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SWARM-E: Leave No One Behind Bottom-up Energy Transformation of Last-mile Communities

D2.4. Demonstration of Sites Decision and Monitoring and Evaluation Framework Development

Organization: VITO

June 2025

Co-funded by the European Union

Co-funded by the European Union., project number 101146291. Views and opinions expressed within the current document are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor CINEA can be held responsible for them.

Document

Settings	Value
Milestone Title	Demonstration of site selection decision and Monitoring and Evaluation framework
Work Package Title	WP2 – Site characterisation and preparation
Description	D 2.4 Summary of demonstration of site selection decision and Monitoring and Evaluation framework, including identification of Key Performance Indicators (KPIs), data gathering methodologies, risks and mitigation strategies
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Doc. Version (Revision number)	0.3
Date:	27/06/2025

Document Approver(s) and Reviewer(s):

NOTE: All Approvers are required. Records of each approver must be maintained. All Reviewers in the list are considered required unless explicitly listed as Optional.

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Document history:

The Document Author is authorized to make the following types of changes to the document without requiring that the document be re-approved:

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Changes to this document are summarized in the following table in reverse chronological order (latest version first).

Revision	Date	Name	Short Description of Changes
3	27.06.2025	V0.3	Final review, spellcheck, numbering, formatting
2	16.06.2025	V0.2	Consistency of using words, spelling correction, revising picture captions, adjustment of the KPIs, summary and recommendation section added, clarification and specifying KPIs
1	24.05.2025	V0.1	Adjustment of terminology, KPIs redefined, most of the texts revised and rewritten, document reorganized, new sections, figures and tables added

Configuration Management: Document Location

The latest version of this controlled document is stored in <location>.

Nature of the deliverable		
R	Report	x
DEC	Websites, patents, filing, etc.	
DEM	Demonstrator	
O	Other	

Dissemination level		
PU	Public	x
CO	Confidential, only for members of the consortium (including the Commission Services)	

ACKNOWLEDGEMENT

This report represents Deliverable 2.4 of the SWARM-E project which has received funding from the European Union's Horizon Europe Research and Innovation programme under grant agreement No 101146291. The Community is not responsible for any use that might be made of the content of this publication.

SWARM-E is a trans- and multi-disciplinary approach for sustainable, affordable and modern energy access and well-being for Sub-Saharan Africa, aligned with the AU-EU Agenda 2063.

SWARM-E consists of several layers: 1) an innovative renewable electricity infrastructure, the SWARM grid, a circular and cyber-smart network where end-users exchange electricity of their solar home systems and form the nodes of a smart grid which can dynamically grow to meet demand; 2) unlocking unutilized renewable energy for productive uses in the water energy food nexus – cold storage, water purification, water pumping and irrigation, carpentry; 3) transfer and decentralisation of Global North energy transformation innovations – decentralised hydrogen production for cleaner cooking, bi-directional charging of light electric vehicles (two- and three-wheelers) to transport goods and people. SWARM-E builds on network effects generated through the inclusion of localised economies with strong producer-consumer linkages embedded within larger systems of trade and exchange for the creation of bottom-up energy communities.

SWARM-E will operate and replicate 5 pilots in Rwanda and Tanzania, under which 5 SWARM grids are installed, delivering 6.9 GWh of renewable electricity while generating income through the trading of electricity and avoiding the discard of 3,200 batteries; 5 water purification applications deliver 101.M L of clean water; 15 light electric vehicles deliver farmers' produce, power mobile productive uses and cold storage, increasing the yields of 1,000 farmers and reducing the food losses of more than 5,000; 700 kg of

H2 blended with LPG for cleaner cooking, and more than 500 jobs for women and youth to be created. The balanced participation of EU and AU private, public and civil society organisations in the consortium will ensure the knowledge transfer North-South and South-South, and the sustainability of value chains based on local value creation and entrepreneurship.

More information on the project can be found at: www.swarm-e.eu

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Summary of the deliverable

This deliverable presents SWARM-E's final site selections for system deployment, along with the Monitoring and Evaluation (M&E) framework for assessing project performance and impact across all chosen locations. It begins with background information and explains the purpose and importance of M&E. The report outlines the project's site selection methodology demonstration, Theory of Change, detailing the inputs, key activities, outputs, expected outcomes, and long-term impacts aimed at improving community development in the selected areas of Rwanda and Tanzania. It underscores the role of M&E in systematically tracking the project's progress and effectiveness, and in supporting evidence-based decision-making.

Key Performance Indicators (KPIs) are identified to assess the project's impact across technical, socio-economic, financial, environmental, and institutional dimensions. Each KPI is clearly defined to show its relevance and intended use.

The report also includes a comprehensive M&E plan, detailing how KPIs will be monitored—covering data collection methods, frequency, baseline values, and target outcomes based on theoretical projections of their evolution over time following the deployment of the SWARM-E infrastructure. Finally, the deliverable emphasizes the value of comparative impact evaluations within and across intervention sites. This will help deepen understanding of SWARM-E's impact and support future replication in other regions with limited access to modern energy services.

List of Acronyms and Abbreviations

Abbreviation	Definition
AC	Alternative Current
DC	Direct Current
FGD	Focus group discussion
H-LPG	Hydrogen blended Liquified Petroleum Gas
IRR	Internal Rate of Return
KPIs	Key Performance Indicators
kWh	Kilowatt Hour
LEV	Light Electric Vehicle
M&E	Monitoring and Evaluation
NPV	Net Present Value
P2P	Peer-to-Peer
PUE	Productive Use of Energy
SHS	Solar Home System
SSA	Sub-Saharan Africa
ROI	Return on Investment
ToC	Theory of Change
WP	Work Package
WTP	Willingness to Pay

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1. Introduction

Access to clean, affordable, and reliable energy remains a major challenge in Sub-Saharan Africa (SSA), where over 570[1] million people still live in energy poverty without consistent access to electricity and modern energy services. This persistent energy gap undermines water, energy, and food (WEF) security, restricts socio-economic development, and heightens vulnerability to climate change. In rural regions of countries such as Rwanda and Tanzania, decentralized renewable energy solutions—such as mini-grids and community-based solar systems—have emerged as viable tools to bridge this gap and promote inclusive local development.

In response to this challenge, the SWARM-E project was launched as a collaboration between African and European research institutions and private sector partners. The project aims to enhance energy access, bolster climate resilience, and promote the productive use of energy (PUE) in off-grid communities in selected rural areas of Rwanda and Tanzania. At its core, SWARM-E introduces a bottom-up approach using interconnected solar home systems (SHSs), referred to as SWARM grids, to enable peer-to-peer (P2P) electricity trading. By allowing households with surplus solar energy to share it with others, the project optimizes local energy use and empowers users to become both producers and consumers of electricity. This model contributes to improved access to energy, clean water, and food, while also advancing broader community development objectives.

Site selection was guided by predefined criteria and informed by field visits to assess local context and accessibility (More information and details were presented in D2.1 and D2.2). To evaluate the project's implementation and impact, a comprehensive Monitoring and Evaluation (M&E) framework has been developed. This framework is a key instrument for ensuring accountability, measuring effectiveness, and facilitating continuous learning throughout the project lifecycle and beyond. It is designed to track how the project is implemented, assess its outcomes, and analyze long-term changes in the project areas in Rwanda and Tanzania. It also supports evidence-based decision-making and adaptive management by project partners and stakeholders.

The M&E framework adopts a performance-based approach, monitoring progress across technical, socio-economic, financial, environmental, and institutional dimensions. It details the methodology for data collection and analysis, covering indicators such as electricity and clean water access, uptake of productive energy uses, environmental impacts, capacity development, and the engagement of women and youth in local development. The framework specifies responsibilities, timelines, and key performance indicators (KPIs) for each project site.

To enable a rigorous evaluation of project impact, monitoring activities will be conducted in both intervention areas (where SWARM-E is implemented) and comparison areas (without the intervention). This comparative analysis allows for more accurate attribution of observed changes to the project. Additionally, the framework incorporates mechanisms to identify and address risks or challenges that may

[1] IEA, IRENA, UNSD, World Bank, WHO. 2024. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. © World Bank.

arise, ensuring that the project remains responsive to local needs and conditions. Through regular reviews and stakeholder input, the framework fosters ongoing learning and helps keep project efforts aligned with community priorities.

Beyond tracking progress, the M&E framework supports continuous project improvement. It provides insights to refine business models, inform technology choices, and shape long-term sustainability strategies. It also captures the project's contributions to entrepreneurship, community resilience, and advancement of the Sustainable Development Goals (SDGs). By systematically documenting and sharing results, the framework promotes collaboration among European and African partners and offers a scalable model that can be replicated in other parts of SSA.

In summary, the M&E framework is a vital component of the SWARM-E project. It enhances transparency, strengthens coordination, and ensures that project activities deliver tangible, inclusive development outcomes that reflect the real needs of the communities involved.

2. Overview of the Site Selection Process and Decision

The site selection decision process depicted in Figure 1 provides a structured and iterative approach followed for the identification of appropriate sites for implementation of the SWARM-E project in both countries. The process was designed to ensure that selected sites meet a set of well-defined technical, social, and economic criteria, aligning with local community needs and project goals. The selection process started with defining pre-selection criteria including:

- Number of inhabitants living in the location and number of households
- SHSs density

Distance between houses

- Infrastructure status (site accessibility)

Location of the site and houses (getting GPS coordinates)

- Mobile network availability (at least 3G)
- Mobile money technologies (possible paying and money transfer options)
- Available cooking technologies and potential development (Rwanda)
- Drinking water sources
- Availability of E-mobility
- The potential of the site being electrified and socio-economic development.

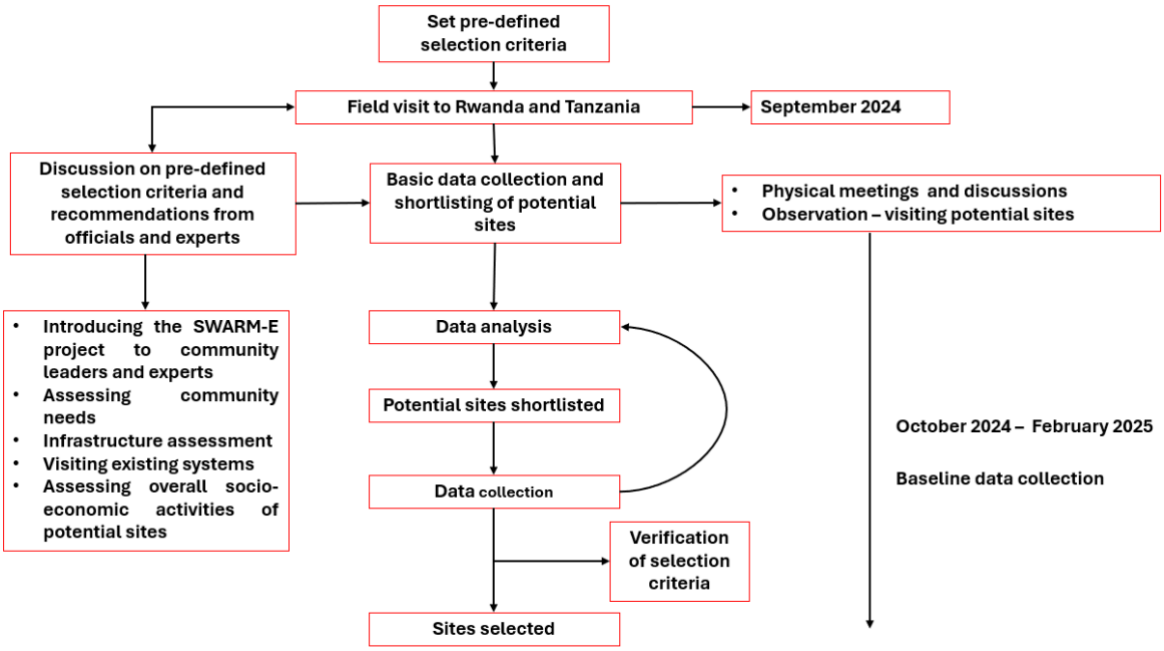

Figure 1. Site selection and decision demonstration

Steps of site selection

Phase 1: Initial field visit and stakeholder engagement

The selection process began with a field visit to Rwanda and Tanzania by local partners of the project located in both countries, with the objective of gathering the data based on the pre-defined selection criteria as well as listing potential sites. The field visits key activities were:

- Physical meetings and discussions with community leaders, local government officials, and sector experts.
- Observational visits to potential sites to understand the local context.

The physical meeting and the observation include:

  - Introducing the SWARM-E project to local community leaders and relevant technical personnel.
  - Assessing community needs to ensure the project will serve essential functions.
  - Evaluating infrastructure availability such as access to transport and telecommunications.
  - Understanding existing systems (such as SHSs and mini-grids) to learn from ongoing local energy access and socio-economic activities.
  - Assessing the broader socio-economic activities at each potential site, ensuring the project complements local development plans.

At this stage in 5 districts of Rwanda (14 villages and 2 refugee camps) and 2 islands in Tanzania were shortlisted and preliminary data were collected based on the predefined selection criteria.

