator during Installation - Commissioning plan done in conjunction with local operator - Training on the biogas ramping up schedule and methodology delivered during commissioning - Training on feedstock sorting and treatment. delivered during commissioning	1. Go through the BOM to identify spare parts required to be delivered during commissioning 2. Develop a curriculum that covers the following topics: - Electronics - Electro-mechanical installations - Understanding of how to work in control panels - Mechanical assembly of Unistrut - Electrical terminations 3. Pilot it with the local operator during the next installation and commissioning	- Minimal resources to develop the training
To collaborate with a TVET to develop a biodigester course	- A training curriculum for a 3-month biodigester technician course	1. Identify potential TVET partners 2. Develop a training programme in collaboration with them given the inputs of the demonstrator 3. Pilot and evaluate the programme	- Minimal financial resources for the TVET
To develop a regional operator training program to train the people that will train the operators	An intensive train the trainer program who can deliver training to the operators in each region that contains the following: - Orientation manual for any new operator - Exam based on the manual - Refresher course (2 day) - Mechanism to incorporate updates from TWT - An intensive course at the plant in the Netherlands for a regional technician and trainer (training the trainer)	1. Evaluate the feasibility of sending a selected operator to represent the region to the Netherlands to work with the demonstrator team during the fabrication of one of the plants. 2. Select a trusted operator or two to train that can be the regional instructor and maintainer of all installations in the region 3. Invite them to the plant in the Netherlands to spend two or three months during an installation to learn all the details.	- Minimal resources and not capable to find a suitable regional operator to train

To encourage more chemical engineering and process engineering degrees in higher education	- A graduate student working at a local University on testing of feedstocks - Proposed curriculum modules to share with local Universities across West Africa	1. Identify a local University with a Chemical engineering department or environmental engineering department 2. Work with them to pick a graduate student that can collaborate with the demonstrator on their thesis 3. Work with the graduate student to develop lab-scale testing	- Difficulty finding a suitable graduate student in the region
To raise more awareness regarding waste disposal for the waste collection service	- Educational videos for social media - Local language fliers	1. Determine the content for the videos 2. Film the videos and release them on YouTube 3. Develop local language fliers	

3. PROPOSED CAPACITY BUILDING PROGRAMME

Once the action planning exercise was completed, it was possible to begin developing the capacity building programmes. The programmes were based off the desired outcomes provided by the demonstrator. Based on the action plan exercise, the following capacity building programmes have been proposed. Note that the first three programmes presented all satisfy the same need and are thus proposed as options, in which 1, 2, or all three can be implemented.

- An apprenticeship and training of a regional maintainer and instructor (option 1).
- A site operator training programme given during installation and commissioning (option 2).
- A training curriculum programme for TVETs (option 3).
- A university graduate student programme for lab-testing.
- An awareness raising programme on proper waste disposal methods.

Detailed capacity building programme outlines are included in the following sections.

3.1.Apprenticeship and training a regional maintainer programme (option 1)

The purpose of this programme is to develop capacity in the region to have a well-qualified local head maintainer and trainer. The idea is for these one or two head operators will be an asset in the region who will be able to properly troubleshoot problems, perform preventative maintenance on all systems in the region, and most importantly be present during the installation and commissioning of each system to train the operator of that system. This will be valuable to the demonstrator for two reasons:

1. There will be a consistent person that knows the details of every system of the region and their unique needs for each site.
2. This person will be from the region and will therefore understand how to communicate with each site operator and importantly, will know the local suppliers and how to work with them to resolve issues using locally sourced solutions that also meet the high engineering standards.

This programme will work towards satisfying the need for more qualified operators in the region.

3.1.1. Programme goals and objectives

The program goals and objectives are as follows:

- Intensively train one or two regional head operators and maintainers on how to install, commission, and maintain the system.
- Enable the head operator to commission and maintain the other systems in the region and train the other operators.

3.1.2. Programme implementation strategy

The program will be implemented over three phases. Phase 1 entails appropriately selecting a highly trustworthy potential operator or two for the region and bring them on an apprenticeship to the demonstrator's factory in the Netherlands to assist in the construction of one of the systems. Phase 2 involves having the regional operator return to Sierra Leone and assist with the installation and commissioning of one or two systems in the region. Phase 3 entails preparing the regional head operator to assist and train each unit operator during the installation and commissioning phases of new installations in the region.

Phase 1: selection of one or two operator(s) and intensive training

In this phase care must be taken to properly select the one or two operators that will come to the Netherlands to assist with the construction of one of the systems. These one or two operators will be integrated into the construction team and will assist with installation of all aspects of the construction over a period of several months. The objective is for them to gain an in-depth understanding of all the installation procedures and have the hands-on experience with the technology so this can be passed on to others in the region. This phase will consist of the following steps:

1. ***Carefully select one or two trustworthy operators:*** work with the local demonstrator site partner to find one or two potential operators to train with the following characteristics:
    - Strong technical and hands-on experience.
    - Demonstrated reliability and commitment to the local partner and mission.
    - Strong ties to the region and in-depth understanding of the supply chain.

2. ***Bring them on an apprenticeship to the Netherlands to work with the demonstrator:*** invite the selected operator(s) to come to the construction plant in the Netherlands to work intensively with the demonstrator crew so they can learn all the details and be present for the entire construction process.

3. ***Ensure that they gain an understanding of the key skills required:*** at the end of the month ensure the operator has absorbed all the skills by allowing them to do some of the construction on their own and evaluate their work. Furthermore, in collaboration with one of the partners, take them time to teach them some of the science behind biodigesters.

Once a head regional operator has been trained, the next phase is to have them return to Sierra Leone to assist with the installation and commissioning of an installation.

Phase 2: have regional operator assist with installation and commissioning of a plant in Sierra Leone

In this phase, the regional operator will return to Sierra Leone to assist in the commissioning of a plant. The objective here is for the operator to learn the start-up procedures and understand how the system is supposed to operate. In this manner, there will be a well-qualified operator on the ground who can assist with all future installations and commissioning. This phase will consist of the following steps:

1. ***Select a site for the operator to assist with:*** determine the site that the operator will help during the installation and commissioning of the plant in Sierra Leone

2. ***Install the plant at the site:*** install the plant with the close collaboration of the regional operator so they can learn and apply the installation process.

3. ***Commission the plant:*** commission the plant with the close collaboration of the regional operator so they can learn and apply the commissioning process.

Once the regional operator has finished installing a plant in Sierra Leone, they can now begin their training to become the regional trainer who will teach each local plant operator the needed skills.

Phase 3: prepare the regional operator to train future site operators

The final phase of this capacity building programme will be to prepare the regional operator(s) to become trainers of the other site operators who will be able to teach each operator the basic skills they will need to operate and maintain the system on a day-to-day basis. This final phase will consist of the following steps.

1. ***Determine the key skills required and how to evaluate them:*** work with the regional operator to make a list of the desired skills and learnings for a site operator taking into consideration the local competencies. For each skill, identify how the skill will be evaluated at the end of the training.

2. ***Determine how to teach the skills during the commissioning process:*** in collaboration with the regional operator, create a high-level training plan taking into consideration the competencies of the human capital in the region.

3. ***Develop a training curriculum:*** using the high-level training plan as a guide, develop a curriculum in which training modules, teaching methods, and training resources are detailed.

4. ***Pilot the training during the commissioning process:*** during the installation and commissioning of the next site, have the regional operator pilot the training with the new site operator.

5. ***Evaluate and update the training as necessary:*** once the pilot-training is completed, evaluate the trainees' competencies to see how effective the training was. Adjust the training as necessary.

Once this final phase is completed, there should be adequate capacity in the region to strongly support future installations and growth in the region. Furthermore, there will be a template model that can be duplicated in other regions.

3.1.3. Timeline and milestones

Now that the Phases and programme implementation steps have been defined, it is time to identify milestones and discuss a possible timeline for implementation. Below are the milestones for each phase.

Phase 1 milestones

- **Selected one or two operators for the programme:** one or two highly reliable and qualified potential regional operators have been selected.
- **Regional operators have completed apprenticeship at demonstrator factory:** the regional operators have completed an internship of several months with the demonstrator to learn the intricacies of constructing the plants.

Phase 2 milestones

- **Completed installation and commissioning of one plant in Sierra Leone:** the operator(s) have completed their apprenticeship by assisting in the installation and commissioning of a plant in Sierra Leone.

Phase 3 milestones:

- **Completed training content and evaluation criteria:** a one-page document that details the desired skills of a graduate and a method to evaluate each skill.
- **Completed strategy to implement the training(s):** a short document that breaks the desired skills into modules and lessons that can be implemented using the implementing partner's existing infrastructure.
- **Successful evaluation of one site operator from pilot:** a student from the pilot programme has assisted with installation and commissioning and their competencies evaluated.

Given the milestones above, the GANTT chart below summarises the timeline for each milestone.

Table 3-1: Milestones and timeline for maintenance programme

MILESTONE	M27	M30	M33	M36	M39	M42	M45	M48
Phase 1								
Selection of one or two potential apprentices								
Apprenticeships with demonstrator								
Phase 2								
Installation and commissioning of one plant in SL								
Phase 3								
Training content and evaluation criteria								
Strategy to implement training								
Pilot and evaluation of one site operator								

3.1.4. Next steps and further development

The next steps are to organise a meeting with the demonstrator and other consortium partners to determine how feasible this programme would be to implement and decide whether it will be pursued and/or heavily modified or reduced.

3.1.5. Strengths and weaknesses of this option

If this option is pursued, it will provide the most long-term dividends. That said, this option could be challenging to implement. Below are the strengths and weaknesses of pursuing this approach.

Strengths

- High degree of control over the quality of the apprenticeship and maximum transfer of knowledge.
- Greater long-term capacity in the region to support long-term growth.
- The right balance of internal control and external execution in the future.

Weaknesses

- Careful selection of an apprentice will be required, and their long-term commitment is not guaranteed.
- Potential complications with visas, immigration, and resources required to host apprentice.

