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Smart Energy Solutions for Africa

SCALE-UP CONCEPTS AND PRE-FEASIBILITY STUDIES

ICLEI – Local Governments for Sustainability e.V.

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D5.1 Report: Scale-up Concepts and Pre-feasibility Studies

From concept to pre-feasibility: development of ideas into sustainable energy solutions

Acronym list

Acronym	Definition
AAU	Aalborg Universitet
AMAC	Abuja Municipal Area Council
ICLEI Africa	ICLEI – Local Governments for Sustainability – Africa
ICLEI WS	ICLEI – Local Governments for Sustainability e.V.
PFS	Pre-feasibility Study
SEACAP	Sustainable Energy Access and Climate Action Plan
SESA	Smart Energy Solutions for Africa
SIN	Smart Innovations Norway AS
T	Task
TAP	Transformative Actions Program
TUB	Technische Universitaet Berlin
UEMI	Urban Electric Mobility Initiative GGmbH
UNEP	United Nations Environment Programme
WI	Wuppertal Institut für Klima, Umwelt, Energie gGmbH
WP	Work Package

1. Executive summary

1.1. Brief overview

Task 5.1 (T5.1) was a key task under Work Package 5 in the Smart Energy Solutions for Africa (SESA) Project aimed at developing concepts and pre-feasibility studies (PFS) for transformational sustainable energy projects. Led by ICLEI – Local Governments for Sustainability e.V. (ICLEI WS) and supported by multiple SESA Partners, T5.1 played a critical role in advancing energy access

innovations with high potential for scalability and replicability, ultimately contributing to the development of 27 concept notes on smart energy solutions received during the Call for Ideas, of which 10 projects were developed and four were supported with PFS.

1.2. Purpose & Scope

The primary objectives of T5.1 were to:

- Facilitate the scale-up and long-term sustainability of innovative energy solutions in the project's countries.
- Develop viable project concepts and implementation plans for scaled-up initiatives.
- Conduct pre-feasibility studies to attract additional financing.
- Facilitate the access of the projects to potential financiers, such as regional and multilateral development banks.

1.3. Summary of key findings

To achieve its goals, T5.1 followed a structured, three-step methodology designed to identify, refine, and support innovative energy solutions across SESA countries. Throughout the process, the eligibility criteria and evaluation framework were carefully developed and agreed upon through consultations. Such a rigorous selection approach ensured that the most promising and impactful projects were supported, laying the groundwork for further investment and implementation. Ultimately, these efforts contribute to advancing sustainable energy access and fostering innovation across urban and rural communities.

2. Introduction

2.1. Background on T5.1 activities

Task 5.1 (T5.1) targeted the development of concepts and PFS for transformational sustainable energy projects. T5.1 was led by ICLEI WS, and supported by a SESA Partners: ICLEI European Secretariat GmbH, ICLEI – Local Governments for Sustainability – Africa (ICLEI Africa), Aalborg Universtitet (AAU), Technische Universitaet Berlin (TUB), Acondicionamiento Tarrasense Asociacion (Leitat), Smart Innovations Norway AS (SIN), Siemens Stiftung, United Nations Environment Programme (UNEP), Urban Electric Mobility Initiative gGmbH (UEMI), Wuppertal Institut für Klima, Umwelt, Energie gGmbH (WI), and F6S Network Ireland Limited. T5.1 was undertaken between Months 12-37 of the SESA Project Timeline.

The task is in alignment with SESA goals to facilitate a structured co-development process of energy access innovations that have a high potential for take-up, aiming to achieve a high level of replicability of actions. It also serves the goal to co-develop innovations with local partners with replication potential, providing essential energy services to rural and urban communities and creating easily replicable business opportunities for local entrepreneurs.

2.2. Overview of methodology used

To meet the deliverable of a minimum of 10 scale-up concepts drafted and at least four of these concepts further developed in PFS, T5.1 activities underwent a 3-step approach to obtain, qualify, select, and support smart and innovative energy solutions in SESA Countries: (1) Call for Ideas and projects shortlisting, (2) Development of Scale up Concepts, and (3) Development of Pre-feasibility Studies – see Figure 1. First, a Call for Ideas was publicly launched, inviting smart and innovative energy concepts in countries where the SESA project is implemented, which was promoted

through SESA and T5.1 partners official channels calling for smart innovation ideas. This served to collect concepts and innovative ideas to pre-feasibility stage. These ideas were then thoroughly evaluated by T5.1 partners through a screening process including evaluation criteria on project description, transformational impact, and financial rationale. The ten highest-scoring projects - ranked based on the average weighted scores from four anonymous evaluations by T5.1 Partners - were selected for further development, with five additional projects retained as backups. Next, in the Development of Scale-Up Concepts phase (step 2), the 10 project concepts projects were further refined into detailed project plans, ensuring alignment with SESA's objectives and assessing their potential for scalability and replicability. Backup projects, ranked 11th to 15th, remained on standby. For the final step, Development of Pre-feasibility Studies (step 3), four projects that had the highest weighted score (of 83 points) were selected. were selected for in-depth PFS. Selection criteria was guided by but extended beyond evaluation scores to include feasibility, replicability, relevance to SESA's objectives, and technical alignment with T5.1 partners. The resulting pre-feasibility studies, annexed to this report as Annex 1, provide detailed insights into the implementation potential of these projects.

The eligibility criteria and evaluation process for the different steps within T5.1 were proposed by work package (WP) 5 and T5.1 leadership, discussed and agreed upon during WP5 and T5.1 calls, and finalised through email coordination with confirmation from T5.1 partners.

Figure 1. T5.1 3-Step approach

3. 3-Step Approach

3.1. Call for Ideas

3.1.1. Approach

The Call for Ideas involved the creation of two key templates, a Word Document template for originating concepts and ideas, and an Excel Document Scoring Sheet for evaluating them. The evaluation followed a streamlined adaptation of the ICLEI-led Transformative Actions Program (TAP) evaluation process, which builds on several years of project selection and preparation experience. The Word template guided concept owners to develop their ideas in a structured manner, and the scoring sheet was designed for T5.1 partners to assess submissions systematically – see Figure 2. For the preparation of templates, the T5.1 Lead collected feedback and suggestions from T5.1 partners, set internal deadlines for input, and incorporated the recommended amendments. The templates were completed by Month 19.

Innovative potential	A novel or unique solution is used		3		Score 1= not a new or unique solution Score 2= Identified, but not a new solution Score 3= Identified and new solution
	The project provides a new service/value to the city		3		Score 0= None identigied Score 1= Services/value identified but weakly justified Score 2= 1-2 benefits Score 3= 3 or more benefits
		0	6	0%	
SUBTOTAL		0	32	0%	
Financial Rationale		Score given	Maximum score in category	Final score	Criteria
Total Cost of the Project	Estimated cost of the project		2		Score 0= Budget or currency not indicated Score 1= Budget realistic in its magnitude/sourcing but not explained Score 2= Initial Budget breakdown provided and realistic in its magnitude/sourcing
Secured Budget	There is a secured a budget for the implementation of the project		1		Score 0= No Score 1= Partial budget secured (>25%) and source identified
SUBTOTAL		0	3	0%	
TOTAL		0	35	0%	

Figure 2. T5.1 Call for Ideas: Excel Document Scoring Sheet

The promotion of the call for ideas was done through SESA Partners throughout Months 19-23. Initial deadlines in mid-2023 were shifted to the second half of 2023, to encompass activities from WP3 – see Figure 1.

3.1.2. Selection Criteria

The selection criteria for the Call for Ideas intended to secure relevant concepts and committed project owners, while ensuring their relevance to SESA and other SESA WPs. The eligibility criteria were the following:

1. The project is to be implemented in one of the SESA Countries.
2. A SESA Partner was involved as project concept proponent or project submitter.
3. The project maturity stage was at project definition (up to pre-feasibility stage). Projects at feasibility stage or at implementation were not eligible.

3.1.3. Results from the Call for Ideas

The Call for Ideas submission closed on the 30th of September 2023. By then, 27 Concept notes were received as listed by project owner or submitter, and title:

1. Leitat - Waste-to-energy for cooking: The project aims to establish waste-to-biogas plants in four public schools in Greater Accra and Ashanti Regions, Ghana, providing a sustainable cooking energy source, reducing fossil fuel dependence, lowering energy costs, improving air quality, and cutting CO2 emissions.
2. Hendy Farms - Solar drying technology solutions for fruit and vegetable: The project promotes solar drying technologies in Shai Osudoku District, Ghana, to reduce postharvest losses and boost incomes through a small-scale fruit drying scheme, training, and commercialization across the country.
3. UEMI and Municipal Development Planning of Accra - Alternative Energy Source for Markets: The project aims to provide two market centres in Ofankor, Greater Accra, Ghana, with affordable renewable energy and potable water, reducing operational costs, improving sanitation, enhancing security, and reducing emissions.
4. UEMI and Municipal Development Planning of Accra - Alternative Energy Source for Health Facilities: The project aims to provide three health centres in Ofankor, Greater Accra, Ghana, with affordable renewable energy and potable water, reducing operational costs and emissions.
5. Continental Solarmate Systems - Solar Water Heater: the concept provides affordable solar water heaters, reducing reliance on grid electricity, deforestation, and fossil fuels in Accra, Ghana, and West Africa.

6. Gamma Energie Limited - Waste (Biomass) – to – Energy: The project promotes clean cooking fuel adoption, reduces air pollution, supports farmers in managing biomass waste, and creates jobs while enhancing energy access and sustainability in Accra, Ghana.
7. Sweet Life Group Ghana Limited - Introduction of Biomass Cook stove Technology for cooking activities: The aim of the project is to increase the use of clean and cheap energy through a solar biomass cook stove, which intends to reduce deforestation and urban waste in Ghana.
8. Leitat - e-Latrines: The project aims to convert liquid human excreta into electricity using Microbial Fuel Cell technology, providing cleaner water, reducing contamination, and enhancing energy access in rural areas of Greater Accra and Ashanti Regions, Ghana.
9. Mr. Daniel Owusu Kyeremateng - Multi-Charcoal Briquettes Production Initiative for Industrial Use: The project seeks to enhance the production and commercialization of high-quality briquettes in Kumasi and Cape Coast, Ghana, as a sustainable alternative to conventional charcoal.
10. Government of Kisumu County - Electric mobility - commercial 2-and-3-wheelers: The project will transition electric 2-and-3-wheelers, reducing carbon emissions, creating jobs, promoting renewable energy, and enhancing sustainable transport through infrastructure development in Kisumu County, Kenya.
11. UNEP Copenhagen Climate Centre UNEP - Cold Storage Kenya: The Solar Cold Chain project aims to provide scalable cooling facilities for smallholders, reducing food waste, increasing farmer incomes, improving food security, and decreasing reliance on food aid in multiple locations in Kenya.
12. Government of Kisumu County - Solar mini/micro-grids: The project aims to provide solar power for three hospitals in Kisumu, Nakuru, and Mombasa, Kenya, enhancing reliable energy access for regional healthcare services across multiple counties.
13. Green Energy Solutions - Enhancing use of Stand-alone solar system for Livelihoods Improvement: The project aims to install 6,000 solar panels in Mulanje, Thyolo, Phalombe, and Chiradzuro, Malawi, providing sustainable electricity access to 4,000 households and 2,000 small businesses.
14. Ndata School of Climate and Earth Sciences - Developing a Mobile Solar Powered Battery Energy Storage System for Power Backup of Milk Cooling Facilities in Thyolo District, Malawi: The project aims to enhance dairy farmers' income in Thyolo District, Malawi, by introducing a mobile solar power backup system for milk cooling, reducing reliance on costly and unreliable diesel generators.
15. Dzaleka Camp - Improving the living conditions of the poor refugee and indigenous unmarried mothers of 18–24 years through renewable energy in Dzaleka Camp, Malawi: The project aims to improve the living conditions of refugee and indigenous, unmarried, and young mothers in extreme poverty in Dzaleka Refugee Camp, Malawi, through enhanced energy access.
16. Community Energy Malawi & Community Energy Zambia - Scaling up Renewable Mini-grids in Malawi & Zambia: The project aims to expand renewable mini-grids in 54 communities across Malawi and Zambia, accelerating electricity access for 210,000 people through scaling up existing infrastructure and conducting feasibility studies for future investments.
17. POGO and UNEP- E-mobility Morocco: The project aims to introduce a franchise transportation model in 10 Moroccan cities centred around electric scooters and mopeds offered for short-term rentals.
18. AAU and Namibia University of Science and Technology - African Rural Indigenous Partnership for Climate-Aware Technology Innovation and Technical Climate Change Insight Model: The project aims to empower rural Namibian communities to develop climate-resilient solutions using indigenous knowledge and renewable energy.

19. Blekinge Institute of Technology - Building Resilient Rural Communities in Africa: The project aims to design self-sufficient rural communities in multiple countries in Africa, with a pilot in Namibia, centred around a solar energy hub, employing compact housing with traditional materials and modern solar technologies to enhance living standards, conserve land for agriculture, and extend sustainable practices.
20. ICLEI WS - Micro-grids for Off Grid Communities: The project will provide reliable solar energy to over 5 million residents in Lagos, Nigeria, reducing 3.47 million tCO2e, lowering electricity costs, creating jobs, empowering women, and improving community safety and air quality.
21. ICLEI Africa - Retrofitting and Upscaling: Sustainable Energy Access and Climate Action Plan, Abuja Municipal Area Council (SEACAP-AMAC): The initiative in Abuja, Nigeria, aims to replace incandescent bulbs with energy-efficient lighting, prioritizing public buildings while engaging commercial and residential consumers in a phased approach.
22. ICLEI Africa - Smart Mini-Grid Solutions: Sustainable Energy Access and Climate Action Plan, Abuja Municipal Area Council (SEACAP-AMAC): This initiative in Abuja, Nigeria, aims to expand solar energy adoption through mini-grids, aiming for seven mini-grids and 1,000 solar home systems by 2030.
23. Celly's Technologies - Smart Ear Tag: The project aims to enhance livestock management by providing real-time data on location, health, and environmental conditions, helping farmers monitor their animals efficiently while minimizing theft and improving overall productivity in Mahikeng, South Africa.
24. TUB - Climate-proofing of self-made and incremental housing: The project aims to integrate passive housing solutions, renewable energy, and sustainable materials into self-made and low-cost housing, enhancing climate resilience and housing affordability in Lagos (Nigeria), Cape Town (South Africa), and Surabaya (Indonesia).
25. ICLEI Africa - Steve Tshwete Municipal Landfill Gas to Electricity: The project converts landfill gas into 7.5 MW of renewable energy, reducing emissions, enhancing waste management, creating jobs, and supporting long-term sustainability in Steve Tshwete Municipality, South Africa.
26. ICLEI Africa - Steve Tshwete Solar Farm: The 90 MW solar farm will provide reliable clean energy, cut 79,000 metric tons of CO2e annually, create jobs, support community development, enhance grid stability, and serve as a model for renewable energy expansion in Steve Tshwete Municipality, South Africa.
27. ASPIRE - Smart Led Street Lighting Project: This concept intends to adopt smart LED street lighting technologies in Amathole, South Africa, to reduce energy usage and CO2 emissions.

3.2. Development of 10 Scale-up Concepts

3.2.1. Approach

The development of scale-up concepts required the coordination efforts of the SESA Partners. As such, SESA Partners were required to be involved as project concept submitters, facilitating the development and submission of concepts, or project concept proponents, facilitating the submission of projects, and aligning the 10 concept notes with SESA Partners. Additionally, a mapping of financiers was developed in T5.1, supporting Task 5.3 (T5.3) activities.

3.2.2. Selection Criteria

To select the 10 projects for Step 2, the concepts were evaluated against a set of indicators on their transformative impact, project description, and financial feasibility. For the first scoring process by Month 24, T5.1 partners were asked to voluntarily score the 27 concepts received.