Phase 2: Data analysis and verifying the selection criteria

The team conducted a thorough analysis of the field data collected by local partners during this stage of site selection. Based on this evaluation, the selection criteria were carefully reviewed and refined to ensure optimal site identification. This process resulted in the selection of seven strategic locations for the project's implementation phase: five in Rwanda (including two refugee camp sites that present unique energy access challenges) and two in Tanzania. An extensive survey was made on the selected locations– to understand the needs of the community, the current situation in terms of SHSs density, number of houses and distance between houses, location, potential productive use of energy and community priorities, clean cooking access and fuel options, training needs and competence, site accessibility, mobile money technologies, mobile network and much more. The complete methodology, selection process details, and outcomes from both Phase 1 (preliminary assessment) and Phase 2 (final selection) have been documented in the project's Deliverable including D2.1, D2.2 and D2.3. Table 1 presents the selected sites in which the SWARM-E project will be implemented: four sites in Mahama, Gakoma and Kanombe in Rwanda, and Kwale in Tanzania. Koma island in Tanzania was proposed in the pre-selection phase but now it will be considered as a control group. This decision is based on the detailed assessment analysis outlined in reports D2.2 and D3.1, which revealed a higher potential for PUEs on Kwale island. Furthermore, the limited accessibility to decentralized PV and the presence of mini-grid infrastructure in

Kwale (which is not functioning during the visit of the project team) provides opportunities to repurpose existing assets in the new setup as well as for further impact investigation of the project.

Table 1. Adapted from table 3 in D2.1. selected sites in Rwanda and in Tanzania. Koma was not selected due to infrastructure challenges.

Site Name	Country	Population	Selected	Brief site description
Mahama camp-Kirehe district I	Rwanda	500	YES	The camp is ideal for the SWARM-E Project. It has business potential, and people are also familiar with OffGridBox technology (three boxes have been installed previously. Beneficiaries are making good use of them by generating profits from their businesses, such as power bank charging, phone charging, shoe making, etc).
Mahama camp-Kirehe district II	Rwanda	435	YES	
Tunduti-Ngoma district	Rwanda	1,900	NO	Highly recommended site for all SWARM-E solutions as very remote and isolated, with no business activity but with plenty of potential due to its booming economy with banana farming. OffGridBox is also nearby.
Gakoma-Kayonza district	Rwanda	845	YES	Recommended by local leaders (Sector Executive secretary), Gakoma has business potential. The distribution of houses seems to be suitable for the implementation of the project.
Kanombe-Nyagatare district	Rwanda	1,700	YES	It is a highly recommended site for all SWARM-E solutions as it is very remote and isolated, with no business activity but with a lot of potential due to its thriving banana economy. There is also OffGridBox installation nearby.
Kwale Island	Tanzania	450	YES	Kwale Island is relatively easily accessible from Dar es Salaam; it has a medium penetration of SHS and a good distribution of houses to suit the needs of SWARM-E. There is also an old mini-grid to be

				revitalized, which currently belongs to the community.
Koma Island	Tanzania	700	NO	Koma Island is located a little south of Kwale Island, also easily accessible by boat from Kisiju. It is estimated to have a high penetration of SHS with a relatively good distribution of houses.

Phase 3: Understanding community needs related to PUEs

An analysis of Productive Uses of Energy (PUEs) was carried out for each location, alongside the initial system proposal, to understand the community's preferences and determine which PUEs will be implemented at each site. This site-specific evaluation considered several factors, including local energy needs, terrain characteristics, and potential socio-economic activities that could benefit from energy access. As a result, potential PUEs and some appliances were recommended for each location to ensure they are technically feasible and have maximum impact, as shown in Table 2. For a comprehensive breakdown of the PUEs and appliances proposed for each site, see deliverable D3.1.

Table 2. Overview of recommended PUEs according to the needs of the communities in each site and implementation phase (adopted from D3.1)

	Evaluation	Recommended implementation phase
Pilot: Kwale Island, Tanzania		
Water desalination system	Positive	Phase 3
Seaweed grinder	Positive	Phase 3
Cold storage for fish, medicine and other uses	Positive	Phase 3, following a four-step process detailed in conclusion
Electric two-wheelers on the island	Positive under three conditions	Phase 3
Electric two- or three-wheelers on the mainland	Unclear at this stage, requiring further data	Decision in Phase 3 on a potential implementation in Phase 4
Electric boats	Unclear at this stage, requiring further data	Decision in Phase 3 on a potential implementation in Phase 4
Pilot: Mahama, Rwanda		

Appliances for small businesses, e.g. electric sewing machines, hair shavers, etc.	Positive	Phase 3
Electric two-wheelers (electric bicycles, motorcycles)	Positive	Phase 3
Cooking with H2/LPG blend	Positive	Phase 4, as planned in the GA
Pilot: Gakoma, Rwanda		
Water purification system	Positive	Decision in Phase 2 on a potential implementation in Phase 3
Milling machine	Positive	Decision in Phase 2 on a potential implementation in Phase 3
Water pump and irrigation system	Positive	Decision in Phase 2 on a potential implementation in Phase 3
Electric two-wheelers for milk transport (electric motorcycles)	Positive	Phase 3
Pilot: Kanombe, Rwanda		
Water purification system	Positive	Decision in Phase 2 on a potential implementation in Phase 3
Maize sheller	Positive	Decision in Phase 2 on a potential implementation in Phase 3
Water pump and irrigation system	Positive	Decision in Phase 2 on a potential implementation in Phase 3
Replication or control: Koma Island, Tanzania		
Water desalination system	Discussion for replication under REA or SWARM-E	
Seaweed grinder	Discussion for replication under REA or SWARM-E	

As suggested in D3.1, PUEs with stronger justification should move forward in phase 3 ("step 3"), following the establishment and interconnection of the peer-to-peer grid with the OGB system in Rwanda and the revitalized mini-grid in Tanzania, while those requiring further assessment or posing greater risk can be addressed in the final phase 4 ("step 4"). As the selection and implementation of PUEs at each location

remain open and uncertain, the implementation will follow the SWARM-E implementation process outlined in D3.1 (Figure 2).

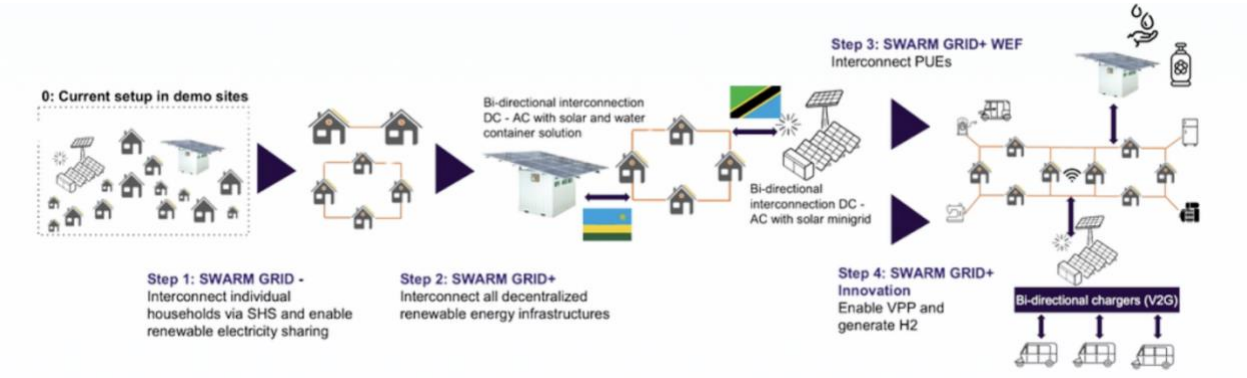

Figure 2. SWARM-E implementation process

3. Monitoring and Evaluation (M&E) Framework

3.1. Background: Definition, why it matters

The Monitoring and Evaluation (M&E) framework consists of two distinct but interconnected components: monitoring and evaluation. While they are closely related, each has its own purpose and methodology, making it important to define and understand them separately to fully grasp the scope and function of the proposed M&E framework. **Monitoring** is a continuous process of collecting, analyzing, recording, and reporting data to track the progress of a project toward its set objectives and expected outcomes. It provides ongoing insights into project performance, helping identify trends and patterns, which in turn supports timely decision-making and effective management. Through monitoring, project teams can adjust strategies as needed, ensuring that activities remain aligned with the intended goals. **Evaluation,** on the other hand, is a systematic, objective, and periodic assessment of a project—whether ongoing or completed. In the case of the SWARM-E project, evaluation focuses on the performance and outcomes achieved. It involves gathering and interpreting reliable data to assess how well the project objectives have been met. It also examines broader aspects such as relevance, efficiency, effectiveness, impact, and sustainability[2].

Together, monitoring and evaluation form a unified framework that supports structured project management, strategic planning, and performance measurement. This framework incorporates key elements including data sources, collection methodologies, roles and responsibilities, risk mitigation strategies, and Key Performance Indicators (KPIs). These KPIs are developed to meet **SMART criteria**—they are Specific, Measurable, Achievable, Relevant, and Time-bound—ensuring clarity, accountability, and meaningful performance and impact tracking. Additionally, it also defines how data will be collected, analyzed, and reported, ensuring the project remains on course and that its results are clearly communicated to all stakeholders[3].

As part of Work Package 2 (WP2), and in alignment with the overall goals of the SWARM-E project, the development of this M&E framework aims to establish a unified and consistent approach to monitoring and evaluation across all work packages (WPs). This integration enhances coordination, transparency, accountability, and impact measurement. Regardless of individual WP responsibilities, all consortium partners will operate under a shared understanding of key project elements such as activities, data collection methods, performance measurement, and impact evaluation. This common understanding helps reduce inconsistencies or confusion that could arise from using different tools, terminologies, or metrics—ensuring that all project teams speak the same "**language**."

By working within a standardized framework, communication improves, expectations are clarified, and the overall effectiveness of the M&E process is strengthened. The framework also offers clear guidance on how data should be managed throughout the project lifecycle—from collection to analysis and

[2] Monitoring-and-Evaluation-2.pdf
[3] What is a Monitoring and Evaluation (M&E) Framework?

reporting, laying a solid foundation for evidence-based decision-making and post-implementation assessment.

Furthermore, this integrated approach supports more effective tracking of progress across WPs, allowing the project team to better monitor impacts, identify successful practices, and address risks in a timely manner. With consistent performance indicators and data collection strategies in place, progress can be measured more accurately in relation to the project's broader goals. This ensures that each WP contributes meaningfully to the long-term impact intended in the rural communities (selected sites) of Rwanda and Tanzania. Additionally, a robust and unified M&E system strengthens accountability and enables transparent reporting to stakeholders. By producing reliable data on project performance and outcomes, the framework also supports scalability and replication of successful interventions, ensuring that the project's benefits can be sustained and expanded.

3.2. Theory of Change

Capturing performance at distinct stages of the project and evaluating its impact requires building a process that reflects the changes the project brings to the community, Theory of Change (ToC). The ToC reflects the transformation the project aims to achieve in the community and outlines:

a) the changes that occurred during and after implementation of the project (activities, factors, and conditions that lead to changes and the reasons behind the changes)

b) lessons learned from the success and challenges of the project implementation and the impacts it brought could help scalability of the project and future SWARM grid initiatives

c) the needs and strategies essential to sustain the changes

d) the goals, the performance indicators and impacts.

Figure 3 presents the simplified schematic of the ToC for the SWARM-E project, adapted from the project proposal's goals, objectives, and expected long-term impacts. The presented ToC is based on the project's explicitly stated long-term impacts and the characteristics of the KPIs identified that are location specific and relevant, quantifiable, goal oriented and timely. The expected impacts include socio-economic development of selected communities (such as income growth, health and education improvements, women and youth economic participation), promotion and diversification of productive use of energy, planned training and capacity building programs (i.e., the change it will bring), job creation and economic empowerment.

For instance, when rural communities gain electricity access through the SWARM-E project, are connected, and receive appropriate training and capacity building for PUE, local socioeconomic development becomes feasible. This may lead to job creation, increase average household incomes, and enhance the overall quality of life and standards of the communities. As a result, the expected outcomes and long-term impacts of the SWARM-E project - including the creation of empowered communities, inclusive socio-economic development, significant emission reduction, improved social services, and other benefits - will be promoted, resulting in the possibility of scalability.

How does the ToC link to the M&E framework of SWARM-E?

The M&E framework is explicitly grounded in the project's ToC, ensuring that all monitoring and impact assessments are directly aligned with the broader vision and intended transformation of the SWARM-E intervention. The ToC provides a structured pathway that outlines how inputs and activities (such as decentralized energy infrastructure, capacity building, and access to productive energy uses) are expected to lead to measurable outputs, intermediate outcomes, and long-term impacts, including improved livelihoods, reduced emissions, and inclusive economic development.

The M&E framework operationalizes this pathway by translating each ToC component into measurable KPIs and defining data collection strategies to track progress across technical, socio-economic, financial, and environmental dimensions. This alignment enables the project team to continuously test the assumptions embedded in the ToC, validate causal links, and adapt interventions as necessary to maximize effectiveness and sustainability.