Overall, this option is a high-risk, high-reward option with extra initial effort required for long-term returns. It will depend heavily on how invested the demonstrator is in the region long-term.

3.2. Site operator training programme (option 2)

The purpose of this programme is to develop capacity at each site to ensure the operators are properly trained to maintain the high standard equipment and reduce damage caused by improper maintenance/repair.

3.2.1. Programme goals and objectives

The program goals and objectives are as follows:

- Develop a clear training strategy that can be delivered to the site operator during installation and commissioning.

3.2.2. Programme implementation strategy

The program will be implemented over two phases and could be implemented in conjunction with the regional operator training programme previously discussed. The first phase involves determining the skills and evaluation criteria that will be required of a site operator and developing this into a training programme. The second phase entails piloting the training during the installation and commissioning of one of the plants. The details of each phase are discussed below.

Phase 1: develop the training programme

In this phase, we will collaborate with the demonstrator to create a list of training content and evaluation criteria to form the basis of the training program. A high-level training program will be outlined, the training equipment required listed, and a curriculum developed.

1. ***Determine the key skills required and how to evaluate them:*** make a list of the desired skills and learnings for a site operator, taking into consideration the local competencies. For each skill, identify how the skill will be evaluated at the end of the training.

2. ***Determine how to teach the skills during the commissioning process:*** create a high-level training plan taking into consideration the competencies of the human capital in the region.

3. ***Develop a training curriculum:*** using the high-level training plan as a guide, develop a curriculum in which training modules, teaching methods, and training equipment are detailed.

Once a detailed training programme has been developed, the next phase would include piloting the programme during the installation and commissioning of one of the plants.

Phase 2: pilot and evaluate the programme

In this phase, the training will be piloted with the site operator for a plant that will be installed during installation and commissioning. The steps taken in the phase are as follows:

1. ***Pilot the training during the commissioning process:*** during the installation and commissioning of a site pilot the training with the new site operator.

2. ***Evaluate and update the training as necessary:*** once the pilot-training is completed, evaluate the trainees' competencies to see how effective the training was. Adjust the training as necessary.

With this programme completed the need for well qualified operators will be satisfied.

3.2.3. Timeline and milestones

Now that the Phases and programme implementation steps have been defined, it is time to identify milestones and discuss a possible timeline for implementation. Below are the milestones for each phase.

Phase 1 milestones

- **Completed training content and evaluation criteria:** a one-page document that details the desired skills of a graduate and a method to evaluate each skill.
- **Completed strategy to implement the training(s):** a short document that breaks the desired skills into modules and lessons that can be implemented using the implementing partner's existing infrastructure.

Phase 2 milestones

- **Successful evaluation of one site operator from pilot:** a student from the pilot programme has assisted with installation and commissioning and their competencies evaluated.

Given the milestones above, the GANTT chart below summarises the timeline for each milestone.

Table 3-2: Milestones and timeline for maintenance programme

MILESTONE	M27	M30	M33	M36	M39	M42	M45	M48
Phase 1								
Training content and evaluation criteria								
Strategy to implement training								
Phase 2								
Pilot and evaluation of one site operator								

3.2.4. Next steps and further development

The next steps in the process would be to determine if this option should be pursued and if so, begin execution on Phase 1 of the programme.

3.2.5. Strengths and weaknesses of this option

This option provides a more balanced approach between long-term reward, and short-term simplicity in implementation. It also maintains internal control of the quality of training delivered. Below are the strengths and weaknesses.

Strengths

- High degree of control over the quality of the training and its content.
- Could be easily implemented as part of the installation and commissioning process.
- Is not region specific and can be used in any region of deployment.

Weaknesses

- Not all knowledge will be transferred as the trainees will not be partake in the construction process.
- Timeframe to deliver the training is limited to the time it takes to install and commission.

3.3. Training curriculum for TVETs programme (option 3)

The purpose of this programme is to develop regional capacity in biodigester technologies. The idea would be to develop a training programme and curriculum that could be handed off to a local TVET and could be delivered independent of new site installations. The objective would be to create a pre-qualified talent-pool to draw from before a new site is selected and an installation occurs.

3.3.1. Programme goals and objectives

The program goals and objectives are as follows:

- Develop a training curriculum that can be implemented by a third party.
- Train a talent-pool of prequalified candidates for the region.

3.3.2. Programme implementation strategy

The program will be implemented over two phases. Phase 1 entails the development of a training programme in collaboration with a local TVET. Phase 2 involves recruiting trainees, piloting the training, evaluating its effectiveness, and updating the training as necessary. Details of each phase are provided below.

Phase 1: develop a training curriculum in collaboration with a local TVET

In this phase, the demonstrator will work with other consortium members and stakeholders to develop an adequate training curriculum in collaboration with a local TVET that is suitable for the local context. The steps to be carried out are as follows:

1. **Identify and partner with a local TVET:** work with partners to identify a suitable TVET to collaborate with and enter into a formal arrangement.

2. **Design the programme:** work with partners, stakeholders, as well as other subject matter experts to create a high-level curriculum outline and selected training methodologies.

3. **Assess resources:** identify preliminary resource requirements, such as budget estimates and potential funding sources.

4. **Develop the curriculum:** develop a detailed curriculum and training methodology that aligns with the identified needs.

Once a training curriculum has been developed, it is possible to pilot, evaluate and launch the training to be hosted by the local TVET.

Phase 2: pilot and evaluate the training with the local TVET

The second phase aims to pilot, evaluate, and launch the training in collaboration with local TVET. The steps are to be executed in this phase are described below.

1. **Pilot testing:** conduct a pilot test of the curriculum and training methods to ensure their effectiveness and relevance.

2. **Program promotion and recruitment:** develop a marketing and outreach strategy to inform potential participants and stakeholders about the program. Begin the recruitment and selection process for program participants.

3. **Facilitator selection and resource procurement:** identify and engage qualified facilitators or trainer for program delivery and begin procuring the necessary resources including training materials and facilities (or work with the TVET to assist).

4. **Program delivery, evaluation, and adaptation:** deliver the training sessions, implement a system for tracking participant progress, and adjust the program as needed.

Once these phases are carried out, the necessary capacity should be in place to address the need of having more qualified operators in the region.

3.3.3. Timeline and milestones

Now that the Phases and programme implementation steps have been defined, it is time to identify milestones and discuss a possible timeline for implementation. Below are the milestones for each phase.

Phase 1 milestones

- **Formal collaboration with a local TVET:** an MOU or other collaboration with a local TVET.
- **Training programme outline:** a high-level curriculum outline and selected training methodologies to be delivered for the new hires or developed into an entire training programme.
- **Completed training programme curriculum:** a detailed curriculum and training methodology to be delivered by a partner TVET.

Phase 2 milestones

- **Completed training pilot:** have piloted the TVET training programme and have a first round of graduates.
- **Completed training program evaluation:** A one page summary of the pilot programme results as well as recommended adjustments for future courses.

Given the milestones above, the GANTT chart below summarises the timeline for each milestone.

Table 3-3: Milestones and timeline for maintenance programme

MILESTONE	M27	M30	M33	M36	M39	M42	M45	M48
Phase 1								
Formal collaboration with a local TVET								
Training programme outline								
Training programme curriculum								
Phase 2								
Training pilot programme completed								
Training programme evaluation								

3.3.4. Next steps and further development

The next steps in the process are to evaluate whether this is an option that will be explored and if so, to begin implementing Phase 1.

3.3.5. Strengths and weaknesses of this option

This option has as both a strength and a weakness the fact that the training is outsourced. Although it will require slightly less effort on the demonstrators' part to implement as they will not deliver the training, the quality is not as guaranteed, and it may not be as specific to their equipment as they may desire. Below is a more detailed discussion of the strengths and weaknesses:

Strengths

- The training is outsourced which reduces some of the effort required by the demonstrator.
- The training length can be longer and the subject of biodigesters can be explored in more detail.

Weaknesses

- The training is outsourced, which reduces control over the quality and relevance of the skills learned to the demonstrator's equipment.
- It does not scale to new regions as easily, as the demonstrator will have to engage a new TVET each time it wants to establish a new market.
- There may not be enough interest in the region to justify offering the course, and the TVET could stop offering it as a result.

Overall, this is a moderate-risk, moderate-reward option. If pursued, much of the control of the quality and content delivery will be lost and relevance of the program to the demonstrator may not be worthwhile.

3.4. University graduate student programme

The purpose of this programme is to develop capacity local and regional laboratory testing to support BMP testing requirements and other research relevant to the digester feeds and products. The objective would be to recruit a local graduate student to develop a laboratory and its testing protocols. The hope is this graduate student will eventually become a professor who can develop a biodigester program over the very long term.

3.4.1. Programme goals and objectives

The program goals and objectives are as follows:

- Partner with a University in the region and recruit a graduate student to do a thesis on biodigesters.
- Work with the graduate student to develop a laboratory and test protocols that can be used locally.

3.4.2. Programme implementation strategy

The program will be implemented over two phases. Phase 1 centres on finding a partner University with a suitable Chemical or Environmental Engineering department and selecting a graduate student to collaborate with. Phase 2 entails connecting the graduate student with consortium research partners to develop lab-testing and evaluate the test results.

Phase 1: find a suitable university partner and graduate student

In this phase, potential universities will be identified in the region and even nationally. The aim is to leverage existing relationships between members in the consortium such as demonstrator partners, the Centres of Excellence, and members of the Energy Transition Boards. Details regarding activities included in this phase are discussed below.

1. ***Use our network to identify potential partners:*** begin by engaging the network within the consortium including demonstrators, Centres of Excellence, and other universities to determine whether they know any potential partners in the region. Make a list of the potential partners and classify them as having an existing connection, or whether a connection will need to be made.

2. ***Engage partners in a discussion to collaborate informally:*** reach out to the identified parties and initiate an informal discussion to determine ways in which a collaboration can occur.