However, a new scoring process was deemed necessary due to individual bias and lack of scores provided voluntarily. In the second scoring process, performed in Months 24-25, partners in T5.1 were requested to score all 27 concept notes, with four partners voluntarily evaluating all concepts – except, where applicable, for those concepts they were involved with as project concept submitters or proponents. To avoid individual bias, the name of the partners was hidden as 'Evaluator N°.'

Once the scores were completed, the average total score of each project served as the guiding principle to select the top 10 project concepts. Additionally, projects with the 11th to 15th top scores were kept as back-up projects, should challenges coordinating with the top 10 project submitters arise. From the top 10 projects, one project submitter withdrew its idea and two were put in the back-up list given the lack of clarity on the maturity of their project concepts.

The top 10 project concept notes selection is as follows – and illustrated in Figure 3:

1. Enhancing use of Stand- alone solar system for Livelihoods Improvement.
2. Smart Mini-Grid Solutions: Sustainable Energy Access and Climate Action Plan, Abuja Municipal Area Council (SEACAP-AMAC).
3. Waste-to-energy for cooking.
4. Smart Ear Tag.
5. Cold Storage Kenya.
6. Scaling up Renewable Mini-grids in Malawi & Zambia.
7. Electric mobility - commercial 2-and-3-wheelers.
8. Waste (Biomass) – to – Energy.
9. Developing a Mobile Solar Powered Battery Energy Storage System for Power Backup of Milk Cooling Facilities in Thyolo District, Malawi.
10. Micro-grids for Off Grid Communities.

5 Back-up project concept notes were:

11. Steve Tshwete Solar Farm.
12. Steve Tshwete Municipal Landfill Gas to Electricity.
13. Retrofitting and Upscaling: Sustainable Energy Access and Climate Action Plan, Abuja Municipal Area Council (SEACAP-AMAC).
14. Smart Led Street Lighting Project.
15. E-mobility Morocco.

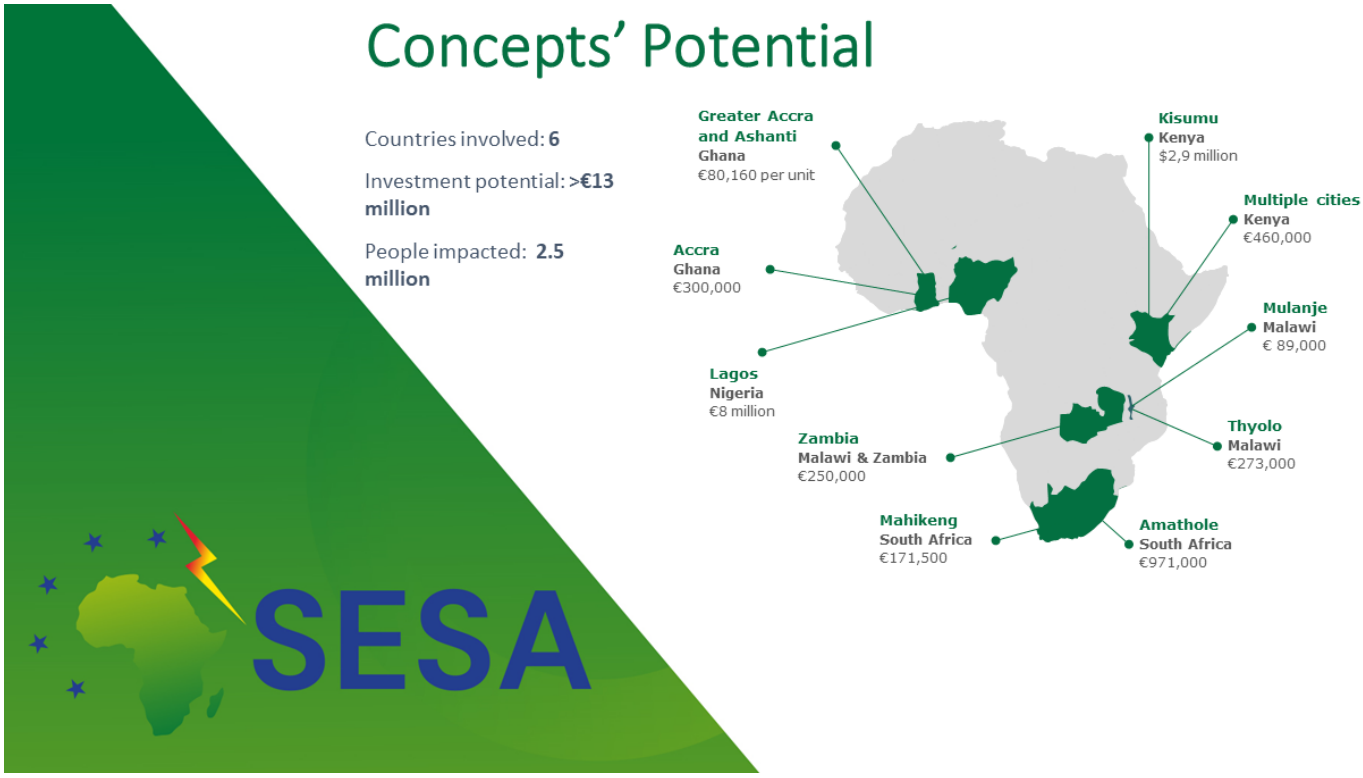


Figure 3. 10 Concept projects developed

3.2.3. Summary of Scale-up Concepts

In Step 2, the selected concepts were supported towards their development. To facilitate this task, T5.1 developed two new templates, a Word document for enhanced concept note development, and an Excel document for a second assessment of the developed concepts and their scoring (in Step 3). Similarly, the development of the templates was done in agreement of T5.1 SESA Partners that included the gathering of comments and suggestions from WP5.1 partners with internal deadlines, and inclusion of amendments. Once completed in Month 25, the templates were shared with selected projects and back up projects to develop the concept notes, with support of SESA Partners acting as project submitter or proponent. The development of concept notes was undertaken until the internal deadline in Month 28 - extended to Month 29 upon request from project submitters. In Month 29, there were nine developed concept projects from the (10) selected concept notes and one developed concept project was submitted from the (5) back-up concept notes.

A key objective behind the Scale-up Concepts is to share them with organisations and potential funders active in the field of energy access in Africa, inside the project consortium and well beyond, to spark the take-up of solutions beyond the projects core-demonstrations and beyond the project's lifetime.

The 10 concept notes supported were as seen in Figure 4:

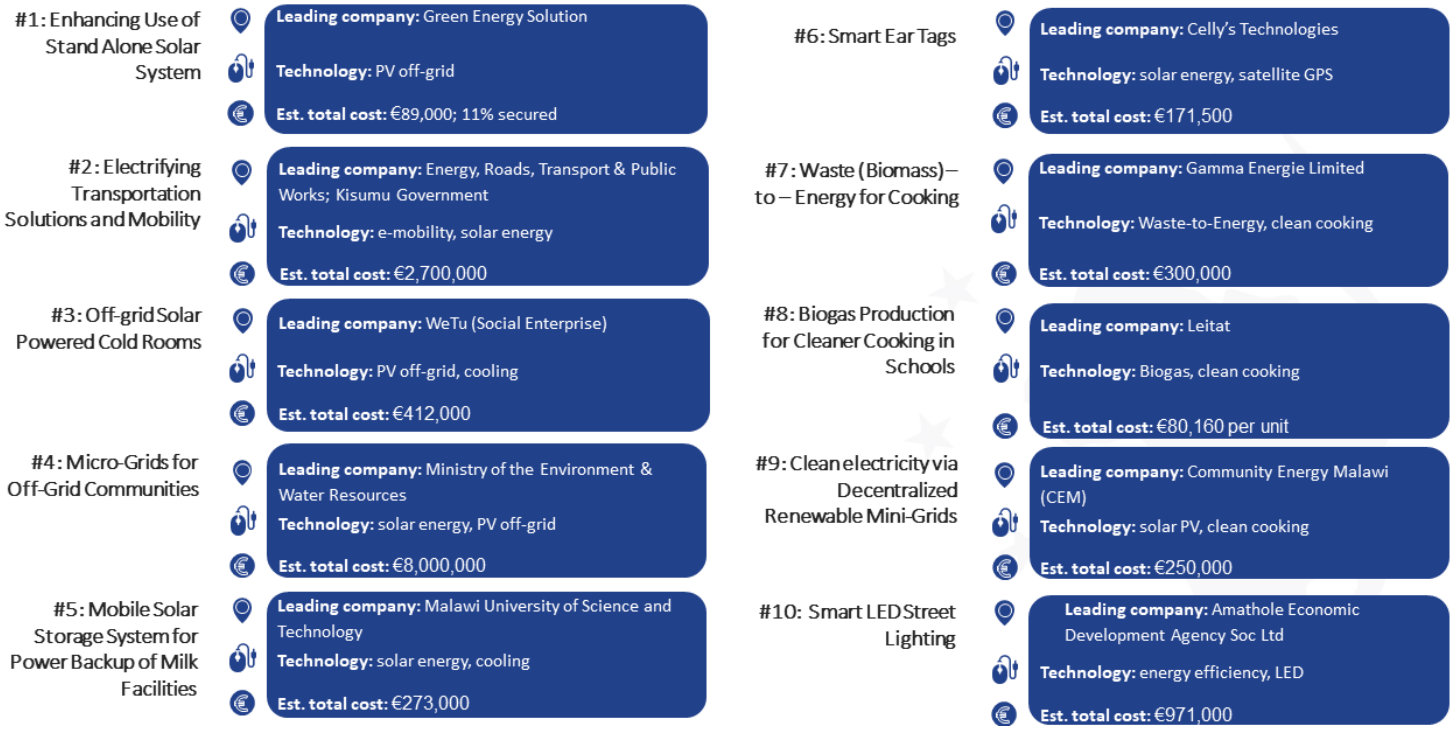


Figure 4. 10 Concept Notes

In *Annex 1. 10 Concept Notes and 4 Pre-feasibility Studies* more information about the 10 developed concept notes can be found.

3.3 Development of Pre-feasibility Studies

3.3.1. Selection of Concepts

Similar to Step 2, Step 3 also underwent a more detailed scoring process using the Excel documents generated in Step 2 – see Figure 5. The scoring process was undertaken in Month 29, during which seven partners in T5.1 were requested to score all 10 developed concept projects independently. The process entailed internal coordination via calls with T5.1 partners responsible to evaluate the scoring results. Additionally, T5.2 Barrier analysis was considered during the evaluation and scoring of the project concept notes.

Financial maturity	A basic business model exists and is attached *a well-defined business model is not required, but an indication on how the concept will generate revenue providing rough estimates/numbers.*		4		Score 0=No Score 1= Basic business model exists but unclear description Score 3= Basic business model exists and proven elsewhere Score 4= Basic business model exists and provided as attachment	
	A basic financial model exists and is attached *a well-defined financial model is not required, but rough estimates on a basic income statement, balance sheet, OR cash flow*		4		Score 0=No Score 1= Basic financial model exists but unclear description Score 3= Basic financial model exists and proven elsewhere Score 4= Basic financial model exists and provided as attachment	
	The project has potential to generate financial savings or revenues		3		Score 0=No Score 2= Yes and at least a preliminary concept exists Score 3= Yes and it is tested/well defined preliminary concept	
	The concept note identified permits and contracts that already exist *(e.g. land / rental / usage rights, all potentially require permits, MoUs, environmental impact assessments or similar, feed-in contracts and remuneration - if relevant).*		2		Score 0= No identified permits and contracts Score 1= Identified permits and contracts, but not relevant Score 2= Identified relevant permits and contracts	
Ability to access loan	The project as limitations/conditions to access debt or international finance		3		Score 0= The project cannot access debt or international finance Score 1 = The project might be able to access debt or international finance but it is unclear Score 2 = The project can access either debt or international finance Score 3 = The project can access debt and international finance	
	The project submitter is capable of borrowing or mobilizing external private resources		2		Score 0= No Score 1= Yes Score 2= Yes and it has been done in the past.	
	The project submitter has already received financing for this concept note		1		Score 0= No Score 1= Yes and reference provided.	
	TOTAL	0	29	0%		
	TOTAL SCORE	0	83	0%		

Figure 5. T5.1 Selection of Concepts: Excel Document Scoring Sheet

Once the scoring was performed by T5.1 partners on a voluntary basis, and evaluating projects description, transformative impact, and their financial viability. T5.1 Partners mandated to support the concept projects used the scores as a basis for the selection. To reduce bias, T5.1 Partners were requested not to score projects they were involved with, and only the averaged results from all assessments were considered. T5.1 Partners discussed all projects, with direct input provided by each Partner for each project.

The projects selected for support with a PFS were:

1. Enhancing use of Stand- alone solar system for Livelihoods Improvement, Mulanje, Thyolo, Phalombe, and Chiradzuro, Malawi.
2. Cold Storage Kenya.
3. Advancing Commercial Electric Mobility County Government of Kisumu: Electric mobility - commercial 2-and-3-wheelers, Kisumu County, Kenya.
4. Developing a Mobile Solar Powered Battery Energy Storage System for Power Backup of Milk Cooling Facilities in Thyolo District, Malawi.

At the same time, T5.1 leads developed, with the support of T5.1 Partners, a PFS Template – see Annex 2. Just as templates developed in Step 1 and Step 2, the PFS Template was developed by ICLEI WS, together with a consortium of partners including the Technical University of Berlin, Wuppertal Institute, Smart Innovation Norway, and the Siemens Foundation as a guiding document for the provision of PFS through SESA. The Template was designed to flexibly accommodate project concepts within the energy sector in Africa.

3.3.2. Development of Pre-feasibility Studies

Step 3 of T5.1 entailed the development of the PFS Template, coordination of T5.1 Partner support for the PFS' development, and coordination with the project owners for their completion. To ensure a robust process, the project owners of the selected developed concept notes were supported by two T5.1 Partners, a lead and a supporting partner, as follows:

1. Enhancing use of Stand- alone solar system for Livelihoods Improvement.
   Supported by TUB as lead partner, and by WI as supporting partner.
2. Cold Storage Kenya.
   Supported by UNEP as lead partner, and by SIN as supporting partner.
3. Advancing Commercial Electric Mobility County Government of Kisumu: Electric mobility - commercial 2-and-3-wheelers.
   Supported by ICLEI WS as lead partner, and by WI as supporting partner.
4. Developing a Mobile Solar Powered Battery Energy Storage System for Power Backup of Milk Cooling Facilities in Thyolo District.
   Supported by SIN as lead partner, and by ICLEI WS as supporting partner.

The PFS were developed throughout 2024, from M30 to M37, which was coordinated by T5.1 Partners' leadership and regular monitoring was performed during the monthly WP5 calls. By M37, four PFS were developed, and key results are included in Annex 1.

In addition to the objective of supporting the take-up of relevant solutions, the PFS also aimed to highlight the opportunities and challenges in core-segments of the energy access value-chain. This aims to highlight aspects to be considered in similar projects in different operating environments.

Find more information about the PFS format in *Annex 2.PFS Template*.

4. Financial Landscape

4.1. Mapping of financial institutions

In parallel to the Call for Ideas, T5.1 also undertook a mapping of financial institutions at national and international levels that could potentially support the engagement of developed concept notes and projects supported with a pre-feasibility study with financiers. The task developed a mapping of financial institutions which, as the project progressed, was revised and enhanced with a specific focus on the concepts' sectors, needs, and country of implementation.

4.2. Engagements and Connection to T5.3

Given that T5.1 and T5.3 were closely connected with the aim to bring financing opportunities to the developed concept notes, T5.1 undertook an outreach effort to mapped financiers to explore potential financing for the 10 developed concept notes. Additionally, T5.1 supported the presentation of the 10 developed concept notes in T5.3 SESA Invest & Procure Summit in M31, to facilitate visibility and fundraising opportunities for the projects.