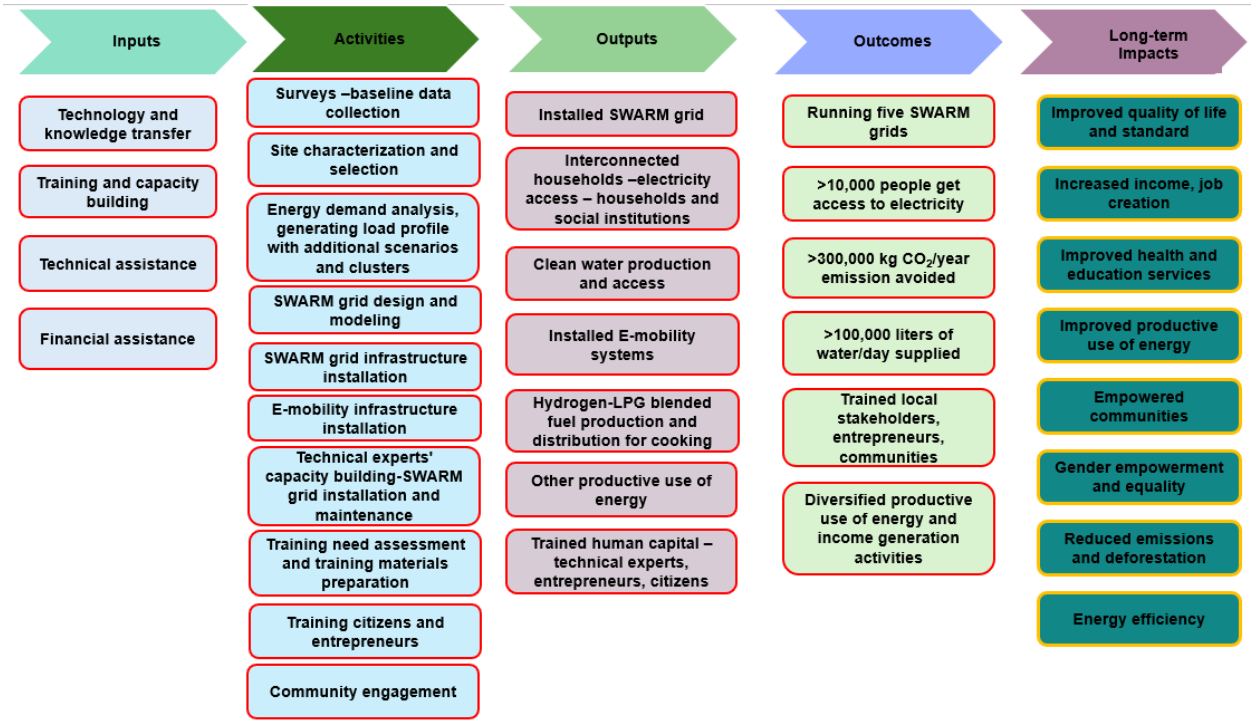

Figure 3. Schematic of SWARM-E project theory of change

3.3. Data collection

An effective data collection mechanism is a vital component of the M&E framework, it helps to track the performance and impact of any intervention, like SWARM-E. It provides the evidence needed to measure progress, measure whether the objectives are achieved or not, evaluate outcomes and long-term impacts, and guide decision-making. It also gives directions to answer questions including:

- What data will be collected - based on KPIs

- Who will collect it - all partners are responsible for the data collection across the different blocks (see Table 9 for more information)
- When and how often it will be collected
- How will it be collected (methods and tools)

Moreover, in the context of the SWARM-E project, data collection enables us to carry out project technical performance assessments, identify consumer satisfaction, analyse financial sustainability, and assess the overall socio-economic impact of the system on project sites. This objective can be achieved by employing a multistage data collection method and comparing the performance and impact of the project after and before the intervention. Figure 4 presents the data collection stages of the SWARM-E project M&E framework throughout the project time period. The data collection stage encompasses three core data collection stages: **baseline (t_{start})**, **intermediate assessment (t_{inter})**, and **endline (t_{end})**. Mainly the data collection stages are the start and the end, however after the installation of the SWARM infrastructure (in the second - third quarter of the second year of the project time), automated data will be generated and recorded from each component including SWARM grid, mini-grid and OGB. The anticipated period for the installation of the systems and assessment is:

t_{start} assessment = M6 | Installation of tech = ~M24 **| t_{end}** assessment = ~M40

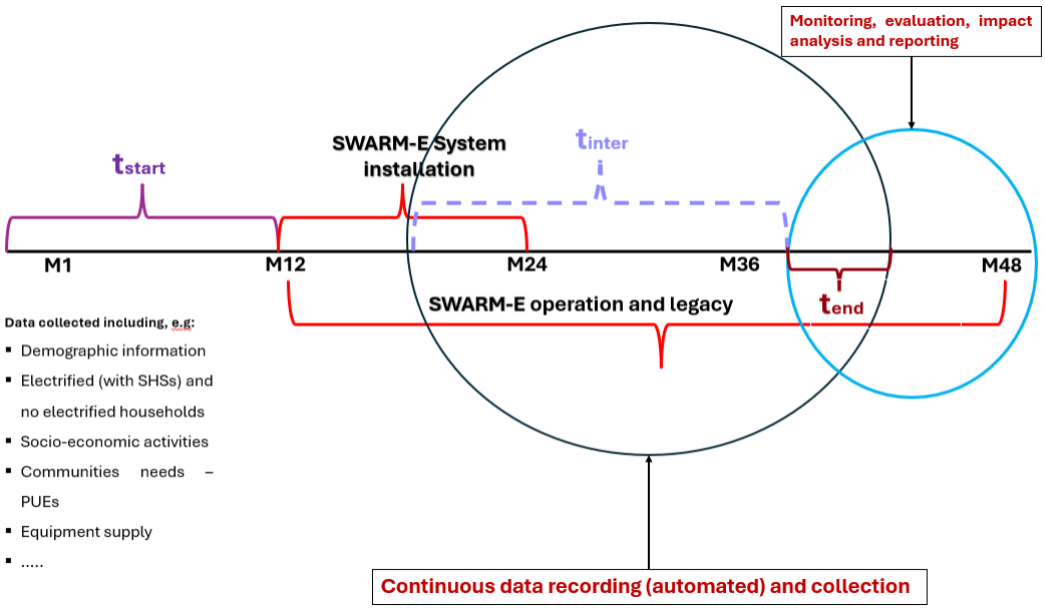

Figure 4. Data collection stages of the SWARM-E project M&E

Depending on the data type, various tools and techniques are applied:

- Structured surveys (household, technical experts, community leaders, institutional leaders)
- Focus group discussions, stakeholder interviews

- Automated data from the control systems of SWARM grid, mini-grid, OGB
- Regular monitoring updates from implementation teams

In the first phase of the project (t_{start}), extensive baseline data in all the selected sites were collected using surveys destined for household and local business, key informant interviews (with local community leaders, public and religious institutions, mobile money operators, and suppliers of appliances), and focus group discussion (See D2.2 for more information). This provided information about baseline socio-economic activities of the villages, the needs of the communities (in relation to PUEs and future socio-economic development), energy demands, SHSs density (electrified and non-electrified households), business activities, number of social institutions and their electricity access situation as well as clean water and clean cook access (available options of cooking technologies and fuels).

In the intermediate phase (t_{inter}) of the project, the automated data from the remote controlling and monitoring system of each system (SWARM-E, mini-grid and OGB) will be recorded. The automated data includes energy consumed (kWh/day), energy generated (kWh/day), energy traded (P2P energy trading), system efficiency, cooking fuel produced and consumed (H-LPG blended), clean water produced and consumed, institution energy consumption (schools and healthcare facilities connected to all SWARM-E infrastructures in all selected sites – this doesn't include healthcare facilities and/or education institutions having their own energy systems). At the later stage of the project phase (t_{end}), extensive data will be collected using automated data from control systems, surveys, focus group discussions and phone calling to get data and information on how the SWARM-E impacts the communities in all intervention sites. This survey will capture the impact of the project from different perspectives: income generation, improving women and youth decision making, economic participation and job creation, additional business opportunities created, additional of new electrified households and appliances additions in the already electrified households (prosumers).

The collected data will be rigorously analyzed to:

- Track KPIs throughout the project lifecycle,
- Improve/intervene with additional technical and capacity building measures to enhance uptake and impact,
- Compare baseline, mid-term and endline data in accordance with the targets,
- Understand the intervention's socio-economic and environmental impacts, and
- Identify lessons learned and best practices for scalability and replicability.

From this dataset, a set of key indicators was selected to monitor progress and impact over time, focusing on the most relevant aspects to the project's objectives.

As with any intervention involving infrastructure development, the SWARM-E project must critically evaluate the effects that its deployment and functioning has on the socio-economic and energy-related outcomes of the target communities. To achieve this, it is essential to distinguish between changes directly attributable to the SWARM-E intervention and those driven by external or unrelated factors. To this end, SWARM-E incorporates **control conditions** into its evaluation framework. These control

conditions allow for the monitoring and comparison of community evolution in both intervention sites (those with SWARM-E installations) and non-intervention sites (similar communities without SWARM-E infrastructure). This comparative approach enables the project to establish a baseline and measure relative impact, thereby strengthening the validity and robustness of the evaluation findings.

To assess the impact of SWARM-E infrastructure, the evaluation strategy employs a combination of ***within-site*** **and** ***between-site*** control conditions. This dual design enables both temporal tracking within communities and comparative benchmarking across different sites, providing a holistic view of the intervention's effects.

I. Within-site (longitudinal) comparison

This approach's objective is to monitor how the same community evolves over time after the introduction of SWARM-E infrastructure. This is achieved by collecting data at multiple time points—before installation (t_{start}), during intermediate stages (t_{inter}), and at endline (t_{end}). Such a longitudinal design enables the observation of temporal change patterns in energy access, quality of life, economic activity, and other key indicators within each SWARM-E site. This approach captures the full trajectory of change and is particularly valuable for understanding cause-effect sequences and the dynamic evolution of impacts resulting from decentralized energy access at the selected sites (Figure 5). This control methodology will be used across all selected sites in Rwanda in Tanzania.

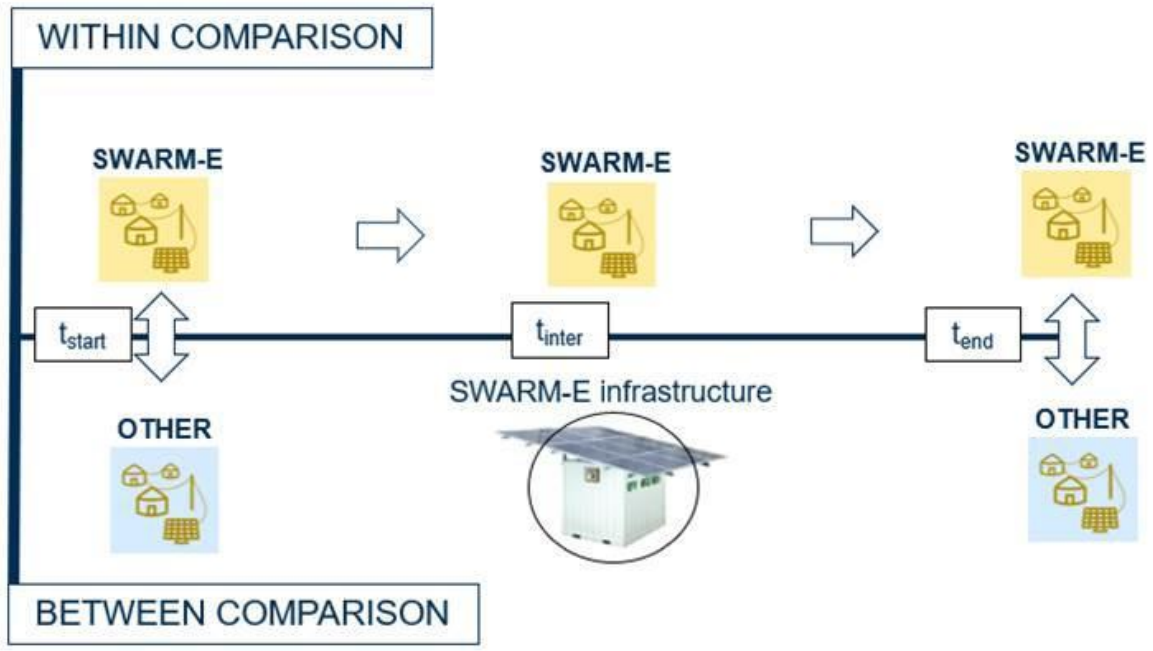

Figure 5. Within- and between-site control methods: microgrid icons mark data points: three at SWARM-E sites (within-site) and two in control communities (between-site).

II. Between-Site (Cross-Sectional) comparison

The goal of this approach is to evaluate the impact of SWARM-E intervention by comparing sites where the technology is implemented with similar communities that do not receive the intervention. To ensure

a valid comparison, control sites must be carefully selected to mirror the intervention villages in terms of socioeconomic characteristics, existing infrastructure, and access to services.

In line with this methodological rigor, **between-site control comparison will be used only in Tanzania**, specifically between Kwale (intervention site) and Koma (control site). These two islands present highly comparable ecosystems, sharing similarities in population size, infrastructure, degree of isolation, economic opportunities, and current levels of electricity access. This comparability provides a solid foundation for measuring the differential impact of the SWARM-E project.