3. ***Connect with a graduate student within those organizations:*** within each organization, aim to connect with a suitable graduate student.

4. ***Establish a collaboration:*** once several graduate students have been identified, begin collaborating between the university and the consortium research partners. Note, the collaboration should take the simplest form possible (e.g., mentorship, research advisor, etc.)

once a suitable university and graduate student have been identified a lab testing programme can be developed.

Phase 2: develop a lab-testing programme

In this phase, the consortium research partners will work with the graduate student to establish a lab-testing programme. This phase potentially will consist of the following steps:

1. ***Share laboratory testing methodology:*** the consortium research partners will share the laboratory testing methodologies and work with them to modify so it is as suitable to the equipment available at the university as possible.

2. ***Work with graduate student to implement:*** the consortium research partners can mentor and coach the graduate student through some test and recording of results.

3. ***Mentor graduate student on how to analyse results:*** the consortium research partner can then mentor the student through the process of analysing the results and what they mean.

Once the programme has been developed it will hopefully be possible to begin establishing a reliable lab that can test samples from the demonstrator sites.

3.4.3. Timeline and milestones

Now that the Phases and programme implementation steps have been defined, it is time to identify milestones and discuss a possible timeline for implementation. Below are the milestones for each phase.

Phase 1 milestones

- **Entered a collaboration with one graduate student:** are working with a graduate student or professor who is keen to implement the programme.

Phase 2 milestones

- **Completed one BMP analysis locally at the university:** a laboratory test result from one BMP analysis that can be corroborated by the consortium research partners.

Given the milestones above, the GANTT chart below summarises the timeline for each milestone.

Table 3-4: Milestones and timeline for maintenance programme

MILESTONE	M27	M30	M33	M36	M39	M42	M45	M48
Phase 1								
Entered a collaboration with one graduate student								
Phase 2								
Completed one BMP analysis locally								

3.4.4. Next steps and further development

The next steps in the process are to discuss with the research partners involved in the consortium to see how feasible this programme will be and to begin discussions with potential local university professors to identify a potential graduate student.

3.5. Waste disposal awareness raising programme

The purpose of this programme is to develop capacity in general social awareness around proper waste disposal methodologies and to assist in adoption of the biogas technology in the region. The objective is to develop locally tailored messaging about waste disposal and raise awareness around FWT's app.

3.5.1. Programme goals and objectives

The program goals and objectives are as follows:

- Develop educational videos in the local language that can be posted on social media or the FWT app.
- Develop flyers in the local language about proper waste disposal techniques that can be distributed in the region.
- Work with waste collectors to increase their capacity to service the increased demand for waste services.

3.5.2. Programme implementation strategy

The program will be implemented over two phases. The first phase will revolve around content creation and the messaging that will be disseminated. The second phase will entail creating and disseminating the content. Details of each phase are provided below.

Phase 1: development of content and messaging

In this phase, the local demonstrator partner will work with the other consortium partners to share the content it has developed around its waste disposal campaigns run in the past. This content will be used as the basis for the development of the content and messaging. The steps that will be taken during this phase are detailed below:

1. ***Share and review existing content:*** work with the local demonstrator to review their existing content.

2. ***Repurpose the content for videos or flyers:*** convert the content into videos or flyers that are written in the local language.

Once completed, the content can be disseminated in the following phase.

Phase 2: dissemination of content and messaging

In this phase, the content developed in the previous phase will be disseminated. This will be done using the following steps:

1. ***Distribute on social media:*** distribute the videos and electronic versions of the flyers on social media channels.

2. ***Distribute flyers:*** make the flyers available for distribution.

Once these phases are completed, capacity regarding general awareness will be increased.

Phase 3: collaborate with waste collectors to increase service

In this phase, capacity building activities will take place in collaboration with the waste disposal service providers to manage any increased supply of waste resulting from the awareness campaign. This will be done using the following steps:

1. ***Recruit more drivers to the app:*** ensure that as part of raising awareness, drivers become aware of the app and join the driver network.

2. ***Add more waste collection capacity:*** if possible, add more waste collection capacity by increasing waste management equipment accessibility and repair to service the drivers.

Once these phases are completed, capacity regarding general awareness will be increased.

3.5.3. Timeline and milestones

Now that the Phases and programme implementation steps have been defined, it is time to identify milestones and discuss a timeline for implementation. Below are the milestones for each phase.

Phase 1 milestones

- **Finalized content for distribution:** either one video or one flyer or both will be finalized.

Phase 2 milestones

- **Content disseminated on at least one media channel:** either the flyer, video or both have been shared on one media channel, such as WhatsApp, YouTube, or via the youth groups.

Phase 3 milestones

- **First driver enrolled in the app service:** at least one driver has enrolled to provide waste collection services through the DortiBox App.

Given the milestones above, the GANTT chart below summarises the timeline for each milestone.

Table 3-5: Milestones and timeline for maintenance programme

MILESTONE	M27	M30	M33	M36	M39	M42	M45	M48
Phase 1								
Finalized content for distribution								
Phase 2								
Content disseminated on at least one channel								
Phase 3								
First driver enrolled in the app service								

3.5.4. Next steps and further development

The next steps in the process are to check with the local demonstrator partner to initiate Phase 1.

4. SUMMARY

This report, one of three reports that make up deliverable 3.1 of the ENERGICA project, assessed the capacity building needs for the demonstrator in Sierra Leone. The report used the TEES framework - a framework developed as part of the ENERGICA project and intended for comprehensive application in future contexts - to develop and propose capacity building programmes that will assist the project and ensure its long-term success in the associated context.

The results of the study outlined a need for capacity building efforts related to:

- Training local operators and maintainers to commission, maintain, and repair the TWT systems.
- Ability to perform lab-testing locally to measure the quality of the feeds and output streams.
- Increasing awareness about waste disposal methods and supporting the growth of waste disposal services as collection becomes more formalized.

Given the needs outlined above, the following capacity building programmes were proposed:

- A biodigester plant operator and maintainer programme (three options are presented).
- A university graduate student programme for local laboratory testing.
- A waste disposal awareness and capacity building programme.

The results presented in this report, make up the work outlined in ***Sub-task 3.1.2: Creation of capacity building and adapted training programmes tailored to each product***. The recommendations and next steps presented in this report will be taken up and implemented in the following tasks:

- Task 3.2: Implementation of the capacity building programmes.
- Subtask 3.3.1: Definition of local value chains and innovative circular economy models
- Subtask 5.1.1: Setting-up of the local manufacturing of plant components.
- Subtask 5.1.2: Optimising day to day operations
- Subtask 7.1.1: Development of a socio-technical model
- Task 8.2: Social acceptance analysis

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ENERGICA

PART C

Capacity building Programme – Kenya Context

1. KENYA CONTEXT BACKGROUND

The following background information was provided for the internal Deliverable 3.1 report. Given that this report is to be made available publicly, the background information is being included again here, as it provides necessary context for the reader. Note that some alterations have been made to remove any proprietary information.

1.1. Demonstrator context – Kenya

In this section we will provide the context for the Kenya demonstrator across the TEES factors at the local, regional, and national levels. With this background context, it will then be possible to discuss the needs assessment. The needs will be assessed in the methodology section.

1.1.1. Technological context

To begin outlining the context we must begin by looking at the technology of the demonstrator (Roam) and what they offer. The demonstrator context looks at electric mobility, including the production and sales of an electric motorbike (Roam Air), and distributed battery charging station network (Roam Hub). Roam is also looking at providing an electric bus in the future, but this report will focus specifically on the motorbike and battery charging network. To provide background context, we will discuss a little about electromobility, and then more specifically about the products that Roam is offering in Kenya.

Background information regarding electromobility

Electromobility technology refers to the use of electricity as a means of powering vehicles. This technology is gaining popularity due to its potential to reduce emissions, improve energy efficiency, and decrease dependence on fossil fuels.

There are two main types of electromobility technology: battery electric vehicles (BEVs) and hybrid electric vehicles (HEVs). BEVs use electric motors powered by rechargeable batteries to move the vehicle, while HEVs use both an electric motor and an internal combustion engine (ICE) to power the vehicle.

One of the main benefits of electromobility technology is that it produces zero tailpipe emissions, which can help reduce air pollution and greenhouse gas emissions. Additionally, electric vehicles (EVs) can be more energy-efficient than traditional ICE vehicles, resulting in lower fuel costs.

However, the adoption of electromobility technology also faces challenges, including the high cost of batteries and charging infrastructure, limited driving range, and longer charging times compared to refueling with gasoline.

Despite these challenges, the market for electric vehicles is growing rapidly, with governments and automakers investing heavily in the development and production of electric cars. As technology improves and costs decrease, electromobility is expected to become an increasingly important part of the transportation sector.

Overview of Roam's electric motorcycle (Roam Air)

Below are excerpts from Roam's website [49].

> [The Roam Air] is adapted and designed in detail for the African use-case and with special focus on affordability, functional design, and performance. An electric motorcycle tailored for

commercial usage such as carrying passengers or cargo with safety at the forefront. The Roam Air is designed both for urban and rural environments, with years of research and months of development dedicated to building the optimal electric motorcycle for the region.

Based on a new updated frame the motorcycle accommodates for a dual battery system. Allowing users to plug their battery into any outlet and switch a battery out when it is empty to a new fully recharged one, lowering downtime and ensuring continuous driving.

The frame is also engineered to tackle all terrains while also accommodating for a storage compartment in the tank and increased carrying capacity on subframe. With extra features like connectivity, a modern user-interface and many more functions [49].

The specifications for the Roam Air motorcycle are as follows **[50]**:

- Driving Range – Dual Battery 200 KM
- Peak Power 8650 W
- Nominal Power 3000 W
- Torque 185 Nm
- Top Speed 90 km/h
- Battery Capacity 2.9 + 2.9 kWh
- Battery Lifecycles >1500 cycles
- Payload 220 kg

Below are some photos of the Roam Air motorcycle taken from various sources on the internet.