Additionally, T5.1 undertook a second mapping, focused on Kenya and Malawi, to submit concept notes to four potential financiers - joining T5.3 efforts in D5.4. This mapping of financiers was centred on financial institutions with a focus or partial focus on green energy finance and that could potentially provide investment support for the 10 Scale-up Concepts. Examples of financiers approached are Community Energy Malawi or Société Générale CIB.

5. Conclusions and Recommendations

5.1. Deviations

From the original work description in the grant agreement, T5.1 has undergone deviations in terms of the output produced. The Call for Ideas was opened to a broader range of stakeholders - beyond projects focused on scaling up demonstration and validation within the SESA Project - due to conflicting timelines within the project WPs and the decision to implement T5.1 activities later to better align with the development of tasks in WP3 and WP4.

The eligibility criteria for the Call for Ideas were no longer strictly focused on sustaining the innovations tested in the demonstration actions or developing them into project proposals within WP3 and WP4. Instead, they shifted to the criteria outlined in Section 2. The selection of 10 project concept notes and four projects to be supported with PFS took place taking the original grant agreement into consideration, despite the deviations from the original grant agreement.

An additional deviation from the original timeline, in alignment with activities from WP3 and WP4, led to deferring of T5.1 causing a shift in timelines of the tasks' delivery by approximately 5 to 6 months.

5.2. Conclusions

Of the 27 concept notes received in the Step 1 Call for ideas, 10 were developed as concept projects from the top 10 scoring projects and five back-up projects. These projects were selected keeping considerations for their innovation, replicability, and impact. Of these 10 developed concept notes, four have been selected as top scorers and fitting the eligibility criteria set by T5.1 partners and supported with a PFS, of which three are deemed as feasible should they incorporate the feedback provided by SESA Partners.

As a continuation of the support to the developed concepts, T5.1 has supported T5.3 activities for towards financing large scale, transformative implementation projects based on the learning from the demonstration activities, and the early involvement of financial institutions in the scoping and planning of transformational projects. The 10 developed concept notes were highlighted and introduced to potential financiers through the SESA Invest & Procure Summit, organised by T5.3 in Rwanda in April 2024. Additionally, the concepts were supported with application to financing opportunities, were suitable, including the Powering Renewable Energy Opportunities (PREO) Open Call 2025 or the United States African Development Foundation.

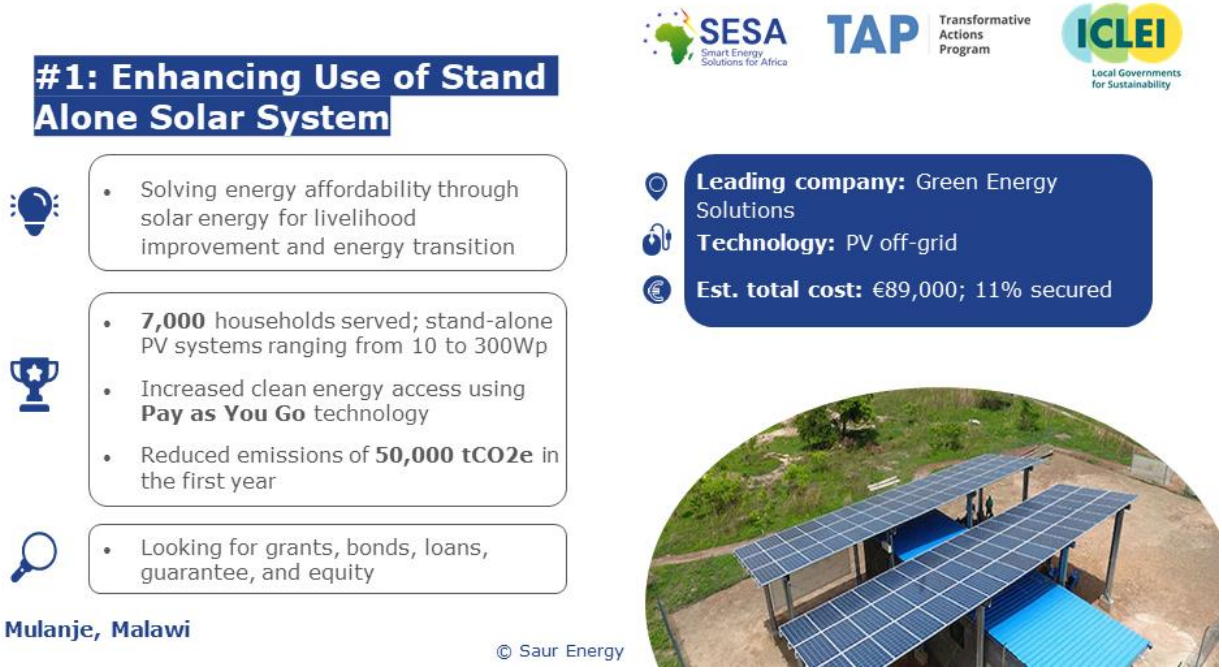
6. Annexes

6.1. Annex 1. 10 Concept Notes and 4 Pre-Feasibility Studies

List of Acronyms

Acronym	Description
AD	Anaerobic Digestion
ADM	Amathole District Municipality
AI	Artificial Intelligence
BES	Bio-electrochemical Systems
BESS	Battery Energy Storage System
EV	Electric Vehicle
GHG	Greenhouse Gas
LPG	Liquefied Petroleum Gas
MBGs	Milk Bulking Groups
MRES	Malawi Renewable Energy Strategy
MUST	Malawi University of Science and Technology
NGOs	Non-governmental Organizations
PUE	Productive Use of Energy
SAPS	South African Police Services
SHS	Solar Home System

1. Enhancing Use of Stand-Alone Solar System for Livelihood Improvement



1. Problem Statement/Background

Malawi is undergoing a sustainable energy sector transition to meet the needs of its people, stimulating economic growth and protecting the environment. Currently, electrification rates in rural areas remain alarmingly low, with only 1% of the population having access to reliable electricity. Dependence on biomass fuels for cooking has led to severe deforestation, environmental degradation, and adverse health effects from indoor air pollution. Recognizing these challenges, the Enhancing Use of Stand-Alone Solar Systems for Livelihood Improvement project aims to increase the affordability, accessibility, and acceptance of solar energy technology among low-income communities. The project aligns with Malawi's national policies, including Malawi Vision 2063, the National Energy Policy, the Malawi Renewable Energy Strategy (MRES), and the National Charcoal Strategy. At the district level, it directly supports the Mulanje District Council's call for improved access to reliable energy, as outlined in its District Development Plan.

2. Challenges Addressed

The project seeks to overcome three primary barriers to solar energy adoption: affordability, access to products, and after-sales support. High upfront costs prevent many low-income households from purchasing solar systems, while limited distribution networks hinder access to quality products. Additionally, the lack of user education and maintenance services reduces system efficiency and longevity. Traditional biomass cooking fuels remain prevalent due to the absence of viable alternatives, contributing to deforestation and respiratory diseases from indoor smoke exposure.

3. Solutions Proposed

To ensure that even the lowest-income earners in remote areas can own and utilize solar energy systems, financial accessibility will be enhanced by engaging informal financial service providers to facilitate microloans for solar system purchases and linking eligible clients to donor-funded solar subsidy programmes, reducing upfront costs. Distribution networks will be strengthened by recruiting and training 25 local sales agents to ensure last-mile distribution and after-sales support. A novel hybrid solar-biomass stove will be introduced, reducing biomass consumption by up to 80% and enabling the use of alternative feedstocks such as cow dung and fallen leaves, mitigating deforestation. Energy efficiency and user education programmes will be provided to households to optimize solar system performance and ensure long-term sustainability. Compliance with Lighting Global Standards and Malawi Bureau of Standards will be enforced to guarantee product quality and safety.

4. Resources Needed

The successful implementation of this project requires €89,000 in financing to cover system installations, training programmes, financial facilitation mechanisms, and operational expenses. The funding will support the procurement and installation of 7,000 stand-alone PV systems ranging from 10Wp to 300Wp. It will also facilitate the development of loan agreements with 50 informal financial service providers, the establishment of partnerships with donor organizations to provide solar home system (SHS) subsidies, and the training of 25 local sales agents for product distribution and customer support. Additionally, the project will implement household energy education programmes for at least 7,000 households.

5. Stakeholders Involved

The project relies on collaboration among key stakeholders, including government agencies, financial institutions, donor organizations, local sales agents, and community organizations.

Malawi's Ministry of Energy and the Mulanje District Council will ensure alignment with national and district-level policies. Financial institutions, including Village Savings and Loan groups, Farmers' Cooperatives, Tea Estate Tenants Associations, and Civil Servants Savings and Credit Cooperatives, will provide microloans for solar system purchases. Donor organizations will support the initiative by offering SHS subsidies to low-income households. Local sales agents will play a critical role in last-mile distribution, customer support, and maintenance services. Community organizations will assist in public awareness campaigns and user education programmes to ensure widespread adoption of the technology.

6. Potential Impact

The Enhancing Use of Stand-Alone Solar Systems for Livelihood Improvement project is expected to significantly increase electrification rates, economic opportunities, and environmental sustainability in rural Malawi. The initiative aims to raise the electrification rate in the targeted area from 1% to 50% within 12 months. It will provide access to clean energy for 38,000 people, improving public health by reducing exposure to indoor air pollution. Educational opportunities for 20,000 schoolchildren will be enhanced through improved lighting for nighttime study. The project will promote gender equality by empowering 1,000 women to establish solar-powered businesses and recruiting 15 female sales agents. Economic growth will be stimulated by enabling 500 dairy farmers to acquire solar-powered refrigerators and 300 young entrepreneurs to launch micro-businesses. Additionally, the initiative is projected to prevent approximately 50,000 metric tons of CO2e emissions in the first year, contributing to Malawi's national greenhouse gas (GHG) reduction targets.

7. Pre-feasibility Study Results

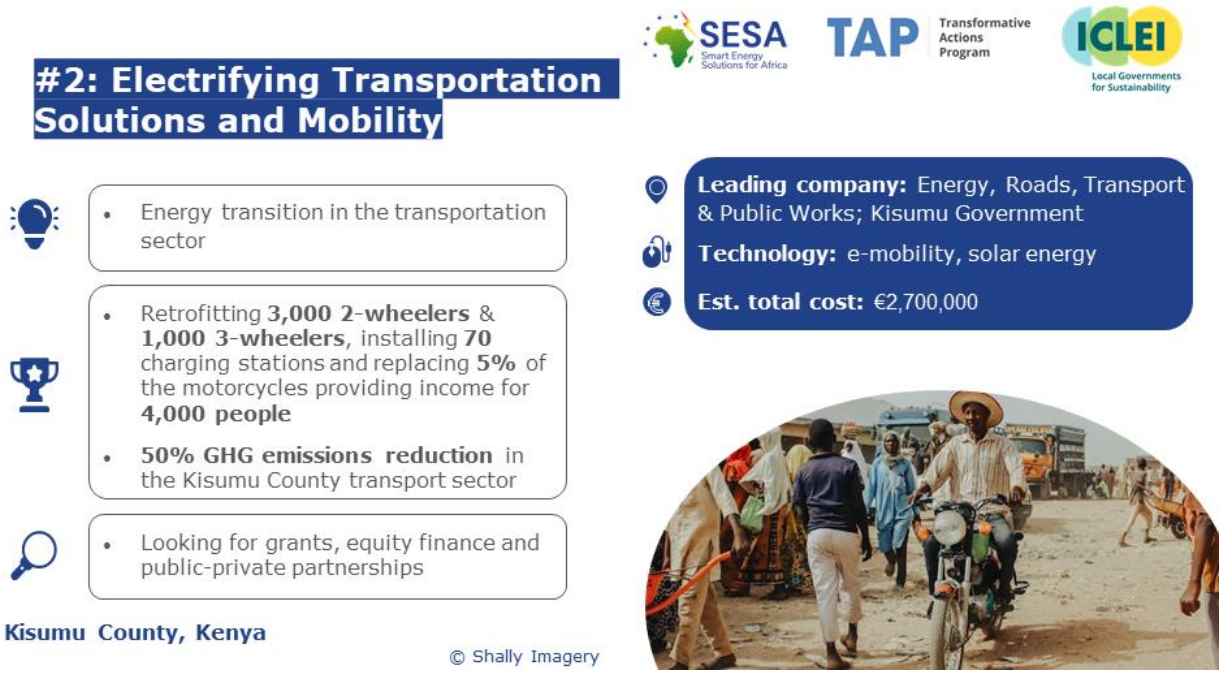
The pre-feasibility analysis conducted on the solar energy project proposed for Mulanje District in Malawi suggests a promising opportunity for economic viability, socio-economic impact, and scalability. The initiative aims to increase electricity access through stand-alone SHS, leveraging a combination of the Pay-As-You-Go model and end-user financing to improve affordability. The project promises significant socio-economic benefits, including increased energy access from 1% to 19% of district households, reduced indoor air pollution, improved business productivity, and enhanced educational outcomes. Also, the installation of solar-powered cold storage facilities will benefit dairy farmers, while small enterprises such as salons, barber shops, and video showrooms will extend their operational hours. Moreover, the initiative supports gender inclusion by employing women and youth as sales agents, thereby fostering economic empowerment.

The projected return on investment for the project is positive, indicating profitability. The financial model relies on instalment-based payments, reducing barriers to affordability while ensuring a steady revenue stream. The engagement with local financial service providers enhances financial accessibility for low-income households, ensuring demand and minimizing default risks. Several risks could impact project success, including high inflation rates, currency fluctuations, supply chain disruptions, and consumer payment defaults; however, the project aims to mitigate these risks through bulk purchasing to counter inflation, payment agreements in local currency to reduce forex-related challenges, and diversified customer segments to ensure sales resilience. Additionally, engagement with reputable suppliers ensures product quality, backed by warranties and after-sales support, addressing concerns about solar technology durability.

To scale the project effectively, the implementing organization needs to strengthen partnerships with financial institutions to expand end-user financing options. Moreover, government-led solar subsidy programmes should be leveraged to further enhance affordability. The use of trained local

sales agents should be expanded to ensure widespread adoption and after-sales support. Finally, future expansion could include solar-powered water pumps and mini-grid solutions for larger communities, aligning with national energy policies and increasing the long-term impact. Overall, the project is highly feasible, presenting a strong case for profitability, sustainability, and scalability while addressing critical energy poverty challenges in Malawi.

2. Electrifying Transportation Solutions for Kisumu County: Advancing Commercial Electric Mobility



1. Problem Statement/Background

Kisumu County's transport sector is a significant contributor to GHG emissions, comprising 84.62% of total emissions in 2021, equivalent to 7,845.8 MtCO2e (Baseline Emission Inventory of Kisumu, 2021). These emissions are expected to rise due to increasing car registrations and the influx of motorbikes and tuk-tuks, which serve as primary transportation for low- and middle-income earners. The transport sector plays a crucial role in Kenya's climate commitments. To address this challenge, Kisumu County is aligning with national and regional climate strategies, including the Kisumu County Integrated Climate Change Action Plan (2022-2027), the County Integrated Development Plan (2023-2027), the National Climate Response Strategy, and the roadmap to 100% Renewable Energy adoption by 2050. The project also integrates energy transition goals under the Energy Transition and Investment Plan, focusing on reducing fossil fuel use in the transport sector, improving air quality, stimulating economic growth, and reducing fuel costs for residents.

2. Challenges Addressed

Kisumu County faces multiple challenges in its transition to sustainable transport. The high levels of exposure to volatile oil prices and high levels of air pollution and GHG emissions from the transport sector contribute significantly to economic inefficiency, health issues, environmental degradation, and climate change. The rapid increase in vehicle registrations, particularly motorcycles and tuk-tuks, further exacerbates the problem by escalating carbon emissions. Economic dependence on

fossil fuels makes transportation expensive and unsustainable in the long run, creating financial burdens for residents.