In contrast, identifying equivalent between-site controls in Rwanda proved more challenging due to greater heterogeneity across the sites. Differences in infrastructure, demographics, and baseline conditions limited the possibility of establishing a valid between-group comparison. As a result, impact monitoring in Rwanda will rely solely on within-site control, tracking changes over time in the same communities where the intervention is implemented. Table 3 presents the summary of planned control sites and conditions in both countries.

Table 3. Summary of planned control conditions

Country	SWARM-E Site	SWARM-E tech	Within control	Between control site
Rwanda	Gakoma	Yes	Yes	No
Rwanda	Mahama	Yes	Yes	No
Rwanda	Kanombe	Yes	Yes	No
Rwanda	Tunduti-Ngoma	No	No	No
Tanzania	Kwale	Yes	Yes	Koma
Tanzania	Koma	No	Yes	Kwale

To track changes against the baseline, a streamlined sub-survey is going to be conducted at regular intervals. This follow-up targets the same households surveyed at the start (t_{start}) and is intentionally concise (approximately 5–8 minutes), designed for efficient yet meaningful monitoring. The sub-survey maintains alignment with the original dataset by drawing from its core themes, but limits questions to those that best capture evolving household conditions (see Figure 6).

The sub-survey is **primarily administered by phone**; when direct contact is not possible, village chiefs might assist in gathering responses. This has proven key during the organization of the focus groups in WP3 and can help ensure good response rates while minimizing logistical barriers.

MAIN FIELDS CONTROL SURVEY
General
Validation SWARM-E infrastructure connection Indicate whether you are currently benefiting from SWARM-E infrastructure
Appliances ownership Do you have any type of electrical appliance in your household? [From list]
Usage of electrical appliances Indicate hours at which electrical appliances are more often used and for how long [From list]
Households
Electricity access Overall, how satisfied with the quality of your supply of electricity over the last 12 months?
Willingness to pay for a SHS How much are you willing to pay per month for a pay-as-you-go (PAYG) solar energy service?
Water availability Was water continuously available during the last 12 months?
Cooking fuel In the last 12 months, has your household used any of the following fuels for cooking? [From list]
Comfort and wellbeing In the last 12 months, how would you rate your comfort and wellbeing level of your household in a scale of 1 to 10?
Income evolution In the last 12 months, how has your household income evolved?
Energy attitudes and capacities Ten related items - [Financial training, Energy literacy training, Social pressure on electricity use, Flexibility provision eagerness, Perceived complexity of electricity management, Perceived benefits of electricity access, Importance of reducing energy costs, Importance of saving energy, Importance of reducing CO_2 emissions, and Importance of energy independence].
Businesses
Electricity access Overall, how satisfied with the quality of your supply of electricity over the last 12 months?
Business impact On average, how many people work here every day?
Market reach What is the geographical reach of your business (e.g., local village, nearby towns, regional)?

Figure 6. Main sub-survey fields that will be recorded to monitor socio-technical improvements associated with the deployment of SWARM-E infrastructure

3.4. SWARM-E Key Performance Indicators

As mentioned above, KPIs are the key element of SWARM-E's M&E framework, which offers a structured guideline to assess progress and measure outcomes as well as impacts. As part of the proposed M&E, the KPIs generated from the proposal document in consultation with each WP, will serve as a tool to track performance, assess efficiency, guide timely decision-making and measure the overall impact of the

project in transforming the communities' life quality and standard. Moreover, KPIs will be used as a metric to analyze and compare the impact of the project on different community groups, including control and treatment (intervention area) groups of SWARM-E intervention sites. Furthermore, KPIs are developed to track the effectiveness, measuring how each WP activity contributes to the intended outcomes/impacts, and to show the changes presented in the ToC are meaningful. Designed to meet the SMART criteria: they are specific to project goals, Measurable with clearly defined metrics, Achievable within available resources, relevant to the desired outcomes, and time-bounded to enable consistent tracking over the project timeline. These indicators ensure that each project's activity and outcome is clearly defined, trackable, and aligned with the project's objectives and timelines.

Therefore, KPIs are identified to reflect goals and objectives across different key domains of the project. These include technical, socio-economic, financial, environmental, and other aspects (e.g., political). All of them are crucial to show the achievement of the broader vision outlined in the project proposal document as well as ToC extracted from it. The summarized and categorized KPIs across the different dimensions as well as specific KPIs under each category and its description are presented below. The extensive list of KPIs identified can be found in Table 9.

3.4.1. Technical KPIs

The technical KPIs identified to assess the performance and impact of the project are described as follows:

1. **Site Selection & Infrastructure Installation:** This category of KPIs focuses on the identification, selection and implementation of the project in the selected sites in both countries. Additionally, it monitors the number of sites where SWARM-E infrastructures have been successfully installed and commissioned. This reflects not only the physical implementation of the project but also the operational readiness of all installed SWARM grids, mini-grid and OGB containers. These indicators provide a clear picture of the project's on-the-ground development, showcasing both the planning and execution phases of electricity access and adoption of PUEs in the selected locations. The data required to select the location was collected in the first phase of the project using predefined criteria and verified in extensive end-user surveys as reported in D2.1 and 2.2. Specific KPIs include:

    - **Number of selected sites** -> ensuring that the sites selected for project implementation are appropriate and fully aligned with the predefined selection criteria is essential. This involves systematically verifying that each site meets the necessary technical, socio-economic, and logistical requirements to support successful deployment and long-term operation of the project interventions.

    - **Number of installed SWARM grids** -> the deployment and operational readiness of the systems implemented across all project sites will be closely evaluated. This includes tracking and monitoring the number of SWARM grids installed (making sure the SWARM grids are installed in all the proposed locations), as well as ensuring that all connections are functioning as intended. Verification of system installation and readiness will be carried out through a combination of field visits, analysis of end-user feedback, and review of automated data collected by the SOLshare control system for the installation of SWARM-E systems.

- **Mini-grid revitalization (number of mini-grid rehabilitated in the selected sites of Tanzania) ->** tracking the number of mini-grid systems that have been rehabilitated in selected sites of Tanzania, focusing on the restoration and improvement of existing energy infrastructure to enhance reliability and operational efficiency. Automated data generated by the mini-grid control system will be continuously recorded and closely monitored, ensuring real-time tracking of the overall system and mini-grid performance as well as the verification of the system revitalization and readiness will be ensured using the collected data.
- **Operational e-mobility ->** tracks the number of electric two- and three-wheeled vehicles (such as electric bicycles and motorcycles) that become operational as a direct result of the SWARM-E intervention in Mahama and Gakoma, Rwanda and in Kwale, Tanzania*.The data will be collected systematically throughout the operational phase, capturing trends and adoption rates as well as energy consumption during and right after the implementation phase. Additionally, a survey will be conducted towards the end of the project (t_{end}) to assess the broader socio-economic impact, including changes in transportation behaviour, created income generation opportunities using e-mobility, and overall mobility patterns linked to the intervention as well as if there are implications of additional interest of users to increase e-mobility options.
- **Installed LEV charging station ->** tracking the number of established dedicated charging stations in Mahama and Gakoma, Rwanda (will be considered in Tanzania as well depending on the evolution of the implementation), including the creation of a "Pit Stop" model—designed for fast charging functionality to enhance convenience and reduce downtime for electric vehicle users. Energy consumption patterns of the charging station will be monitored using the SOLshare and mini-grid control systems and the LEVs charging per day or within a given period will be captured during the survey at the end line.
- **Number of OffGridBox products installed ->** this involves monitoring and evaluating the number of individual OffGridBox (OGB) units installed in Rwanda, while ensuring each unit remains fully operational. It includes tracking installation progress, assessing system functionality and performance over time, and taking necessary actions. Additionally, the control system of the OGB will be used to track real-time data of the overall system performance and operational readiness.
- **Amount of clean water production and supply (liters/day)** -> This KPI monitors the daily clean water output, measured in liters per day, from the OffGridBox (OGB) systems going to be installed in Mahama, Kanombe, and/or Gakoma, Rwanda, as well as from a different water purification/desalination system going to be installed in Kwale, Tanzania (decision the type of technology and implementation will be made in later phase of the project). Each system is equipped with its own control system, enabling real-time tracking of their

* *Like other KPIs, the implementation and operation of e-mobility remain open, flexible and adaptable, with uncertainties that are likely to change and evolve throughout the implementation phase*

operation and performance. It specifically measures the total volume of water purified by each OGB unit and the actual amount distributed to community members. The data collection occurs through automated system reporting from the OGB units (recording daily production and distribution) and household surveys documenting average daily water consumption patterns from the users. The combined data provides a complete picture of water supply performance, from production to end-user consumption.

- **Technology adoption (H-LPG blended fuel) and operation->** this KPI focuses on the efforts made by the project in the transition towards clean cooking solutions by installing a production facility and overseeing the production of blended hydrogen-LPG fuel in Rwanda. It tracks the installation and operationalization of the electrolyzer system powered by the SWARM-E infrastructure. Field visit reports by local partners will be used for the verification of the installation of the system.
- **Clean fuel produced and distributed (kgs) in Rwanda ->** this indicator focuses on tracking the total amount of hydrogen-LPG blended fuel that is produced and delivered to end users. The monitoring process will involve two main methods: first, using metered data to measure the actual quantities produced and distributed; and second, conducting endline household surveys. These surveys will help gather information directly from users to understand whether they are using the blended fuel, how often they use it, and in what quantities. This combined approach ensures accurate and comprehensive data collection on both the supply and the actual household usage of the fuel.

2. **Energy Demand & Supply Profiles:** This category of KPIs evaluates energy demand and supply across key sectors—households, institutions, and businesses in selected sites. It involves creating detailed load and supply profiles (hourly, daily, monthly, yearly) by analyzing current energy consumption patterns and installed SHSs, mini-grids, water purification systems including OGB, based on baseline surveys and future projections. These projections consider evolving user behaviour, such as the adoption of new appliances in the already electrified households, addition of non-electrified households, energy services in business sectors (e.g., working for longer night hours) and productive energy use. The profiles will guide the system designs tailored to local needs in all selected sites and be compared with automated operational data from the SWARM-E infrastructure including P2P, mini-grid and OGB after implementation. Future energy demand scenarios will also assess the impact of training for citizens, experts, and entrepreneurs. Accordingly, upcoming surveys should gather insights on how training and awareness programs influence energy consumption in households, social institutions and businesses.
3. **Operation & Connections**: This KPI ensures the continuous operation and performance of the entire SWARM, mini-grid and OffGridBox (OGB) systems, by focusing on both system functionality and user connections. It tracks the number of households, social institutions and businesses connected to the SWARM -E infrastructures and monitors how many are actively benefiting from the service. By continuously assessing energy metrics, the KPI evaluates the efficiency and reliability of the grid in meeting the energy demands of households, social institutions, productive energy users, and

businesses. The objective is to maintain stable and sustained operation of the SWARM-E infrastructures for at least 24 months. Throughout this period, the P2P performance will be closely monitored via the SOLshare control system and supported by on-site technical experts to ensure optimal operation, quickly address any issues, and guarantee consistent access to reliable energy for users. Similarly, the mini-grid and OGB systems are independently monitored through their respective remote-control systems alongside on-ground technical support to ensure their effective functioning and timely resolution of any operational challenges.

4. **Energy Metrics:** This class of KPIs monitors the performance of the installed SWARM grid, mini-grid revitalized and OGB containers by collecting and analyzing detailed data on energy generation (kWh/day), consumption (kWh/day), efficiency of the system and P2P trading (kWh) in all selected sites.

    - **Generated energy (kWh) ->** involves continuous tracking and recording of energy production levels at all locations where the SWARM grid, mini-grid and OGB systems are installed. Data will be collected in real-time through automated monitoring of each technology remote monitoring system during system operation, ensuring accurate and up-to-date measurements of generation output. The collected generation data will be systematically compared with site-specific demand profiles to assess the supply-demand balance. This analysis will determine whether the system meets local energy needs efficiently and identifies any surplus generation capacity. Excess energy availability will be evaluated for potential applications, such as energy trading (e.g., peer-to-peer sales) and additional socio-economic initiatives (e.g., powering small businesses, community services, or productive-use appliances). By correlating generation trends with demand patterns, this metric will provide actionable insights for optimizing system performance, expanding energy access, and maximizing the project's economic and social impact.

    - **Consumed energy (kWh) ->** tracks daily energy use across homes (including those with solar home systems and newly electrified households, households connected to the SWARM grid, mini-grid and households/individuals charging batteries at the OGB container installation), businesses, and income-generating activities. The system automatically records this data to create detailed demand patterns and predict future energy needs. This helps optimize energy distribution, plan system upgrades, and measure how electricity access improves lives and local economies

    - **Energy traded (kWh) ->** tracks the amount of energy traded between users (peer-to-peer) through the SWARM-E, mini-grid and OGB systems, using automated data collection from the control system of each system to record all transactions. Additionally, endline surveys will gather feedback from participants—both energy consumers and prosumers (users who both produce and consume energy)—to assess trading activity, user satisfaction, and overall system perception. The combined data will help evaluate the success of the peer-to-peer trading model, measure user engagement, and identify opportunities for improvement in future implementations.

- **System efficiency (%) ->** tracks and records the SWARM grid, mini-grid and OGB system's energy conversion efficiency as well as subsequent interconnection performances using automated performance data recorded and generated from the remote-control system of each SWARM-E infrastructure. The efficiency measurements will enable direct comparisons with other off-grid solutions, including decentralized mini-grids and solar home systems (SHS), providing valuable insights into the relative performance of different distributed renewable energy technologies.