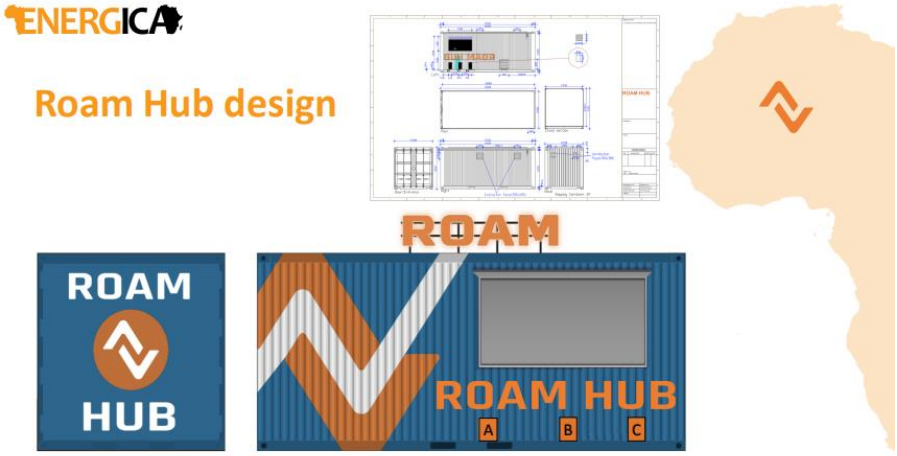
Figure 1-1: Photos of the Roam Air motorcycle [49]

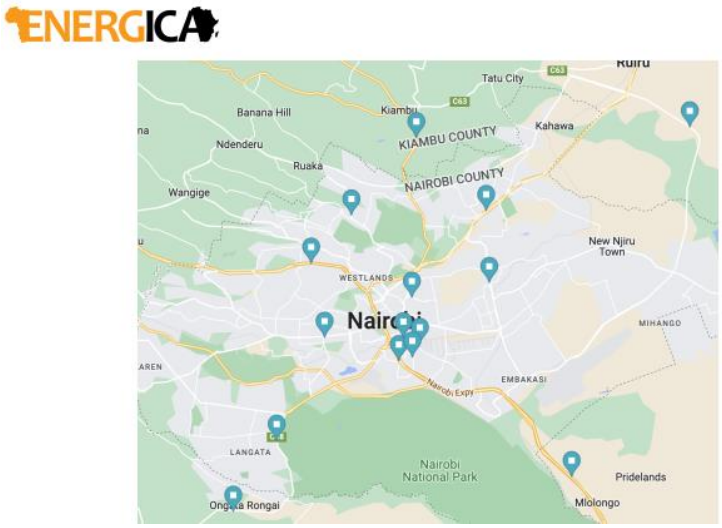
Photo of the Roam Air motrocycle, note the two rectangular removable batteries located behind the front wheel and below the rider.

Overview of Roam's battery swapping stations (Roam Hub)

One of the key elements to ensuring that users can travel long distances within a day is to provide a quick way to top up the energy available to them. This can be done through charging or battery rental. As a result, Roam is deploying Roam Hubs, a network for charging and battery rental stations. The Roam Hub is currently under development, but the concept is a shipping container that has a way to charge batteries so that users can drive up and swap out their batteries, or if they choose, top up their battery directly in a resonably short period of time. Below are images of the Roam Hub concept presented at the ENERGICA consortium in Nairobi in November of 2022, as well as a map detailing the 15 locations that have been pre-selected to install the Roam Hubs.

Figure 1-2: Image of the Roam Hub concept as well as preselected locations [51]





Summary of the technological context background information

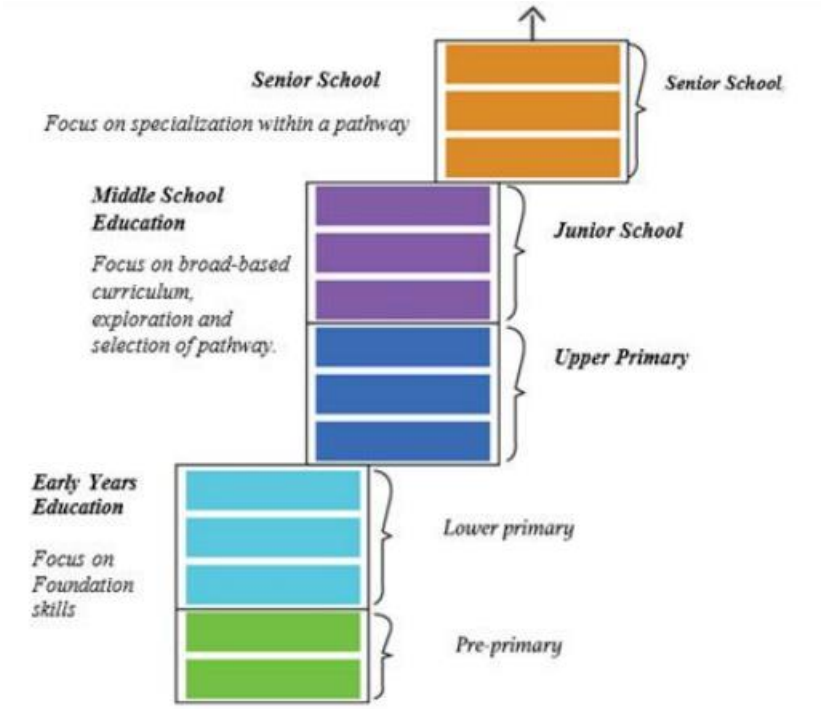
In this section, we provided a brief introduction and background of the technological offering of the demonstration project in Kenya. The objective here was to set the context of the technical solution pertaining to this report. Further detailed discussions surrounding availability of parts, capacity to maintain and repair, as well as the local, regional, and national supply chain will be presented in the results section.

1.1.2. Educational context

Overview of the educational system in a national context

Education is considered a basic right that should be offered to every individual [52]. Kenya has manoeuvred through three education curriculums since independence with the latest being, the Competency-Based Curriculum (2-6-3-3-3), rolled out in 2017 to replace the 8-4-4 Curriculum that has been in practice since 1985 [53]. An image taken from a UNESCO report illustrates the organisation of the new Competency-Based Curriculum (CBC).

Figure 1-3: Image depicting how Kenya's CBC education system is organized [53]



In 2017, Kenya's education system was rated as the strongest among other forty-three mainland countries on the African continent by the World Economic Forum with a score of around 4.4 (world average is 3.8) [54]. Furthermore, Kenya has lots of educational options available to the public (relative to other African contexts) with over 31,000 registered primary schools, 9400 secondary schools, 874 Technical, Vocational Education, and Training (TVET) institutions and 53 Universities as of 2015 [55].

Figure 1-4: Table of registered educational institutions in Kenya as of 2015 [55]

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Primary schools	20,587	21,702	22,876	24,114	25,382	26,549	28,026	29,460	31,333
Secondary schools	4,663	5,128	5,639	6,201	6,257	7,174	7,834	8,747	9,440
Teacher training	69	132	179	233	236	245	256	267	271
TIVET institutions	540	568	597	627	630	701	753	755	874
Universities	28	28	31	32	34	35	52	53	53

Summary of educational context in Kenya

Overall, Kenya has a highly developed education system, that has been rated the best in mainland Africa. Furthermore, there are numerous universities and training institutions making the educational context nationally very suitable for the demonstrators' context.

1.1.3. Economic context

The economic context is another important context in the TEES framework, as it has a great effect on business development and growth, as well as on the ability to build capacity because the economic makeup of a context drives the everyday life of the individual. It further affects capacity building as economic activity is what most typically defines the supply chain, and transportation logistics.

Overview of the economy in a national context

Kenya, located in East Africa, has a population of over 53 million people [56] and is one of the most developed countries in Africa. Since independence was achieved in 1963, Kenya's economy has contained both privately owned and state-run enterprises. Most of the country's business is in private hands (with a large amount of foreign investment), but the government also shapes the country's economic development through various regulatory powers and "parastatals," or enterprises that it partly or wholly owns. The aim of this policy is to achieve economic growth and stability, generate employment, and maximize foreign earnings by achieving high levels of agricultural exports while substituting domestically produced goods for those that have been imported [57] . It is currently the third largest Sub-Saharan economy, strong in agriculture, emerging services, and tourism [58].

Key Economic Indicators

Kenya's GDP was estimated at $110.35 billion in 2021, with a real growth rate of -7.5% [56] The country's inflation rate was estimated at 6.1% in 2021, while the unemployment rate was estimated at 5.6% [56]. Kenya's current account balance was estimated at a deficit of $5.74 billion in 2021 [58]. Kenya had a total export of $6 billion and total imports of $15,4 leading to a negative trade balance of -$9.4 billion dollars. [59]

Major Economic Activities

Below are excerpts taken from the Encyclopaedia Britannica regarding the major economic activities in Kenya:

> Agriculture plays an important role in Kenya's economy. Although its share of gross domestic product (GDP) has declined—from more than two-fifths in 1964 to less than one-fifth in the early 21st century—agriculture supplies the manufacturing sector with raw materials and generates tax revenue and foreign exchange that support the rest of the economy. Moreover, it employs most of the population [57].
>
> Soda ash (used in glassmaking) is Kenya's most valuable mineral export and is quarried at Lake Magadi in the Rift Valley. Limestone deposits at the coast and in the interior are exploited for cement manufacture and agriculture. Vermiculite, gold, rubies, topazes, and salt are also important, as is fluorite (also known as fluorspar and used in metallurgy), which is mined along the Kerio River in the north. Deposits of titanium- and zirconium-bearing sands were found in multiple locations northeast of Mombasa and to the south of the city. Exploration for petroleum has so far met with limited success [57].
>
> Kenya is the most industrially developed country in East Africa, but it has not yet produced results to match its potential. Manufacturing is based largely on processing imported goods, although the government supports the development of export-oriented industries. Major industries include agricultural processing, publishing, and printing, and the manufacture of textiles and clothing, cement, tires, batteries, paper, ceramics, and leather goods. Assembly plants, which utilize imported parts, produce various kinds of commercial and passenger

vehicles, and even export a small quantity to other African countries such as Uganda, Tanzania, Rwanda, and Burundi [57].