Additionally, the county lacks sufficient infrastructure to support the widespread adoption of electric vehicles (EVs), including charging stations and maintenance facilities. Limited awareness and technical capacity among stakeholders' present barriers to e-mobility adoption. Social and gender inequalities also persist in the energy and transport sectors, limiting opportunities for women and marginalized groups to benefit from the shift to clean transportation.

3. Solutions Proposed

The project envisions a collaborative public-private partnership to drive e-mobility adoption in Kisumu County. This initiative includes a comprehensive plan to manufacture and retrofit EVs, develop charging infrastructure, and promote clean transportation. To support the transition, subsidies will be provided to retrofit 3,000 two-wheelers and 1,000 three-wheelers, making them more accessible and affordable to transport operators.

A network of 70 charging stations will be installed, strategically distributed across the county, with 42 stations located in peripheral and rural wards and 28 in city centre wards. To complement infrastructure development, awareness campaigns will be conducted to educate residents about the benefits and operational aspects of e-mobility. In a forward-looking approach, Kisumu County intends to allocate funds within the Rural Electrification Fund and the Consolidated Energy Funds to support e-mobility businesses and enterprises registered within the county.

All charging infrastructure will be powered entirely by solar energy, ensuring a sustainable and cost-effective energy supply. Solar panels will be installed on existing boda boda shades, requiring only minimal modifications during project implementation. This approach leverages existing structures to minimize costs and enhance accessibility to clean energy for transportation.

4. Resources Needed

The successful implementation of the project will require a combination of financial, technical, and policy support. Financial resources are needed to fund retrofitting subsidies, establish charging stations, and provide incentives for private sector participation. Technical expertise is crucial for the manufacturing, retrofitting, and maintenance of EVs to ensure efficiency and reliability.

Policy support will play a key role in creating an enabling environment for e-mobility, including regulatory approvals, incentives, and standards for EV adoption. Additionally, capacity-building initiatives will be implemented to train boda boda operators, mechanics, and entrepreneurs on the technical and business aspects of e-mobility. Public awareness campaigns will also be essential to encourage behavioural change and acceptance of electric mobility solutions within the community.

5. Stakeholders Involved

The project will bring together a diverse group of stakeholders from both the public and private sectors to ensure its success. The Ministry of Energy will provide approval and regulatory oversight, ensuring compliance with national energy and transport policies. The County Government of Kisumu will facilitate land allocation for charging stations and support policy development to create a conducive environment for e-mobility investments. International

organizations such as the United Nations Institute for Training and Research will contribute to capacity-building efforts, providing training and knowledge-sharing opportunities. The E-Mobility Association of Kenya will offer technical support and advisory services, ensuring that the project aligns with best practices and industry standards. Boda Boda Riders Association members will be key beneficiaries and end-users of the retrofitted electric two- and three-wheelers. Private sector partners, including Knights Energy, Roam Electric, Qtron Industries, and E-Safiri, will play a crucial role in the development of charging infrastructure, EV manufacturing, and battery supply. Local entrepreneurs and enterprises will also be engaged in business operations and service delivery to foster economic growth within the county.

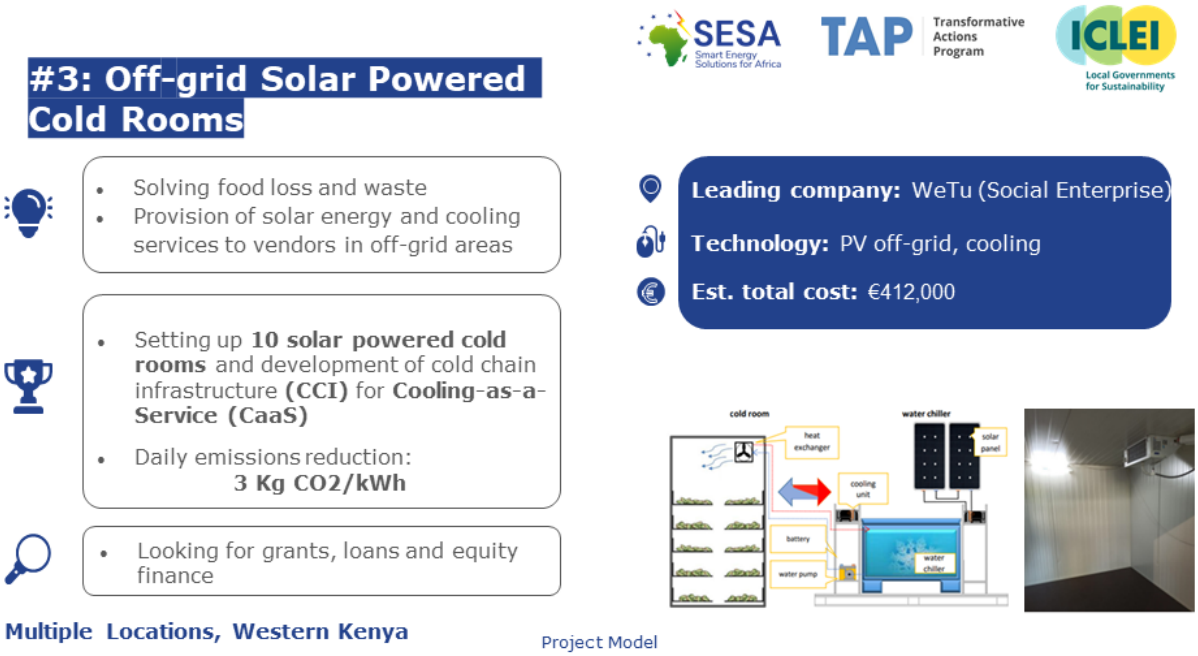
6. Potential Impact

The transition to e-mobility in Kisumu County is expected to generate a wide range of benefits across environmental, economic, and social dimensions. Environmentally, the project will significantly reduce GHG emissions from the transport sector, supporting Kenya's national climate commitments and improving air quality within the county. The shift to electric mobility will also reduce reliance on fossil fuels, decreasing carbon footprints and mitigating climate change effects. Economically, the project will create new green job opportunities in the manufacturing, maintenance, and operation of electric mobility infrastructure. This will provide sustainable employment options for residents and stimulate the local economy. Additionally, the lower operational costs of EV will result in cost savings for transport operators and residents, increasing disposable income and financial stability. The project is committed to promoting social and gender inclusion by ensuring that at least 30% of women and marginalized groups are involved in decision-making processes and employment opportunities. Dedicated roles will be allocated to women in charging station operations and retrofitting facilities, fostering gender equality in the energy and transport sectors. By reducing fuel costs and emissions, the project will enhance overall quality of life for Kisumu residents. Improved air quality will lead to better health outcomes, particularly for vulnerable populations exposed to pollution from conventional fossil fuel vehicles. Beyond Kisumu County, the project serves as a model for replication across Kenya and Africa. The initiative aligns with existing climate financing mechanisms such as the Financing Locally Led Climate Actions initiative, presenting opportunities for expansion to other regions. With an innovative approach that combines public-private partnerships, clean energy adoption, and inclusive economic growth, Kisumu County is positioning itself as a leader in sustainable transport solutions, paving the way for a just and equitable energy transition across Africa.

7. Pre-feasibility Study results

The project presents a significant opportunity to enhance sustainability in Kisumu through the retrofitting initiative. The project currently lacks feasibility from a technical and economic standpoint, based on the data, information and assumptions outlined in this pre-feasibility study. To enhance its viability, specific recommendations and changes must be implemented. The following sections detail these necessary adjustments.

3. Off-grid Solar Powered Cold Rooms in Kenya



Project Model

1. Problem Statement/Background

Kenya has implemented a National Cooling Action Plan (2023) with energy efficiency targets for cooling equipment, the promotion of natural refrigerants, and the enhancement of agricultural cold chains. Key initiatives include enabling market conditions for cold chains, expanding fiscal benefits for cold storage, raising awareness, supporting research and development, promoting access to innovative business models, and designing financing mechanisms for smallholder farmers. However, these efforts remain incomplete due to gaps in regulatory frameworks and enforcement. The informal nature of many markets further complicates implementation. Food loss and waste remain major concerns in Kenya. The UNEP Food Waste Index (2021) reports that approximately 14% of global food production is lost before reaching retail, while 17% is wasted at retail and consumption levels. In Sub-Saharan Africa, food losses amount to at least USD 4 billion per year, sufficient to feed 48 million people. Homabay County, particularly Mbita, suffers from food waste due to inadequate cooling infrastructure, inefficient handling and storage, and long transport distances. The region relies on fishing as a primary livelihood, with limited local fruit and vegetable production, exacerbating dependence on perishable produce transported over 100–500 kilometres.

2. Challenges Addressed

The cold chain sector in Kenya faces multiple obstacles that hinder its development and effectiveness. A major challenge is the absence of sufficient regulatory incentives and enforcement mechanisms, making it difficult to ensure compliance and widespread adoption of best practices. Smallholder farmers and retail vendors also struggle with limited access to cold storage facilities, leaving perishable goods vulnerable to spoilage before reaching the market. High food loss in the supply chain is another critical issue. Inefficient handling, long transport distances, and a lack of refrigeration infrastructure result in significant amounts of wasted food, directly impacting food security and economic stability. Additionally, in rural areas, conventional cold storage solutions remain largely unfeasible due to their reliance on grid electricity, which is often unreliable or unavailable. This is further compounded by inconsistent government policies that

create uncertainty for renewable energy investments and hinder the scaling of sustainable cold chain solutions. Disaggregated and informal market structures also pose a challenge, as they make it difficult to coordinate stakeholders and implement systematic cold chain interventions. Without better integration and strategic alignment, small-scale vendors and farmers remain unable to benefit from available solutions.

3. Innovative Solutions Proposed

Through the SESA project, WeTu collaborated with SelfChill, an award-winning provider of modular cooling solutions, to pilot an off-grid solar-powered cold room in Mbita, Homabay. This initiative introduced a ground-breaking approach to sustainable and energy-efficient cooling, utilizing solar PV with advanced thermal storage capabilities to provide off-grid refrigeration technology. The pilot project began with an extensive baseline assessment, engaging over 50 retailers, market associations, and wholesalers to evaluate food waste levels and income loss. This research guided the implementation of a cooling-as-a-service model, which allows small vendors and farmers to access refrigeration without requiring large upfront investments. By offering an inclusive financing approach, the project made cold storage more accessible and affordable. The initiative also demonstrated the viability of modular, off-grid cold storage solutions as a scalable alternative to traditional diesel-powered refrigeration. Additionally, a commercially viable business model was developed to expand cold room installations along the Lake Victoria shoreline, combining sustainability with economic feasibility. Looking ahead, the plan is to scale up by deploying 10–15 solar-powered cold rooms across Western Kenya, targeting fresh produce and fish value chains. The expansion strategy incorporates blended financing mechanisms, combining concessional financing, equity, and grants to ensure long-term sustainability while attracting private sector investments.

4. Resources Needed

For the successful scale-up of this initiative, several key resources are required. Financial support is critical to transition from a pilot project to multiple locations, necessitating investment through blended financing models. Additionally, technical assistance is needed for system installation, maintenance, and capacity building to ensure operational effectiveness. Policy advocacy plays a crucial role in securing regulatory support and incentives for off-grid cold storage solutions, helping to create an enabling environment for expansion. Establishing partnerships with private sector actors, local governments, and development organizations will also facilitate smooth implementation and coordination. Finally, market data and impact assessments are essential for optimizing business models and operational strategies, ensuring the intervention remains effective and sustainable in the long run.

5. Stakeholders Involved

A diverse group of stakeholders plays a role in the success of this initiative. Smallholder farmers and retail vendors, particularly women, stand to benefit from reduced food loss and increased income due to improved storage solutions. Local government agencies are key actors in shaping policies that support agricultural and energy-related initiatives. The private sector, including technology providers like SelfChill, contributes innovative solutions for solar cooling and other advancements in cold storage technology. Development partners and non-governmental organizations (NGOs) focused on food security, climate resilience, and economic development also support the project through technical expertise, funding, and community outreach. Lastly, community-based organizations facilitate local engagement and awareness, ensuring the adoption and long-term success of the intervention.

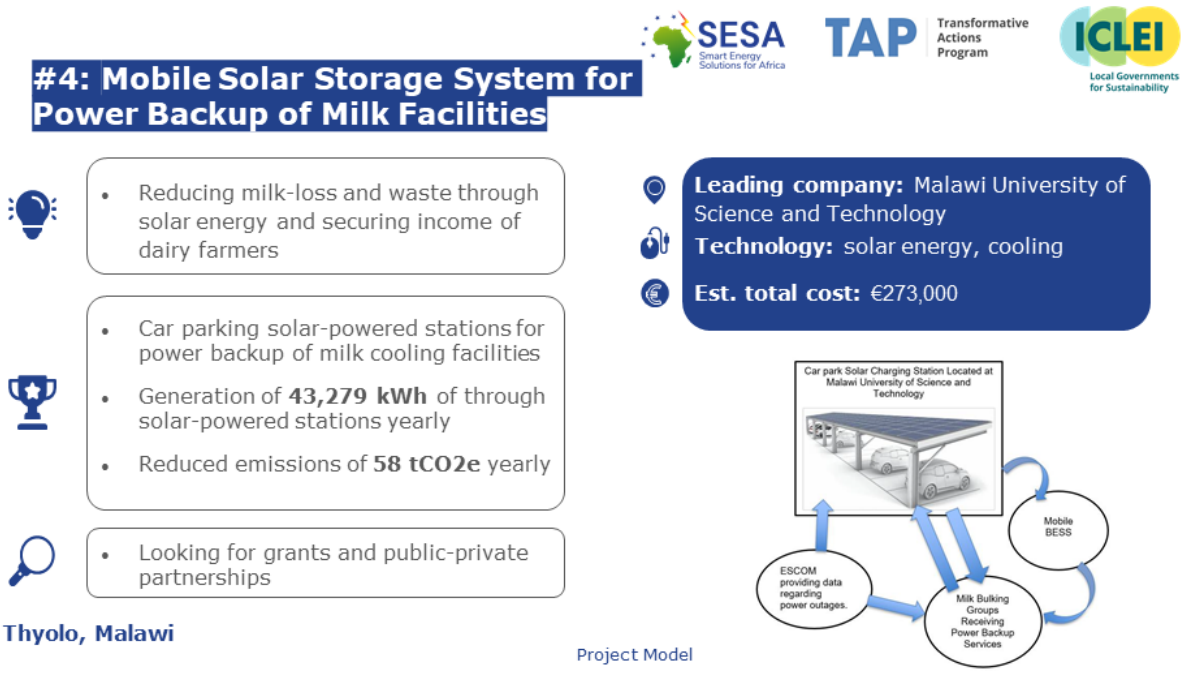
6. Transformational Impact

The scale-up of solar-powered cold rooms has the potential to create significant economic, social, and environmental benefits. By reducing food loss and waste, the initiative contributes to food security, ensuring a more reliable supply of fresh produce and fish, particularly in regions that rely on transported perishables. Economically, the project enhances income opportunities for smallholder farmers and vendors, particularly women, by minimizing spoilage and improving market access. The environmental impact is also substantial, as reducing food waste directly lowers GHG emissions, while the use of alternative refrigerants further mitigates climate impact. From a technological perspective, the initiative promotes cutting-edge solar-powered cold chain solutions, fostering local expertise and innovation in the renewable energy sector. The project also addresses social equity, as women vendors, who constitute most of marketplace retailers, gain increased financial stability and economic resilience. Additionally, the intervention strengthens policy and market development by demonstrating replicable cold chain models that can be scaled in Kenya and beyond. Comparative life cycle assessments indicate that operating the SelfChill cold room with solar PV results in 86% lower emissions compared to diesel generators and 81% lower emissions than grid electricity. With the Mbita cold room consuming 6 kWh per day, its avoided emissions amount to approximately 3000 gCO2/kWh per day. Furthermore, considering that each ton of food spoilage emits nearly one ton of CO2 equivalent, the project delivers notable climate benefits. By introducing innovative, sustainable cold storage solutions, this initiative has the potential to transform food systems, enhance economic resilience, and contribute to Kenya's climate goals, while directly benefiting vulnerable communities that rely on perishable goods for their livelihoods.