3.4.2. Socio-economic KPIs

The socio-economic KPIs are described as follows:

1. **Electrified households, businesses and social institutions & energy reliability:** This KPI measures two dimensions of the project impact: the extent and number of households, social institutions, and businesses gaining access to electricity as well as the reliability of the modern energy services delivered by the installed SWARM grid. Detailed KPIs under this category are presented below in Table 4.

Table 4. Electrified households, businesses and social institutions - specific KPIs description and M&E methodology

KPI	Description	M&E methodology
Electrified households	Tracks the total number of residential units gaining new or improved electricity access through SWARM grid (P2P), mini-grid and OGB systems.	→ Automated metered data → Verified through baseline and endline household surveys
Number of households added appliances	Measures how many households acquired new electrical appliances (e.g., TVs, refrigerators) after being connected to the SWARM-E infrastructures.	→ Household surveys (baseline and endline data analysis) → Technician spot checks during field visits → Energy consumption pattern analysis – automated metered data
Energy reliability	Assesses the stability and availability of power supply to connected users as per the demand	→ Automated system logs (uptime/downtime) → Endline household survey - asking the households if the energy they have got is enough for their demand or if there are times when they need more but their activities are affected due to the capacity and reliability
Number of electrified businesses	Counts commercial enterprises (formal and informal) that obtained	→ Comparing baseline and endline surveys

	electricity connections and/or upscale their business activities – increased working hours	→ Energy consumption patterns – automated metered data → Field visit data and reports
Businesses added appliances	Tracks electrical equipment adopted by businesses to enhance operations (e.g., grinders, freezers) after the operationality of the SWARM-E infrastructures (including P2P, mini-grid and OGB systems)	→ Business owner interviews – baseline and endline survey data comparison. → Energy consumption patterns – automated metered data
Introduced PUEs (the PUEs are different from location to location depending on the priority of the communities, See Table 2 for more)	Monitors new income-generating activities enabled by reliable electricity access due to the SWARM-E infrastructures (including P2P, mini-grid and OGB systems)	→ Household and community surveys → Identifying new enterprises – baseline and endline survey data analysis → Observation of energy usage patterns during working hours → Case studies of successful implementations of selected productive use of energy
Number of electrified institutions or improved access to electricity	Records of public facilities (schools, clinics, government offices, religious institutions) connected to the SWARM-E infrastructures (including P2P, mini-grid and OGB systems), based on the availability of public facilities -> this works for location where there are public facilities.	→ Baseline and endline institution survey data → Energy consumption patterns for newly electrified institutions or institutions with improved services due to energy access → Field reports → Change in working hours of the institutions

2. **Economic impact:** This indicator focuses on assessing the socio-economic outcomes during and after the project implementation, with particular attention to some key dimensions including increment of income, diversification of businesses and jobs created. It monitors improvements in household and individual income levels, the expansion and diversification of local businesses, especially those that are women-owned and the creation of employment opportunities resulting from the SWARM-E implementation. Specific KPIs includes (Table 5):

Table 5. Economic impact - specific KPIs description and M&E methodology

KPI	Description	M&E Methodology	Impact Indicator
Household income growth	→ Measure the average increase in household income from trading energy through	→ Survey (comparison baseline and endline)	→ The number of households reported income increased due to access to

	connected SWARM-E infrastructures, including P2P, mini-grid, and OGB systems. Includes savings from reduced energy expenditures (e.g., kerosene and wood fuel replacements) and new income opportunities.	→ Gender-disaggregated surveys → Energy expenditure records Mobile money transaction analysis for P2P trading	electricity, energy trading (mostly for pre-electrified households) and savings from avoided use of traditional fuels. → % reduction in energy expenditures due to avoided use traditional fuels
Business income increase	→ Quantifies revenue growth for electrified enterprises enabled by reliable power (extended operating hours, new services). → Focuses on formal/informal businesses using SWARM-E infrastructures, including P2P, mini-grid, and OGB systems in all locations, emphasizing on women/youth-owned enterprises.	Survey (baseline and endline) on: → Financial related surveys → Increased working hours	→ Additional operating hours → Energy expenditure savings (using electrified appliances) → Increases supply and outreach → Avoided traditional fuel costs → No of businesses upscale their services → New business created
Scale up of existing and/or new business created	→ Tracking scaled up existing businesses or newly created businesses due to the interventions in all selected sites.	Survey on (baseline and endline) on: → Scale and dimension of the existing business before and after intervention → Financial related surveys Business registry data analysis	→ No of the businesses scaled up their service and working hours - additional appliances, outreach, services → Newly created business → Jobs created for people in the business (number of people working before and after the intervention)
Income increased due to introduction PUE	Tracks the income generated from both existing and newly introduced energy-dependent activities, such as milling, cold storage,	→ Baseline and endline survey on productive use of energy, existing and newly added PUEs → Operating hours of PUEs	→ Changes in income before and after implementation → Energy consumption patterns and energy savings → Energy services diversification

	refrigeration services, and sewing. → It helps to assess and evaluate the economic impact of productive energy use at each specific location.	→ Number of people working in PUEs activities → Financial surveys	→ Scale up of PUEs → Newly added PUEs – presenting more machines and activities (such as sewing, milling …) → Production capacity and services
Women's economic participation	Tracks scaled up (existing) and/or new energy-related opportunities created for women.	→ Survey on women lead household and businesses as well as economic participation	→ Increased number of women participations in economic activities → Women participation in energy-related activities – like supply of off-grid appliances → Number of existing women-led businesses scaled up → Number of women-led business newly added
Opportunities created for youth	Youth engaged in energy-related jobs/training – including installation, maintenance, operation, entrepreneurship,	→ Surveys (comparing baseline and endline survey data)	→ Number of youths engaged in energy related activities per location.

By tracking these key impact indicators, this KPI category provides valuable insights into how the project contributes to inclusive economic growth, entrepreneurship, and the empowerment of marginalized groups, particularly women and youth.

3. **Training and capacity building:** It is an important element of project activities, serving as a measuring factor in ensuring both the sustainability and long-term operational success of the SWARM-E infrastructures, including P2P, mini-grid, and OGB systems. This KPI is intended to comprehensively assess the project's efforts in building local capacity by tracking both the delivery of structured training sessions and certification programs, and the resulting impact on end-users particularly in how they use appliances, their energy consumption habits and resulting behavioural changes. It also measures community empowerment outcomes, reflected in increased confidence and decision-making ability, particularly among target groups such as women, youth, and entrepreneurs. In this regard, this KPI will monitor and record the number and type of training delivered, disaggregated by participant demographics, including gender, age group, and socio-economic background. It will also assess the effectiveness of these capacity-building programs performed throughout the project timeline, highlighting not only the number of trainings conducted but the impact of knowledge and skills transfer. Furthermore, it will provide insights about user behavioural changes such as changes in energy consumption, the

adoption of productive uses of energy, the diversification and growth of business supported by electricity access and the creation of job opportunities resulting from the knowledge gained from the training and capacity building programs. These behavioural and economic shifts will be captured through a systematic data collection and analysis framework, implemented both during and at the end of all the project components intervention including SWARM grid, mini-grid and OGB. Table 6 presents specific KPIs under this category, description of each KPI and the methodologies the M&E will follow.

Table 6. Training and capacity building - specific KPIs description and M&E methodology

KPI	Description	M&E Methodology
Number of trained experts	Quantifies local technicians and professionals trained in SWARM-E infrastructure installation, maintenance, and repair. Focuses on building technical capacity for system sustainability.	→ Attendance records → Endline survey – number of trained experts and technicians involved in the overall SWARM-E project activities.
Number of trained citizens	Measures community members who participated and benefited from awareness programs. Aims to improve user competence and system adoption.	→ Survey on level of understanding (initial survey) → Workshop and training attendance → Pre- and post-training knowledge assessments (written/oral) → Surveys and field visits to understand if behavioural and energy usage patterns changes occurred due to the training given.
Number of trained women entrepreneurs	Specifically tracks female participants completing energy entrepreneurship programs (business management, appliance and infrastructures repair, renewable energy ventures).	→ Gender-disaggregated training attendance → Surveys on women lead businesses (up scaled or newly created) → Follow-up interviews on the change the training brought – level of understanding, benefits, …
Impact of the training	Evaluates the practical application and outcomes of training programs across all participant categories, for instance if there is a change in energy consumption patterns and working hours due to the training.	→ Field visit reports → Surveys on training participants if there changes after the training – in terms of employment, business creation, energy usage pattern changes, working hours changes …

4. **Social Impact (health and education benefits):** These indicators focus on the social impacts of the project, specifically measuring improvements in health resulting from reduced indoor pollution, access to clean water, and enhanced healthcare services due to electrification of healthcare

facilities. In relation to education, improved study hours and increased school attendance due to reliable energy access will be monitored and evaluated. Therefore, this indicator will assess and monitor the changes before and after the implementation of the SWARM-E, particularly in relation to health improvements from access to clean cooking (e.g., reduced household air pollution and injuries), lighting (e.g., eliminating the use of kerosene or wood fuels) and clean water access. Additionally, the time saved from fuel gathering, particularly for women and children will be tracked, along with improved study hours, school attendance and improved grades. Moreover, the project's impact will be compared with a **control group** to assess the actual social impact of the SWARM-E intervention across selected locations and groups. Table 7 shows the key KPIs related to the social impact of the project.

Table 7. Social impact - specific KPIs description and M&E methodology

KPI	Description	M&E Methodology
Increased operational hours of health facilities	Measures extended service availability at electrified clinics due to reliable power for lighting, medical devices, and vaccine refrigeration. The data can be collected and gathered by local partners.	→ Endline survey – working hours of the clinics per location → Night staff attendance records → Equipment usage logs, energy consumption patterns of clinics per day
Decreased waterborne diseases	Tracks reduction in diarrheal/cholera cases linked to powered water purification systems.	→ Clinic case reports → Household and clinic surveys
Reduced respiratory infections	Quantifies decline in indoor air pollution-related illnesses from solid fuel and kerosene use	→ Fuel transition surveys → Clinic admission data → Household and clinic surveys
Avoided fuel gathering hours (Women and Children)	Measures time savings from reduced biomass collection due to clean cooking solutions	→ Household survey (women and children) and FGD
Children's study hours	Evaluates additional study time enabled by electric lighting replacing fuel-based lamps and avoided fuel gathering hours for children	→ Parent/teacher reports – household and school survey → Energy consumption patterns at night
School performance	Tracks educational improvements.	→ Recorded grades and attendance after and before SWARM-E intervention

3.4.3. Financial viability & scalability KPIs

This KPI category evaluates the financial sustainability and scalability of the SWARM-E project, ensuring its long-term growth and operational success. It measures critical indicators such as the development of

viable business models, investor and private sector engagement, and the effectiveness of commercialization strategies across all deployment locations. By assessing these factors, the KPIs provide insights into the project's financial potential, supporting its expansion and sustained operation in Rwanda and Tanzania. The goal is to establish a self-sustaining model that secures ongoing investment and ensures the long-term viability of SWARM-E systems. To enable evidence-based decision-making, these KPIs track key financial and operational metrics (Table 8).

Table 8. Financial and operational metrics - specific KPIs description and M&E methodology

KPI	Description	M&E Methodology
Payback Period	Time required to recover the initial investment through net cash inflows.	→ Track cumulative annual net cash flows (revenue – costs). → Identify when cumulative inflows match/offset initial investment.
Net Present Value (NPV)	Present value of cash inflows vs. outflows, indicating profitability.	→ Forecast annual cash flows. → Apply discount rate (cost of capital/hurdle rate). → Sum discounted cash flows minus initial investment.
Internal Rate of Return (IRR)	Annualized return rate at which NPV equals zero.	→ Use financial tools to solve the discount rate where NPV = 0. → Compare IRR to required ROI thresholds.
Number of business/Financial models developed	Viable business models constructed and monetization strategies (e.g., leasing, PAYGO) created for SWARM-E project.	→ Document all proposed models. → Validate feasibility via market analysis/pilot testing.
Number of investors/stakeholders Consulted	Level of engagement with potential investors and partners for building business models.	→ Meeting records and reports. → Maintain a stakeholder database with investment status.
Finalized commercialization approach	Selected strategy for commercialization and scaling SWARM-E (e.g., franchising, PPPs).	→ Evaluate options against feasibility studies. → Finalize approach based on stakeholder input and pilot results.

3.4.4. Environmental KPIs

1. **Avoided CO_2 emissions:** tracks the reduction in carbon emissions achieved by using the SWARM grid instead of traditional energy sources (like diesel generators or charcoal). ***How it is going to be monitored and evaluated:***
    - Compare emissions before (baseline) and after SWARM infrastructure installation.
    - Track energy use data from the SWARM-E system vs. old fuel sources.
    - Evaluate differences between project sites to see which locations benefit most.

2. **Improved indoor air quality:** Measures how cleaner and safer the air becomes in homes after switching from kerosene/biomass to SWARM electricity.

How it is going to be monitored and evaluated:

- Household surveys (baseline and endline).
- Track respiratory illness rates in clinics near project sites.
- Compare burn injuries before (from open fires/kerosene) and after SWARM adoption.