Steel processing for reexport and for the construction industry is a growing sector, with about a dozen steel mills in operation. The petroleum industry, which was deregulated in 1994, produces diesel and jet fuel from imported crude oil at a refinery near Mombasa and provides a major source of foreign exchange [57].

Kenya is home to some of the rarest and most interesting species of wildlife in the world. Because of this, tourism is one of the country's major sources of foreign exchange, with visitors coming largely from countries of the European Union. Tourism revolves around a basic framework of national parks, game reserves, and game sanctuaries, where a wide variety of animals and cultural attractions can be enjoyed [57].

Overview of the supply chain:

Kenya's supply chain is a complex system that involves multiple stakeholders, including manufacturers, distributors, wholesalers, retailers, and consumers. The supply chain consists heavily of road, some ports, and railways. With a large interconnection between its neighboring countries, sea and air freight are not the only options for importation of goods. This is outlined in the following excerpts [57] :

Railways, the second most important mode of transport after roads, are operated by Kenya Railways. The main line runs northwest from Mombasa through Nairobi, Nakuru, and Eldoret to the Ugandan border. Major branch lines run from Nakuru to Kisumu on Lake Victoria and from Nairobi to Nanyuki near Mount Kenya, and another goes into Tanzania.

The strategic location of Kenya on the western shores of the Indian Ocean, with easy connections to different parts of Africa, the Middle East, and Asia, has greatly enhanced the role of the international airports at Nairobi and Mombasa. Another international airport is located at Eldoret.

Mombasa, the country's principal port, handles the bulk of the import and export traffic not only of Kenya but of Burundi, Rwanda, Uganda, and the eastern part of the Democratic Republic of the Congo. The ports of Lamu and Malindi serve mainly the coastal trade and fisheries.

To dive further into the existing infrastructure, we have included a transportation and logistics maps provided by Logistics Capacity Assessment tool that show the major cities, railways, and roads in Kenya [60]. According to the World Port Source, there are only three ports in Kenya [61]. They are summarized in the ***Table 1-1*** below. The Port of Mombasa is the port in the country that handles most international trade.

Table 1-1: Summary of the registered ports in Kenya [61]

PORT NAME	LOCATION	PORT AUTHORITY	DESCRIPTION
Port of Mombasa	Mombasa	Kenya Ports Authority	Container service, Seaport, Medium
Port of Lamu	Lamu	Kenya Ports Authority	Pier, Jetty or Wharf; Small
Port of Malindi	Malindi	Kenya Ports Authority	Pier, Jetty or Wharf; Small

Figure 1-5: Transportation and logistics map of Kenya – Road Network. [60]

Figure 1-6: Transportation and logistics map of Kenya - Rail network [60]

As can be seen from the logistics map, there are major arterial railways and roads that go inland from the Port of Mombasa, all the way to Nairobi. This indicates that supply chain and logistics should not pose a serious difficulty to the demonstrator.

Summary of the economic context background information

Of the three demonstrators, the Kenya economic context is by far the most conducive to a successful project. It has significant trade, ports, and an extensive rail and road network making it easy to ship most parts in as necessary.

1.1.4. Social context

Kenya is situated in East Africa and is bordered on the north by Ethiopia, the north-west by South Sudan, the north-east by Somalia, the west by Uganda, the south by Tanzania, ad on the east by the Indian Ocean.

Brief history of Kenya

Below is an excerpt from the Central Intelligence Agency World factbook describing the political history of Kenya [58].

> Trade centres such as Mombasa have existed along the Kenyan and Tanzanian coastlines, known as the Land of Zanj, since at least the 2nd century. These centres traded with the outside world, including China, India, Indonesia, the Middle East, North Africa, and Persia. By around the 9th century, the mix of Africans, Arabs, and Persians who lived and traded there became known as Swahili ("people of the coast") with a distinct language (KiSwahili) and culture. The Portuguese arrived in the 1490s and, using Mombasa as a base, sought to monopolize trade in the Indian Ocean. The Portuguese were pushed out in the late 1600s by the combined forces of Oman and Pate, an island off the coast. In 1890, Germany and the UK divided up the region, with the UK taking the north and the Germans the south, including present-day Tanzania, Burundi, and Rwanda. The British established the East Africa Protectorate in 1895, which in 1920 was converted into a colony and named Kenya after its highest mountain. Numerous political disputes between the colony and the UK subsequently led to the violent Mau Mau Uprising, which began in 1952, and the eventual declaration of independence in 1963.
>
> Jomo KENYATTA, the founding president, and an icon of the liberation struggle led Kenya from independence in 1963 until his death in 1978, when Vice President Daniel Arap MOI took power in a constitutional succession. The country was a de facto one-party state from 1969 until 1982, after which time the ruling Kenya African National Union (KANU) changed the constitution to make itself the sole legal political party in Kenya. MOI acceded to internal and external pressure for political liberalization in late 1991. The ethnically fractured opposition failed to dislodge KANU from power in elections in 1992 and 1997, which were marred by violence and fraud. President MOI stepped down in December 2002 following fair and peaceful elections. Mwai KIBAKI, running as the candidate of the multi-ethnic, united opposition group, the National Rainbow Coalition (NARC), defeated KANU candidate Uhuru KENYATTA, the son of founding president Jomo KENYATTA, and assumed the presidency following a campaign centred on an anticorruption platform.

KIBAKI's re-election in 2007 resulted in two months of post-election ethnic violence that caused the death of more than 1,100 people and the dislocation of hundreds of thousands. Opposition candidate, Raila ODINGA, accused the government of widespread vote rigging. African Union-sponsored mediation led by former UN Secretary General Kofi ANNAN resulted in a power-sharing accord that brought ODINGA into the government in the restored position of prime minister. The power sharing accord included a broad reform agenda, the centrepiece of which was constitutional reform. In 2010, Kenyans overwhelmingly adopted a new constitution in a national referendum. The new constitution introduced additional checks and balances to executive power and devolved power and resources to 47 newly created counties. It also eliminated the position of prime minister. Uhuru KENYATTA won the first presidential election under the new constitution in March 2013. KENYATTA won a second and final term in office in November 2017 following a contentious, repeat election. In August 2022, William RUTO won a close presidential election; he assumed the office the following month after the Kenyan Supreme Court upheld the victory.

People

In the following paragraphs we will discuss the people of Kenya, including the various ethnic groups, the languages, religion, and settlements patterns. All this information is taken from the website of the Encyclopaedia Britannica.

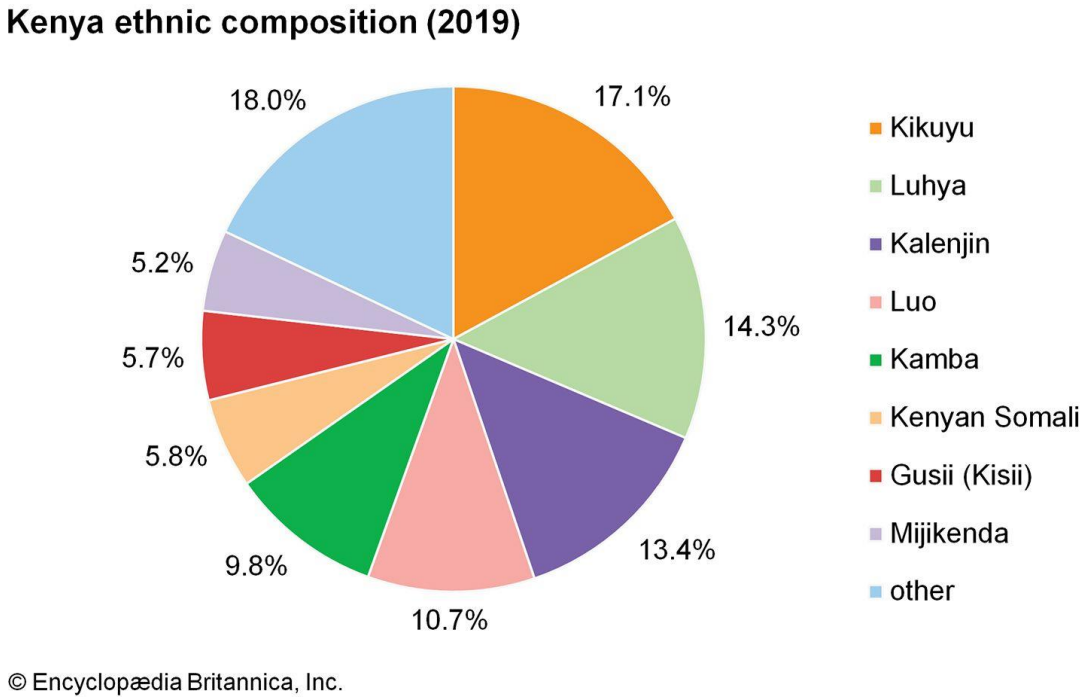
Ethnic groups and languages

The people of Kenya are divided into three language groups: Bantu, Nilo-Saharan, and Afro-Asiatic. Details regarding each are presented below [57]:

- Bantu is by far the largest and its speakers are mainly concentrated in the southern third of the country.
    - The Kikuyu, Kamba, Meru, and Nyika peoples occupy the fertile Central Rift highlands.
    - the Luhya and Gusii inhabit the Lake Victoria basin.
- Nilo-Saharan—represented by the languages of Kalenjin, Luo, Maasai, Samburu, and Turkana—is the next largest group.
    - The rural Luo inhabit the lower parts of the western plateau, and the Kalenjin-speaking people occupy the higher parts of it.
    - The Maasai are pastoral nomads in the southern region bordering Tanzania.
    - The Samburu and Turkana are also pastoral nomades in the arid northwest.
- The Afro-Asiatic peoples, who inhabit the arid and semiarid regions of the north and northeast, constitute only a tiny fraction of Kenya's population.
- The Swahili lives along the coast.
- Arabs introduced Islam into Kenya when they entered the area from the Arabian Peninsula about the 8th century CE.