7. Pre-feasibility Study Results

Based on the viability of the cold room, the next steps will entail conducting demand and needs assessments at the other existing WeTu hubs in the Western Kenya region to explore the customer segment, the willingness, potential opportunities to link farm to retail storage cold chain, etc. As demonstrated already through the data, the uptake of crates and the use of cold room is increasing gradually and it requires time for new services and innovations in the rural markets to stabilize and for business developers to identify modalities which are feasible, and subsequently establish the links with the financing community on the optimal avenues and financing instruments for structuring cold room and cold chain projects. There is a need to establish a solid sustainable business case and clear usage and uptake by the users. Currently, many cold rooms in the Kenyan market remain underutilized, and we believe it would be unwise to invest in assets and infrastructure that are likely to sit idle if we scale up now. Hence, it is important to allow maturity of the application, sensitivity and awareness among the users, further engaging with the ecosystem of market actors to find co-benefits and incentives for higher uptake and demand.

4. Developing a Mobile Solar Powered Battery Energy Storage System for Power Backup of Milk Cooling Facilities in Thyolo District, Malawi.



Project Model

1. Problem Statement/Background

Malawi's economy heavily relies on agriculture, which contributes approximately 30% to the national GDP, employs 80% of the economically active population, and provides a livelihood for 90% of the total population. However, the country is highly vulnerable to climate change, experiencing severe droughts and flooding that threaten agricultural productivity. While short-term interventions like cash transfer programmes have been implemented, these solutions are not sustainable. A long-term approach is necessary to enhance climate resilience within Malawi's agriculture sector.

Dairy farming has been identified as a key component of Malawi's 2063 Agenda for agricultural diversification. In Thyolo District, smallholder farmers receive dairy cattle to produce milk for sale to processing companies. However, unreliable power supply leads to milk wastage, negatively affecting farmers' incomes. In response, cooperatives have adopted alternative energy solutions that are often expensive and environmentally unfriendly, contradicting Malawi's goal of universal access to clean and affordable energy.

2. Challenges Addressed

Dairy farmers in Thyolo District face significant milk wastage due to frequent power outages. The Milk Bulking Groups (MBGs), responsible for cooling milk before delivery to processing companies, struggle with operational inefficiencies due to unreliable electricity. Farmers often incur high costs to access these facilities, forcing them to sell milk at lower prices to alternative buyers. The energy system is further vulnerable to climate change-related disruptions, such as flooding and droughts that damage power infrastructure. Between 2014 and 2016, the National Commission of Science and Technology piloted a solar-wind hybrid power system for milk cooling, but sustainability challenges persisted. Farmers lacked the technical and economic capacity to operate and maintain

the system, particularly the Battery Energy Storage System (BESS). Lessons from this initiative have informed the development of a new, more sustainable intervention.

3. Solutions Proposed

The Malawi University of Science and Technology (MUST) is piloting an innovative solar-powered mobile BESS to provide power backup for MBGs in Thyolo District. Designed as a university-private sector partnership, the project ensures long-term sustainability through the commercialization of energy services. Initial funding of 32 million kwacha has been secured, with part of the funds allocated to baseline studies on milk waste and the feasibility of solar-powered mobile BESS. A solar charging station will be installed at MUST, featuring solar panels, a charge regulator, an inverter, and deep-cycle batteries configured to meet the energy demands of milk cooling facilities. A private company will be contracted through open tendering to operate the system as a business, ensuring financial viability and sustainability. The project is expected to generate 43,279 kWh of electricity per year, significantly reducing dependency on diesel generators and cutting CO2 emissions.

4. Resources Needed

The project requires infrastructure development for the solar charging station at MUST, the procurement of solar panels, inverters, charge regulators, and deep-cycle batteries, as well as the fabrication of mobile BESS trailers. Additionally, technical training will be provided for operators and entrepreneurs, and funding will be allocated for system maintenance and expansion.

5. Stakeholders Involved

Key stakeholders in the project include MUST, which provides research and technical expertise, and private sector partners responsible for operating and commercializing the energy services. MBGs serve as the primary beneficiaries, while local government authorities offer regulatory and policy support. Development partners and investors contribute financial and technical assistance, and women's groups are engaged to ensure gender inclusivity in project benefits.

6. Potential Impact

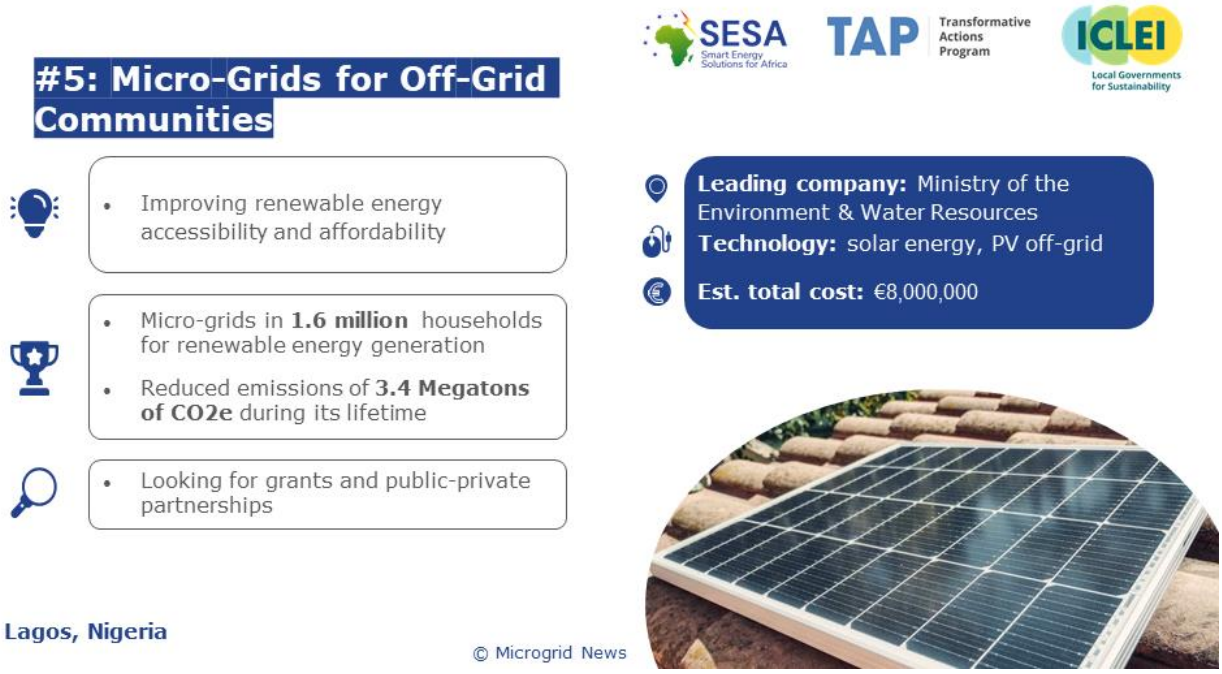
This project offers significant environmental, economic, and social benefits. The solar-powered BESS will replace diesel generators, reducing CO2 emissions by approximately 58 tons per year. By preventing milk wastage, the initiative enhances food security, improves farmers' incomes, and supports economic empowerment, particularly for women who make up the majority of MBG members. Beyond dairy farming, the mobile BESS model is scalable and can support other economic activities, such as providing power backup for fish traders, fresh produce retailers, and social events. The project also creates employment opportunities for youth in marketing, technical maintenance, and operations. Additionally, it fosters research and education at MUST, allowing students and faculty to engage in practical learning and data-driven innovations. In the long term, the model can be replicated across Malawi and other countries facing similar challenges, fostering sustainable energy solutions and economic resilience in climate-vulnerable communities.

7. Pre-feasibility Study Results

There is huge untapped potential for such milk cooling facilities. The government is also promoting enterprises in the domain of milk cooling which provides a suitable opportunity for this project concept to be developed further. However, a detailed feasibility and viability analysis of the project should be done further to concretely address the unanswered questions in the pre-feasibility

study. It will also help in exploring funding opportunities and in convincing the funders about the sustainability of this business in the coming years.

5. Micro-grids for Off-Grid Communities in Lagos, Kenya



1. Problem Statement / Background

Lagos, Nigeria, is home to over 27 million residents, making it one of the largest urban centres in the world. Despite its status as the largest consumer market in Sub-Saharan Africa and a key economic hub, access to electricity remains a critical challenge. As of 2020, only 31% of households were connected to the grid, leaving approximately 69% either unconnected or relying on self-owned generators, kerosene lamps, and other high-cost, fossil-based energy sources. Current grid supply meets only 0.9 GW of the estimated 5 GW electricity demand, resulting in severe energy deficits, especially in informal settlements and poorer communities. Without intervention, full electrification through traditional grid expansion could take up to 20 years.

2. Challenges Addressed

Millions of Lagos residents, particularly those in low-income communities, struggle with unreliable and unaffordable electricity. Poor households spend over 10% of their income on alternative energy sources such as generators, which are both costly and environmentally damaging. The city's energy sector is responsible for 55% of its GHG emissions, amounting to 14.56 MtCO2e, contributing significantly to climate change and air pollution. Limited electricity access also restricts business growth, job creation, and economic productivity, disproportionately affecting women and girls, who bear the brunt of energy poverty. With unreliable power, educational opportunities are limited, and safety concerns are heightened, especially in unlit areas at night.

3. Solutions Proposed

This project seeks to provide clean, affordable, and reliable electricity to five million off-grid urban residents in Lagos through solar-powered micro-grids. By electrifying 1.6 million households—36% of all households—by 2030, this initiative aims to enhance access to energy in a sustainable and scalable manner. The project will prioritize solar technology due to its adaptability, ease of installation, and capacity to meet increasing energy demands. Beyond energy access, the initiative is expected to stimulate socio-economic growth by enabling business expansion, fostering entrepreneurship, and generating over 40,000 jobs. Environmental benefits are a key focus, with the project estimated to reduce emissions by approximately 3.47 $MtCO_2e$, improving both indoor and outdoor air quality while mitigating noise pollution caused by generators. The initiative will also enhance public services by providing reliable electricity to schools and healthcare centres, ensuring they can operate efficiently with modern equipment and communication systems. Women will particularly benefit from the programme, as reduced reliance on fossil fuels will lessen their household labour burden, allow more time for income-generating activities, and create opportunities for participation in renewable energy initiatives.

4. Resources Needed

The successful implementation of this project requires significant financial investment from multilateral finance institutions, donor agencies, and private investors. Policy and regulatory support will be crucial to fostering an enabling environment for off-grid solar solutions and accelerating deployment. Technical expertise will also be needed, necessitating collaboration with local and international partners for infrastructure development, training, and capacity building. Moreover, community engagement is essential to ensure public awareness and acceptance, encouraging active participation from residents and businesses in the transition to clean energy.

5. Stakeholders Involved

The Lagos State Government and the Federal Ministry of Power will play central roles in policy formulation and project oversight, while local councils will be instrumental in implementation. Private sector actors, including solar technology providers and micro-grid developers, will contribute to infrastructure development and service provision. Development partners such as multilateral finance institutions, donor agencies, and climate finance organizations will support the project with funding and technical assistance. Local communities, businesses, and community leaders will be actively involved in the planning, execution, and maintenance of the micro-grid systems, ensuring that the solutions align with their needs and priorities.

6. Potential Impact

By improving access to reliable electricity, this project will directly benefit 1.6 million households, significantly transforming the lives of millions of Lagos residents. Increased energy availability will stimulate local economies, enabling small businesses to expand and new enterprises to emerge, ultimately driving job creation and economic growth. The environmental impact will be substantial, as the transition to solar power will significantly reduce emissions, contributing to Nigeria's Nationally Determined Contributions and Lagos' Climate Action Plan. Furthermore, the project presents a scalable and replicable model that can be extended across Lagos and other Nigerian cities, leveraging supportive policies and regulatory frameworks to accelerate clean energy adoption on a national and regional scale.

6. Enhancing Livestock Security and Farm Management: Smart Ear Tag Technology in South Africa

1. Problem Statement/Background

Livestock theft is a growing challenge in South Africa, particularly for small-scale farmers in rural areas. The issue has been recognized as a national priority in the National Rural Safety Strategy 2019 by the South African Police Services (SAPS). The escalating incidents of stock theft, especially in bordering regions such as the Eastern Cape, Free State, KwaZulu-Natal, and Limpopo, have stifled the progress of small-scale farmers, preventing them from scaling into commercial operations. Syndicates have increasingly engaged in organized crime, using vehicles and trucks to steal livestock, leading to substantial financial losses. Many farmers, lacking confidence in law enforcement, do not report these incidents, while low recovery rates further discourage new entrants from pursuing livestock farming.

2. Challenges Addressed

Livestock farmers face numerous challenges that hinder their ability to grow and sustain their businesses. The prevalence of stock theft, particularly in rural and border regions, has had a profound impact on the agricultural sector, leaving small-scale farmers vulnerable to financial instability. Many farmers lack trust in law enforcement agencies due to the low recovery rates of stolen livestock, which discourages them from reporting thefts. The inability to secure their livestock prevents small-scale farmers from transitioning into commercial farming, keeping them in subsistence-level operations. Additionally, these farmers often have limited access to modern monitoring and management technologies, making it difficult to efficiently oversee their herds.
Environmental factors also play a role in farm management, as climate variability affects grazing patterns and the overall health of livestock. Farmers need a reliable system to track environmental changes and adapt their practices accordingly. Gender disparities in the sector further complicate matters, with women facing significant safety risks and logistical challenges in managing their livestock. Livestock farming is a labour-intensive occupation, and women farmers often rely on

shepherds due to the risks involved in monitoring their animals on-site. These challenges collectively highlight the urgent need for a sustainable, technologically advanced solution.

3. Solutions Proposed

To address these pressing issues, Celly's Technologies is developing an innovative tracking and monitoring solution specifically designed for small-scale and commercial livestock farmers. Their Smart Ear Tag and mobile application platform will provide real-time livestock tracking and monitoring capabilities. Unlike traditional ear tags, which only serve identification purposes, the Smart Ear Tag integrates GPS satellite tracking to monitor the movement of animals, significantly reducing stock theft incidents and enhancing farm security.
The mobile application platform will allow farmers to oversee their livestock remotely, monitor farm activities, and receive real-time alerts on movement and environmental conditions. The Smart Ear Tag is designed to go beyond just tracking; it will collect environmental data such as air quality, temperature, and humidity to help farmers assess their livestock's health and surroundings. By utilizing artificial intelligence (AI), the system will analyse historical data, predict trends, and provide actionable insights to farmers, ultimately improving farm productivity and security.

Key features of the Smart Ear Tag include:

- GPS tracking via satellite, enabling real-time monitoring without reliance on cellular networks.
- Solar-powered, battery-less design, ensuring sustainability and eliminating risks associated with battery-operated devices.
- Environmental monitoring, including air quality, temperature, and humidity tracking, to assess livestock well-being.
- AI-based data analytics, offering predictive insights to help farmers make informed decisions.
- Mobile application integration, allowing remote livestock tracking and farm management.

This solution provides a cost-effective, scalable, and universal approach to livestock monitoring, as it is not dependent on specific network providers or land-based systems.