3.4.5. Other KPIs

Political, policy and regulatory alignments: This KPI evaluates the effectiveness of collaboration and cooperation established with diverse stakeholders—including government entities, local authorities, and community organizations—at both national and local levels in Rwanda and Tanzania. It measures their readiness and willingness to actively support and participate in the project's activities, goals, and objectives moving forward. Additionally, this KPI examines the extent to which project outcomes align with national and local priorities, ensuring coherence with broader socio-economic development plans, energy access targets, climate action strategies, and policy frameworks.

4. M&E Plan

4.1. Overview of M&E plan and deliverables

Table 9 outlines the M&E plan for the SWARM-E project, designed to systematically track KPIs and assess overall performance and impact. This plan serves as a strategic tool, ensuring that all project activities remain aligned with the goals and objectives detailed in the project proposal.

The M&E plan provides a comprehensive list of KPIs, clearly assigning responsible partners and deliverables for tracking each, thus ensuring accountability throughout the project lifecycle. Data gathering is fundamental to this process, providing the necessary evidence to measure targets and the long-term impacts of SWARM-E. Project reports and automated data will be the primary sources for analyzing outcomes. To ensure comprehensive data coverage and track changes during and after implementation, surveys and instruments initially used for baseline data collection will be adapted and reused as needed. This approach helps fill data gaps and captures meaningful shifts in key indicators, ensuring robust and responsive M&E.

By thoroughly applying this M&E plan, the project team will be able to make data-driven decisions, identify areas for improvement in real time, and demonstrate the impact of the project to stakeholders and partners.

Table 9. Overview of the M&E plan and deliverables

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
2	VITO	ELI - in Tanzania, INKO, UR OGB - in Rwanda	D2.4	Sites selected	List of sites in both countries as per the predefined criteria	Household survey, Interview with local officials and experts, Site visit report and Admin data	One time	5	5 (4 in Rwanda, 1 in Tanzania)
		VITO	D2.2	Generated energy demand profiles per location	Energy usage patterns and source, appliances with their capacity per household and institutions	Household and institutional surveys	Before and After implementation	0	5 (one per location)
		VITO and local partners including ELI - in Tanzani	D5.1	Longitudinal assessment metrics	Baseline survey data & KPI data over time	Household survey on selected metrics	After the implementation (Endline)	5 selected sites (see section 4.2)	Reassessment of baseline metrics for selected sites

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		a, UR, OGB - in Rwanda							
3	RES4A and WUP	ELICO in Tanzania and INKO / OGB in Rwanda	D3.2	Number of trained experts	List of training participants, training theme and module, training supporting materials	Training attendance records	Before and after training activities		
		ELICO in Tanzania and INKO / OGB in Rwanda	D3.2	Number of trained citizens	List of training participants, training theme and module, training supporting materials	Training attendance records	Before and after training activities		

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		ELICO in Tanzania and INKO / OGB in Rwanda	D3.2	Number of trained women entrepreneurs	Gender-disaggregated training participants list, training materials	Training attendance records	Before and After training activities		
3, 5 & 6	WUP & MEI	ELI - in Tanzania, UR and OGB- in Rwanda	D5.1 D6.2	Existing electrified households per location	Number of households with SHS per location	Household survey	One time		
		ELI - in Tanzania, UR and OGB - in Rwanda	D5.1 D6.2	Electrified households (new)	Number of new households get access to electricity due to the project intervention from all components of the project (SWARM grid, mini-grid, OGB….)	Household survey, automated data, field reports	Before and After implementation	0	

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		ELI - in Tanzania, OGB and UR- in Rwanda	D5.1 D6.2	Number of households added appliances (among pre-electrified households)	Number of households added new or more appliances after connecting all components of the project (SWARM grid, mini-grid, OGB….)	Household survey	Before and After implementation	0	
		ELI - in Tanzania, INKO- in Rwanda	D5.1 D6.2	Existing electrified businesses per location	Number of businesses before/after SWARM -E implementation	Business survey, field reports, automated connection and energy consumption patterns	Before and after implementation		
		ELI - in Tanzania, INKO - in Rwanda	D5.1 D6.2	Number of electrified businesses per location	Number of businesses before/after SWARM-E implementation	Business survey, field reports, automated connection and energy consumption patterns	Before and After implementation		

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		Local partners including ELI in Tanzania, INKO - in Rwanda and others	D5.1 D6.2	Businesses added PUE appliances	Number of businesses or households with more or new additional PUE appliances before/after SWARM-E implementation	Business survey, automated data on energy consumption patterns of businesses	After implementation		
		Local partners including ELI in Tanzania, OGB and UR - in Rwanda and others	D3.2 D5.1 D6.2	Number of electrified institutions or improved access to electricity	Health, education and local government institution with better electricity access	Institutional Survey, automated energy consumption patterns	Before and After implementation		

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		Local partners including ELI in Tanzania, OGB and UR - in Rwanda and others	D3.2 D5.1 D6.2	Household income growth	Average monthly household income before and after project implementation	Household Survey	Before and After implementation	0	
		Local partners including ELI in Tanzania, INKO - in Rwanda and others	D3.2 D5.1 D6.2	Business income growth per location (existing)	Average monthly business income before and after project implementation	Business survey	Before and After implementation	0	

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		Local partners including ELI in Tanzania, INKO - in Rwanda and others	D3.2 D5.1 D6.2	New businesses created	Number business after and before project implementation	Business survey	Before and After implementation	0	
		Local partners including ELI in Tanzania, INKO - in Rwanda and others	D3.2 D5.1 D6.2	Women's economic participation	Direct and indirect jobs created, disaggregated by gender	Household Survey, Women focused FGD	Before and After implementation		

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		Local partners including ELI in Tanzania, INKO - in Rwanda and others	D3.2 D5.1 D6.2	Opportunities created for youth	Direct and indirect jobs created for youth because of the project implementation	Youth and jobs focused surveys, FDG	Before and After implementation		
		Local partners including ELI in Tanzania, UR - in Rwanda and others	D5.1 D6.2	Increased operational hours of health facilities	Clinic records and schedule (if there is change due to the energy access after SWARM grid)	Clinics working hour record, clinic surveys, field visit reports	Before and After implementation		

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		Local partners including ELI in Tanzania, UR - in Rwanda and others	D5.1 D6.2	Decreased waterborne diseases	Clinic records	Clinic patient records, clinic surveys	Before and After implementation		
		Local partners including ELI in Tanzania, UR - in Rwanda and others	D5.1 D6.2	Reduced respiratory infections	Clinic records - reported respiratory infections	Household and clinic surveys	Before and After implementation		

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		Local partners including ELI in Tanzania, /UR - in Rwanda and others	D5.1 D6.2	School performance	School grade report records before, during and after implementation periods	School students' performance records	Before and After implementation		
4	SOL	SOL	D4.2	SWARM grid installed	Number of sites where SWARM grid deployed	Project and site visit reports	Bi-annual	0	
		ELI	D4.4	Mini-grid revitalized in Tanzania	Number of sites where mini-grids rehabilitated	Project and site visit reports	Bi-annual	0	
		OGB	D4.3	OffGridBox installed in Rwanda	Number of sites and OffGridBox installed	Project and site visit reports	Bi-annual	0	

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
5	MEI	Local partners including UR and OGB - in Rwanda and ELI in Tanzania	D5.1	Operational two- and three-wheelers in Rwanda and Tanzania	Number of two- and three-wheelers deployed and functional	Project and site visit reports	Bi-annual	0	
		Local partners including UR and OGB - in Rwanda and ELI in	D5.1	Installed LEV charging station in both countries	Development of a pit stop charging station and installation	Project and site visit reports	Bi-annual	0	

WP	Respo nsible	Data collecti on - Respon sible	In delive rable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		Tanzani a							
		OGB	D5.1	Clean water production and distribution (Liters/day or month)	Amount of monthly water production and distribution	Household survey, Automated metering and field reports	Monthly (after installation)	0	
		OGB	D5.1	H-LPG blend fuel production (kgs)	Hydrogen Production in Kgs	Automated data and site visit reports	Monthly (after installation)	0	
		SOL	D5.1	Operation and connections (number of systems and connections operating successfully for all the components of the SWARM-E including mini-grid, P2P connections, OGB) -	Number of operational systems (P2P, mini-grid, OGB)	Automated data from SOLshare remote control system for P2P, the remote control system of mini-grid and OGB and site visit reports	Monthly (after installation)	0	

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
6	TAREA, INED	SOL and Local partners including ELI in Tanzania, OGB - in Rwanda and others	D6.2	Generated energy (kWh/day) from all systems including: - P2P - Mini-grid - OGB	Total electricity generated in kWh/day	Automated	Continuous data collection (automated) + weekly/monthly data evaluation	0	
		SOL and local partners including ELI in Tanzania, OGB - in	D6.2	Consumed energy (kWh/day) from all systems including: - P2P - Mini-grid - OGB	Total energy consumption (kWh/day) and consumption patterns	Automated	Continuous data collection (automated) + weekly/monthly data evaluation	0	

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		Rwanda and others							
		SOL and local partners including ELI in Tanzania, OGB - in Rwanda and others	D6.2	Energy traded (kWh) from all systems including: - P2P - Mini-grid - OGB	Amount of peer-to-peer energy traded (kWh) in all systems of the project	Automated (Meters)/SOL share cloud and mini-grid and OGB remote control systems	Monthly	0	
		SOL, ELI, OGB	D6.2	System efficiency (%) for all systems P2P, mini-grid and OGB	Input energy (kWh) and corresponding useful output energy (kWh)	Automated	Continuous data collection (automated) + weekly/monthly data evaluation		

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		INEDIT	D6.2	Avoided CO_2 emissions	Results from the LCA study	Elaboration of the life cycle inventory	Comparison of the baseline with the implementation of the SWARM-E solution	0.6945 kg CO2/kWh	-10%
		Local partners including ELI in Tanzania, UR and OGB in Rwanda and others	D6.2	Improved indoor air quality	Fuel type usage changes per household	Household surveys, health surveys	Before and After implementation		
		TAREA	D6.2	Political, policy and regulatory alignments with government strategies	National and local policy review reports	Stakeholder engagement, reviewing policy documents	One time (before or during implementation)		

WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
7	BWB	BWB	D7.2 D7.3 D7.4	Payback Period, tariffication	Initial investment value and annual net cash inflow or savings data (€ or other currency)	Recording of initial investment costs and annual net cash inflows	M24		
		BWB	D7.2 D7.3 D7.4	Net Present Value (NPV)	Initial investment value and annual net cash inflow or savings data (€ or other currency)	Recording of initial investment costs and annual net cash inflows	M24		
		BWB	D7.2 D7.3 D7.4	Internal Rate of Return (IRR)	Initial investment value and annual net cash inflow or savings data (€ or other currency)	Recording of initial investment costs and annual net cash inflows	M24		
		BWB	D7.2	Number of Business/Financial Models Developed	WP2-WP4 inputs	Project reports	M46 (as per proposal KPIs)	0	Based on WP2 and WP4 outputs

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WP	Responsible	Data collection - Responsible	In deliverable	KPI	Data required	Data collection Method	Frequency	Baseline	Target
		BWB	D7.5	Number of Investors/Stakeholders Consulted	Concrete SWARM-E solutions design, list of investors and stakeholders	Meeting minutes and memos, stakeholder engagement reports	M46 (as per proposal KPIs)	0	
	MEI, BWB	MEI	D5.2 D7.6	Finalized commercialization approach	Concrete SWARM-E solutions design, draft final commercialization document	Internal review and approval	M46 (as per proposal KPIs)	0	Based on WP2 and WP4 outputs
8	RES4A, EP	RES4A, EP	D8.2	Website/social media engagement statistics	Web analytics, follower counts	We analytics report	Yearly	0	

4.2. Example of plotted estimations for the sub-survey fields - Socio-economics section (3.4.2)

4.2.1. Illustration of current and expected results based on hypothesis: Illustrated graphs - Estimation of change and impact

The SWARM-E project is expected to improve quality of life and create new business opportunities for residents in the communities where it is implemented. The core hypothesis is that the SWARM-E infrastructure, by enabling access to basic electricity services, will lead to increased ownership and use of electrified appliances, ultimately contributing to better living conditions and local economic development. For instance, access to electricity may allow households to extend lighting hours, improve indoor comfort with fans, or initiate small businesses using refrigerators or freezers to store perishable goods like fish or dairy products for resale. The expected results are illustrated using baseline data (t_{start}) collected through initial surveys across sites in the two countries. Final metric after the intervention (t_{end}) and the dashed lines between t_{start} and t_{end} are used to indicate the anticipated trends, both within the same community over time and between intervention and control sites. These visualizations do not represent precise forecasts but serve as indicative representations of the potential impact of the SWARM-E implementation.

How are the estimates for the evolution of the different metrics computed?

The evolution of various energy access, socio-economic and well-being indicators is estimated using a combination of empirical baselines (t_{start}) and plausible assumptions for project improvement (t_{end}). The starting points are driven from survey data, typically using averages for numeric variables (e.g., comfort level, SHS access) or modes for categorical variables (e.g., cooking fuel type, income perceptions). Future estimates are then projected based on site-specific multipliers or additive changes that reflect expected impacts of interventions like SWARM-E infrastructure. These projections are not derived from predictive modelling, but rather from reasonable, manually set assumptions informed by contextual understanding or hypothesized program effects.