Although a wide variety of languages are spoken in Kenya, the language most used is Swahili. This multipurpose language, which evolved along the coast from elements of local Bantu languages, Arabic, Persian, Portuguese, Hindi, and English, is the language of local trade and is also used (along with English) as an official language in the Kenyan legislative body, the National Assembly, and the courts [57]. Below are images of the breakdowns by ethnicity are shown in the figure below.

Figure 1-7: Breakdown of ethnicities as reported in the Encyclopaedia Britannica [57]



Settlement patterns

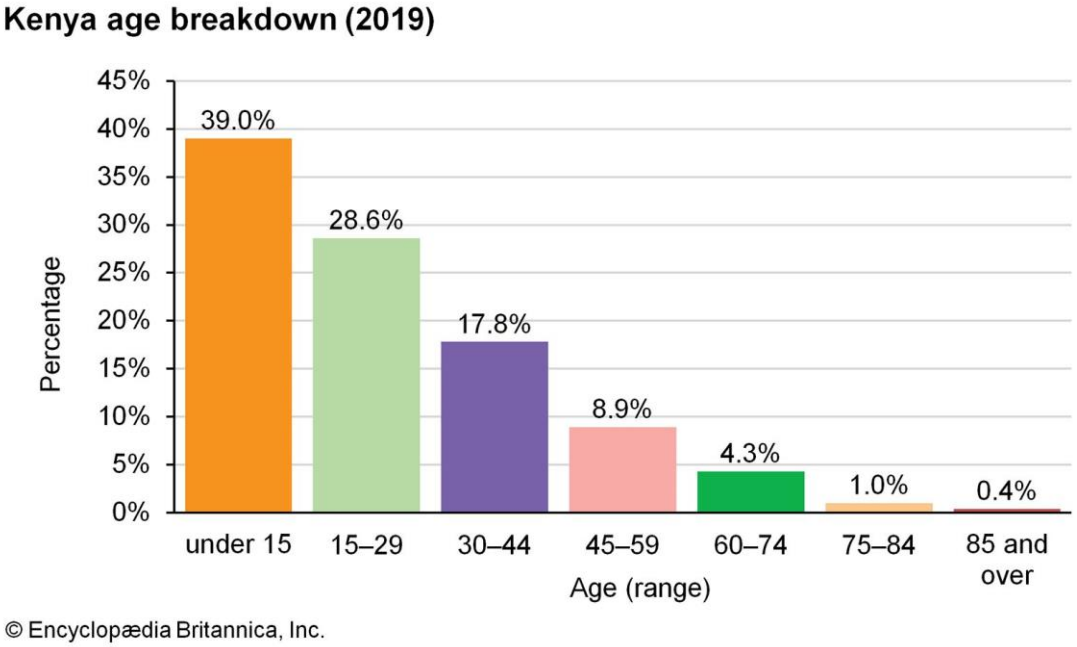
Most of Kenya's population is rural (68.8%) and lives in scattered settlements, the location and concentration of which depend largely on climatic and soil conditions. Before European colonization, virtually no villages or towns existed except along the coast, while urbanization was confined to fishing villages, Arab trading ports, and towns visited by dhows from the Arabian Peninsula and Asia. The modern cities of Mombasa, Lamu, and Malindi were among the pre-existing urban areas that were expanded during the colonial period. Nairobi, originally a Maasai watering hole, became important because of its connection to the railroad, which came through the area at the beginning of the 20th century. Other towns, such as Eldoret, Embu, Kisumu, and Nakuru, were established by Europeans as administrative centres, mission stations, and markets. [57]

The migration from rural to urban areas has accelerated since independence, spurred by greater economic development in urban areas. In the late 1960s about one-tenth of the national population lived in urban areas of 1,000 or more people; by the turn of the 21st century the figure had more than doubled. The largest coastal city is Mombasa, while most urban Kenyans in the interior live in the capital city, Nairobi [57].

Demographics

Kenya is also a young country, with over 2/3 of the population being under the age of 30 as evidenced in the figure below. Freedom of religion is guaranteed by the constitution. More than four-fifths of the people are Christian, primarily attending Protestant or Roman Catholic churches. Christianity first came to Kenya in the 15th century through the Portuguese, but this contact ended in the 17th century. Muslims constitute a sizable minority and include both Sunnis and Shiʿis. There are also small populations of Jews, Jains, Sikhs, and Bahaʾis [57].

Figure 1-8: Age demographics as reported by the Encyclopaedia Britannica [57]



Information relevant to access to energy and transportation

As part of this project, an extensive survey was done in the regions of each of the demonstrators for Work Package 2 (WP2) to get an idea of access to energy and background energy use information. In this section we will present some background contextual information. We will present more detailed results in ***Section*** *Error! Reference source not found.*. Below is an overview of the findings from those surveys [47]:

- 98.7% of the respondents had access to energy in the household (HH) with the main energy service provider being Kenya Power as pointed out by 87.6% of the respondents.
- The energy was reliable as implied by 87.3%
- 81.9% of the respondents reported to have access to energy for an average of 17-24 hours per day.
- The average distance covered per day by Boda Boda riders (motorcycle taxis) was 124.08KM and a maximum of 550 km.
- On average, $5.49 was spent on boda-boda fuel every day with an average daily net income of $12.19.
- Half of the sample (49.3%) know about the existence of electric motorcycles, with 45.3% having used them before

Summary of the social context background information

Kenya is a highly diverse country with many ethnicities. It is a generally young population. Almost all residents of Nairobi that were surveyed reported having access to energy. The average distance of a motorcycle taxi drive covered in a day was reported to be between 124 and 550 km, with an average of $5.49 spent on fuel every day.

2. RESULTS

2.1. Needs Assessment

A thorough needs assessment was performed, the details of which were shared with the demonstrator partner internally for Deliverable 3.1. That report contains proprietary information and as such will not be made publicly available.

2.2. Field Trip

A field trip was also performed, the details of which were also shared internally via Deliverable 3.1 and contained proprietary information.

2.3. Triage

Following the needs assessment completed for Deliverable 3.1 the triage exercise was performed to determine which needs could be actioned as part of the capacity building programme. Given that this is a report that is to be publicly released, a high-level version of the triage results will be shared below which omits some details specific to the demonstrator.

Table 2-1: Triage result for Kenyan context (action plan items in bold)

FACTOR	NEED IDENTIFIED	RECOMMENDATIONS	POTENTIAL NEXT STEPS	TRIAGE
T1 - SIMPLICITY AND OPERABILITY	Battery handling process or machine because of the weight of the battery for Roam Hub	· Consider hydraulic lift tables as an option in which the battery can be raised or lowered to a certain height through a foot pump.	· Purchase and try either a hydraulic lift table or manual lift stacker	Do Later
	HVAC and fire safety specialists	· Hire an HVAC and fire safety specialist company. A local partner is preferred, but an international partner may be necessary.	· Consider approaching a local fire station, or the building inspection department for a fire safety expert	Do
T2 – CAPACITY TO MAINTAIN AND REPAIR	User/repair manuals	· Create a repair/owner's manual that can be distributed with each motorcycle	· Create owner's manual	Done
	Ability to repair and replace parts	· Ensure that spare parts are ordered in the supply chain above what is needed for assembly. · Find one or two potentials after sales suppliers to sell the parts to	· Make list of parts that most often need replacing. · Order spares that can be distributed to other suppliers	Already Doing
	Onboard and Certify Informal after sales technicians	**· Create a series of videos for maintenance and repair that can be shared using a QR code. · Aim to find one or two after market repair partners**	**· Develop repair/ maintenance instructional videos**	**Action Plan**
T3 – AVAILABILITY OF PARTS	To circulate more aftermarket parts into the local supply chain	· Become a distributor of aftermarket parts for some key partners/dealers	· Find potential dealers that could sell motorcycle and parts	Do Later

ED1 – TECHNICAL ABILITIES TO OPERATE/ MAINTAIN/ REPAIR	**Training for Roam employees on motorcycle maintenance during their onboarding**	**· Develop a training programme that can be given at Roam for people who are interested in becoming technicians**	**· Develop a training program outline · Work with a partner to develop into a training program**	**Action Plan**
	A method for users to know best practices that will extend life of battery and motorcycle as well as efficiency and range	**· Create instructional videos for basic repairs that are different from an ICE · Create a QR code or have links to them on the app so customers can show the videos to their repairmen.**	**· Find a suitable partner that can film and edit instructional videos that can be posted online.**	**Action Plan**
ED2 – CAPACITY TO TRAIN	TVETs and other training institutions that can offer an electric motorcycle technician's course	· Develop curriculum and specified courses at university / trade schools for after sales technicians/engineers and assembly personnel. · Identify potential TVET partners to deliver this type of training. · Develop instructional videos for simple repairs and maintenance	· Develop an outline and curriculum for potential training that could be delivered by a TVET partner. · Find a training partner	Do Later
	To train people on response to battery fire, safety training, etc. for Roam Hub	**· Find a fire safety specialist who can develop and deliver a one day or half day training that can be provided externally as part of staff onboarding**	**· Find a fire safety training partner (fire department, fire inspector service)**	**Action Plan**
ED3 – EDUCATIONAL BACKGROUND	To propose curriculum adjustments for universities, trade schools, and TVETS via the Energy Transition Board	· Create an outline of key learning points that can be used as the basis for developing a proposed curriculum and training outline to be share with partners in the education sector. · Join the Energy Transition board and propose curriculum changes to the University and government agency partners.	· Provide a brief outline of training needs to a partner to help develop a training program. · Join the Energy Transition Board to begin forming relations with Universities and Regulators	Do Later
EC1 – AFFORDABILITY LOCALLY	To raise awareness in community to spur adoption	· Strongly market the economic benefits in terms of affordability due to reduced fuel costs	· Develop a strong marketing plan that includes affordability as a strong pillar	Already Doing
EC2 – EMPLOYMENT REGIONALLY	To update competencies for electrification	· Work with partners to develop strong training programs and University curriculum around these needs (See Section 2.2.3 and Section 3.2) for details	· None	Do Later
EC3 – MAJOR ECONOMIC ACTIVITY NATIONALLY	None	· None	· None	Do Later
S1 – WILLINGNESS OF	To ensure there are enough battery swapping station and they are well advertised to	· Heavily market and make visible the Roam Hub network so people equate this with availability of fueling stations	· Ensure the Roam Hubs have a message about	Already Doing