4. Resources Needed

To successfully implement this project, several key resources are required. Financial investment is needed for the development, testing, and large-scale production of Smart Ear Tags, as well as for setting up the necessary satellite communication infrastructure. Technical expertise in hardware development, AI integration, and software engineering will be essential to refine the technology and ensure its reliability. In addition, farmer training programmes must be established to educate users on how to leverage the Smart Ear Tag and mobile applications to maximize its benefits. Furthermore, the project must adhere to regulatory requirements, including compliance with national policies on animal tracking and data security. Strategic partnerships with agricultural organizations, financial institutions, and government agencies will be critical in facilitating the deployment and adoption of this technology across various farming communities.

5. Stakeholders Involved

The successful implementation of this project will require collaboration among multiple stakeholders. Small-scale and commercial farmers will be the primary beneficiaries, gaining access to an advanced tool that enhances livestock security and farm management. Government

agencies, including SAPS and agricultural departments, will play a vital role in supporting the initiative and reinforcing security measures to combat stock theft.

Technology developers and engineers will be responsible for designing, producing, and maintaining the Smart Ear Tags, ensuring that they remain functional and effective. Financial institutions and investors will be needed to provide funding for research, development, and large-scale deployment. Additionally, NGOs and agricultural cooperatives can assist in training farmers and distributing the Smart Ear Tags, particularly to smallholder farmers in rural areas. The inclusion of women farmers in this initiative will help address gender disparities in livestock farming by enabling them to monitor and manage their herds safely and efficiently.

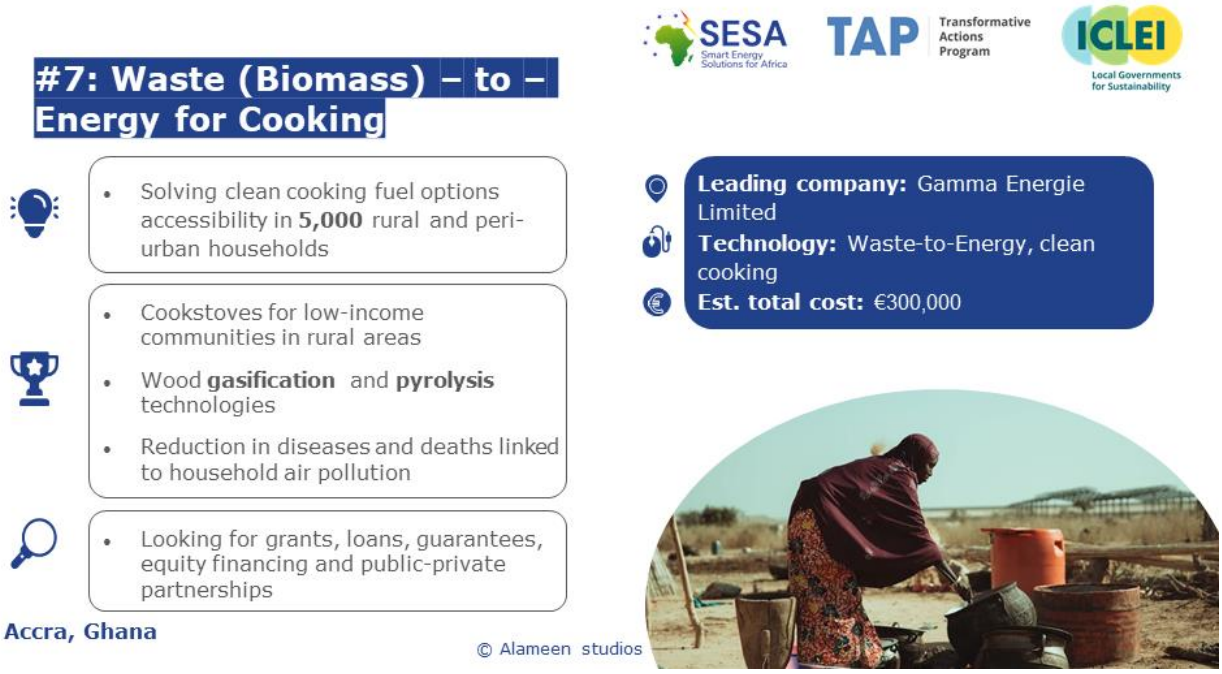
6. Potential Impact

The introduction of Smart Ear Tags is expected to have a transformative impact on livestock farming in South Africa. By providing real-time tracking, the system will significantly reduce stock theft and improve livestock security. Farmers will benefit from enhanced farm efficiency, as they will be able to monitor herd movement, track health conditions, and optimize grazing patterns based on data-driven insights.

From a climate resilience perspective, the ability to monitor environmental conditions will help farmers adapt their practices to changing weather patterns. This will contribute to sustainable farming, as better grazing management will prevent overgrazing and land degradation. A key aspect of this initiative is women's empowerment, as the technology will allow female farmers to remotely monitor their herds without relying solely on on-site supervision. This will increase their participation in livestock farming while enhancing their safety and decision-making power.

Overall, the Smart Ear Tag represents a ground-breaking step forward in modernizing livestock farming, addressing critical challenges such as stock theft, farm security, and climate resilience. By equipping farmers with cutting-edge tools to monitor and manage their herds, this initiative has the potential to transform the agricultural landscape in South Africa. Through data-driven decision-making, enhanced security, and sustainable farming practices, the Smart Ear Tag will empower farmers—particularly women—to thrive in a competitive industry while contributing to economic growth and climate adaptation. This initiative is more than just a technological advancement; it is a pathway to a more secure, efficient, and resilient future for livestock farming.

7. Expanding Clean Cooking Solutions in Ghana: Char-Briquettes for Sustainable Energy Access



1. Problem Statement/Background

Access to clean and affordable cooking energy remains a significant challenge in Ghana, particularly for low-income communities in rural and peri-urban areas. Many households still rely on traditional cooking fuels such as firewood and wood charcoal, which contribute to deforestation and generate harmful indoor air pollution. This exposure leads to serious health risks, particularly for women and children who spend considerable time near cooking stoves. Additionally, inefficient biomass usage results in increased cooking costs, further straining low-income households. At the same time, agricultural waste from smallholder farms remains underutilized, often discarded or burned, contributing to environmental degradation. Addressing these intertwined challenges requires a sustainable solution that promotes clean cooking energy while simultaneously managing biomass waste more efficiently.

2. Challenges Addressed

One of the main obstacles in transitioning households and small enterprises to cleaner cooking energy is accessibility. Many low-income households in rural and peri-urban Ghana lack the financial resources or market availability to adopt improved cookstoves and alternative fuels. Additionally, deforestation continues to escalate as firewood and wood charcoal remain primary fuel sources. Addressing these challenges requires a sustainable supply chain, effective distribution mechanisms, and strong community engagement to ensure the long-term adoption of char-briquettes as a viable alternative.

3. Solutions Proposed

This project aims to introduce char-briquettes, a cleaner and more efficient alternative to traditional cooking fuels, alongside improved biochar cookstoves. By leveraging biomass waste to produce char-briquettes, the initiative promotes circular economy principles, ensuring that local

agricultural residues are repurposed into valuable energy sources. The strategy includes expanding access to char-briquettes among rural households and small businesses, developing sustainable supply chain partnerships with smallholder farmers, and raising awareness of the health and economic benefits of cleaner cooking fuels. The integration of a mobile pyrolysis unit within a shipping container provides an additional safeguard against potential disruptions in production, ensuring continuity in case of fire-related risks at the facility.

4. Resources Needed

Successful implementation of this project requires financial investment to scale up production, secure distribution networks, and develop supply chain partnerships. Additionally, technical expertise is essential for monitoring GHG emissions and ensuring the effective deployment of pyrolysis technology. Fire safety measures, including fire insurance and the development of mobile pyrolysis units, will be critical to mitigating risks and ensuring uninterrupted operations. Community outreach and training programmes will also be necessary to drive awareness and adoption of char-briquettes and improved cookstoves.

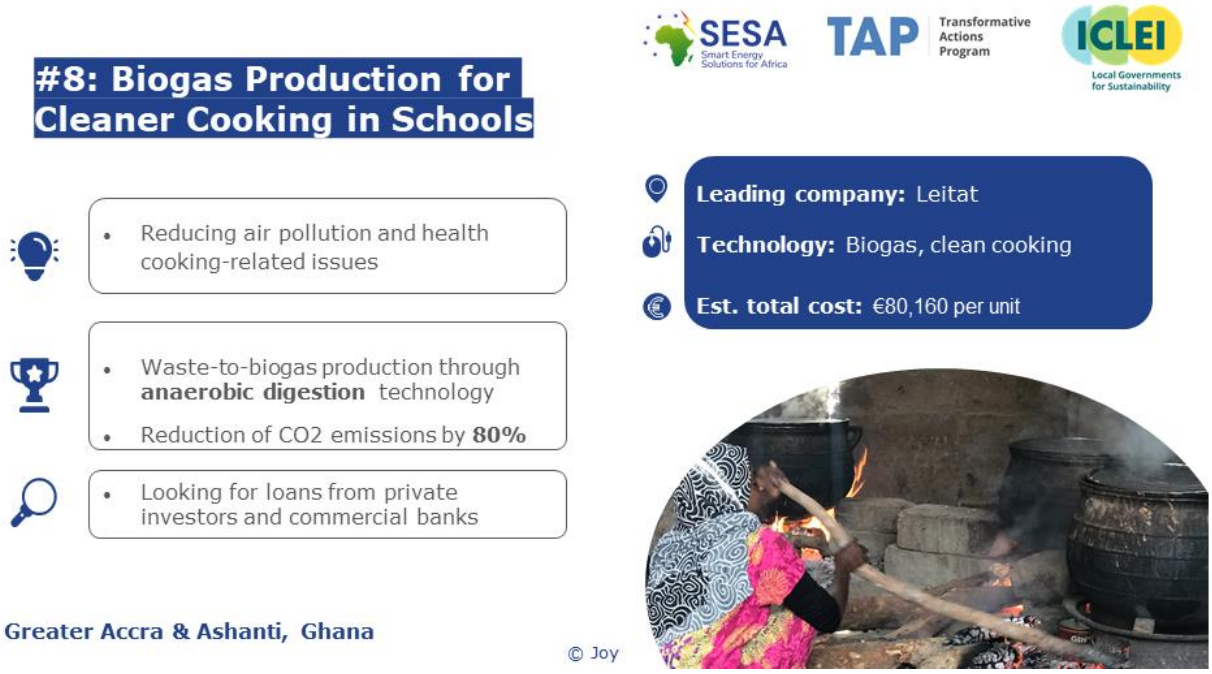
5. Stakeholders Involved

The initiative will bring together multiple stakeholders to ensure its success. Rural and peri-urban households, as well as public schools, will be the primary beneficiaries of the clean cooking solutions. Micro, small, and medium enterprises (MSMEs) in the hospitality sector will also benefit from more efficient and cost-effective cooking fuels. Partnerships with smallholder farmers in the Eastern and Volta Regions will facilitate the collection and repurposing of agricultural biomass waste. Local governments, NGOs, and academic institutions, such as Ashesi University, will play a role in research, advocacy, and knowledge sharing to support the broader impact of the project

6. Potential Impact

The anticipated impact of this project is multifaceted. By reaching 5,000 rural and peri-urban households, the initiative aims to achieve an 85–90% adoption rate, leading to significant reductions in household energy costs and indoor air pollution. The distribution of 3,000 improved cookstoves is expected to prevent 45,000 tons of CO2 emissions over a five-year period, driving economic empowerment by providing smallholder farmers with opportunities to monetize their biomass waste while creating a more sustainable energy ecosystem. Women, who are disproportionately affected by household air pollution and fuel collection burdens, will experience improved health outcomes and greater economic opportunities through cost savings and reduced time spent gathering firewood.

8. Biogas Production for Cleaner Cooking in Schools



1. Problem Statement/Background

In recent decades, electricity consumption in Ghana has risen, and national electricity coverage has expanded. However, the energy system remains heavily dependent on fossil fuels. Cooking energy is largely derived from wood (41.3%), charcoal (31.5%), and gas (22.3%). This reliance presents significant ecological and economic challenges, including deforestation, high carbon emissions, and increasing costs that make energy access difficult for schools, public buildings, and individuals. The cost of firewood and liquefied petroleum gas (LPG) continues to rise, with a truckload of firewood and 100 litres of LPG both priced at approximately GH₵900 (€121). Additionally, cooking with firewood and charcoal in poorly ventilated homes poses serious health risks, particularly for women and children. Finding a cleaner, healthier, and more affordable cooking solution is an urgent necessity.

2. Challenges Addressed

The continued reliance on fossil fuels and traditional biomass for cooking results in high energy costs, increased deforestation, and severe health risks due to indoor air pollution. As Ghana's population grows, excessive exploitation of forests may lead to their depletion, causing adverse environmental consequences. Additionally, conventional Anaerobic Digestion (AD) processes for biogas production face limitations, as the quality and quantity of biogas generated are influenced by environmental factors such as temperature, pH, and substrate composition. The presence of inhibitors like ammonia and high organic acid levels can further disrupt the digestion process. To create a sustainable solution, a more resilient and efficient biogas production system is needed.

3. Solutions Proposed

This project aims to enhance energy access and provide a healthier and more sustainable cooking fuel by implementing Waste-to-Biogas technology through AD and Bio-electrochemical Systems (BES). AD technology converts biomass from food waste and invasive weeds into biogas, which serves as a clean and cost-effective alternative for cooking. Biogas, primarily composed of

methane (50-80%), can be used for heating, electricity generation, or as a purified fuel for cooking. Unlike traditional biomass fuels, biogas combustion does not produce harmful fumes, improving indoor air quality while reducing dependency on fossil fuels. By integrating BES with AD, the project enhances biogas production efficiency. BES technology employs electroactive bacteria that exchange electrons with solid electrodes, allowing for improved methane generation through electro-methanogenesis. This integration results in a more resilient and higher-yielding process compared to conventional AD alone. Although this advanced technology requires additional capital investment, its long-term benefits outweigh the costs by ensuring greater methane yields, system stability, and improved sustainability.

4. Resources Needed

The successful implementation of the AD-BES system will require financial investment for infrastructure development, including the installation of digesters, BES components, and necessary energy inputs. Additionally, training programmes for school staff and local communities will be essential to ensure proper operation and maintenance of the biogas systems. Partnerships with technical experts and research institutions will also be crucial for optimizing system performance and ensuring long-term sustainability.