4.2.1.1. General Information: both household and businesses

1. **Connection microgrid**

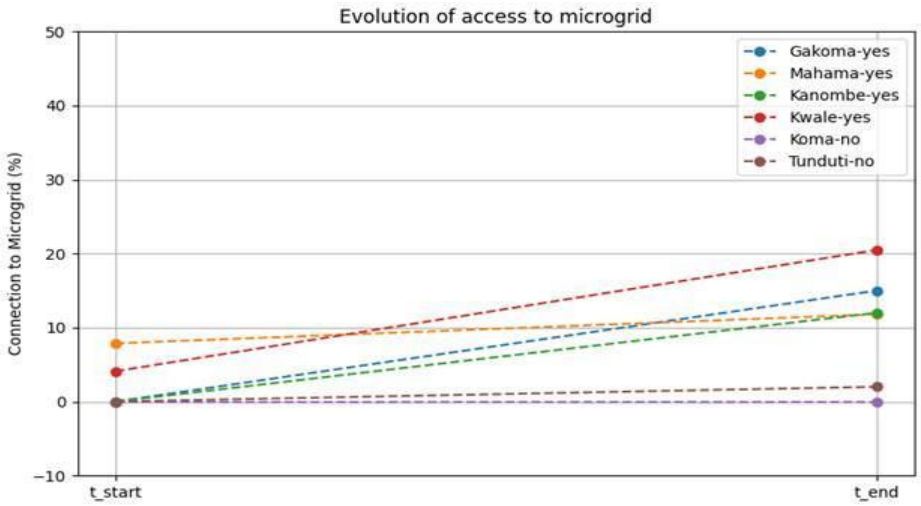

Figure 7. Grid connection access evolution from t_{start} to t_{end} t, showing % of households connected. 'Yes'/'No' indicate SWARM-E deployment

4.2.1.2. Households

2. **Satisfaction electricity access**

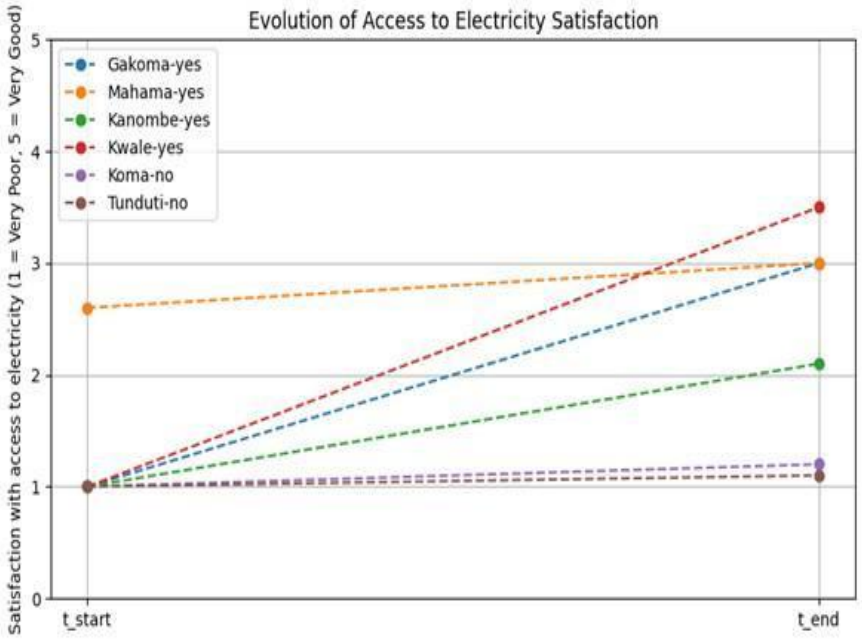

Figure 8. Predicted satisfaction with electricity access from t_{start} to t_{end} after SWARM-E implementation (1: Very Poor, 5: Very Good).

3. **Willingness to pay for SHS**

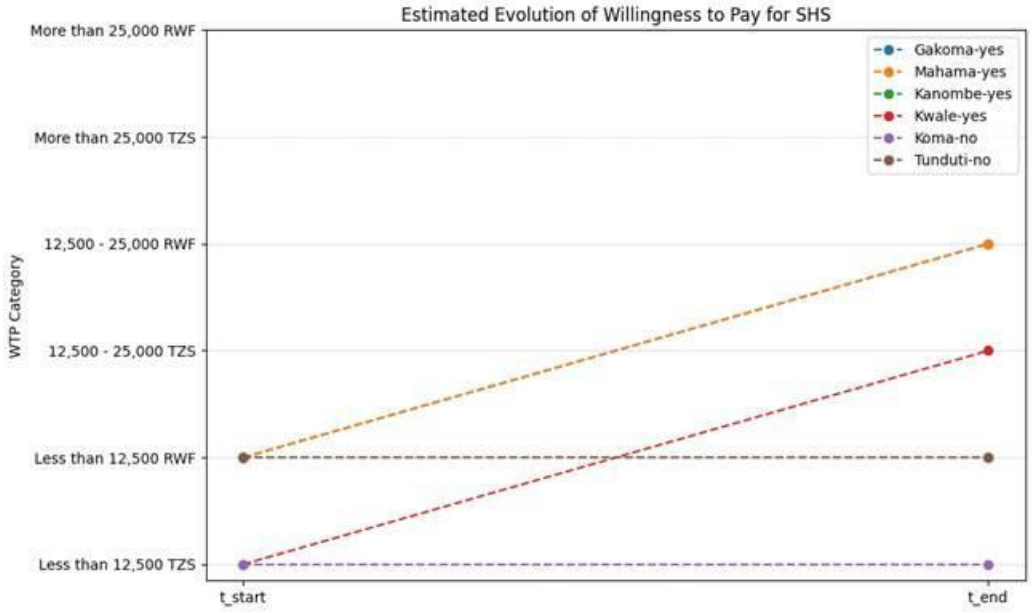

Figure 9. Estimated WTP for SHS from t_{start} to t_{end} after SWARM-E deployment. Gakoma, Kanombe, Tunduti overlap due to identical trends

4. Water availability

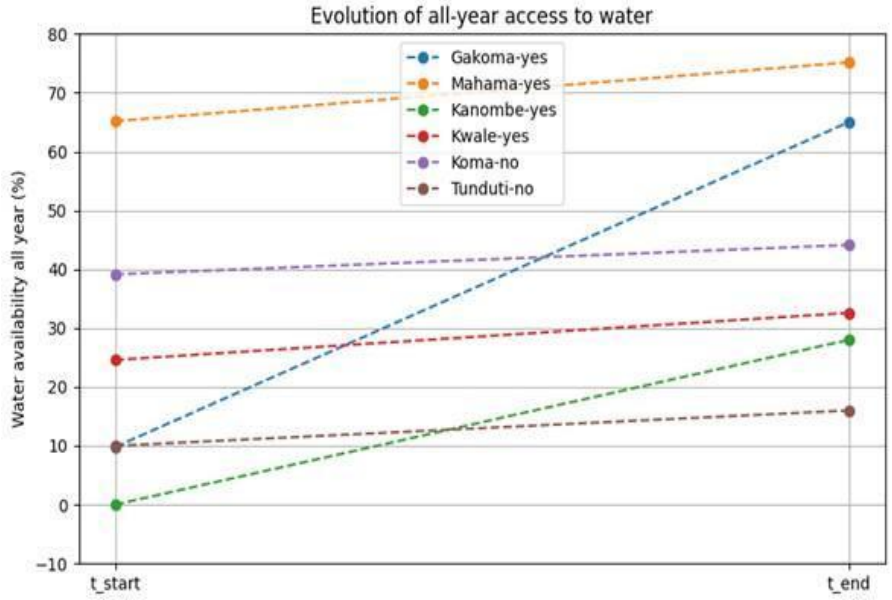

Figure 10. Year-round water access evolution from t_{start} to t_{end} with SWARM-E (% of households) (No OGB installation in Kwale, which does not include evolution estimation).

5. Main cooking fuel usage

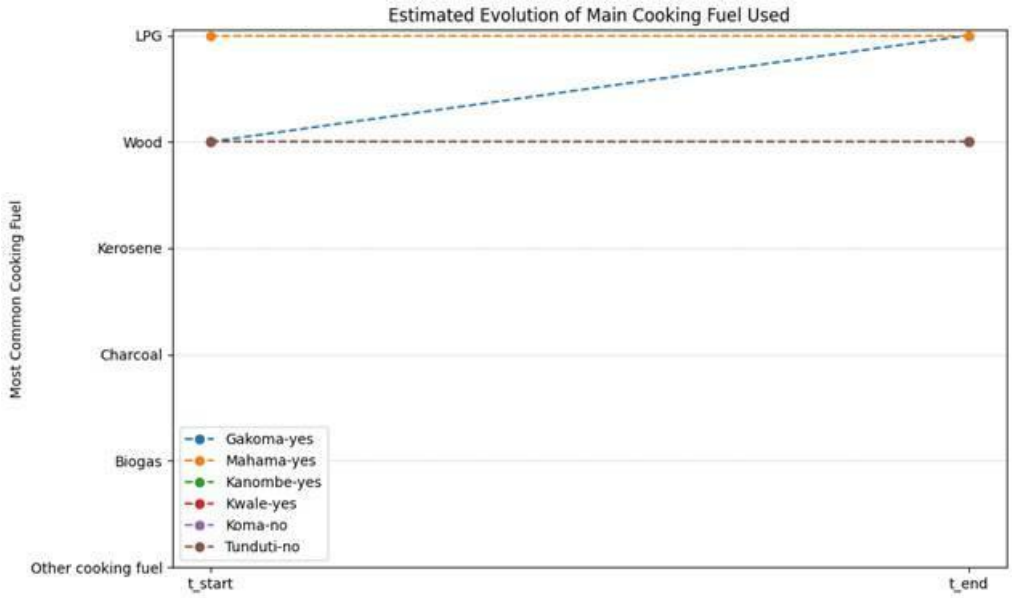

Figure 11. Most-used cooking fuel trend from t_{start} to t_{end} with SWARM-E. Kanombe, Kwale, Koma, Tunduti overlap due to identical transition estimates

6. Comfort levels

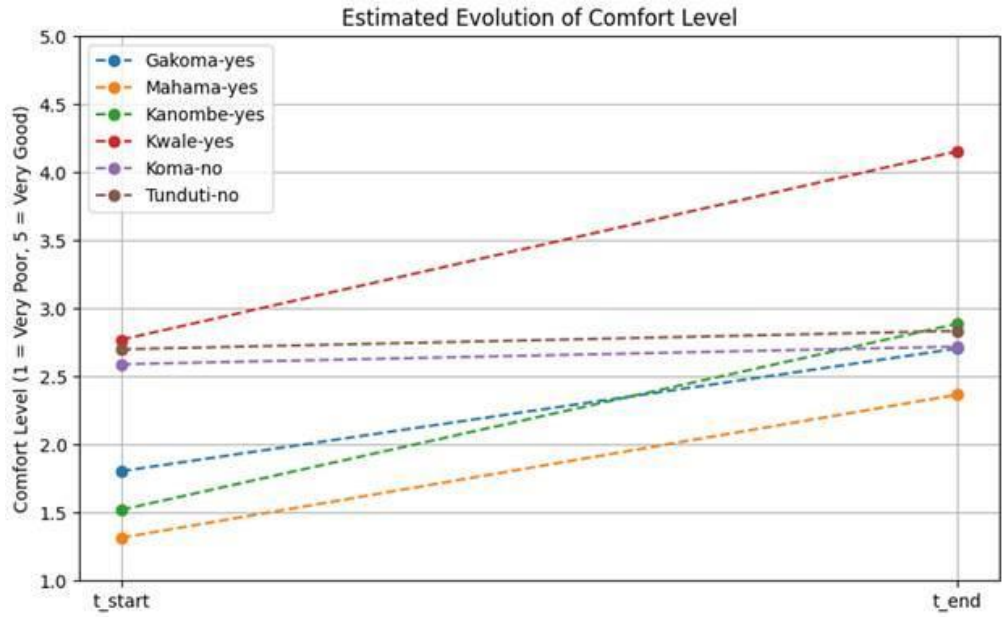

Figure 12. Projected comfort level change from t_{start} to t_{end} with SWARM-E implementation

7. Income

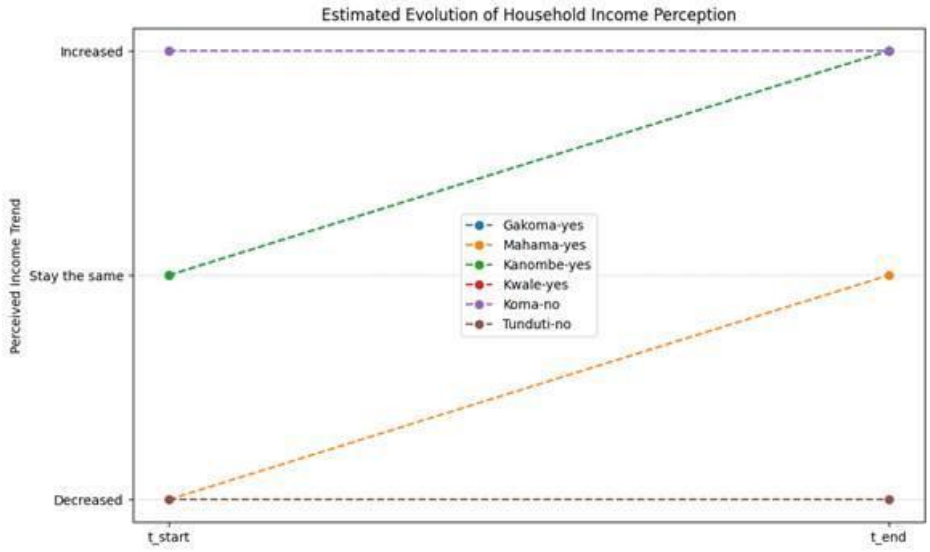

Figure 13. Projected income trend from t_{start} to t_{end} with SWARM-E. Kwale/Koma and Gakoma/Kanombe overlap.