	reduce concerns about "refuelling"		refueling painted on them.	
	To heavily market and raise awareness about reduced fuel costs, charging time, and maintenance and repair	· Develop a strong marketing campaign centered on 3 pillars: o Reduced maintenance/fuel costs o Avoid charging time with battery swapping, o Easy to maintain and repair	· Develop a marketing campaign around these 3 pillars	Already Doing
S2 – EMPLOYMENT OPPORTUNITIES CREATED VS. EXISTING	To create more brand awareness and information campaigns, as well as brand evangelists/influencers	· Find influencers and brand evangelists who can serve as early adopters and create hype around the product	· Look online for potential influencers and brand evangelists who can support the brand and create hype	Already Doing
S3 – ADOPTION SUCCESS OF SIMILAR PRODUCTS	None	· None	· None	Do Later

2.4. Action plans

The next step in the process was to develop action plans with the demonstrator site. These will form the basis for the capacity building programme to be implemented for each context. For the Kenyan context, the most apparent needs were (note: there is less need for intervention at university level because Kenya is a well-developed context with strong human capital):

- Need to onboard and certify aftersales technicians.
- Need to train internal technicians (reword)
- Training about battery fire and safety training

Below are details of the desired outcomes, steps, and potential hurdles required to satisfy these needs. Note: the content has been generalized to exclude sharing of any proprietary information.

Table 2-2: Action plan result for Sierra Leone context

NEED IDENTIFIED	DESIRED OUTCOME	STEPS	POTENTIAL HURDLES
Onboard and Certify Informal after sales technicians	A comprehensive program to certify informal and after sales technicians	1. Determine the content and how to deliver it. 2. Identify the key maintenance needs. 3. Identify the scope boundaries between Roam repairs and aftersales repairs. 4. Develop a training programme. 5. Pilot and evaluate the programme. 6. Adjust as necessary.	Clearly defining the boundaries between what external aftersales
Training for Roam employees on motorcycle maintenance during their onboarding	An internal training program to be given during the onboarding process, designed for the internal technicians (apart from scope for aftersales technicians)	1. Identify the scope boundaries between Roam repairs and aftersales repairs 2. Identify the key maintenance needs 3. Create an outline of the training modules 4. Determine how training will be given (videos, external training partner, etc) 5. Develop the training programme. 6. Pilot and evaluate	Will take too many resources and distract from other needs
A method for users to know best practices that will extend life of battery and motorcycle as well as efficiency and range	Customer app tutorials explaining general maintenance and care with aftersales onboarding to download the app, and/or a pamphlet to be distributed to client during aftersales onboarding, with a QR-code to download the app	1. Determine the content and how to disseminate it. 2. Create and develop the content. 3. Disseminate the content.	see above
To train people on response to battery fire, safety training, etc. for Roam Hub	A half-day to one day training course that could be delivered as part of the employee onboarding and recurring training for Roam employees,	1. Identify a potential partner that can deliver the training 2. Determine the training needs. 2. Work with partner to develop the training. 3. Deliver training and evaluate.	Understanding how to react to fight a lithium battery fire and how to be extremely pertinent

3. PROPOSED CAPACITY BUILDING PROGRAMME

Once the action planning exercise was completed, it was possible to begin developing the capacity building programmes. The programmes were based off the desired outcomes provided by the demonstrator. Over the course of the action planning exercise, it became apparent that the internal electric motorcycle training programme and the external version for after-sales technicians could be accomplished with different versions of the same course, therefore they were both combined into one outcome/capacity building programme. Based on the action plan exercise, the following capacity building programmes have been proposed.

- Develop a comprehensive electric motorcycle technician programme for internal and after-sales technicians.
- Work on after-sales onboarding process to ensure users are properly shown how to care for and maintain their motorcycle and not void the warranties.
- Develop a half-day to one day fire safety training that can be delivered by a training partner.

Details for each capacity building programme are included in the following sections.

3.1. Electric motorcycle technician programme

The purpose of this programme is to develop capacity in maintenance and repair of electric motorcycles in the region. Although there are many similarities to conventional motorcycles there are unique differences specifically with the power electronics and other elements. Below is a detailed discussion about this programme.

3.1.1. Programme goals and objectives

The program goals and objectives are as follows:

- Develop a comprehensive electric motorcycle technician programme that can be used to train technicians internally.
- Develop a smaller version of the comprehensive programme that can be offered as a certification to after-sales repair people.

3.1.2. Programme implementation strategy

The program will be implemented over three phases. Phase 1 includes developing an internal pilot training programme to determine how best to deliver the training. Phase 2 consists of opening a simplified version of the internal programme to certify aftersales technicians. These phases are discussed in greater detail below.

Phase 1: develop and pilot a comprehensive programme for internal technicians

The first phase of this capacity building programme will be to comprehensively train internal technicians to repair the motorcycles and pilot methods to deliver the training efficiently and effectively. This phase will consist of the following steps.

1. ***Determine the key skills required and how to evaluate them:*** make a list of the desired skills and learnings for a technician to have. For each skill, identify how the skill will be evaluated at the end of the training.

2. ***Determine how to teach and test the skills:*** create a high-level training plan, taking into consideration the competencies of the human capital in the region.

3. ***Develop a training curriculum:*** using the high-level training plan as a guide, develop a curriculum in which training modules, teaching methods, and training resources are detailed.

4. ***Pilot the training internally:*** have a group of selected technicians complete the pilot training.

5. ***Evaluate and update the training as necessary:*** once the pilot-training is completed, evaluate the trainees' competencies to see how effective the training was. Adjust the training as necessary.

Once the training has been successfully piloted, it will be possible to outline the scope of skills necessary for an internal, vs. an external certified technician and begin developing the after-sales technician training programme.

Phase 2: develop and pilot a simpler aftersales technician certification

The second phase will determine the scope boundaries between an internal technician and an aftersales technician and use a simplified version of the comprehensive program to offer an aftersales technician certification. This phase will consist of the following steps:

1. ***Determine the scope boundaries between internal and after sales technician skills:*** pare down the comprehensive technician training list of skills to the limited repairs that can be offered for an aftersales technician.

2. ***Develop training for how aftersales technicians can elevate issues beyond their scope:*** for skills beyond the aftersales technicians' scope, ensure they are trained on how to use any troubleshooting or issue tracking system to raise the issue to the internal team.

3. ***Develop a training curriculum:*** using the high-level training plan as a guide, develop a curriculum in which training modules, teaching methods, and training resources are detailed.

4. ***Pilot the training:*** have a group of selected technicians complete the pilot training.

5. ***Evaluate and update the training as necessary:*** once the pilot-training is completed, evaluate the trainees' competencies to see how effective the training was. Adjust the training as necessary.

Once these phases are completed, capacity will be increased with internal technicians as well as after-sales technicians for this innovative product in the region.

3.1.3. Timeline and milestones

Now that the phases and programme implementation steps have been defined, it is time to identify milestones and discuss a possible timeline for implementation. Below are the milestones for each phase.

Phase 1 milestones

- **Training programme outline:** a high-level curriculum outline and selected training methodologies to be delivered for the internal technicians.
- **Completed training programme curriculum:** a detailed curriculum and training methodology.
- **Completed training pilot:** have piloted the training programme and have a first round of graduates.
- **Completed training program evaluation:** A one page summary of the pilot programme results as well as recommended adjustments for future courses.

Phase 2 milestones

- **Training programme outline:** a high-level curriculum outline and selected training methodologies to be delivered for the aftersales technicians.
- **Completed training programme curriculum:** a detailed curriculum and training methodology.
- **Completed training pilot:** have piloted the training programme and have a first round of graduates.
- **Completed training program evaluation:** A one page summary of the pilot programme results as well as recommended adjustments for future courses.

Given the milestones above, the GANTT chart below summarises the timeline for each milestone.

Table 3-1: Milestones and timeline for maintenance programme

MILESTONE	M27	M30	M33	M36	M39	M42	M45	M48
Phase 1								
Training programme outline								
Training programme curriculum								
Training pilot programme completed								
Training programme evaluation								
Phase 2								
Training programme outline								
Training programme curriculum								
Training pilot programme completed								
Training programme evaluation								

3.1.4. Next steps and further development

The next steps include following up with the demonstrator to ensure that they would like to implement this programme and if so, begin Phase 1.

3.2. After-sales user onboarding programme

The purpose of this programme is to raise awareness and capacity in the social context on general care for electric motorcycles and spur an increase in adoption. This programme is aimed at addressing the need to teach the end users how to raise issues, create tickets, and maintain their warranties. Below is a detailed discussion about this programme.

3.2.1. Programme goals and objectives

The program goals and objectives are as follows:

- Develop an after-sales user onboarding process so they understand how to use the Roam app, raise issues in the issue tracker, and where to go for repairs and maintenance to avoid voiding their warranty.

3.2.2. Programme implementation strategy

The program will be implemented over two phases. Phase 1 entails defining and developing the after-sales user onboarding process. Phase 2 covers disseminating the after-sales onboarding. These phases are discussed in greater detail below.