5. Stakeholders Involved

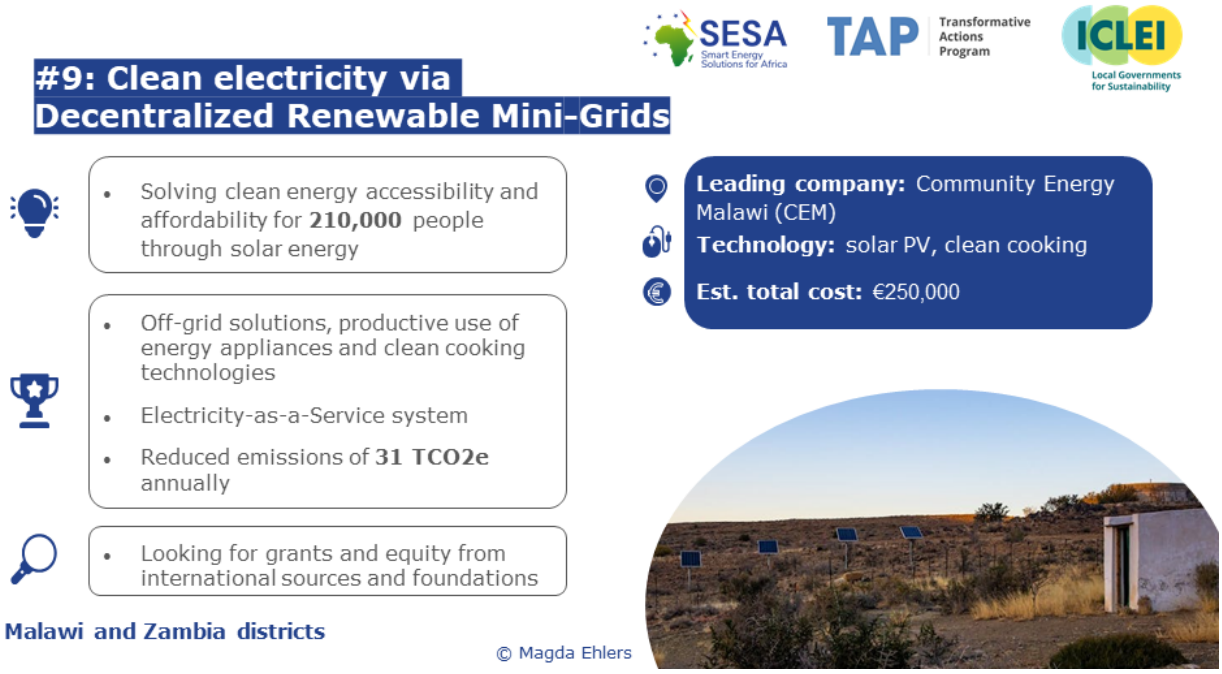
This project involves multiple stakeholders, including:

- Government agencies responsible for energy and environmental conservation
- Educational institutions (four public Second Cycle Schools)
- Local communities and market vendors supplying organic waste
- Research institutions and technical experts supporting AD-BES technology optimization
- NGOs and donors interested in clean energy and sustainability

6. Potential Impact

The implementation of Waste-to-Biogas plants in four public schools will significantly reduce energy costs, with an expected 64% decrease in cooking expenses. Additionally, the transition to biogas will lead to an 80% reduction in CO2 emissions while improving indoor air quality and mitigating deforestation. Beyond environmental benefits, the project will enhance economic independence by reducing reliance on external fuel suppliers. The digestate produced as a byproduct of the AD process serves as a nutrient-rich organic fertilizer, which can be used in school agricultural activities or sold to nearby farmers, providing an additional source of revenue. This initiative also promotes capacity building and gender empowerment. Training in biogas technology will equip school staff and community members with valuable skills, fostering local expertise in renewable energy management. Since cooking responsibilities traditionally fall on women, transitioning to a cleaner and more efficient cooking system will significantly improve their health and well-being. Additionally, the revenue generated from the sale of digestate could be reinvested in educational resources, enhancing student learning conditions.

9. Accelerating access to clean and affordable electricity in Malawi and Zambia



1. Problem Statement/Background

Malawi, with a population of 20 million, faces a severe energy access crisis. Only 12.5% of the population has grid access (46% in urban areas and just 4% in rural areas), while only 4.5% benefit from off-grid electricity solutions (Malawi Integrated Energy Plan, 2022). Malawi is one of the least electrified countries globally, with an average per capita electricity consumption of 85 kWh per year - far below the 560 kWh required for healthy living. Due to low electricity access, 89% of the population relies on biomass for cooking, leading to approximately 13,000 deaths annually, primarily among women and children, due to indoor air pollution.

Since 1980, the Malawi Rural Electrification Programme has been the government's primary strategy for grid expansion. However, progress in electricity generation remains insufficient. Recognizing these challenges, MRES (2017) emphasizes that universal access (United Nations Sustainable Development Goal 7) cannot be achieved by 2030 through grid expansion alone. Instead, 27% of Malawians are best served through mini-grids and other off-grid technologies. The Government of Malawi's National Energy Policy (2018) supports this approach, recommending off-grid solutions for areas located more than 5 km from the national grid.

2. Challenges Addressed

The project seeks to tackle several pressing challenges related to energy access and sustainable development in Malawi and Zambia. With grid expansion progressing at a slow pace, rural communities remain largely underserved, limiting their ability to improve livelihoods and economic prospects. The widespread dependence on firewood and charcoal for cooking contributes to deforestation and severe respiratory health risks, particularly among women and children. The high costs associated with extending the national grid to remote areas make off-grid solutions a more viable and scalable alternative. Additionally, without access to reliable electricity, communities face limited opportunities to establish businesses and improve agricultural productivity.

3. Proposed Solutions

In response to these challenges, CEM will deploy off-grid renewable energy solutions, including mini-grids, micro-grids, solar home systems, clean cooking technologies, and productive use of energy (PUE) appliances. The project aims to:

- Conduct feasibility studies in 42 sites across Malawi, exploring the potential for serving a mini-grid market of 259,000 households.
- Build on pre-feasibility studies conducted in 42 villages, covering 31,265 households - representing 12% of the potential market.
- Expand activities to Zambia, conducting feasibility studies in 10 additional villages.
- Deploy renewable mini-grids in 54 villages, ultimately providing clean electricity to an estimated 210,000 people across Malawi and Zambia.

4. Required Resources

The success of this initiative depends on securing key resources, including financial investment for feasibility studies and mini-grid construction, technical expertise in system installation and maintenance, and active community engagement. Establishing Village Energy Committees (VECs) will ensure local ownership and participation, while policy support from government stakeholders will help facilitate regulatory approvals and alignment with national energy strategies.

5. Stakeholder Involvement

The project will be implemented through a collaborative approach involving:

- CEM: Leading project design, implementation, and monitoring.
- Local communities and authorities: Ensuring local engagement and regulatory compliance.
- Private sector partners: Supplying mini-grid technology and PUE appliances.
- Financial institutions and investors: Providing capital for project deployment.
- Civil society organizations: Supporting awareness campaigns and advocacy for clean energy access.

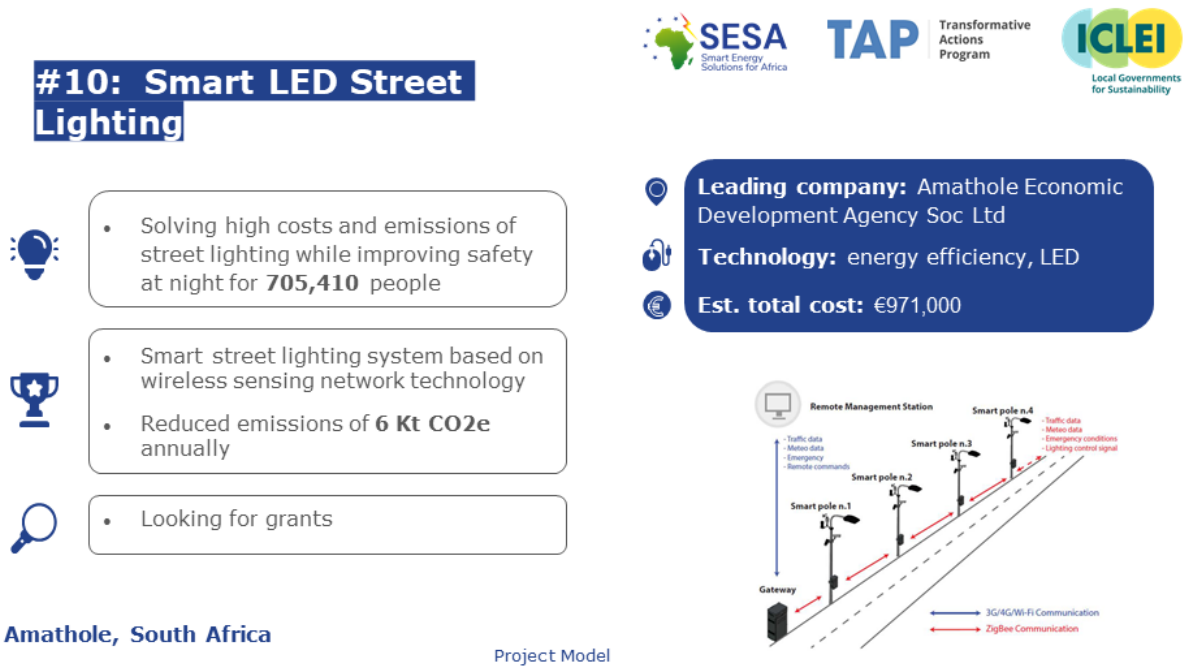
6. Anticipated Impact

The project will deliver significant benefits in multiple areas:

- Improved energy access: Providing renewable electricity to 210,000 people will transform their living conditions and economic opportunities.
- Economic empowerment: Mini-grids will enable small businesses to thrive, particularly in agriculture, retail, and service industries.
- Environmental sustainability: The shift from diesel-powered mills, kerosene lamps, and charcoal usage to renewable energy solutions will reduce GHG emissions and preserve forests.
- Gender equality: Increased access to electricity will support the expansion of women-owned businesses, reduce indoor air pollution, and decrease the time women and girls spend on household chores.

- Enhanced education and health services: Improved lighting in schools and health clinics will contribute to better educational outcomes and enhanced medical care.
- CEM's Electricity-as-a-Service model, which integrates productive use capacity-building and local participation, will ensure long-term sustainability. By scaling up renewable mini-grids, this initiative will drive economic development and promote energy resilience in Malawi and Zambia.

10. Smart LED Street Lighting in Amathole, South Africa



1. Problem Statement/Background

South Africa, like many nations, faces the dual challenge of energy inefficiency and climate change. The country's electricity grid, managed by Eskom, has struggled to meet demand, resulting in frequent load shedding since 2008. Local municipalities, particularly in the Amathole District Municipality (ADM), heavily depend on outdated street lighting technologies that consume excessive energy, incur high maintenance costs, and contribute significantly to carbon emissions. To address these challenges, South Africa's National Energy Efficiency Strategy mandates a 20% reduction in municipal energy consumption. In alignment with national policies, including the National Climate Change Response Policy, the Climate Change Bill, and South Africa's Low Emission Development Strategy, ASPIRE has proposed a Smart LED Street Lighting Project to enhance energy efficiency and sustainability across ADM municipalities.

2. Challenges Addressed

The project seeks to mitigate several critical challenges associated with conventional street lighting. High electricity consumption and wastage result from outdated high-intensity discharge lamps. Increased operational and maintenance costs are an issue due to manual lighting systems and frequent breakdowns. Inefficient street lighting contributes to inadequate public safety, particularly at night, leading to crime and road accidents. Additionally, significant GHG emissions from outdated systems exacerbate climate change, while the lack of automated monitoring systems makes municipal resource management inefficient.

3. Solutions Proposed

The project will replace outdated street lighting infrastructure with smart LED lighting systems featuring wireless sensing network technology. Automated, adaptive lighting controls will optimize energy use, with lights dimming to 20% intensity when no movement is detected and increasing to full intensity upon detection. Light-dependent resistor and photoelectric sensors will ensure

lighting is activated only when necessary. A centralized remote monitoring and management system will reduce operational costs and enhance maintenance efficiency. The deployment of LED lights will cut energy consumption by 65%, extend lamp lifespan, and lower carbon emissions by approximately 6,000 tons per year. Additionally, temperature and humidity sensors will be used for environmental monitoring, improving overall system efficiency.

4. Resources Needed

Successful implementation will require financial investment for LED retrofitting and smart monitoring infrastructure. Technical expertise will be necessary for system installation, integration, and ongoing maintenance. Policy and regulatory support from local and national authorities will ensure seamless implementation. Capacity-building initiatives will be required to equip municipal staff with the skills needed to manage and sustain the smart lighting system.

5. Stakeholders Involved

ASPIRE will lead project implementation and coordination, working closely with the Amathole District Municipality and local municipal authorities to provide regulatory and operational support. The National Department of Energy will ensure alignment with energy efficiency policies. Private sector partners and technology providers will supply LED and smart lighting technology, while local businesses and contractors, including women-owned enterprises, will be engaged in installation and maintenance. Community members and civil society organizations will benefit from improved safety and environmental sustainability.

6. Potential Impact

The project will lead to a significant reduction in municipal energy consumption, lowering costs and alleviating pressure on the national grid. Enhanced public safety and reduced crime rates will result from improved night time visibility. Road accidents will be reduced, creating safer pedestrian and vehicle movement. Job creation during implementation and maintenance will prioritize local and women-owned businesses. Municipal service delivery and urban planning capabilities will be enhanced through data-driven lighting management. Furthermore, the project will contribute to South Africa's climate change commitments by significantly cutting municipal carbon emissions. Through this project, ADM and ASPIRE aim to pioneer a scalable, replicable model for smart municipal energy efficiency, reinforcing South Africa's commitment to sustainable urban development.

6.2. Annex 2. PFS Template

How to use this document?

This Pre-feasibility Study Template was developed by ICLEI – Local Governments for Sustainability e.V., together with a consortium of partners including the Technical University of Berlin, Wuppertal Institute, Smart Innovation Norway, and the Siemens Foundation as a guiding document for the provision of pre-feasibility studies through the Smart Energy Solutions for Africa Project in 2024.

This Template was designed to flexibly accommodate project concepts within the energy sector, and for the context of Africa; therefore, the project owner or project developer should ensure that the items measured, and indicators used, are suitable and appropriate to the project receiving the pre-feasibility study.

Please note that the Template follows the following format:

From the above, only the instructions should be removed once the text of the subsection is completed.

Authors

ICLEI, Technical University of Berlin, Wuppertal Institute, Smart Innovation Norway, and the Siemens Foundation
Bonn, 2024

PRE-FEASIBILITY STUDY

Project Title

Developed by

Project Submitter/Proponent

SESA
Smart Energy Solutions for Africa

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Acronyms

Acronym	Description
CAPEX	Capital Expenditure
CFo	Cash Flow from Operating Expenses
CO_2	Carbon Dioxide
DCF	Discounted Cash Flow
DEVEX	Development Expenditure
EUR	Euro
FID	Final Investment Decision
IRR	Internal Rate of Return
LCOE	Levelized Cost of Energy
MW	Megawatt
MWh	Megawatt Hour
NPV	Net Present Value
OPEX	Operational Expenditure
PBT	Payback Time
PPA	Purchase Price Allocation
WACC	Weighted Average Cost of Capital

1.Background and scope

1.1 Description

This section presents a full overview of the project scope, beneficiaries, and stakeholders.
[Text]

1.2 Location

This section includes geography, weather, demographics.
[Text]

1.3 Fulfilled necessity

Mention the causes or drivers that make this project imperative and important for implementors & stakeholders.
[Text]

1.4 Power system context

This section entails a technical description about the intended system to be installed, annual demand, access to infrastructure, and logistics.
[Text]

1.4.1 System description

[Text]

1.4.2 Annual demand and generation

[Text]

1.5 Infrastructure and logistic

1.5.2 Infrastructure access

Illustrate the access to infrastructure, e.g., ports, roads.

[Text]

1.5.2 Grid infrastructure

Illustrate the strength and connection points of the grid infrastructure.

[Text]

1.6 Scalability

How far can the project be scaled or the possibility for an extension and outreach to other contexts/ cities.

[Text]

1.7 Political context

This section reveals how the project would support and reinforce existing policies, planning agendas, and governmental endeavours towards renewable energy solutions. In addition to exploring the current investment situation to see if there is a welcoming market for it or not. The political stability in the targeted region of the project and existing regulations.

1.7.1 Renewable energy and other policy targets

[Text]

1.7.2 Investment landscape

[Text]

1.7.3 Political stability

[Text]

1.8 Regulation

Key regulations in place and how they affect the project.

[Text]

1.9 Stakeholders

All the parties involved in the project, in addition to system operators, off-takers, governmental bodies, local population, environmental groups.

1.9.1 Owners

[Text]

1.9.2 Contractors

[Text]

1.9.3 Facilitators

[Text]

1.9.4 Consultants

[Text]

1.9.5 Regulators and standards reviewers

[Text]

1.9.6 Operators

[Text]

1.9.7 Financers

[Text]

1.9.8 Beneficiaries

The main targeted users to directly benefit from the project.