8. User profiles

The ten questions assessing energy attitudes and capacities, which were originally used to identify segmentation profiles (for more detail refer D2.2), could be reconsidered for inclusion in the control condition towards the end of the project. The aim would be to analyse how the relevance and distribution of these profiles evolve following the intervention. It is hypothesized that individuals currently categorized under Profile 1 (as described in D2.2; farmers and fishers lacking energy access, currently representing 28% of the population) will shift to other profiles. Similarly, those in Cluster 0; typically, more stable farmers with some electricity access, are expected to transition toward Cluster 2, which includes users with more regular energy access and greater capacity for innovation.

4.2.1.3. Businesses

9. Satisfaction electricity access

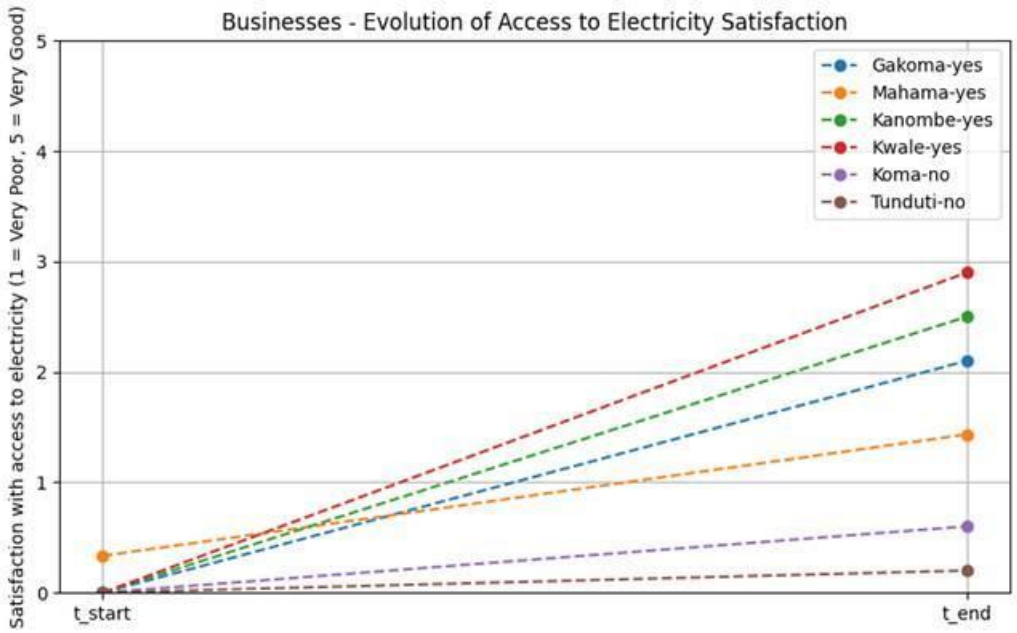

Figure 14. Projected business electricity satisfaction trend from t_{start} to t_{end} with SWARM-E.

10. Evolution of number of employees per business

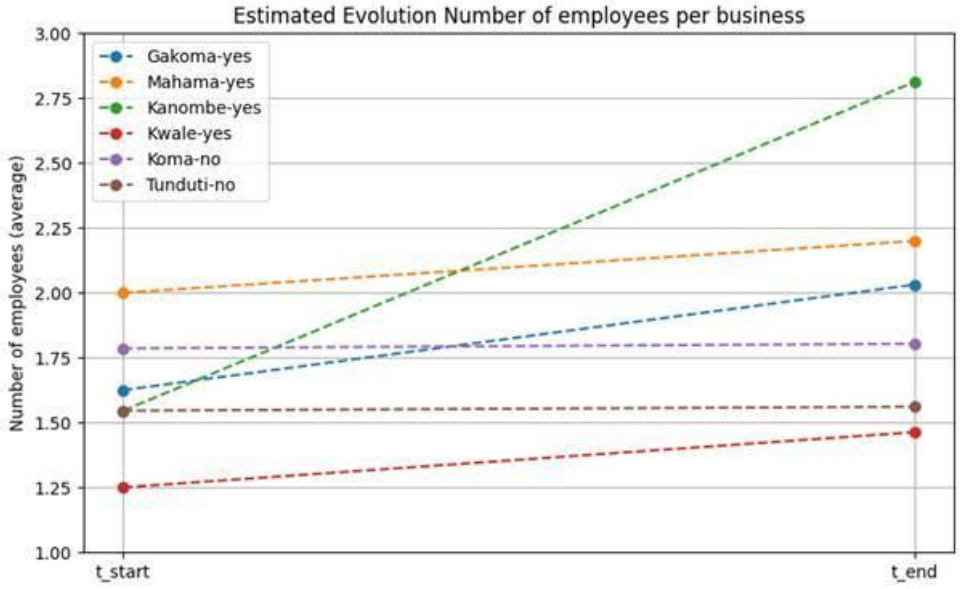

Figure 15. Projected employee count per business from t_{start} to t_{end} with SWARM-E.

11. Evolution of the number of market outreach level

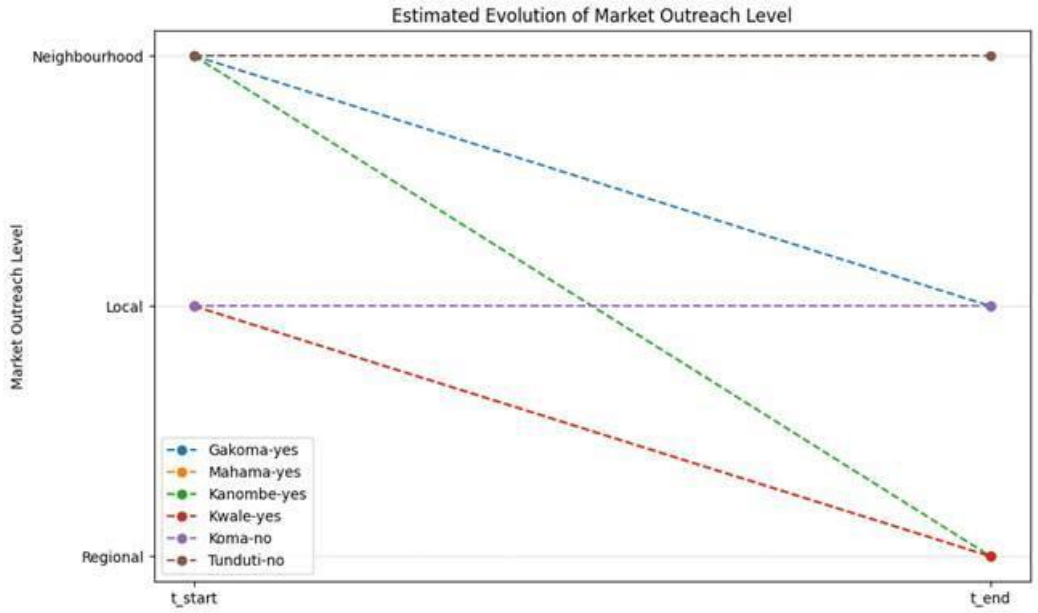

Figure 16. Projected market outreach trend from t_{start} to t_{end} with SWARM-E. Mahama & Kwale overlap.

5. Risk and Mitigation Strategies

Table 10 provides a detailed overview of the potential risks that could hinder the successful execution of the project. It also presents the corresponding mitigation strategies that should be proactively implemented to minimize these risks and ensure the project stays on track.

Table 10. Potential risks and mitigation strategies

Risks	Description	Likelihood of occurrence	Impact	Mitigation Strategies
Delays in data collection	Collecting data on different aspects of the project can be slowed down by delayed responses from partners, logistical issues in fieldwork, or other unexpected challenges	Likely	Medium	Ensure early planning and keep project coordination teams informed and actively involved to minimize delays in data collection.
Limited data availability	Some data and information may be missing, outdated, or difficult to obtain	Likely	Medium	Maintain regular contact with partners and ensure clear, ongoing communication. If data is unavailable, use estimates based on literature, existing databases, or comparable datasets.
Challenges in accessing local datasets	Obtaining reliable local data can present difficulties due to limited public availability or gaps in regional datasets	Very Likely	Minor	Look for similar datasets from neighbouring countries or rely on existing literature and available international data to fill gaps.

Power price not competitive	SWARM grid, mini-grid and OGB electricity prices (for buying and selling) not competitive	Likely	Major	SWARM-E will conduct an in-depth demand side assessment. WP 7 (activity 7.2) will model different options for tariffing (based on load demand, time of the day, dynamic pricing, community power purchase agreements) which will be customized for each site.
System Failure	SWARM grid system failure - that could create disruption in power reliability and services	Unlikely	Major	Continuous monitoring of the system and taking immediate action to maintain the system. Training experts that can take over the system control, monitoring and maintenance activities could minimize the impact hugely
Business models are not viable	The payback period is excessively long.	High	Major	Outline details with clients about the ability to pay for energy.
Mismatch between sizing and usage	Microgrid may be oversized (leading to inefficiency) or undersized (failing to meet demand), resulting in energy losses or poor service quality	Likely	Medium	Use detailed baseline and projected load profiling (WP2, WP3). Regularly update demand estimates based on usage monitoring. Introduce the sizing in phases.
Difficulties maintaining the mini-grid running	Long-term sustainability threatened by limited local capacity or lack of maintenance culture	Likely	Major	Establish strong local governance structures. Train community operators. Integrate business models for cost recovery and affordable maintenance financing.

Community resistance or low adoption	Households and businesses may be reluctant to switch to or invest in microgrid electricity services due to cultural, economic, or awareness barriers. There is no exchange of money and money flow/this is difficult for users to adopt.	Likely	Major	Include community engagement, education campaigns, and financial incentives from early stages. Tailor communication to local contexts. Customers sign up beforehand and/or pay a certain amount.
Regulatory uncertainty	National or local energy policies may shift, affecting licensing, tariffs, or renewable energy incentives	Unlikely	Medium	Maintain dialogue with relevant authorities and design project compliance frameworks. Consider regulatory buffer scenarios in economic modelling. Ensure non-objection letters are signed and build continued relationships and share reports back to the authorities.

6. Summary and Recommendation

6.1. Summary

The report outlines a comprehensive M&E framework as a core component of the SWARM-E project, designed to ensure effective implementation and measuring impacts. The M&E framework adopts a performance-based approach that monitors technical, socio-economic, environmental, financial, and institutional impacts of the project across selected rural areas in Rwanda and Tanzania. It includes clear methodologies for data collection and analysis, with key performance indicators (KPIs) covering energy metrics, productive use of energy, environmental impact and overall socio-economic impacts as well as participatory training and capacity building efforts, especially the inclusion of women and youth. The framework also incorporates a comparative analysis between intervention and non-intervention areas to measure the direct impact of the project. The M&E system is structured to support adaptive impact evaluation by identifying risks, informing decisions, and enabling ongoing project evolution. It contributes to long-term sustainability by guiding business models and technology choices, and by capturing the project's contributions to local development and the Sustainable Development Goals (SDGs).

6.2. Recommendations

As the SWARM-E project moves toward implementation, it should be noted that the M&E framework presented in this report is part of an ongoing preparatory process and will continue to evolve as the implementation progresses. The following key considerations are recommended to strengthen the M&E framework:

- The framework is expected to be a strategic tool, remaining open to future improvements and changes. As implementation unfolds, mechanisms should be in place to allow for iterative adaptation based on practical experience, stakeholder input, and emerging challenges.
- The proposed key performance indicators (KPIs) are subject to revision and may be refined to ensure they remain context-appropriate, measurable, and aligned with project objectives in different locations.
- Flexibility and adaptability are central to the design of the framework. It is anticipated that site-specific adaptations will be required to accommodate the diverse socio-economic and local contexts across the project areas.
- The framework is designed to accommodate various changes as the project evolves and moves through its implementation phases. For example, in the case of PUEs, it is important to consider location-specific and community-specific needs. As a result, the KPIs related to PUEs will be adjusted and developed throughout the implementation phase. The same approach applies to other activities and KPIs of the project that may evolve because of the SWARM-E implementation.
- Finally, the M&E framework is not only a reporting mechanism but also a tool for learning and adaptation. It is designed to support evidence-based decision-making and should be used to inform project adjustments, improve implementation strategies, and guide future scaling efforts

by measuring and quantifying the impacts of the project in achieving inclusive sustainable development.