Phase 1: define and develop after-sales user onboarding process

In this phase, an after-sales user onboarding process will be defined and developed. It could take the form of a short demonstration at the point of delivery, a pamphlet with a QR code that leads to something on the app, or any other form. This phase will comprise the following steps.

1. ***Define the information to be included in the onboarding process:*** make a list of the vital information the user should know. Ensure it is simple and concise.

2. ***Determine how the onboarding process will be delivered:*** evaluate different methods of disseminating this information to the user taking into consideration the local context.

3. ***Pilot the process:*** have a group of selected users complete the onboarding.

4. ***Evaluate and update as necessary:*** once the process has been piloted, evaluate the users' competencies to see how effective the onboarding was. Adjust as necessary.

Once an onboarding process has been developed and piloted the next phase includes disseminating the process.

Phase 2: disseminate the after-sales user onboarding process

In phase 2, the onboarding will be disseminated either through the app, to the dealerships, or the sales team. This phase will comprise the following steps:

1. ***Define the point and method of dissemination:*** define exactly at which point in the sales process the onboarding will take place (ideally, it is at are shortly before the moment that the end user is handed the keys) and describe how it will be provided (person to person, via video, via pamphlet, etc.)

2. ***Disseminate the process:*** roll the process out gradually across the sales network.

3.2.3. Timeline and milestones

Now that the phases and programme implementation steps have been defined, it is time to identify milestones and discuss a timeline for implementation. Below are the milestones for each phase.

Phase 1 milestones

- **Finalized onboarding process:** a well-defined after-sales onboarding process in its final form (in person demonstration, app tutorial, pamphlet, etc.)

Phase 2 milestones

- **Process has been rolled out to at least one new place:** at least one new client has been delivered the onboarding during their purchase.

Given the milestones above, the GANTT chart below summarises the timeline for each milestone.

Table 3-2: Milestones and timeline for onboarding programme

MILESTONE	M27	M30	M33	M36	M39	M42	M45	M48
Phase 1								
Finalized onboarding process								
Phase 2								
Process rolled out to one new place								

3.2.4. Next steps and further development

The next steps in the process are to verify with the demonstrator that this programme is of value and if so, begin with Phase 1.

3.3. Fire safety training programme

The purpose of this programme is to develop capacity and knowledge around battery safety and how to manage battery fires. Given that these fires are of a different nature, it is important that the staff be trained in how to safely extinguish them. Details regarding this programme are given below.

3.3.1. Programme goals and objectives

The program goals and objectives are as follows:

- Develop a half-day or one day training in collaboration with an external partner that can deliver this training to employees.

3.3.2. Programme implementation strategy

The program will be implemented over one single phase. This phase entails collaborating with a fire safety training centre to develop and deliver the training. Details for this phase are discussed below.

Phase 1: collaborate with a fire safety training centre

In this phase we will identify potential fire safety training centres that exist in the region and determine whether they have battery safety modules included in their training. If they do not, we will work with international experts to provide us with the content to be shared with the local centre. This phase includes the following steps:

1. ***Create a list of potential fire safety training centres in the region:*** search online for fire safety training centres in the region and compile a list of their contact information.

2. ***Determine their capabilities:*** determine whether any of them offer battery fire extinguishing training. If not, proceed to the following optional steps.

3. ***Find an international expert who can provide their content (optional):*** if the capacity does not currently exist in the region, reach out to fire departments in developed countries to see if they will share their training content. Also check if any content exists online.

4. ***Incorporate the new content into the regional trainers' programme (optional):*** work with the local training center identified in step 1 to incorporate the new battery related material into their training.

5. ***Attend the local training centres' training:*** schedule a time to attend the training.

Next is s discussion of the timeline and milestones for this programme.

3.3.3. Timeline and milestones

Now that the Phases and programme implementation steps have been defined, it is time to identify milestones and discuss a possible timeline for implementation. Below are the milestones for each phase.

Phase 1 milestones

- **Completed list of fire safety trainers in the region:** a one-page list of fire safety training centres in the region and their competencies
- **Completed list of battery safety content:** a one-page list of the subjects that need to be covered when it comes to electric vehicle batteries (whether from the local centre or an international one).
- **A group of training graduates:** a small group of people within the demonstrators' company that has completed the training.

Given the milestones above, the GANTT chart below summarises the timeline for each milestone.

Table 3-3: Milestones and timeline for the fire safety programme

MILESTONE	M27	M30	M33	M36	M39	M42	M45	M48
Phase 1								
Completed list of local fire safety centres								
Completed list of battery safety content								
A small group of graduates from the programme								

3.3.4. Next steps and further development

The next steps in the process are to compile a list of potential training centres and reach out to other fire marshals to see about how the electric vehicle fire training looks.

4. SUMMARY

This report, one of three reports that make up deliverable 3.1 of the ENERGICA project, assessed the capacity building needs for the demonstrator in Kenya. The report used the TEES framework, a framework developed as part of the ENERGICA project and intended for comprehensive application in future contexts, to develop and propose capacity building programmes to assist in the development of the demonstrator project and ensure its long-term success in its associated context.

The results of the study outlined a need for capacity building efforts related to:

- Training internal and after-sales technicians in the specifics of repairing and maintaining electric motorcycles.
- Informing users about the proper care and maintenance of their motorcycles and where to get repairs made in the event of an issue.
- Training of staff working in the battery swapping stations on battery fire safety as it differs from traditional fire safety techniques.

Given the needs outlined above, the following capacity building programmes were proposed:

- An electric motorcycle technician capacity building programme.
- An after-sales user onboarding programme.
- A battery fire safety programme.

The results presented in this report, make up the work outlined in ***Sub-task 3.1.2: Creation of capacity building and adapted training programmes tailored to each product***. The recommendations and next steps presented in this report will be taken up and implemented in the following tasks:

- Task 3.2: Implementation of the capacity building programmes.
- Subtask 3.3.1: Definition of local value chains and innovative circular economy models
- Task 6.2: Development and testing of adapted urban mobility solutions
- Task 6.3: Demonstration in Nairobi
- Subtask 7.1.1: Development of a socio-technical model
- Task 8.2: Social acceptance analysis

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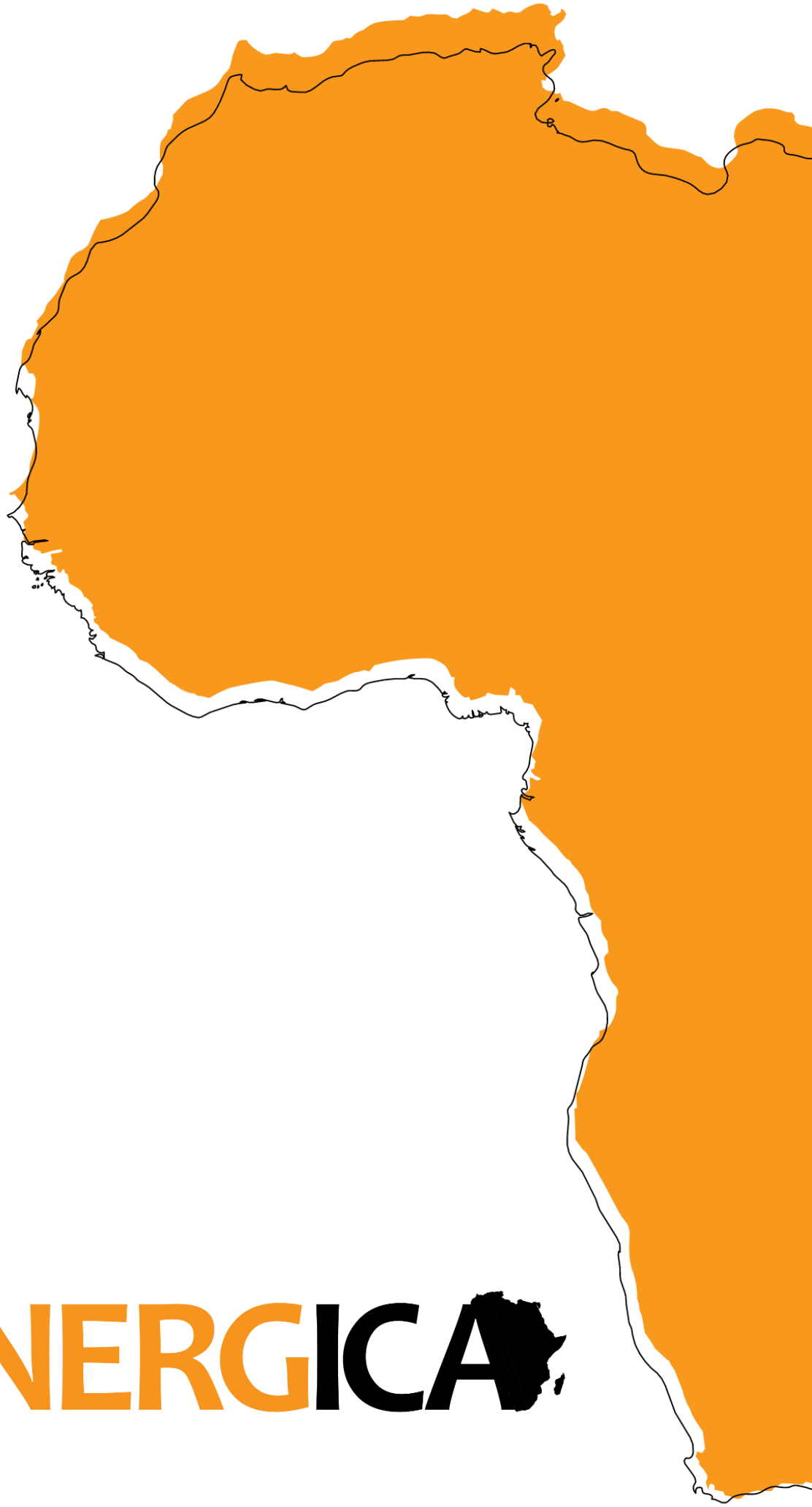

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