[Text]

1.10 Time and phases

[Text]

1.11 Projected time

[Text]

1.12 Evaluation of project boundaries and energy system considerations

The project boundaries need to be defined at the project's outset. This approach clearly states to which extent technical, economic and environmental aspects are considered. Project boundaries can differ across themes: For example, cost figures might concern only the facility under study (up to the grid connection point), but environmental studies can extend to larger areas impacted by the project.

[Text]

2. Revenue streams

2.1 Market

Need to collect information on historical power prices/product demand and project future prices.

[Text]

For power generation projects: Considerations to negotiate a power purchase agreement (PPA) with off-takers.

[Text]

2.2 Vertically integrated system

Need to collect information on average generation/product cost in the system and current procurement regulation for the product.

[Text]

For power generation projects: Assess potential off taker of PPA.

[Text]

2.3 Existing subsidy schemes / financial support

Analyse subsidy schemes and/or national/local financial support (including duration, remuneration, contractual conditions, taxation and risks).

[Text]

2.4 Presumed revenues streams

Add as many as necessary: revenues can be stacked and sourced from different support schemes, agreements, and/or markets.

[Text]

2.5 Other factors to consider

Listing all the other factors that may affect the implementation of the project, either economic factors, local content requirements, or stream revenues.

2.5.1 Currency denomination (local vs international)

[Text]

2.5.2 Taxation level

[Text]

2.5.3 Inflation index

[Text]

2.5.4 Possible local content requirements

[Text]

2.5.5 Other potential revenue stream (i.e., sale of by-products)

[Text]

2.6 Evaluation of future power/product demand and/or prices

It is important to assess whether the revenue stream is stable over the years. This involves an estimation of, for instance, the development in future power/product prices; the risk of a stagnation of demand; or related risk of overcapacity/ low demand in the market.

Both yearly demand projections of supply and demand are key aspects to be considered. The average price, as well as its usage / power distribution, should be considered. Official projections can be used, and uncertainties assessed in relation to the project size.

[Text]

3. Resource evaluation

It is about listing all the used data collection methods and resource mapping.

3.1. Data collection

A detailed and suitable data collection methodology should be utilized.

[Text]

3.2 Mapping

A detailed mapping of wind/solar resources, as well as forestry/biomass resources, that will power this solution. If the project is not a renewable energy-generating project, indicate/map which sustainable energy sources will be used to power your solution.

[Text]

3.3 Solar energy generation projects

3.3.1 Distribution of energy at location (i.e., solar irradiance).

[Text]

3.3.2 Energy resource to electricity generation in megawatts (MW) or megawatts hour (MWh)

[Text]

3.3.3 Annual power generation

[Text]

3.4 Bioenergy generation projects

3.4.1 Feedstock availability

Determine the type of biomass; Determine potential of the available feedstock; Mapping of the available feedstock: Determine the optimal location and size (capital cost vs transport): Determine a reasonable price for biomass.

[Text]

3.4.2 Total Potential capacity

[Text]

4. Financial assessment & technical key figures

4.1 Projected capital expenditures including:

- DEVEX: development and planning, land acquisition, permitting and logistics - before Final Investment Decision (FID).
- Deployment/Construction: equipment, grid connection costs, civil works - after FID.
- Soft costs: financing, overhead costs and eventual decommissioning costs, etc.
- Additionally: consider cost changes over time (i.e., technology), cost of connection to grid (i.e., regulation, status), and estimate uncertainty (robustness).

Element	Cost per annum in euros (EUR)
Total	

4.2 Presumed operational expenditures

Includes all the administrative, legal and utilities costs that are needed to run the project.

Element	Cost per annum (EUR)
Total	

4.3 Presumed revenues streams

Includes basically the company's source of income.

Source	Annual Revenue (EUR)
Total	

4.4 Financing scheme

Includes any public and/or private financial investments required by the infrastructure over the project's life cycle.

Expected Share in Project Budget	Financing Option/Instrument

4.5 Financial figures

General definitions:

- Capital Expenditure (CAPEX): are expenses and funds used by the company to acquire, upgrade, and maintain physical assets such as property, plants, buildings, technology, or equipment.
- Development Expenditure (DEVEX): defined as all costs spent in the period from idea and development to design & planning.
- Operational Expenditure (OPEX): are costs incurred via the production of goods and services.

4.5.1 Capital cost: CAPEX and DEVEX (If applicable EUR/MW)

[Text]

4.5.2 Operation and maintenance cost (If applicable EUR/MW, EUR/MWh)

[Text]

4.5.3 Weighted Average Cost of Capital (WACC)

WACC: represents a company's average after-tax cost of capital from all sources, including common stock, preferred stock, bonds, and other forms of debt. Its calculation can be found in subsection 6.3.

[Text]

4.5.4 Corporate tax rate

[Text]

4.5.5 Depreciation rate and amortization approach if relevant

- Depreciation and amortization are ways to calculate asset value over time; Depreciation is the amount of asset value lost over time.
- Amortization is a method for decreasing an asset cost over time.

[Text]

4.5.6 Inflation rate

[Text]

4.5.7 Economic lifetime of project

[Text]

4.5.8 Financing sources identified (i.e., soft loan, commercial loan, equity, etc.)

[Text]

4.6 Financial risk

4.6.1 Credit worthiness

(If relevant: assessment of debtor credit and financial wealth)

This is the lender's appraisal of how likely the project owner will be able to repay their debts. Lenders assess your creditworthiness by considering your income and looking at your history of borrowing and repaying debt.

[Text]

4.6.2 Collaterals and coverage

Refers to the percentage of the loan that's backed by a discounted asset.

[Text]

4.6.3 Probability of insolvency

If relevant: any factors decreasing the capability of the project submitter /debtor payback ability.

[Text]

4.6.4 Transparency measures applied

If applicable: are there control and reporting to prevent corruption or misuse of funds.

[Text]

5. Operational assessment

Focuses on the degree to which the proposed development project fits in with the existing business environment and objectives about the development schedule, delivery date, corporate culture, and existing business processes.

5.1 Development requirements (High-level)

Equipment, technology, permits, processes & capabilities, infrastructure, competencies, technical design, or raw materials.

Element	Attainability/Capacity

5.2 Running requirements (High-level)

Consumables, know-how, workforce, tools, or maintenance.

Element	Attainability/Capacity

5.3 Relevant expertise capacity

5.3.1 Review of similar project

- Which, where and when these projects were developed?
- Does the project management team have access to professionals who run any of these projects?
- What were the results, challenges, and overall success rate?

[Text]

5.3.2 Project management expertise relevancy

Did the project management team develop any identical/ similar projects? If so, kindly mention the similarities.
[Text]

5.4 Technology figures

Sources for technological and financial figures: literature, manufacturers catalogues, technology catalogues, interviews with manufacturers/industry experts and relevant stakeholders.
[Text]

5.4.1 Power capacity

If applicable, in MW.
[Text]

5.4.2 Technical lifetime

In years.
[Text]

5.4.3 Availability

In terms of access to energy, outages in %, days.
[Text]

5.4.4 Efficiency

Compared to current/traditional solutions if applicable.
[Text]

5.4.5 Space equipment

If applicable in m2/MW
[Text]

5.4.6 Capacity factor ranges

If applicable.
[Text]

5.4.7 Electricity usage

Total energy usage; feeding into the grid; grid capacity; and tariffs.
[Text]

5.4.8 Other technical information

(i.e., performance ratio for photovoltaic) relevant to the project purpose and expected operations.
[Text]

5.5 Technical risks and constraints

(Most critical)
The factors that could jeopardize project success of completion such as natural disasters, technical limitations, legal problems, sudden shortages in workforce or raw materials. Political instabilities (project halt if decision makers change), lacking certain technology, or infrastructure limitations.

Aspect	Chance of occurrence

6. Business Case

6.1 Inputs from background and scope

6.1.1 Background and scope

Parameters affecting business robustness (system development, regulation, investment landscape etc.).
Input: Cost of capital and financial environment.
[Text]

6.1.2 Revenues stream

Quantified revenue sources for the entire project lifetime. Stability of revenue sources over time to assess robustness of the business case (including outages, maintenance needs, demand projections, etc.)
Input: Revenue, demand, outage (if relevant)
[Text]

6.1.3 Resource evaluation

- If energy generating: Potential annual power generation, in full load hours or capacity factor (including uncertainty).
- If bioenergy generating project: total availability and price of feedstock for biomass and biogas.
- If not, energy generating electricity costs as per energy-source selected.

[Text]

6.1.4 Financial assessment

- Technology estimates and financial figures for the project lifetime.
- Uncertainty ranges for as many figures as possible.

Input: CAPEX, OPEX, WACC, Financial figures & Risks.
[Text]

6.1.5 Operational assessment

- Expected central estimate for project size, technical and operational capacity.
- Technological estimates for the lifetime of the project.

Input: operational feasibility requirements.
[Text]

6.2 Discounted cash flow (DCF)

Cash flows in the earlier periods are weighted higher than cash flows in the later periods.

$$DCF = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \frac{CF_n}{(1+r)^n}$$

CF_1 = The cash flow for year one
CF_2 = The cash flow for year two
CF_n = The cash flow for additional years
r = The discount rate

[Text]

6.3 Weighted Average Cost of Capital (WACC)

Equals cost of equity plus cost of debt (after tax):
WACC = [E/V x Re] + [(D/V x Rd) x (1 – Tc)]
[Text]

6.4 Net Present Value (NPV)

- NPV: represents the difference between the present value of cash inflows and the present value of cash outflows over a period of time).
- CFo: Cash Flow from Operating Activities = Funds from Operations + Changes in Working Capital.

$$NPV = -CF_0 + \sum_{t=1}^{T} \frac{CF_t}{(1+r)^t}$$

[Text]

6.5 Internal Rate of Return (IRR)

IRR: is a metric used in financial analysis to estimate the profitability of potential investments. Shows the annual effective compounded return rate of a project i.e. the annual return a project is expected to yield. The discount rate yielding an NPV of 0.

$$0 = -CF_0 + \sum_{t-1}^{T} \frac{CF_t}{(1 + IRR)^t}$$

[Text]

6.6 Payback Time (PBT)

PBT: the length of time it takes to recover the cost of an investment or the length of time an investor needs to reach a breakeven point.

[Text]

6.7 Levelised Cost of Energy (LCOE)

Shows the average cost of a project over its lifetime, considering the cost of capital. Often used for comparing technologies and for tracking economic developments of technologies over time.

[Text]

6.8 Sensitivity analyses – if applicable

Consider technical assumptions (i.e., solar irradiance estimates).

[Text]

6.9 Different approaches in business case evaluation to be considered

6.9.1 Comparison of LCOE with potential tariff or PPA

[Text]

6.9.2 Comparison of IRR with expected WACC or investor benchmark

[Text]

6.9.3 Evaluation of absolute value of NPV

[Text]

6.9.4 Comparison of payback time to economic lifetime and investor preference or duration of PPA

[Text]

7. Environmental and social aspects

Mention all the environmental and social risks that the project may produce during the construction, implementation, or running operations of the project.

7.1 Key aspects

7.1.1 Pollution of air, water and soil

[Text]

7.1.2 Land use

[Text]

7.1.3 Visual impact, noise, odor

[Text]

7.1.4 Wildlife endangerment

[Text]

7.1.5 Emissions of pollutants (Particulate Matter, Nitrogen Oxides, Sulphur Oxides) and carbon dioxide (CO2)

[Text]

7.1.6 Conflict with other local activities (e.g., agriculture/fishing)

[Text]

7.1.7 Project acceptance from local stakeholders

[Text]

7.1.8 Socio-economic Impacts by sector

In terms of jobs and gross domestic product. Consider separating construction and operation & maintenance phases.

[Text]

7.1.9 Utilities

Services that the project will provide on a local level.

[Text]

7.1.10 Construction

Methods of construction, if applicable.

[Text]

7.1.11 Manufacturing

The production mechanism of the provided technologies.

[Text]

7.1.12 Sales

All activities involved selling the products or services to the consumers.

[Text]

7.1.13 Transportation & Warehousing

All the means of transport used business-to-business or business-to-customers or to any part of the supply chain.

[Text]

7.1.14 Finance, professional and business services

The financial, business, and professional impacts that the project will create.

[Text]

7.1.15 Education and Healthcare

[Text]

7.1.16 Other

[Text]

7.2 For Renewable energy projects

If applicable

7.2.1 Avoided Particulate Matter, Nitrogen Oxides, Sulphur Oxides and CO2 emissions

- Average approach: Calculated based on annual production and it is assumed that the project replaces the average annual generation.
- Marginal approach: Entails the identification of the marginal production technology that is replaced by the project, hour-by-hour and over time.
- Energy Generated (MWh): Over 20-year lifetime of carbon & water savings.

[Text]

8. Risk assessment

It is about identifying, evaluating, and preventing or mitigating risks to a project that could impact the desired outcomes.

8.1 Risk categories

- These potential risks should be screened, and main project risks identified – Useful tool is a basic risk matrix on likelihood (probability) vs impact (potential capital loss).
- For each risk identified, a dedicated risk mitigation measure (or strategy) should be identified – Useful tool is a Risk Register including risk name/type, description, impact, and action.

8.1.1 Political risks

Changes in support schemes, taxation rates, international sanctions, etc.

[Text]

8.1.2 Economic risks

I.e., interest rates, credit risks, option price, etc.

[Text]

8.1.3 Technical risks

They illustrate efficiency, maintainability, new technologies, etc.

[Text]

8.1.4 Social risks

I.e., safety, labours, environmental, etc.

[Text]

8.1.5 Legal risks

I.e., related to public authorities & commercialization, energy-related policies, permits for project development and operation, provisions associated with property and land, etc.

[Text]

8.2 Specific risks must be evaluated in a case-by-case scenario

8.2.1 Pre-construction

- Change in PPA/tariff structure

[Text]

- Local opposition stop/delay construction

[Text]

- Land acquisition issues

[Text]

- Limits in the infrastructure to deliver materials or construct

[Text]

- Shortage skilled personnel

[Text]

8.2.2 Post construction

- Higher degradation of panels

[Text]

- Curtailment

[Text]

- Damage from extreme events

[Text]

- Increased requirements for forecasting or regulation

[Text]

- Technology risk (breakdown, lower performance)

[Text]

- Operation and maintenance risks

  Provisions associated with policy obligations, state of surrounding energy network, installation & operational performance standards of plant and equipment.

  [Text]

8.3 Financial risks

8.3.1 Credit worthiness

If relevant: assessment of debtor credit and financial wealth.

[Text]

8.3.2 Collaterals and coverage

They are legally watertight, valuable liquid property pledged by the recipient as security on the loan's value.
[Text]

8.3.3 Probability of insolvency

If relevant: any factors decreasing the capability of the project submitter/debtor payback ability.
[Text]

8.3.4 Transparency measures applied

If applicable: are there control and reporting to prevent corruption or misuse of funds?
[Text]

8.3.5 Currency

Unfavorable moves in exchange rates.
[Text]

8.3.6 Inflation

The inflation rate is higher than what is expected.
[Text]

8.3.7 Interest rate

Interest rate higher than expected.
[Text]

8.3.8 Off-taker default

Sudden and persistent loss of demand.
[Text]

8.4 Regulatory risks

8.4.1 Change in Law

Unfavourable law changes.
[Text]

8.4.2 Amendment of terms

Unfavourable changes in terms.
[Text]

8.4.3 Revision of support

Unfavourable changes in subsidies and support.
[Text]

8.5 General risks

8.5.1 Cybersecurity

Risk of hacking and lock-down from cyber-attack.
[Text]

8.5.2 Violence/Terrorism

Risk of violent/terror attack and damage to the project.
[Text]

8.5.3 Natural catastrophe

Risk of sudden onset (natural) event that will damage the project. Here is a good source to map this risk.
[Text]

9. Conclusion

9.1 Concluding remarks

Challenges, learnings, and recommendations.
[Text]

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